Not on My Watch: Understanding the Affordances of Self-Tracking for Adolescents' Social and Psychological Wellbeing

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Thesis Abstract

We can see aspects of our everyday lives through data – how many steps we took to the supermarket, how many kilometres we covered walking the dog, or how many calories we burned cycling to work. Whilst self-tracking is not new, and indeed not always digital, we have seen the continuing development of digital tools that enable us to monitor, control, and analyse vast quantities of personal health data. Self-tracking tools have become increasingly relevant in the wake of the COVID-19 pandemic. COVID-19 has raised important questions about what it means to track data, what it means to be tracked, and how we understand the consequences of tracked data. Never has it been more apparent that our self-tracked data have social consequences.

We know that many adolescents engage in self-tracking practices. Nevertheless, existing research on adolescents' self-tracking is limited outside of intervention-based studies. Most work has focused on adult users; however, adolescents' self-tracking practices do not always map neatly onto those of adults. In this thesis, I describe insights from my mixed methods study involving over 600 adolescents in the United Kingdom across an online survey, online interviews, and online co-design workshops. Drawing data from these methods together, I explore the affordances of self-tracking for adolescents' social and psychological wellbeing to better understand how we can take positive steps forward to empower adolescents' autonomous choices around their self-tracking practices.

My empirical findings emphasise the complexity and variation in adolescents' self-tracking practices, illuminated by the context of the COVID-19 pandemic. Adolescents negotiate complex sociomaterial relations with self-tracking tools, with key tensions around practices of creativity and control. I argue that the limited attention paid to adolescent voices in self-tracking research and design is problematic and that urgent work is needed to ensure that these valuable perspectives are heard and heeded.

To my family. For everything.

"You can kiss your family and friends good-bye and put miles between you, but at the same time you carry them with you in your heart, your mind, your stomach, because you do not just live in a world but a world lives in you."

– Frederick Buechner

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The story of this DPhil begins on 5 March 2019, when two exceptional people sat across from me in an upstairs office on St. Giles. Their warmth, genuine interest in my work, and encouragement of an early career researcher are gifts I treasure. So here I express my boundless gratitude to Gina Neff and Kathryn Eccles. You changed my life that day in ways that I cannot explain, and I will never be able to thank you enough for what you have both done for me.

So, in 2019, the Oxford Internet Institute (OII) became my new academic home. It is here that I have met some of the kindest and most inspirational individuals I could ever imagine. Firstly, to my amazing supervision team: Gina Neff, Sara Shaw, and Chrysanthi Papoutsi. Thank you for making the transition to online supervisions a little easier and a little less lonely. Sara and Chrysanthi, thank you for welcoming me so warmly into the Interdisciplinary Research in Health Sciences (IRIHS) community, for your encouragement of my work, and your generosity in sharing your extensive knowledge. I cannot begin to quantify what you have both taught me. Gina, your mentorship, wisdom, and kindness (in equal measure) have been such a source of inspiration and comfort to me over the past four years. It has been an absolute honour to think with you, to write with you, and to learn from you. I know this is only the beginning…

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Alex, throughout the course of this thesis you have been so many things to me – my best friend, my partner, my fiancé, and now my husband. This work would not have been possible without your endless support, love, and encouragement. Thank you for holding my hand.

To all of the incredible teenagers across the UK who gave their time to participate in this work. This thesis could not exist without you. Working alongside you all has been the greatest joy of my academic career and I can only hope I have done you justice.

COVID-19 Impact Statement

Before journeying into the thesis, I wanted to take a moment to acknowledge the impact of COVID-19 on this project and on my experience as an early-career researcher. Less than six months into my DPhil studies, the world around me changed. Seemingly overnight, I learned a new vocabulary that included social distancing, PCR tests, and the names of virus variants. I had moved to a new city and carefully planned the next few years of my life on the DPhil programme. Having just settled into a new rhythm, I found myself dramatically revising plans – both in my research and in my personal life.

My work environment shifted from the libraries and cafés of Oxford to a desk in my bedroom. Coffees and meetings with colleagues and friends migrated to Zoom rooms and supervisions found their new home on Microsoft Teams. Conferences I had hoped to attend were cancelled and others were later moved online. The DPhil experience I had imagined was gone.

Going into the 'digital field' was an unexpected challenge filled with questions and unknowns. Recruiting was very difficult and translating the planned project into something that made sense online took time. In moving online, my window into adolescents' worlds became simultaneously more geographically distant and yet somehow more personal as I found myself 'sitting' with adolescents in their family homes or bedrooms. As I was navigating the seeming constant changes of uncharted COVID-19 territory, my participants were also contending with their own profound challenges. My interviews and workshops were filled with heart-wrenching stories of young people whose lives had changed in unimaginable ways. These stories will stay with me forever; they permeate this thesis, and I am humbled to be able to share them.

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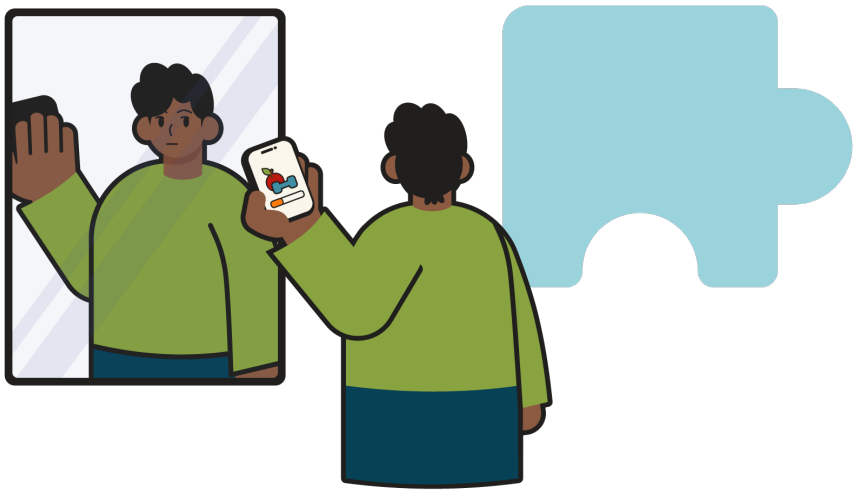
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List of Abbreviations

CUREC	Central University Research Ethics Committee
FAS	Family Affluence Scale
HBSC	Health Behaviour in School-aged Children
HCI	Human-Computer Interaction
INCOM	Iowa-Netherlands Comparison Orientation Measure
PCOS	Polycystic ovary syndrome
SES	Socioeconomic status
TA	Thematic Analysis
UK	United Kingdom
US	United States
VPA	Vigorous Physical Activity
WEMWBS	Warwick-Edinburgh Mental Wellbeing Scale
WHO	World Health Organization

1 Step Into Tracking: An Introduction



"The Covid has made me worry more about my physical health so I used the self tracking app more and got used to it. I even started to enjoy it a little." (Female, 16)[1]

1.1 Thesis Background and Overview

1.1.1 Setting the Scene

Over the course of writing this thesis, I have accumulated over 21,780,000 steps, I have drunk approximately 1,250 cups of coffee, and—depending on how smoothly the writing was flowing—my resting heart rate has fluctuated between 47 and 83 BPM. But who's counting?

[1] Throughout this thesis, quotations from participants in my research or adolescents' contributions in other studies will be italicised to emphasise adolescent voices and to distinguish them from quotations from scholars and other texts which will not be italicised. For quotations taken from the online survey, details in parentheses indicate the gender and age of the participant (e.g., Female, 18). For quotations drawn from interviews, details in parentheses indicate the pseudonym and age of the participant (e.g., Damian, 13). Quotations from workshops are identified by workshop number (e.g., W2).

We can see aspects of our everyday lives through data – how many steps we took to the supermarket, how many kilometres we covered walking the dog, how many calories we burned cycling to work. Whilst self-tracking is not new, and indeed not always digital, over recent years we have seen the continuing development of digital technologies that enable individuals to monitor, control, and analyse vast quantities of personal health data (Ridgers et al., 2018). There are over 500 such digital technologies available to consumers and this market is expanding (Mau, 2019). These digital technologies are marketed as instruments that can provide us with data, which can tell us something about ourselves and help us make 'healthy' lifestyle choices. In view of the increasing prevalence and affordability of these technologies (Toner, 2018), critical analyses of the social implications of their use are imperative (Gilmore, 2016).

We know that adolescents are engaging in self-tracking practices (Depper & Howe, 2016; Freeman & Neff, 2021; Wartella et al., 2015); however, there remain open questions around what these practices afford users at this stage of life. Through this thesis, I make an original contribution to the literature by offering new insights into the adolescent practices of self-tracking and mapping how these practices have been shaped by the changing sociomaterial arrangements that have emerged from the COVID-19 pandemic. Paying particular attention to the affordances of self-tracking health and fitness data for social and psychological wellbeing, I demonstrate what scholars can learn from adolescent voices about young people's self-tracking, and how this might inform the design of self-tracking technologies that more effectively support positive experiences for young people.

The stakes for this work are high. I argue that the entanglements of sociality and psychological wellbeing with adolescents' self-tracking practices present opportunities for

both benefit and harm for adolescents. Tracking intimate personal data within tightly-controlled social structures reveals a stark tension between creativity and control. This has important theoretical implications for how we think about self-tracking practices, for adolescents specifically, and other user groups more generally. The methodological significance of this work is also high, particularly owing to the online nature of this research and the fact that this research was carried out in a crisis context. Adopting methods that amplify adolescent voices is vital for future work in this area. Recognising adolescents' autonomy and supporting them to find their own paths, such as through co-design work, is urgent to empower them in their self-tracking practices.

1.1.2 Self-Tracking

The term 'self-tracking' itself can be misleading as it is simultaneously descriptive and opaque. Who, or what, is the self? What does it mean to be tracking? And is it really only the self that is tracked through these self-tracking practices? Whilst it would be interesting to consider an alternative term that captures some of these complexities, I have chosen not to reinvent the wheel in this thesis and continue to use 'self-tracking' for consistency and because this term was familiar to, and used by, the adolescents involved in this project. Instead, throughout this work, I will attempt to map out why the current term should be read carefully and what sets of assumptions researchers might need to be aware of when engaging with work concerning 'self-tracking'.

It is difficult to clearly define the scope of what constitutes digital self-tracking technology as all technologies are intimately interconnected (Frith, 2017) and many digital technologies can be used for a variety of purposes. In alignment with previous work in this area (e.g., Goodyear et al., 2019), I recognise that a range of devices exist for tracking various aspects

of life (e.g., work output, finances, media consumption, mental health). In particular, the tracking of physical health and fitness data (e.g., steps taken, heart rate, distance travelled) is an important case as it is an increasingly popular pursuit (Clark & Lupton, 2021), and provides an opportunity to explore practices around what is simultaneously *intimate* and *social* personal data. Thus, in this project I focus on the self-tracking of physical health and fitness data, as the uses for and implications of these practices are widespread (Cock et al., 2017).

Technologies currently available for the purpose of tracking health and fitness data range from smartphone apps to wearables, and also include larger apparatuses such as connected exercise equipment (see Figure 1.1). Examples of popular technologies on the market today include Fitbit, Apple Watch, Peloton, MyFitnessPal, and Strava (Garbett et al., 2021; Statista, 2022c, 2022b, 2022a). Each of these technologies differ in terms of their sociomaterial affordances[2] and the data they can track.

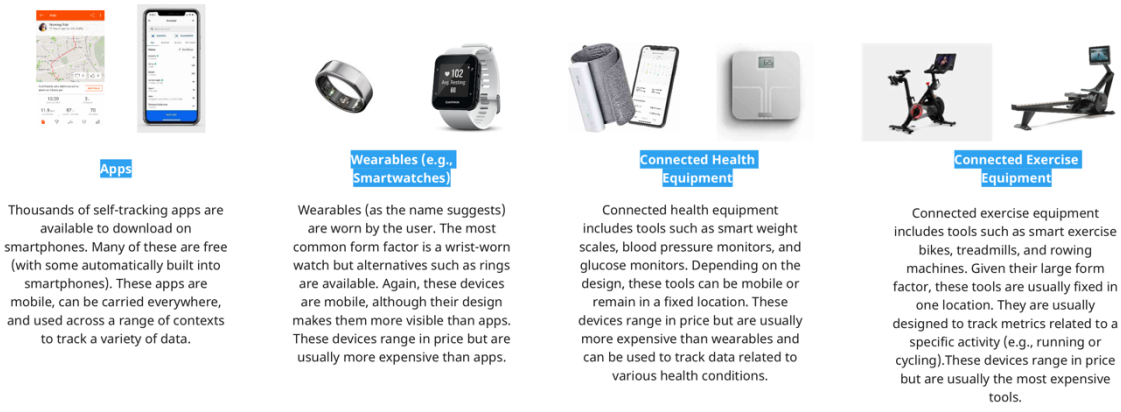


Figure 1.1. Examples of common self-tracking technologies for monitoring health and fitness data.

[2] Sociomateriality and affordance theory are discussed in further depth as key theoretical frameworks in Section 2.2 in Chapter 2.

The self-tracking tools on the market today broadly sit within two categories: tools designed for 'children' and tools designed for 'adults'. On the one hand, we have tools for younger children such as the Garmin vívofit® jr. 2 (pictured in Figure 1.2 is the Disney Princess Character Icons design). Such technologies are marketed as appropriate for children of various ages between 4 and 12 years old. These tools often feature parent-controlled apps, include basic tracking functionalities such as for taking steps and sleeping, and offer additional features such as chore tracking and rewards and gamified challenges. As many as 20% of children's tracking devices also allow on-demand remote audio and video capabilities for parents to monitor their children (Zehrung et al., 2021). Whilst these technologies offer parents a sense of security regarding their children's wellbeing (Zehrung et al., 2021), some scholars have raised concerns about the potential for surveillance and possible compromises to children's privacy and development (Holloway, 2019; Marx & Steeves, 2010; Nash et al., 2019).



Figure 1.2. An example of a self-tracking wearable designed for monitoring children's health and fitness data. Source: https://www.garmin.com/en-GB/p/637005/pn/010-01909-15.

Conversely, self-tracking technologies designed for adults can offer sophisticated tracking metrics, including data such as respiration tracking, pulse oximetry, heart rate variability, and split pace (see Figure 1.3 for an example). The minimum age requirement for these technologies is usually 13 years old (Fitbit, 2022; Strava, 2020a). Garmin's minimum age requirements for their self-tracking products are 13 years old in the United States (US) and 16 years old outside of the US (Garmin, 2022).



Figure 1.3. An example of a self-tracking wearable designed for monitoring adults' health and fitness data. Source: https://www.garmin.com/en-GB/p/760778.

The dichotomy between these two categories of self-tracking technologies places adolescents in a challenging position. They are yet to meet the minimum age threshold for some 'adult' devices; however, devices designed for children are often inappropriate and parental surveillance can pose significant challenges as this group straddles a precarious threshold between dependence and independence (boyd, 2014). Despite this liminality, we know that many adolescents engage in self-tracking practices (Depper & Howe, 2016; Freeman & Neff, 2021; Wartella et al., 2015). In a recent study in the United Kingdom (UK) conducted prior to the COVID-19 pandemic, Rich et al. (2020) found that almost

half of adolescents surveyed used digital health technologies to track aspects of their everyday lives such as calorie intake, sleep, physical activity, and menstruation.

It is important to understand adolescents' self-tracking practices as they are entwined in young people's social and psychological development. For example, previous work has demonstrated that such practices can create social opportunities for motivational or competitive interactions (Depper & Howe, 2016; Fotopoulou & O'Riordan, 2016); however, they can also present challenges for psychological wellbeing such as maladaptive eating and exercise behaviours and body dissatisfaction (Honary et al., 2019; Lupton, 2016a).

Nevertheless, existing research on adolescents' self-tracking is limited outside of intervention-based studies or studies in which researchers prescribe the uses and intended outcomes of such technologies (Lupton, 2020; Potapov et al., 2019). These interventions often deny individuals autonomy in deciding their own self-tracking practices (Rooksby et al., 2014), and many adolescents express uncertainty about how to best harness the affordances of digital health technologies for their individual circumstances (Rich et al., 2020). Indeed, most studies have focused on adult users (Potapov et al., 2021) yet we know that adolescents' self-tracking practices do not always map neatly onto those of adults (Freeman & Neff, 2021). Adolescents' experiences of self-tracking often exist in highly controlled institutions such as families (Pina et al., 2017) and schools (Freeman & Neff, 2021), where devices are increasingly used as technologies in Physical Education to promote physical activity (Casey et al., 2017; Gard, 2014; Lupton, 2016b; Williamson, 2015). Notably, the COVID-19 pandemic disrupted these institutional routines dramatically, which has presented a unique opportunity to explore what self-tracking

practices looked like in this new adolescent context of physical distancing and online schooling. The complete data collection for this research took place between June 2021 and March 2022. In particular, the online survey and interviews provided deep insights into adolescents' experiences of the COVID-19 pandemic, with these research activities taking place between June 2021 and December 2021. Throughout this thesis, I refer to this time (June 2021–December 2021) as being encompassed in the 'early stages' of the ongoing COVID-19 pandemic period. This was a time period that included a phase of lockdown (a legally enforced Stay at Home order in the UK) as well as times when restrictions were lifted. Therefore, this allowed adolescents to reflect on their relationships with online spaces during and after lockdowns. This thesis aims to illuminate how the sociomaterial affordances of self-tracking are entangled with these changing norms of our increasingly digital lives.

In particular, the COVID-19 pandemic made clear technology's increased relationship with adolescents' notions of *control*. The concepts of *control* and *choice* are cited frequently in healthcare literature (e.g., Mol, 2009; Murray et al., 2019; Pallisera et al., 2021) and these concepts are especially relevant to our understanding of self-tracking where control is diffuse (Calvard, 2019). Self-tracking advertising promises a deeper sense of self-knowledge and bodily control through measurement (K. Crawford et al., 2015; Fors et al., 2020); however, there are intricacies of control that are unaccounted for in this narrative. Control is not unidirectional when it comes to self-tracking and the power relations and information balance are often asymmetrical (Calvard, 2019). Users have very little choice – or control – over the data flows of their self-tracked metrics. Thus, notions of governmentality and surveillance situate self-tracking technologies as instruments of control and biopower through which bodies might be disciplined (Ajana, 2017; Lupton,

2013). These paradoxical imaginings of control are the site of considerable tension in existing work on self-tracking (Fors et al., 2020).

Furthermore, an additional body of work has focused on the complexities of the choices users make when it comes to their self-tracking practices. For example, the importance of these choices can be seen in technology selection (J. H. Lee et al., 2021), decisions around data sharing and privacy (Lupton, 2021b), personalised goal setting (Ridgers et al., 2018), and the selection of which metrics to track and when (Esmonde, 2020; Schroeder et al., 2018). These choices give users a sense of control over their self-tracking. Nonetheless, there are many factors that influence the level of choice and control that adolescents have within the wider context in which self-tracking tools are being used. These include, for example, expectations and norms set by advertising, families, and peers, and institutional constraints of schools (Freeman & Neff, 2021; Potapov et al., 2019). These concepts of control and choice permeate this thesis and remind us of the importance of adolescents' sense of control in their self-tracking practices.

My work is informed by Lomborg and Frandsen's (2016) conceptualisation of self-tracking as a communicative practice that is embedded in everyday social and cultural practices. In this work, digital self-tracking technologies are framed as apps or devices that "allow ordinary individuals to systematically monitor, document and analyze an array of aspects of daily life, including sleep patterns, mood, calorie intake, heart rate and physical exercise" (Lomborg & Frandsen, 2016, p. 1016). This conceptualisation of digital self-tracking involves communication between the digital technology, individual bodies, and other people (e.g., family, peers). Leveraging this definition is useful as it considers how 'ordinary individuals' (adolescents, in the case of this thesis) use these technologies and opens the

way for an exploration of how self-tracking technologies might be positioned within adolescents' social networks.

1.1.3 Adolescents and COVID-19

In this thesis, I adopt the term 'adolescent'[3] to describe an individual aged between 10 and 19 years of age, in line with the World Health Organization (WHO) definition (2014). Acknowledging that such categories are socially constructed and dependent on context (Schlegel & Barry, 1991), I use the term 'adolescent' to emphasise my focus on the developmental stage between childhood and adulthood. In accordance with the secondary school system in the UK, participants in this study were between 13 and 18 years of age.

More specifically, this thesis captures adolescents' experiences during the COVID-19 pandemic. The COVID-19 pandemic has claimed the lives of millions around the world. To limit the spread of the virus, many countries introduced restrictions on movement, and social contact, including physical distancing, quarantine, and the closures of schools and businesses. For countless people, these restrictions fundamentally changed the patterns and routines of everyday life. The long-term impacts of these policies on global health and wellbeing remain unknown. Whilst this global pandemic has taken its toll on so many – be that emotionally, physically, financially – the social isolation has been particularly challenging for adolescents (Magson et al., 2021). An editorial in *The Lancet Child & Adolescent Health* stressed that "[a]lthough children and adolescents are generally less

[3] The term 'young people' will also be used interchangeably with 'adolescents' in this thesis.

clinically vulnerable to COVID-19 than are adults, the wider effects of COVID-19 policies have disproportionately and negatively affected the young" (2020, p. 1).

Scholars have raised concerns over the "collateral damage" done to young people resulting from physical distancing policies (Crawley et al., 2020, p. 1), as these groups are overlooked in such policymaking decisions. Remote learning, social isolation, reduced medical, social, and educational service provisions, and increased anxiety are but a few of the challenges that adolescents have had to face in response to the virus (Crawley et al., 2020). For example, school closures and physical distancing impacted opportunities to meet physical activity guidelines as many young people get some exercise through activities such as travel to and from school, Physical Education classes, and organised sports (Guan et al., 2020). Research has also raised concerns about the impact of school closures exacerbating the epidemic of childhood obesity (Rundle et al., 2020). It is therefore important to understand the situation for young people during the pandemic and the ways in which their lives have been disrupted, altered, and shaped by the global public health crisis and associated restrictions.

At the same time, digital technologies have taken on a central role in our broader society during the pandemic, perhaps more so than ever before. Users and technologies have come together to create spaces that allowed co-workers to connect, children to attend school, doctors to meet with patients, and physical activity to remain social but safely distanced. Whilst Marelli et al. (2022) warn of the challenges of techno-solutionism in the COVID-19 pandemic, Stoilova et al. describe how life for young people during the pandemic became "digital by default" (2020, p. 197), and this norm persists. Digital technologies are interwoven into adolescents' social and psychological lives in ever more complex ways,

presenting us with both an opportunity and an urgent challenge to think through how adolescents engage with these technologies and how technology might best be leveraged to support adolescents' health and wellbeing.

1.1.4 Adolescent Self-Tracking in the Age of COVID-19

As the opening quotation of this chapter emphasises, digital self-tracking technologies have become increasingly relevant in the age of COVID-19: *"The Covid has made me worry more about my physical health so I used the self tracking app more"* (Female, 16). From the UK's NHS COVID-19 app to Australia's COVIDSafe app and TraceTogether in Singapore, a myriad of formal, institutional technologies have emerged in response to the pandemic for purposes such as contact tracing, symptom tracking, and isolation and quarantine tracking (Sharma & Bashir, 2020). COVID-19 has raised important questions about what it means to track data, what it means to be tracked, and how we understand the consequences of tracked data. Never has it been more apparent that our self-tracked data have social consequences.

Moreover, COVID-19 made people *"worry more about [their] physical health"* (Female, 16), and many sought to better understand their physical health and fitness and adapt to COVID-19 restrictions on movement and social distancing. Consequently, off-the-shelf digital health and fitness tracking tools, such as Fitbits and Apple Watches, saw a surge in adoption (Osborne, 2021). According to the UK mobile network EE (2020), tracking apps such as MapMyRun and Strava saw two- and three-fold increases in data usage respectively during the first lockdown compared with pre-lockdown usage figures in February 2020. This "boom in digital fitness" (Criddle, 2020, l. 1) was celebrated by many as a way of creating community, promoting physical health, and bolstering psychological wellbeing during a

time of global trauma. However, we lack a deep understanding of the lived experience of these practices for adolescents.

This monumental shift in day-to-day life in the UK made my research both more urgent and more challenging. This chapter sets the scene for the context in which my research was conducted – the pandemic has shaped the timing, data collection methods, and emerging data. This situation has brought to light the very real implications of tracking in our world and has raised important questions about the affordances of adolescents' self-tracking practices.

1.2 Project Aims and Objectives

Self-tracking practices reach far wider than the self: peers, families, institutions, and communities are often seen in and through self-tracking practices. At the same time – particularly in the case of tracking health and physical activity data – these practices allow individuals to monitor, collect, and analyse extremely intimate biometric data. These practices are therefore both deeply personal and fundamentally social. How, then, might we think through what this means for individuals' social and psychological experiences? This is the aim of this mixed methods project: to explore the affordances of self-tracking practices for adolescents' social and psychological wellbeing. In this thesis, I delineate the results of empirical research conducted over 16 months comprising an online survey, online interviews, and online co-design workshops with over 600 adolescents in the UK.

The **objectives** of this project include the following:

1. To lay out what UK adolescents' self-tracking practices looked like during the early stages of the COVID-19 pandemic.

2. To combine an affordances framework with a sociomaterial understanding of self-tracking.
3. To use the above framework to map out the variability in adolescents' self-tracking practices and how they intersect with adolescents' social relationships and psychological wellbeing.
4. To outline design recommendations for resources (e.g., educational guides) concerning self-tracking specifically for adolescents.
5. To demonstrate to adolescents and other stakeholders the value of young people's contribution to self-tracking research.

1.2.1 Research Questions

The findings of this thesis extend across disciplinary boundaries. In line with the approach of Fors et al. (2020), rather than adopting a single disciplinary perspective or speaking to one particular audience, I draw on work from several different fields (namely psychology, sociology, and human–computer interaction (HCI)). Here, my research questions do important work by providing a thematic structure to the project and deftly traversing disciplinary thresholds to enable me to draw together a range of perspectives to better capture the complexity of the adolescent experience. Although this interdisciplinary work with health technologies can be challenging (Williams et al., 2020), it is pivotal for research to be done in this area so that we can think deeply and critically about the many and varied aspects of adolescents' engagement with self-tracking tools and develop an approach that includes creative insights from diverse types of expertise.

My project seeks to further our understanding of adolescents' self-tracking practices by addressing the following research questions:

RQ1. How did adolescents experience self-tracking during the early stages of the COVID-19 pandemic?

We currently know relatively little about what self-tracking practices look like for adolescents, or how adolescents themselves might understand and articulate these practices. Through this first research question, addressed in Chapter 4, I explore how the early stages of the COVID-19 pandemic might have shaped adolescents' self-tracking practices. What were the affordances of these technologies for adolescents during a time of social upheaval and global crisis? How did adolescents engage in tracking practices in ways that made sense to them during various periods of the pandemic, such as when physical distancing and online schooling were necessitated?

RQ2. How are adolescents' relationships with the self and others seen with and through self-tracked data?

At the centre of RQ2 is the recognition that self-tracking data are social and can infiltrate peer relationships and conversations. This question is therefore concerned with the varied ways in which adolescents mobilise their data, in both online and offline contexts. In answering RQ2 in Chapter 5, I am also interested in understanding the mechanisms that might explain how adolescents engage in data-sharing practices (e.g., with peers, parents, healthcare professionals) in social contexts. I use frameworks such as social comparison theory (Festinger, 1954) and sociomaterial models of care (Mol, 2008; Mol et al., 2010) to better understand the varying social affordances of self-tracking for adolescents. For example, I consider how processes of upward and downward social comparison, care, and control might emerge through young people's digital self-tracking practices.

RQ3. How do adolescents make sense of the affordances of digital self-tracking practices for their psychological wellbeing?

This research question centres around understanding whether and, if so, how adolescents' self-tracking practices might promote or undermine psychological wellbeing at this time of potential vulnerability for mental health. Keeping adolescent perspectives at the centre of this research question, in Chapter 6, I explore how young people understand the entanglements between tracking and wellbeing. RQ3 concentrates on what we can learn about the emotional and identity affordances of self-tracking for young people and how these affordances might look different for adolescents across distinct use contexts.

RQ4. How might we co-design flexible resources to support adolescents' self-tracking practices?

Ankrah et al. (2022) emphasise that work is needed to explore how research and technologies might empower users in their self-tracking practices. In response, I ask the following question: what can we learn from adolescent voices about theory, design, and empirical notions of self-tracking? Taking a future-oriented approach, in Chapter 7, I describe the process of working with adolescents to co-design an educational resource (such as a user guide) that centres on self-tracking. I argue that by working alongside adolescents and highlighting their voices, we can better understand the different sociomaterial entanglements at play in adolescents' self-tracking practices and that this can inform the design of educational resources built around young people's tracking. In doing so, I claim that adolescent voices can teach us how we might best support self-tracking practices that can potentially promote positive psychological and social experiences for young people.

1.3 Authorship Statement

Throughout the course of my DPhil studies, I have presented conference papers and published several works that are of relevance to this thesis. Final author copies of these accepted manuscripts are available in Appendix I. I have cited these appropriately throughout the thesis and signposted in the relevant empirical chapters where these findings have been published. I summarise the key works of relevance to this thesis in this section.

Chapter 7 is based on a published extended abstract and a paper that has been accepted to be published in conference proceedings. The two papers discuss the data from the co-design workshops that took place as part of this DPhil project. These are as follows:

Freeman, J. L., & Curtis, A. N. (2022). "Ask yourself WHY you want to track yourself": Co-Designing a Self-Tracking Guide with Teenagers. *CHI Conference on Human Factors in Computing Systems Extended Abstracts*, 1–6. https://doi.org/10.1145/3491101.3519650

Freeman, J. L., & Curtis, A. N. (2023). Putting the Self in Self-Tracking: The Value of a Co-Designed 'How Might You' Self-Tracking Guide for Teenagers. [Accepted as a full paper for the *2023 CHI Conference on Human Factors in Computing Systems*]. https://doi.org/10.1145/3544548.3580938

Additionally, during my DPhil program, I worked on two related self-tracking projects. These projects informed how I thought about and approached this thesis; however, primary data from these projects are not used in the thesis. These are as follows:

Freeman, J. L., & Neff, G. (2021). The challenge of repurposed technologies for youth: Understanding the unique affordances of digital self-tracking for adolescents. *New Media & Society*, 146144482110402. https://doi.org/10.1177/14614448211040266

DiCosola, B., **Freeman, J. L.**, & Neff, G. (2022, May 26-30). *Connected Fitness During COVID-19: Care, Control, and Social Connection through Digital Self-Tracking Across Three Countries* [Conference Presentation]. International Communication Association (ICA) Conference, Paris France.

1.4 A Note on Art and Design Work

I want to take a moment to foreground the art and design work involved in this thesis. Incorporating these designs is an important way I have chosen to tell the story of my work and the decisions around the inclusion of these pieces that have been made carefully as part of the process of carrying out this research. There are three key types of art and design I want to draw the reader's attention to: chapter illustrations (positioned at the beginning of each chapter), the proof-of-concept Instagram guide (an example is available in Figure 7.3 and the designs can be seen in full in Appendix B), and the infographic of key findings for adolescents (seen in Figure 8.4). For these pieces, I have worked closely with Weezy Dai (a graphic designer and illustrator) to produce artefacts that speak to the key arguments of the thesis.

Firstly, at the beginning of each chapter there is an illustration. Illustrations are a powerful way of communicating complex information and can be a valuable addition to a researcher's toolkit (Janis et al., 2020). These illustrations have been carefully designed to ensure that they emphasise the lived experiences of young people and make adolescents

feel represented. Much like the chapters of this thesis, each of these illustrations fit together, like pieces of a puzzle, to tell the story of the affordances of self-tracking for adolescents' social and psychological wellbeing. Indeed, the completed puzzle is placed on the final page of this thesis to mark the conclusion of this stage of my journey.

These same illustrations are also found on the infographic designed for adolescents (see Section 8.6.1 in Chapter 8). I wanted to have a sense of cohesion between the thesis, which is intended for an academic audience, and the infographic, which is intended for adolescents and other non-academic audiences. I did this to demonstrate that we should be including all stakeholders in these conversations, both inside and outside academia.

Furthermore, these illustrations sit alongside a series of Instagram posts designed with adolescents as part of this research. These posts are the culmination of the co-design workshops, the key findings of which are outlined in Chapter 7. When helping to design these posts, Weezy Dai wrote to me during our email correspondence and explained:

> The colour palette so far is bold, saturated, and gender neutral, and I think they create an eye-catching, youthful effect that will grab the attention of teens while still feeling trustworthy. The emphasis on blues and greens invoke a sense of calm and are reminiscent of natural landscapes, which help set a positive stage for all of this important information about health. (personal communication, 2 September 2022)

Together, these art and design pieces enhance the findings in a way that would not have been possible with words alone. I am grateful to have been able to include these as an additional lens on my work. They serve to bring adolescents' voices to life in new and interesting ways.

1.5 Structuring the Thesis and Chapter Outline

In this section, I provide a brief overview of each chapter in my thesis. I have deliberately chosen to open each chapter with a participant quotation from this study. In many ways, this thesis is a vehicle that has been used to amplify the voices of young people; they are a group who have so many insights to offer but are too often neglected in research in this area of self-tracking. By anchoring my work in their words, I aim to ensure that I capture their experiences and do justice to their generosity of time and insight.

In *Chapter 2*, *A Journey Through Theory and Existing Literature*, I review the literature that explores adolescents' self-tracking practices and argue that further research is urgent and important. I begin by outlining the key theoretical lenses and how they are used throughout the thesis to frame adolescents' self-tracking practices: sociomateriality, practice theory, and affordance theory. I then journey briefly through the history of self-tracking literature to highlight our limited understanding of young people as everyday self-trackers and the absence of the adolescent voice in research and design. I situate the contribution of this thesis by examining some of the open questions around adolescents' self-tracking that are addressed in this work. I argue that there is important work to be done in understanding the affordances of self-tracking for adolescents' social and psychological wellbeing; a task made more urgent by the COVID-19 pandemic and the growth in self-tracking behaviours.

In *Chapter 3*, *Amplifying Adolescent Voices: Methodology and Methods*, I turn my attention to the methods I used to explore adolescents' self-tracking practices during the early stages of the COVID-19 pandemic. I walk through the significant ethical considerations required when working with adolescents, particularly for online research. I then detail each of the methods used: an online survey, online interviews, and online co-design workshops. I argue that a

mixed methods design was necessary for this work to allow me to bring different types of data into dialogue with one another to capture the various complex angles of adolescents' engagement with self-tracking technologies. This paves the way for the following four empirical chapters.

Chapter 4, *The Changing Context of Tracking: Adolescents' Tracking During the COVID-19 Pandemic* establishes the context of the research. Drawing largely on the data from the online survey, I set out what we can understand about adolescents' self-tracking practices during the early stages of the COVID-19 pandemic and how adolescents understand the impact of the pandemic on their self-tracking behaviours. I discuss how during the pandemic, these tracking practices allowed adolescents to exercise control over their physical health and the ability to monitor and adjust to lifestyle changes. Here, I emphasise how the COVID-19 pandemic has changed the landscape of self-tracking; many more adolescents are self-tracking, although their experiences are diverse. It is here that I first introduce the notion of control as central to adolescents' self-tracking experience, and highlight how this became particularly valuable in an environment where so much felt out of control. The findings of this chapter demonstrate the importance of not underestimating the power of self-tracking to impact many aspects of adolescents' lives.

In *Chapter 5*, *Moving Beyond the Self: Self-Tracking and the Social*, I look beyond the self and instead turn to the social life of self-tracked data. This chapter focuses on interview and survey data to answer the question: How are adolescents' relationships with the self and others seen with and through self-tracked data? I discuss how adolescents demonstrate controlled, careful, and care-filled data-sharing practices and how self-tracked data are interwoven in adolescents' social relationships in complex ways. I argue that adolescents

engage in ambivalent, messy exchanges and renegotiations of data in their social relationships. Once again, control is central here. Adolescents resist rigid data-sharing designs that feel disempowering and instead prefer to leverage their data as a way to connect with or care for others. I stress that social sharing is part of the language and fabric of adolescents' self-tracking and that these highly social and carefully curated data audiences and narratives introduce opportunities for both benefit and harm in adolescents' social worlds.

My sixth chapter, *A Complicated Tale: The Psychological Affordances of Self-Tracking Practices for Adolescents*, examines how adolescents perceive psychological wellbeing in the context of self-tracking. This chapter centres on the following research question: how do adolescents make sense of the affordances of self-tracking practices for their psychological wellbeing? Bringing the online survey and interview data into tension with one another, I explore what we can learn about the emotional and identity affordances of self-tracking for young people, and how they understand the entanglements between tracking and wellbeing. I emphasise that whilst the quantitative data suggest that there is no overall significant relationship between self-tracking practices and psychological wellbeing, the interview data tell a different story. I argue that by focusing on individual lived experiences, we can begin to see the nuanced psychological affordances of self-tracking across different sociomaterial arrangements and the ways in which adolescents negotiate these in their own lives. In particular, calorie-tracking emerges as an important site for understanding further how adolescents negotiate the psychological affordances of self-tracking. Again, control sits at the centre of these concerns for adolescents. I claim that losing one's sense of autonomy over tracking practices or starting to see the world only through the lens of data can lead to harm for some adolescents.

In the final empirical chapter, *Chapter 7*, *One Small Step, One Giant Leap: Co-Designing Digital Self-Tracking Resources with Adolescents*, I consider the question: how might we co-design flexible resources to support adolescents' self-tracking practices? I look to the future and consider how adolescents might imagine educational resources that focus on self-tracking practices that are useful to them and their specific use contexts. Through a series of co-design workshops, I describe the process of co-creating an Instagram-distributed self-tracking 'how might you' user guide written with and for young people. Through this, I argue that adolescent collaboration can teach us much about theory, design, and empirical notions of self-tracking and that by listening carefully to their perspectives, we can work to support better tracking experiences for young people.

Closing with *Chapter 8*, *On the Right Track: Conclusion*, I draw together the findings of the empirical chapters to paint a picture of the complexity of the social and psychological affordances of self-tracking for adolescents. I make clear recommendations for future research and work to be carried out in collaboration with adolescents. In doing so, I argue that we can and must do better to empower adolescents who are engaging in self-tracking practices by acknowledging the sociality of tracking and the varying ways in which tracking might be seen in and through adolescents' social relationships and psychological wellbeing.

1.6 Key Contributions

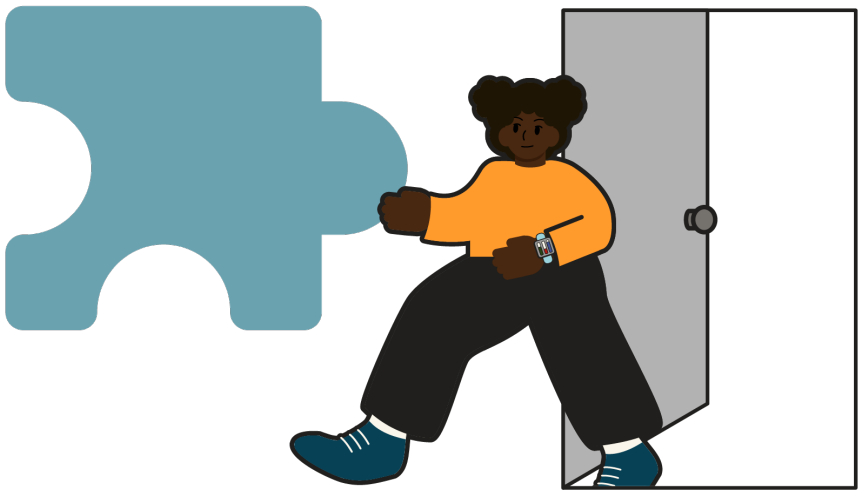
The key contributions of this thesis are discussed in detail in Chapter 8. Nevertheless, I outline a brief summary here of some of the central recommendations of this thesis to provide the context for engaging with the chapters to come. If the reader were to take nothing else away from this thesis, I hope to emphasise these four key takeaways:

1. We should celebrate individual differences in adolescents' self-tracking practices.

2. We should recognise the centrality of control in adolescents' self-tracking practices, and the tensions that emerge between controlled and creative practices.
3. We should leverage opportunities for social support and community-building to promote positive, autonomous self-tracking experiences for adolescents.
4. We should employ principles of inclusive design as we work towards better self-tracking futures for adolescents.

At its core, this thesis argues that the affordances of self-tracking for adolescents' social and psychological wellbeing reveal the tension between self-tracking as a set of simultaneously personal and social practices. This tension was particularly stark in the context of this thesis, which was set against the backdrop of the COVID-19 pandemic. This has important implications for how we theorise about, research, and design technologies and resources to empower adolescents to choose the self-tracking practices that work best for them. I begin laying the groundwork for this argument in my literature review.

2 A Journey Through Theory and Existing Literature[4]



"I used a Fitbit as motivation to get outside during the pandemic. Now self tracking still motivates me, but I've stopped using the Fitbit and use my phone instead because I wore the Fitbit ALL the time, whereas my phone I can create a bit of space between self tracking apps and social media and stuff etc" (Female, 18)

2.1 Introduction

Although the quotation that opens this chapter, which is drawn from a survey response from an 18-year-old female participant, confirms that self-tracking served as *"motivation to get outside during the pandemic"*, it also brings to light a more complex relationship with the different materialities of tracking tools. What social and tracking practices might this participant's phone allow that her Fitbit might refuse? How might these affordances reveal

[4] There are similarities between this chapter and the literature review included in Freeman and Neff (2021). This is because it is a review of similar literature on a related topic; however, it is not the same literature review.

a space for different sociomaterial practices? In the review that follows, I highlight the gap in the literature on adolescents' self-tracking practices to which my thesis contributes. I argue that there is important work to be done to explore the everyday experience of adolescent self-trackers. Explorations of institutional or intervention-based tracking within schools are worthwhile; however, they cannot capture the complex interplay between social and material elements when adolescents are tracking of their own volition. Previous work has started to recognise the psychological and social affordances that might emerge from this interplay; however, we are lacking an exploration of how adolescents might situate self-tracking within their relational and affective experiences. This understanding is fundamental to future work on how we might learn from adolescents and their need for and expectations of support when they are navigating their autonomous relationships with self-tracking technologies.

Self-tracking practices are complex and multidimensional, and they need to be understood from different perspectives. An interdisciplinary framework, therefore, is required to position my DPhil research within the existing tapestry of work in this space. This interdisciplinary framework allows me to draw on the extensive knowledge of different disciplines and synthesise these into a more cohesive whole to achieve a comprehensive understanding of the affordances of self-tracking practices for adolescents' social and psychological wellbeing. As such, this interdisciplinary approach and use of theory form part of the original contribution of this thesis. By working in this way, I identify gaps and key areas for further exploration and situate the novelty of my findings. To weave this tapestry together, I will first explore the key theoretical concepts that will help to guide this research.

When I was framing this work, I had two options, namely: (i) situating self-tracking technology as a case of adolescents' technology use or (ii) situating adolescents as a case of self-tracking users. I deliberately chose to examine adolescents as a case of self-tracking users rather than situating self-tracking technology as an example of adolescents' technology use. This decision was grounded in an understanding of the differences between self-tracking technologies and other technologies adolescents might engage with. Emphasising adolescents as a case of self-tracking users has enabled me to focus more closely on the unique affordances of digital self-tracking tools and the work adolescents do to integrate these into their routines. In light of this decision, my literature review is primarily embedded in self-tracking literature but it does touch on some relevant work on adolescents and technology. I have discussed components of this literature review elsewhere (Freeman & Neff, 2021), where I have argued that there is a need for better research on the unique affordances of digital self-tracking tools for adolescents. My aim in this review is to make clear why adolescents are an important, and overlooked, population in this work, and why their experience matters. Further, I explain why this moment in history (i.e., the COVID-19 pandemic) provides a unique opportunity to explore adolescents' everyday experiences of self-tracking.

This chapter comprises two sections: a description of relevant theoretical lenses and a survey of the self-tracking literature. Structuring the chapter in this way enables me to situate my understanding of self-tracking up front and allow this to inform my reading of existing self-tracking research. In the first section, I outline the key theoretical lenses that I adopted to make sense of self-tracking and how I leverage these ideas to explore the existing literature and my own findings. The second section briefly traces the long history of our understanding of everyday self-tracking from pre-digital tracking, through to the rise

of the Quantified Self movement and beyond, with a focus on the affordances of these tools that are most relevant to the current research. I conclude by centring specifically on what we currently know about adolescents' experiences of self-tracking. I argue that we lack a common understanding about (i) how adolescents might situate self-tracking within their relational and affective experiences, (ii) how the emerging sociomaterial dimensions born out of the COVID-19 pandemic have shaped these experiences, and (iii) how this can inform self-tracking engagement and support for adolescents who want to self-track. Finally, by demonstrating how these key questions are left unanswered by the literature, I point to the novel contribution of this thesis within the existing fabric of work.

2.2 A Journey Through Theory

I begin this literature review with a short summary of the key theoretical lenses I use to work through the interdisciplinary literature and to situate my thesis. Lievrouw and Livingstone define new media as "infrastructures with three components: the *artefacts or devices* used to communicate or convey information; the *activities and practices* in which people engage to communicate or share information; and the *social arrangements or organizational forms* that develop around those devices and practices" (2006, p. 2, emphasis in original). Lievrouw (2014) proposes that the concept of 'mediation' is a helpful way of conceptualising the ways in which these three components are mutually determining and inseparable from one another(Lievrouw, 2014). A desire to understand these ongoing mediated relationships between artefacts, practices, and social arrangements has informed my choice of theory and my approach to the study of self-tracking tools in this thesis.

In this work, I primarily engage in theorising as a means of applying existing concepts to new observations (Krause, 2016). The key theoretical lenses I cover are **sociomaterial**

practices and **affordances.** Here, theory performs a useful function. As Collins and Stockton highlight, "Theories make sense of difficult social interactions and phenomena, and articulating a theoretical framework helps the sense-making process to be more explicit" (2018, p. 6). Together, the theoretical lenses I discuss in this section provide a way in to understanding self-tracking that is more nuanced than what the literature to the time of writing has covered. For example, it can be extremely challenging to draw firm conclusions about specific technologies (e.g., Fitbit, Strava) in the face of rapid technological change (K. Davis et al., 2020) in addition to constant social change, such as during the COVID-19 pandemic. Instead, by examining self-tracking as a sociomaterial practice, I am able to more successfully draw together findings from a wide range of disciplines and literature and find a language through which to articulate the different affordances of adolescents' self-tracking practices across a range of sociomaterial arrangements of devices, software, data, users, and non-users. These theories informed my choice of methods and provided the foundations of my data analysis.

Collins and Stockton (2018) suggest that the best way to present a conceptual framework is often in a visual format, such as an image to indicate how ideas work together. In Figure 2.1, I have demonstrated how I have integrated the ideas of sociomaterial practices and affordances to explore adolescents' digital self-tracking. This is intended as an overview, with the combination of these lenses allowing for rich exploration of the landscape of available (imagined) affordances offered by adolescents' sociomaterial environment and the mechanisms and conditions under which they might unfold. I provide further detail on the different aspects of Figure 2.1 in the remainder of this chapter.

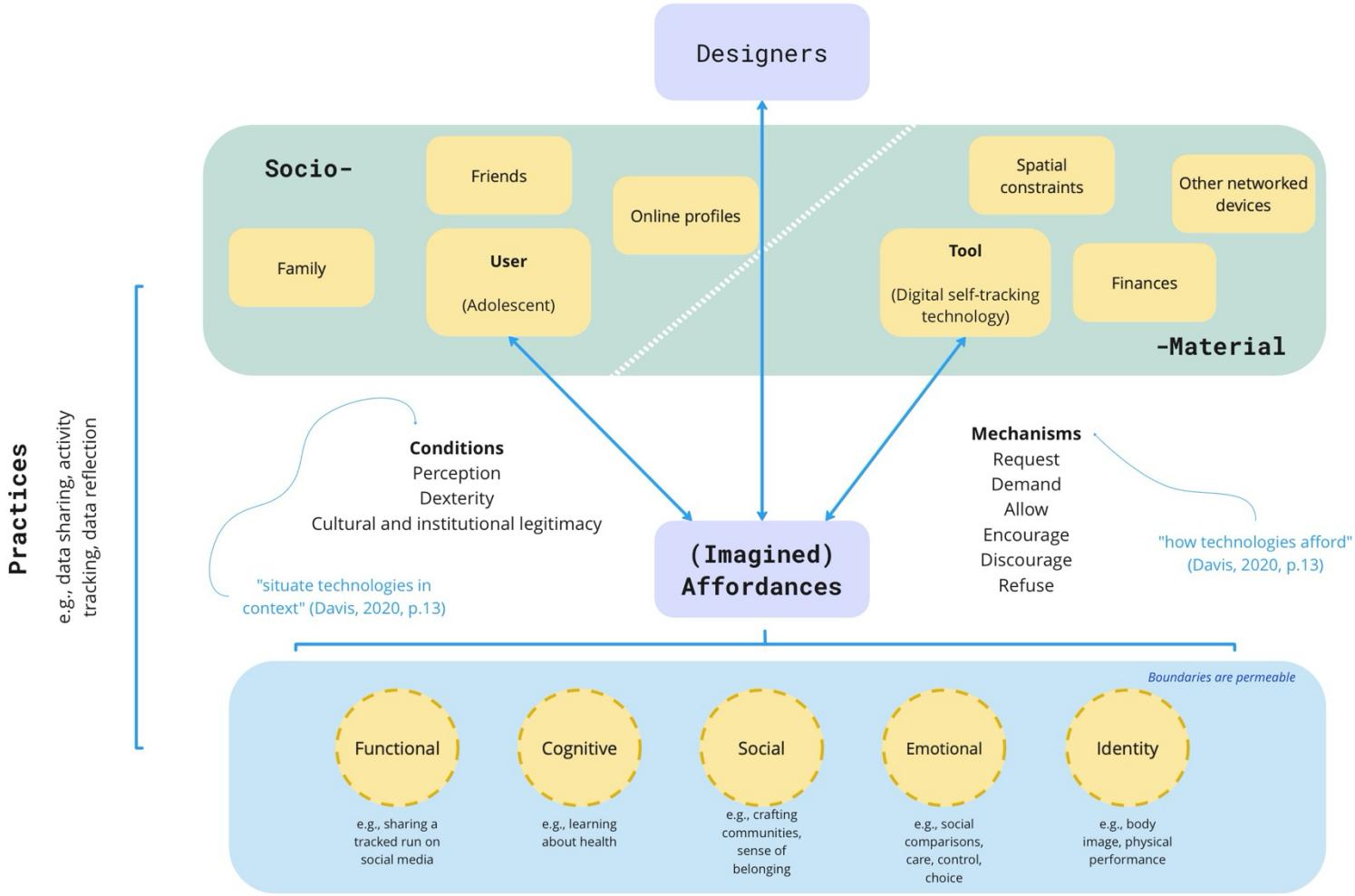


Figure 2.1. Drawing together the key theoretical lenses underpinning the project: sociomaterial practices and (imagined) affordances.

2.2.1 Self-Tracking as a Sociomaterial Practice

The term 'sociomateriality' reminds us that the social and the material are intimately entangled (Orlikowski, 2007). Theories of sociomateriality have previously been used to study digital self-tracking tools as they emphasise the "entanglements between humans and non-human actors" (Lupton, 2017, p. 12) and open the way for questions concerning "the role played by material artefacts in social relations and the construction and negotiation of meaning" (p. 12). A sociomaterial perspective has also been helpful in considerations of care, choice, and control (Mol, 2008; Mol et al., 2010), particularly in relation to self-tracking (Kristensen et al., 2021; Will et al., 2020). This theoretical lens is integral to understanding how self-tracking is situated within broader sociomaterial structures. Lupton refers to "self-tracking cultures" to capture the broad context of self-tracking and argues that "[s]elf-tracking as a phenomenon has no meaning in itself. It is endowed with meaning by wider discourses on technology, selfhood, the body and social relations that circulate within the cultural context in which the practice is carried out" (2014b, p. 78).

Moreover, a focus on sociomaterial arrangements in previous work on self-tracking has allowed researchers to nuance our understanding of the ways in which digital self-tracking technologies "both assume and configure certain kinds of capacities, desires and embodiments" (Lupton, 2014a, p. 441). For example, this perspective has been used to explore the following: the ways in which workers make sense of their role within an organisation through self-tracking in the workplace (Calvard, 2019); how apps to track sexual and reproductive health might reinforce normative sexual and reproductive stereotypes and assumptions (Lupton, 2014a); the broad sets of materials and social relationships shaping the flows of curated self-tracked data (Weiner et al., 2020); and the embodied and affective experiences of digital Physical Education assemblages (Lupton,

2021a). The lens of sociomateriality allows me to avoid technological determinism and move beyond an uncritical consideration of self-tracking technologies as *tools* – for example of behaviour change or surveillance – and instead to maintain a focus on the emergent, relational materiality and agency of self-tracking technologies (Henwood & Marent, 2019).

I would like to note that in this thesis, I use the term 'self-tracking tools' frequently. Echoing a longer history of how we track and how we keep records, from mirrors and weight scales to Fitbits and Strava (Fors et al., 2020; Neff & Nafus, 2016), when I adopt the term 'tools' in this way, I am using it to cover a large and diverse set of practices that are mediated through digital technologies. In this research, I am intentionally not drilling down into the particular interfaces and form factors of the digital processing of self-tracked data, but rather I am interested in the ways in which adolescents' practices interact with a range of self-tracking tools, as seen through the lens of affordances. As such, I use the word 'tools' in this thesis but do so in a way that is not technologically deterministic.

By adopting this sociomaterial perspective, things can be constituted in 'sociomaterial practices' (Orlikowski, 2007), that is, things only exist in their ongoing relations to one another. Lievrouw describes practices as "a concrete way to describe communicative action" (2014, p. 45). So, a practice-based perspective, because it understands these sociomaterial relations, allows researchers to detail more than just what people *do* with digital tools and instead opens the way for thinking more deeply about how individuals' practices might be involved in processes of meaning-making, identity formation, knowledge acquisition, and power (Nicolini, 2013; Sharon, 2017). This is particularly valuable when considering the adolescent context where such processes are crucial. What is important here is that a practice-based approach allows scholars to consider variation and

agency in what individuals do, granting an exploration of creativity and innovation (Nicolini, 2013). In this way, following Nicolini (2013), I understand the concept of sociomaterial practices in my research as routine activities that are facilitated by contributions from a collection of material resources.

A practice-based approach has been useful in this thesis as it has helped to identify the "profoundly social practices and cultural meanings" (Calvard, 2019, p. 7) embedded in the use of digital self-tracking tools. Whilst there is not a single, unified practice theory (Schatzki, 2001), a practice-based framing is helpful for contemplating how everyday practical activity can shape the order and meaning of our social world (Nicolini, 2013). Practice-based approaches are relational and "bring to the fore the critical role of the body and material things in all social affairs" (Nicolini, 2013, p. 4).

Sharon (2017) advocates such an approach to self-tracking research to move away from a focus on the digital tool itself and instead shift towards exploring the everyday experiences of individuals who engage in digital self-tracking. Using practice theory as a lens, we can ask novel questions about what different kinds of practices might look like under different conditions. This facilitates a thoughtful analysis of how digital tools are used for everyday practices and how meaning and affect might come to be invested in these tools (Lupton, 2016b). As the opening quote of this chapter highlights, the social and the material work together to create different tracking experiences for adolescents. Whilst tracking on a wrist-worn Fitbit might enable one kind of consistent tracking practice, tracking on a phone can open up different experiences and *"create a bit of space between self tracking apps and social media and stuff"* (Female, 18).

An approach focused on sociomaterial practices and affordances informs not only my critical approach to the literature but the thesis overall, from conceptualising my original research questions to providing a guiding structure for my data analysis. This frame offers an entry point for thinking about everyday and long-term practices as well as how, and under what conditions, such actions are actually performed. But I still find myself in need of a language to describe how the affordances of self-tracking practices might be shaped by different sociomaterial arrangements.

2.2.2 Thinking Through Affordances

The theoretical framework used most extensively in this thesis is that of affordances. The concept of affordances is useful for understanding how different people might have differing experiences with the same material tools, again emphasising the entanglements between the social and material in people's everyday practices. The term 'affordance' stems from the field of ecological psychology where Gibson described affordances as "what things furnish, for good or ill" (Gibson, 1966, p. 285). Since then, this concept has been drawn on in much communication technology and media studies literature as an analytic tool through which we might understand the "dynamic link between subjects and objects within sociotechnical systems" (J. L. Davis & Chouinard, 2016, p. 1).

In this thesis, I adopt a more expansive definition of affordances that is based on the work of J. L. Davis and Chouinard (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016). Defining affordances as "the range of functions and constraints that an object provides for, and places upon, structurally situated subjects" (J. L. Davis & Chouinard, 2016, p. 1), J. L. Davis and Chouinard's (2016) work, later expanded by J. L. Davis (2020), is valuable for my work on adolescents as it allows us not only to think through the "politics and values in

technical systems but also lays the groundwork for intentional (re)design" (J. L. Davis, 2020, p. 20); it also made me think practically about "how features will prompt and dissuade, for whom, and under what circumstances" (J. L. Davis & Chouinard, 2016, p. 7).

J. L. Davis and Chouinard (2016) present a theoretical framework of interweaving mechanisms and conditions to describe how affordances work. Affordances are not fixed but rather technological tools afford uses and actions along a "porous continuum" (J. L. Davis, 2020, p. 22) of interrelated *mechanisms,* whereby technologies can: request, demand, encourage, discourage, refuse, and allow. The categories 'request' and 'demand' are directions made by the technological tool to the user. The terms 'encourage', 'discourage', and 'refuse' describe how the tool responds to the user's desired practices. Finally, the mechanism 'allow' refers to both the tool's response to users and the directions from the tool itself. These mechanisms are *conditioned* by perception (knowing a tool's functions are available), dexterity (being physically and cognitively able to utilise the functions of a tool), and cultural and institutional legitimacy (conventions and codes that guide the ways in which people and tools relate to one another) (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016). This means that how technologies afford is based in part on an individual's socialised awareness of and ability to use available features within the user's social contexts. In short, "[t]he mechanisms of affordance specify how technologies afford, while the conditions of affordance situate technologies in context" (J. L. Davis, 2020, p. 13). I use the language of these mechanisms and conditions throughout my empirical findings chapters.

Situating technological affordances in the adolescent context, Moreno and Uhls (2019) have also carried out important work on integrating affordance theory with a

developmental lens to explore adolescents' use of social media. By considering affordances alongside the key developmental tasks of adolescence, they point to five categories of affordance: functional, social, identity, cognitive, and emotional. In this thesis, social (e.g., sense of belonging), identity (e.g., developing a sense of body image), and emotional (e.g., social comparison) affordances will be central. However, of course, the boundaries between these affordances are permeable and, in practice, they feed into and out of one another. When using this developmental lens, I recognise that it is important that researchers are careful not to patronise adolescents or imply that their use of self-tracking technology is somehow deficient at their stage of development (Goodyear, Wood, et al., 2018). Instead, I use affordances to inform my research questions and data analysis by offering categories through which to describe key considerations for adolescents' practices in their interaction with digital self-tracking tools.

Finally, there is one piece of the puzzle missing. In an important addition to the work on affordances, Nagy and Neff (2015) propose the concept of "imagined affordances" that arise between the experiences of the users and designers and the materiality of the digital tools. Imagined affordances capture "a process that is simultaneously material and perceptual" and as such enable scholars to "reflect technological environments' material qualities that mediate affective experiences" (Nagy & Neff, 2015, p. 2). Adding this approach demonstrates how "expectations for technology that are not fully realized in conscious, rational knowledge but are nonetheless concretized or materialized in socio-technical systems" (Nagy & Neff, 2015, p. 1). In the context of my thesis, this allows me to ask, and address, important questions about how adolescents articulate their expectations and beliefs about self-tracking tools, rather than solely focus on the materiality of these tools. This distinction is important as the framework of imagined affordances looks beyond

the design and material features of digital self-tracking tools and instead opens the way for a deep exploration of the often complex social and psychological aspects of adolescents' engagement with these tools.

In sum, an affordance approach allows me to explore the potential shaping effects of digital self-tracking tools in a way that is not technologically deterministic (J. L. Davis, 2020) but instead remains open to dynamic affordances that can vary over time and according to different circumstances (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016). A particular strength of this approach is its flexibility; it allows me to embrace the "variability, otherness, and difference" (J. L. Davis, 2020, p. 124) in affordances of digital self-tracking tools for different people.

Drawing together this notion of affordances with the perspective of sociomaterial practices presented earlier, van Dijk and Rietveld argue that "such affordances exist as they persist in shared and social practices" (L. van Dijk & Rietveld, 2017, p. 3). Thus, these theoretical approaches are complementary; affordances are "always and everywhere sociomaterial" (L. van Dijk & Rietveld, 2017, p. 3). van Dijk and Rietveld go on to argue that sociomaterial practices and affordances are constitutively entangled. That is to say, (i) practices and the affordances that emerge within them are interdependent – "any affordance will imply a practice for realizing it and any practice will imply a landscape of available affordances" (2017, p. 4) – and (ii) neither practices nor affordances are prioritised over the other. The value of this approach for my research is that within it "practices and affordances are two sides of the same coin, i.e., of the same sociomaterial entanglement of people, activities, places and things, [which] allows us to switch between foregrounding the one or the other" (L. van Dijk & Rietveld, 2017, p. 4). I now turn to a review of the existing self-tracking

literature, read through the lenses of sociomaterial practices and affordances to identify key gaps in our understanding of adolescents' experiences of self-tracking.

2.3 Surveying the Self-Tracking Literature: Searching for Adolescent Experiences

When writing this review, I was struck by Fors et al.'s provocation in the prologue of their autoethnographic book on self-tracking:

> But what happens in the wake of the hype, when ordinary people take on the project of digital self-tracking in their everyday lives? How do their uses, expectations and imaginaries relate to the history of self-tracking, to the ideas that underpin the development and design of contemporary self-tracking devices and apps, and to how early adopters in self-tracking communities and top-end researchers imagine future self-tracking? (2020, p. 1)

These questions captured what had long been troubling me about our understanding of the affordances of technologies for adolescents' self-tracking practices. Adolescents' social and psychological "expectations and imaginaries" of self-tracking are often missing from the literature, and answering these questions is essential to designing better self-tracking futures with young people. To better interrogate these questions, it is important to briefly trace what we know about the (imagined) affordances of digital self-tracking. The affordances of these self-tracking practices for adolescents might differ from the affordances imagined by designers, or indeed the affordances of these practices for other user groups. For example, previous work has explored just how complex and messy adults' self-tracking practices can be, with a wide variety of individual and group experiences (e.g., Chung et al., 2017; Gorm & Shklovski, 2019; Nafus & Sherman, 2014). Whilst my empirical research does not compare adolescents' self-tracking practices with those of adults, the literature review below sets out the need for the recognition of adolescents' unique sociomaterial practices and the imagined affordances of self-tracking tools.

2.3.1 Beyond the Quantified Self: On Affordances for Everyday Users

Communities have long come together around the idea of self-tracking. For example, the Quantified Self movement was founded by Wired magazine's Gary Wolf and Kevin Kelly in 2007. Since then, an international community has grown that shares an interest in self-tracking and focuses on generating "self-knowledge through numbers" (Quantified Self, n.d.). Community members share findings in a show-and-tell-style presentation centred around three questions: What did you do? How did you do it? What did you learn? Perhaps because of the visibility and prevalence of the Quantified Self community, the terms 'self-tracking' and 'Quantified Self' have been conflated in some of the existing literature,[5] and much of the existing research has centred on the Quantified Self movement (e.g., Barta & Neff, 2015; Kristensen & Ruckenstein, 2018; Sharon & Zandbergen, 2017; Wolf & Groot, 2020).

Although widely studied, the Quantified Self has been heavily criticised as a movement that appeals to ideas of 'data fetishism' (Sharon, 2017; Sharon & Zandbergen, 2017) or 'dataism' (J. van Dijk, 2014; Ruckenstein & Pantzar, 2017). These critiques of the Quantified Self often centre around its reductionist view of data and assumption that the ultimate goal of tracking is knowledge acquisition through the collection of objective data (Heyen, 2020), arguing that they obscure the affective, meaning-making, and social processes embroiled in these practices (Sharon & Zandbergen, 2017). Indeed, such reductionist positions can be seductive when it comes to the Quantified Self community as it is populated by many avid

[5] Whilst these terms are sometimes used interchangeably, I will adopt the term 'self-tracking' in this thesis as the continuous verb 'tracking' reminds us of the ongoing nature of these practices and the 'self' emphasises the ways in which people might come to imagine themselves, and others, through these practices. The use of the term 'self-tracking', therefore, helps me to maintain a focus on sociomaterial practices throughout this work.

users of digital self-tracking technologies, for whom "biohacking" through tracking is "a mission in life" (Ruckenstein & Pantzar, 2017, p. 407).

In response to this historic focus on the Quantified Self, Didžiokaitė et al. (2018) highlight the importance of considering self-tracking not only from the perspective of members of the Quantified Self community, but also from the position of those who might engage in everyday 'self-tracking' but who do not feel that their self-tracked data give rise to a new 'quantified' self or identity. The demographic of the Quantified Self movement has been historically most represented by white males between 20–40 years of age (V. R. Lee, 2014) and although some work has been done to extend the Quantified Self practices to youth populations (V. R. Lee & Briggs, 2014), to date this work has been limited. Diversifying our understanding of populations who might self-track is important because the goals, use, and effects of self-tracking tools in the existing literature might look different for more 'everyday' users (Didžiokaitė et al., 2018), and indeed may be very different for adolescents, because these tools were not designed for them (Freeman & Neff, 2021; Potapov et al., 2021). This literature review therefore looks towards what we know of the (imagined) affordances for everyday adolescent users, that is, "ordinary people [who] take on the project of digital self-tracking in their everyday lives" (Fors et al., 2020).

2.3.2 Adolescents Online: Understanding the Empirical and Policy Context

As mentioned previously, I situate my work within the literature on self-tracking; however, before turning to exploring what we know about *adolescents'* self-tracking, it is important to briefly remind ourselves that self-tracking tools sit amongst a wide range of technologies in adolescents' rich digital lives. There is an extensive history of academic work on children's and adolescents' digital participation and key scholars have focused on areas including

children's rights, digital skills, digital divides in online opportunities, and the internet's entanglements with young people's identities (e.g., boyd, 2014; Davies & Eynon, 2012; K. Davis, 2010, 2012b, 2013; Eynon, 2009; Eynon & Geniets, 2016; Haddon et al., 2020; Livingstone, 2016; Livingstone & Bulger, 2014).

This existing work has called attention to the myriad ways in which children and adolescents engage in online spaces, from educational resources to social media and games. Many of these online products and services have not been designed with young people in mind and this has led to increasing policy attention being given to this space. For example, on 2 September 2021, the Children's Code (or the Age-Appropriate Design Code) (Information Commissioner's Office, 2021) came into effect and the UK took a significant step forward in protecting children and adolescents online. The Code, consisting of 15 standards, sets out a statutory code of practice for online services designed for – or likely to be accessed by – children under the age of 18 years. These standards include guidance that service providers should set higher privacy settings for children as the default, collect and retain minimum data about children, turn off geolocation services and operate on an opt-in basis, and should not use nudge techniques to encourage children to change these privacy settings.

Putting privacy at the centre, the Children's Code marks an important policy shift because it recognises that the contexts of children and their motivations for using certain online services differ from those of adults, and therefore more tailored policies are appropriate. Elizabeth Denham CBE wrote in the Information Commissioner's foreword to the Children's Code: "One in five UK internet users are children, but they are using an internet that was not designed for them" (Information Commissioner's Office, 2021). This

understanding sits at the heart of my thesis. Although there is a broad literature that is concerned with young people's general internet use, comparatively little attention has been paid to adolescents' use of adult-oriented self-tracking tools that were not designed for them. It is this gap that I highlight in the following sections.

2.3.3 Adolescents as Self-Trackers

To the time of writing, little has been done to explore adolescents' everyday experiences of self-tracking, with much academic understanding of self-tracking practices typically stemming from research on adult user groups (Freeman & Neff, 2021; Potapov et al., 2021). Indeed, many digital self-tracking tools are designed for adult consumers (Schaefer et al., 2016; Wartella et al., 2015). This can be frustrating for adolescents (Goodyear, Armour, et al., 2018a) as their perception of and dexterity in engaging with these tools at this life stage may differ from those of adults. For example, digital self-tracking tools that present an individual's data aggregated over time may not be the most appropriate or helpful type for the adolescent population (Wartella et al., 2015) and there may be better ways of communicating these data so that they are more useful to young users.

Digital self-tracking tools are sold as instruments of data-driven behaviour change that provide insights and cognitive affordances that can lead to improvements in health outcomes: you must "know yourself to improve yourself" (see Figure 2.2). This notion reflects the Quantified Self movement's deep focus on "self-knowledge through numbers" (Quantified Self, n.d.) discussed previously. In theory, self-tracking provides individuals with a sense of control over their data and their own health. Indeed, within the field of

HCI, several frameworks for self-tracking[6] have been proposed (e.g., Choe et al., 2014; Epstein et al., 2015; I. Li et al., 2010; Rooksby et al., 2014). For example, I. Li et al.'s stage-based model of personal informatics systems suggests that users move linearly through these stages from preparation, collection, integration, reflection, and eventually action in pursuit of behaviour change goals. Later work, such as Rooksby et al.'s (2014) model of *lived informatics* and Choe et al.'s (2014) research with "extreme" self-trackers, have challenged this stage-based approach by highlighting other motivations for self-tracking beyond behaviour change and pointing to the complex, sometimes messy, sets of self-tracking behaviours for users.

Overall, these models can be misleading, because Ploderer et al. argue "there is an inherent assumption in self-tracking research that the data will simply lead to reflection and action, with little consideration on how to initiate and support reflection" (2022, n.p.). Much of this thesis is concerned with considerations of how young users reflect on their data and I build on these models by exploring what structures and environments might support empowered reflection of self-tracking data for adolescents.

[6] It is worth noting that the terms 'personal informatics' and 'self-tracking' are often used interchangeably in the HCI literature (Lupton, 2014b). In this research, I found that adolescents were more familiar with the term 'self-tracking' and this term is more commonly seen in literature across disciplines. As such, I will primarily use the term 'self-tracking' in this work, as explained in Section 1.1.2 in Chapter 1.

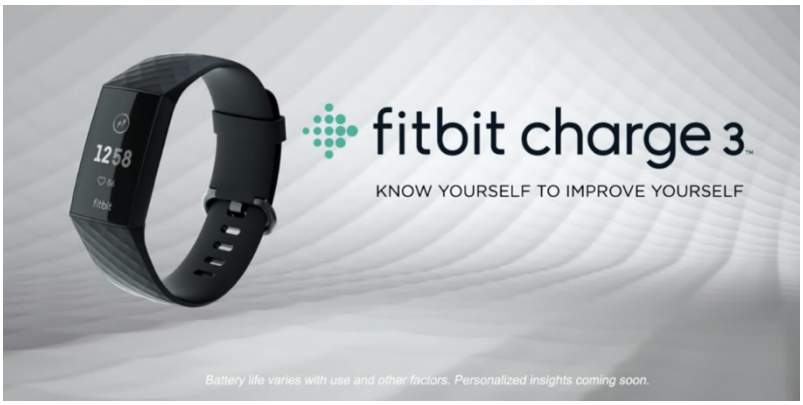


Figure 2.2. Screenshot of "Introducing Fitbit Charge 3" Advertisement. Source: https://www.youtube.com/watch?v=omJhc4iv4z4

There is important work to be done to understand how individuals reflect on self-tracked data. The designs of self-tracking tools often rely heavily on models of behaviour change; their aim is to empower users to become more self-aware and take control of their health behaviours (I. Li et al., 2010). For example, studies have demonstrated that self-tracking tools are beneficial for increasing motivation, self-efficacy, and levels of physical activity (Consolvo et al., 2008, 2009; Munson & Consolvo, 2012). Nevertheless, the model of behaviour change built into many self-tracking tools and research hinges on flawed logic, which suggests that collecting the data automatically enables one to interpret the data and to have the control to make changes based on these data (Neff & Nafus, 2016). In this way, "[t]he promise of individuals 'taking control' may very well be a burden disguised as empowerment" (Neff & Nafus, 2016, p. 57). This burden might be especially heavy if adolescents do not understand what this responsibility means for them and are unable to 'take control' as a result of environmental constraints placed upon them. By 'nudging' (Thaler & Sustein, 2008) individuals towards 'healthier' choices and behaviours, consumers of these products are positioned as projects to be shaped (Schüll, 2016).

There are many reasons for caution when applying understandings of the affordances of digital self-tracking for adults to adolescents and it is important to dispel the idea of adolescents as 'mini adults' rather than a user group in their own right with unique needs and motivations. There is great variability in adolescents' self-tracking practices (Freeman & Neff, 2021) and adolescents are often skilled users of self-tracking tools (Potapov et al., 2019); however, the same motivational 'nudges' (Thaler & Sustein, 2008) encoded into digital self-tracking tools designed for adults may not work for adolescents and may even be harmful. After using self-tracking tools, adolescents report increased feelings of competition, guilt, and internal pressure (Kerner & Goodyear, 2017). They are also sceptical about the educational value of self-tracking, experience negative feelings about themselves after using them, and are left with narrow conceptions of health and fitness through peer-level surveillance, self-surveillance, and normative physical activity standards (Depper & Howe, 2016; Goodyear et al., 2019; Kerner & Goodyear, 2017). Moreover, a recent UK-based study found that 16- to 18-year-olds appreciated the affordances of instantaneously reviewing their data, competing against others, and reaching for goals, but they struggled with how to engage with their data, found data interpretation hard, and often forgot to use the device (Rich et al., 2020).

2.3.3.1 Empowerment vs. Surveillance

The paradox between empowerment and surveillance is evident in the existing self-tracking literature (Wissinger, 2017). The emotional affordances of empowerment often feature in self-tracking marketing and scholarship. Proponents of the value of self-tracked data in healthcare argue that they provide beneficial insights that can be used by clinicians to determine diagnoses, and to provide enhanced care for chronic conditions, as well as more personalised, targeted preventative care (Gabriels & Moerenhout, 2018), and allow patients

to be more autonomous in relation to their healthcare (Lupton, 2014b; Rich & Miah, 2014). However, such empowerment-related affordances may look different for adolescents and indeed have been widely criticised for adults (Neff & Nafus, 2016; Sharon, 2017). Adolescents may vary in their perception of and dexterity in engaging with self-tracking tools for self-optimisation or experimentation. The problem is that many tools, "sold through appeals to 'empowerment', do not actually help people figure out which questions they should be asking, much less how to ask the next question, test ideas, or make discoveries" (Neff & Nafus, 2016, p. 11). Adolescents are tasked with navigating this, too, but in a period of considerable biological, social, and emotional development (Archibald et al., 2008). Adolescents are tracking bodies that are neither child nor adult and are experiencing marked growth. Thus, our current understandings of the affordances of self-tracking tools may be inappropriate for adolescents, especially when the inbuilt metrics and standards are established for adult bodies.

Furthermore, affordances of adolescents' digital self-tracking practices raise serious questions around issues of surveillance, privacy, data ownership, and data access (Goodyear et al., 2019; Neff & Nafus, 2016). These are particularly relevant when considering relationships between adolescents, digital tools, and the data the tools and adolescents collectively gather. Digital self-tracking practices require individuals to record, and leave a trail of biomedical data over time. In his discussion of algorithmic identities, Cheney-Lippold (2018) highlights the complexities for individuals in understanding the biopolitical implications of their data being surveilled. He argues that our data allow us to be classified by measurable types (e.g., 'young', 'fit', 'unfit', 'healthy', 'good'); however, these measurable types are ontologically and epistemologically distinct from what we understand by the categories of young, fit, healthy, and good. Despite this disconnect, these measurable types

still have power over individuals and can govern what futures are made available or closed off in offline social spaces. These measurable types "define from a distance but assess us with incredible intimacy" (Cheney-Lippold, 2018, p. 144). Thus, concerns over the possible implications of these data practices and the emergence of the 'quantified child' have led to considerable attention on the consequences of adolescents' digital self-tracking practices and the potential for both present and future harms (Goodyear et al., 2019; Mascheroni & Holloway, 2019; Third et al., 2017; Williamson, 2015; Wyant & Baek, 2018).

Foucauldian analyses of digital self-tracking tools have emphasised their role as implements of biopower; they use systems of surveillance to promote self-discipline and self-regulation of individual bodies on the one hand and biopolitical control of populations on the other (Schüll, 2016). Indeed, describing those who engage in self-tracking practices, Lupton argues that "[t]hese individuals have readily adopted the subject of the responsible, entrepreneurial citizen as it is privileged in neoliberal governmentality in seeking to take action to achieve healthy and fit embodiment and engaging in self-governance" (2013, p. 398). This notion of a self-tracking individual as the ideal neoliberal citizen who is "responsible", "entrepreneurial", and "seeking to take action to achieve healthy and fit embodiment" is perhaps challenged when thinking about the ways in which adolescents might engage in self-tracking practices. Not only might adolescents' differing perception and dexterity make this conceptualisation problematic, but they might also be limited in their ability and agency to control their own bodies as a result of (i) social and institutional restrictions and boundaries placed upon them, and (ii) navigating a time of rapid physiological change.

If we take a step back from what Sharon describes as this "polarised debate" (2017, p. 93) of empowerment versus surveillance, we can instead begin to think through what these tools might afford the users who engage with them in their everyday lives. Self-tracking practices are not merely instrumental but are also "highly personalized experiences that are embedded in our daily lives, routines and interpersonal relationships" (Pink et al., 2016, p. 44). Aligning with scholars such as Fors et al. (2020) and Will et al. (2020), I argue that purely pedagogical or Foucauldian biopolitical approaches to self-tracking are often too technologically deterministic; issues of discipline and power are important considerations, but there is so much more at stake for adolescents as they navigate their elaborate social and psychological worlds. A narrow focus on these models of empowerment and surveillance alone does not equip us to explore the complexities that emerge when digital self-tracking practices become entangled with adolescents' everyday lives. It is for this reason that I view my work through the lenses of sociomaterial practices and affordances.

2.3.3.2 Tracking In and Out of School

Lupton (2014c) describes five typologies of self-tracking: private (tracking for one's own use); communal (sharing data with others who also engage in self-tracking); pushed (tracking encouraged by others); imposed (tracking forced upon people); and exploited (self-tracked data are repurposed for others' purposes). Each of these typologies of tracking might open up spaces for different affordances of self-tracking practices. However, for adolescents, the distinctions between these modes might be particularly blurred where practices cross institutional boundaries, such as between home and school.

Self-tracking tools, however, are not necessarily constrained by these same institutional boundaries. Sanders describes the digital self-tracking tool as an "institutionally unbound

element" (2017, p. 44) of a public health surveillant assemblage. While these tools might be "unbound", adolescents certainly are not. Adolescents often perceive a clear difference between the imaginings of individual and institutional uses of self-tracking tools, showing how there is a shift in affordances when the setting, social circumstances, or mechanisms of control change (Freeman & Neff, 2021).

Schools are important spaces for adolescents' learning and development. Across the Organisation for Economic Co-operation and Development (OECD) countries, average time spent in compulsory education for young people in primary and lower secondary general education is 7, 634 hours over an average of nine years (OECD, 2023). Schools are increasingly harnessing the cognitive affordances of digital self-tracking tools, for instance Fitbit devices or the Polar GoFit app, in an effort to educate young people about the benefits of physical activity and how to improve their own physical activity levels (Casey et al., 2017; Gard, 2014; Lupton, 2016b; Williamson, 2015). This application is most often seen in the context of Health and Physical Education (Casey & Jones, 2011; Nation-Grainger, 2017; Pang et al., 2018), where schools have been established as target settings for physical activity interventions (Tymms et al., 2016). Figure 2.3 shows one such example, Moki, which is designed to be "a fun and easy way to get kids engaged with physical activity at school" (Moki, 2022). When thinking about applying principles of the quantified self to these learning spaces, Eynon (2015) raises critical questions and encourages careful consideration of the consequences of quantified learning for all individuals. For example, Eynon writes that "there is likely to be a kind of trade-off between the reliability of the data that can be collected and the richness of what can be measured" (2015, p. 408). Whilst digital self-tracking tools are typically marketed towards

individuals (Gilmore, 2016), their use within institutions has been well documented. But what can they measure? And what are the trade-offs?

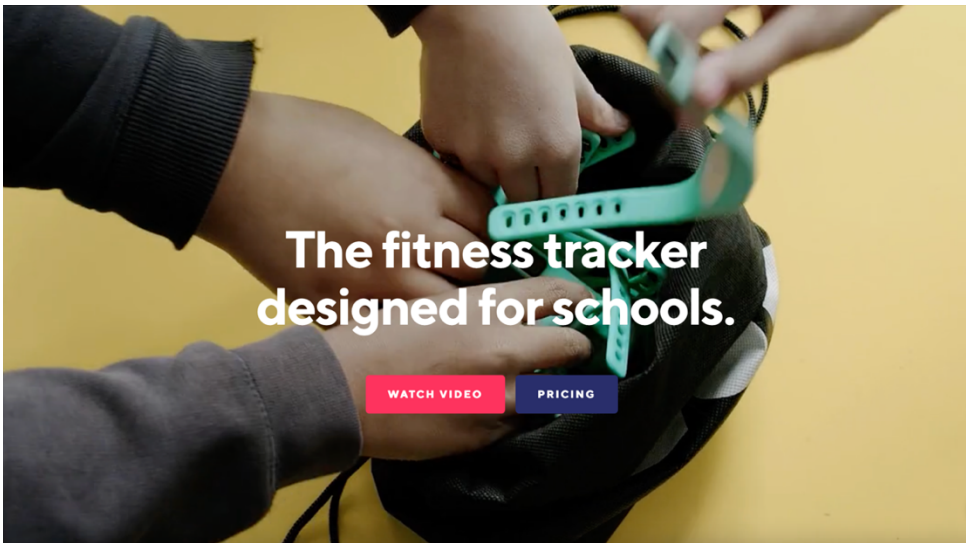


Figure 2.3. Moki, an example of digital self-tracking tools used in schools. Source: https://moki.health.

Scholars working in this area tend to articulate one of two narratives (Goodyear & Armour, 2018). Some are optimistic about the opportunities presented by digital self-tracking tools in this context, lauding them as 'the solution' for engaging adolescents in Health and Physical Education and supporting student learning (Casey et al., 2017; Depper & Howe, 2016; Goodyear et al., 2019; Goodyear & Armour, 2018; Pang et al., 2018). Many of these researchers argue that digital self-tracking tools are cost-effective methods of increasing adolescents' physical activity (Goodyear et al., 2019; Rich & Miah, 2014). Others adopt a more critical perspective on these technologies, and their arguments are dominated by concerns that the surveillance practices and risks associated with digital self-tracking tools render their use inappropriate in education (Goodyear et al., 2019; Third et al., 2017; Wyant & Baek, 2018). Researchers have also raised concerns about the possible harmful effects of digital self-tracking tools for adolescents' physical and psychological wellbeing (Depper &

Howe, 2016; Kerner & Goodyear, 2017; Lupton, 2016a) and the potential for the limited cognitive affordances of digital self-tracking tools to restrict learning environments and assessments (Gard, 2014; Williamson, 2015).

Both of these narratives are quite deterministic, and there is a need for a more nuanced perspective here. Whilst digital self-tracking tools might encourage increased levels of physical activity (Ringeval et al., 2020), when taken too far they can also encourage disordered eating and obsessive exercise behaviours (Hahn et al., 2022; Levinson et al., 2017). Similarly, although adolescents are often more concerned about peer-level surveillance than top-down surveillance by teachers (Freeman & Neff, 2021), these same surveillance affordances can foster feelings of community and support amongst users (Lupton, 2015). Neither perspective can adequately capture the intricacies of adolescents' experiences of tracking. Consequently, it is helpful to consider the sociomaterial arrangements that might open up or constrain different tracking practices to better understand how self-tracking might be better integrated into adolescents' lives, both in and out of school.

The design of many digital self-tracking tools relies on an imagined daily, consistent, and continuous use (Gorm & Shklovski, 2019). Indeed, Gilmore describes digital self-tracking tools as "everywear" (2016, p. 2524): so ubiquitous that they infiltrate everyday spaces. Owing to challenges around cultural and institutional legitimacy, this model of continuous use may not be realistic for adolescents in the school or home context. As Clark, Southerton, and Driller emphasise, "digital self-tracking devices are not always used in the ways imagined or intended, but instead are often repurposed according to the specific contexts, histories and needs of those using the device" (2022, p. 5).

Models of consistent, continuous use of self-tracking tools might also be unsuitable for adolescents. If adolescents are not in the position of power that is necessary to successfully negotiate or reconfigure these boundaries of appropriate behaviour, there may be a disconnect between the imaginaries of self-tracking tools as behaviour change agents and the possible self-tracking practices available to adolescents in institutional contexts. This is problematic and worthy of further exploration. However, Lupton (2020) found that relatively few studies have been conducted on young people's use of wearable tools for health and fitness and that most of the work had centred on work in which participants were provided with self-tracking technologies by the research team. Such interventions and prescriptive school-based studies often do not consider what these tools might afford adolescents in their everyday lives, and adolescents might choose to engage with these tools differently when they do so of their own volition (Potapov et al., 2019).

Marketing for off-the-shelf tracking tools often focuses on their ability for data-driven behaviour modification, nonetheless such modification depends on people's ability to make changes based on their access to and negotiations around their data (Neff & Nafus, 2016). This imagined affordance of behaviour change may not be an appropriate framework for understanding adolescents' digital self- practices, because they are considerably more constrained by the routines and rituals of home and school institutions than adults might be in their workplace and everyday lives. For them, agency works differently. By drawing on the work of Spiel et al. (2018) in the field of HCI, we can see how the rigid, normative design of digital self-tracking tools often embodies the goals and ideals of designers rather than the diverse practices of the end users. As Williams et al. point out, "New technology advancements are often made for a generalized population within a specific population, meaning that technology cannot always benefit everyone" (2020, p. 5). For example,

periodic reminders to 'stand' or 'move' (a functional affordance of many self-tracking devices e.g., Fitbit and Apple Watch) may not be appropriate for adolescents whose daily timetable is often outside of their control. Moreover, certain digital tools have been banned from certain spaces within the boundaries of the school, such as exams and ironically, Physical Education lessons.

2.3.4 The Social Life of Self-Tracked Data

If we adopt Morris's definition of social media as "all the technologies we use to connect" (2018, p. xx), it is helpful to think of digital self-tracking tools as forms of social media. Morris argues that "we are not just information-processing machines. We may initially procure connected devices for efficiency but we use them relationally—to send and receive social signals" (2018, p. 2). Understanding self-tracking tools as social media reminds us that they are about so much more than the *self* and sit within a broader, relational information ecosystem that allows connection, comparison, and community. Indeed, many of these social capabilities are in-built into self-tracking tools. For example, Strava describes their platform as "the social network for athletes" (Strava, 2022), allowing users to give 'kudos' to each other in recognition of their performance. Applying this to the adolescent context, boyd articulates that "social media has become an important public space where teens can gather and socialize broadly with peers in an informal way" (2014, p. 5). For these reasons, it is of great importance to consider the social life of digital self-tracking data and their role in adolescents' social networks.

Just like many adolescents, self-tracked *data* have a rich and vibrant social life. Indeed, the affordances of self-tracking extend far beyond the *self* (Neff & Nafus, 2016). Social, emotional, and identity affordances work together in the digital self-tracking experience.

Many of the self-tracking devices and apps available on the market today include social data sharing, competition, and gamification capabilities. Evidence suggests that these social features can have positive effects on individuals' health and wellbeing, intention to exercise, motivation, sense of achievement and performance in physical activity and health contexts, and feelings of social connectedness (Fukuoka et al., 2011; Morrissey et al., 2015; Sarkar et al., 2016; Zhu et al., 2017). Companies have been eager to harness these in their product design. In 2017, Fitbit expanded their app's social capability to include a new 'Community' feature: a social network built into the app to allow users to "connect, share and compete when you want, with anyone you want" (Fitbit, 2019).

boyd explains that "[t]eens continue to occupy an awkward position between childhood and adulthood, dependence and independence. They are struggling to carve out an identity that is not defined solely by family ties" (2014, p. 17). The body and the data relating to it are critical for understanding one's identity and the physicality of many self-tracking tools is important; there is a performative aspect to using and owning digital self-tracking tools. Identity can be manifested in these tools and that can play into this concept of identity formation (Lupton, 2016b) for adolescents. Self-tracking devices, as the name suggests, aggregate data that say something about the 'self'. Moreover, as Neff and Nafus emphasise, "[s]elf-tracking data refers to an individual person, but it is fundamentally social" (2016, p. 8). Digital self-tracking tools have made personal data social through links with other media and opportunities for motivational, comparative, and competitive interactions with other users (Depper & Howe, 2016; Fotopoulou & O'Riordan, 2016).

Social comparisons are a powerful emotional affordance of self-tracking tools. Self-tracking tools are firmly embedded within a "biomedicalized culture [that] teaches us to measure

ourselves in the context of others" (Neff & Nafus, 2016, p. 38). These social comparisons serve an important role as psychological mechanisms that influence individuals' judgements, behaviour, and experiences (Corcoran et al., 2011). Such comparison processes are seen in adolescents' offline interactions too (e.g., Krayer et al., 2008), but, as boyd highlights, "[n]ew technologies and mobile apps change the landscape, but teens' interactions with social media through their phones extend similar practices and activities into geographically unbounded settings" (2014, p. 8). These social relationships and peer-level comparisons perform an important function during the adolescent period as this is a critical time for identity formation (boyd, 2014; Erikson, 1968; Ragelienė, 2015).

Digital self-tracking tools afford opportunities for comparison through functional affordances like leader boards (i.e., a ranked list of individuals' names and activity levels compared against one another) and through competitions with known and unknown others. Mau argues that when it comes to self-tracking tools, "the availability of quantitative information reinforces the tendency towards social comparison" (2019, p. 6). Because of this, one possible lens through which to consider adolescents' comparative social relationships is Festinger's (1954) social comparison theory. Social comparison theory suggests that individuals possess an innate drive for accurate self-evaluation. However, in contrast to Festinger's (1954) emphasis on self-evaluation as the purpose of social comparisons, subsequent research has suggested that individuals might engage in biased social comparisons for the purposes of self-improvement or self-enhancement (Wood, 1989). An example of this might include comparing one's step count with that of an extremely active friend as a means of motivating oneself to walk further each day.

Social comparison theory has recently been applied to social media (e.g., Vries & Kühne, 2015; Yang et al., 2018) and digital self-tracking tools (Zhu et al., 2017) and offers an important lens through which to consider adolescents' social relationships seen with and through self-tracked data. Digital technologies are increasingly important in the construction of individuals' personal and social identities (Kietzmann et al., 2011; Miller et al., 2016), and as self-tracking devices are said to provide users with 'self-awareness' and access to previously invisible biometric data about the self and the body, they are important sites for identity construction (Lupton, 2016b). As adolescents struggle with how others perceive them, these processes take on even greater complexity when considering the comparison of intimate self-tracked biomedical data that is allowed or encouraged by digital self-tracking tools.

Existing work on social comparisons on social media has paid great attention to associations between upward social comparisons and reduced psychological wellbeing (Fardouly et al., 2017; Ho et al., 2016; Reer et al., 2019). Lupton argues that, within self-tracking, bodies that cannot be contained or controlled are objects of "pity" while those that are lean and fit are "portrayed and regarded as morally just" (Lupton, 2016b, p. 51). Social comparisons with friends play an important role in adolescents' dissatisfaction with their body image (Ho et al., 2016), and this can have negative impacts on adolescents' wellbeing (Neumark-Sztainer et al., 2006). In a previous paper, I have shown that these self-tracking comparisons can have very real offline consequences for adolescents, and they share concerns around bullying and lowered self-esteem (Freeman & Neff, 2021). Conversely, such comparisons are also important for motivation and for helping young people to navigate their social worlds (Goodyear & Armour, 2018). Consequently, this context of peer comparison in adolescence points to important areas for research

concerned with the unique affordances of technological tools for this population so that we can understand "the very lenses we use to see ourselves and others" (Neff & Nafus, 2016, p. 9).

Social self-tracking practices are not always contained within the ecosystem of the self-tracking tool itself, and extensions are often seen in posts on other social media platforms, such as Facebook and Instagram, as well as in online and offline peer conversations and relationships (Kent, 2020). As described by Sharon, "digital self-tracking tools usually have built-in functions that enable and encourage users to share and compare their findings with others, via social media and specially created platforms" (2017, p. 111). Thus, these social and emotional affordances are not only important for competition and comparison, but also for making connections with others (Kristensen et al., 2021; Rooksby et al., 2014). Indeed, belying the term *'self*-tracking', Rooksby et al. describe how tracking practices are often "co-present activit[ies]" (2014, p. 1170) that are carried out with friends, family, and colleagues. These social connections, found through self-tracking, were particularly important during the height of the COVID-19 pandemic lockdown periods when people were socially and physically distant from one another (DiCosola et al., 2022). We currently know little about what these connections and comparisons look like for adolescents.

2.3.5 Tracking Towards Wellbeing: Managing the Impact of COVID-19

Companies that sell digital self-tracking tools have turned their attention to not only physical but also psychological wellbeing (see Figure 2.4 for an example). There is growing interest, both in academia and in industry, in how digital self-tracking of health and fitness might trigger emotional responses.

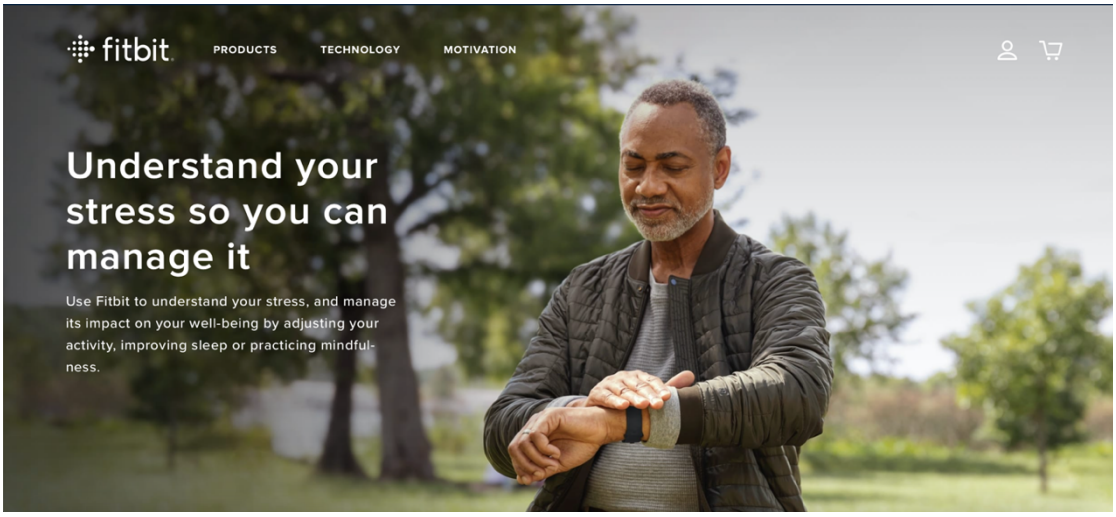


Figure 2.4. Fitbit advertising focusing on psychological wellbeing and stress. Source: https://www.fitbit.com/global/uk/technology/stress.

Adolescence is a particularly vulnerable period for reduced psychological wellbeing (Bonell et al., 2014; Chanfreau et al., n.d.) and mental health problems often first emerge at this time (P. B. Jones, 2013; Kessler et al., 2005, 2007). Poor psychological wellbeing can have harmful effects on various aspects of adolescent life such as social relationships, physical health, and academic achievement (Kern et al., 2016). Good psychological wellbeing is fundamental to a range of developmental tasks. These tasks include: acquiring the emotional and cognitive skills that are necessary for independent living, transitioning to university or employment, and establishing long-term relationships with others (Patton et al., 2016).

Self-tracking tools are often designed to promote improvements in physical wellbeing (Gilmore, 2016; Nation-Grainger, 2017); however, these tools might have negative consequences for psychological wellbeing, for example by encouraging obsessive, or addictive behaviours (Lupton, 2016a). Self-tracking research has found that these tools can

sometimes allow or encourage disordered eating behaviours, dissatisfaction with one's body image, and maladaptive exercise behaviours (Honary et al., 2019). Despite this, there has been limited exploration of psychological wellbeing in the context of adolescents' self-tracking practices. Quantitative data have yet to be used to explore the relationship between adolescents' psychological wellbeing and self-tracking practices. Meanwhile, qualitative data have been used to highlight the potentially harmful effects that digital self-tracking practices can have for adolescents' psychological wellbeing (Goodyear, Armour, et al., 2018a; Goodyear et al., 2019). For instance, Goodyear et al.'s data suggest that the use of digital self-tracking tools might create internal pressure and negative feelings about the self; *"when I'm not wearing it [a Fitbit], it's less pressure to get the steps done"* (2019, p. 9) and *"if you don't do a lot of exercise in a day, then you just feel really bad"* (p.9). Goodyear et al. used these quotations to demonstrate "how the surveillance practices [of self-tracking] impacted on wellbeing" (2019, p. 9) .

In previous work, I found that adolescents recognise the potential for their own, and others' self-tracked data to have negative effects on psychological wellbeing (Freeman & Neff, 2021). For example, one 17-year-old female said, *"Health tracking apps can instigate false ideals such as weight loss which is especially damaging to pupils mental health"* (Freeman & Neff, 2021, p. 8). Thus, there remains important work to be done to understand the affective dimensions of adolescents' self-tracking practices.

Given the global crisis caused by the COVID-19 pandemic and its disruption of routines, this period has also been an important one in which to consider psychological wellbeing. Young adults (aged 18-24 years) have demonstrated the greatest deterioration in mental health as a result of the COVID-19 pandemic (Pierce et al., 2020). An Australian study of

760 adolescents found that 75% of young people experienced worsened mental health, as well as greater sleep disturbance, psychological distress, and health anxiety compared to normative samples (S. H. Li et al., 2021). Nonetheless, there remains a lack of research into the disruptive effects of COVID-19 for adolescents and its impact on psychological wellbeing (Racine et al., 2020) and thus this is an important moment to consider the emotional affordances of self-tracking for young people.

Vallee writes, "The COVID-19 pandemic redefines how we think about the body, both physiologically and socially. But what does it mean to have and to be a body in the COVID-19 pandemic?" (2020, p. 1). Tracking the *adolescent* body adds new layers of challenge (Freeman & Neff, 2021). This thesis aims to help us better understand how we might think about the following important question: what does it mean for adolescents to have and to be a tracked body during the COVID-19 pandemic?

2.3.6 Fighting Invisibility in Design: Where Are Adolescent Voices?

There is a long history of academic work on adolescents and technology that foregrounds young people's perspectives (K. Davis & Subramaniam, 2022). However, adolescents are often underrepresented not only in academic scholarship concerning self-tracking but also in technology design work, particularly in the self-tracking space (Potapov et al., 2021). In a recent report by *Data & Society*, Lenhart and Owens (2021) revealed that for many technology companies, adolescents are commonly an afterthought (often owing to recruitment and ethics-related challenges), or indeed intentionally absent from design research in order to avoid legal liability. It is therefore worth considering more deeply the disconnect between the imagined affordances of adult designers and adolescent users. As Lenhart and Owens argue, "Designing for adolescents doesn't just address some unique

vulnerabilities they possess because of their developmental life stage and disempowered legal status, but can serve as a vanguard for better tech for everyone" (2021, p. 9).

One avenue is to consider the educational resources that are designed to support adolescents' engagement with technologies. During adolescence, young people learn behaviours that they carry with them into adulthood (Manganello, 2008; Skopelja et al., 2008). They often lack the social and educational support required to feel confident in making informed health-related decisions (Freeman et al., 2018; Jeminiwa et al., 2019; Rich et al., 2020). Technology increasingly sits at the heart of much health-related education as adolescents change their health behaviours in response to online content (Goodyear, Armour, et al., 2018a).

There is an urgent need to move away from a traditionally patronising and didactic education paradigm around health-related technologies, which can be frustrating for young people and potentially hinder them from getting the best out of technology (Freeman et al., 2020; Goodyear, Wood, et al., 2018). Instead, drawing on work done elsewhere to emphasise adolescents' perspectives, we should consider how flexible education interventions might support young people's interactions without technology curtailing their opportunities (Livingstone & Helsper, 2010; Stoilova et al., 2020). Adolescents have repeatedly been shown to be critical and sophisticated users of self-tracking technologies (Potapov et al., 2019); however, little work has been done to understand how we might support their self-tracking experience with additional educational resources to encourage positive and fulfilling engagement with self-tracking tools in a way that meets their needs and expectations. There is an opportunity to now think about how stakeholders might better collaborate to scaffold the self-tracking experience for young people. An important step in the right direction is

dialogic exchange, which can take place in co-design workshops, for example (Robert et al., 2015).

Recent research in HCI has increasingly sought to engage with adolescents through innovative extended co-design and participatory design methods (Pitt & Davis, 2017). Although this work is not always specific to health and fitness tracking, it is important work that is extending ideas about self-tracking beyond the school institution and is delving into adolescents' everyday lives (Potapov et al., 2019; Potapov & Marshall, 2020). This work has highlighted that adolescents' motivations for self-tracking and the effects of these practices in their lives are distinct from those of adults, and it emphasises the importance of affordances for flexibility and self-expression and the ways in which self-tracking practices can foster social connection, learning about the self, and identity development (Potapov & Marshall, 2020). Privacy and curation affordances are key for adolescents (Potapov & Marshall, 2020) and adolescents are concerned about how their tracking allowed them to fit in with accepted social norms, which are often set by adults (Potapov et al., 2019).

Young people are skilled at making technology work for them (boyd, 2014), but they typically lack guidance to provide them with the perception and dexterity to condition the affordances of these tools in their particular circumstance and often lack the social support and resources required to access relevant health information and make informed health decisions (Freeman et al., 2018; Jeminiwa et al., 2019). Ploderer et al. make an important argument: "What is needed, we contend, are ways to help teens figure out what questions to ask in the first place, what data to collect, and what reflections and insights might be possible through personal data" (2022, n.p.). This lays the foundation for future design

work, which should go beyond thinking about the tools themselves and instead lean towards thinking about how best to design self-tracking communication resources with adolescents; what do adolescents want to know about how to integrate these tools into their personal and social worlds?

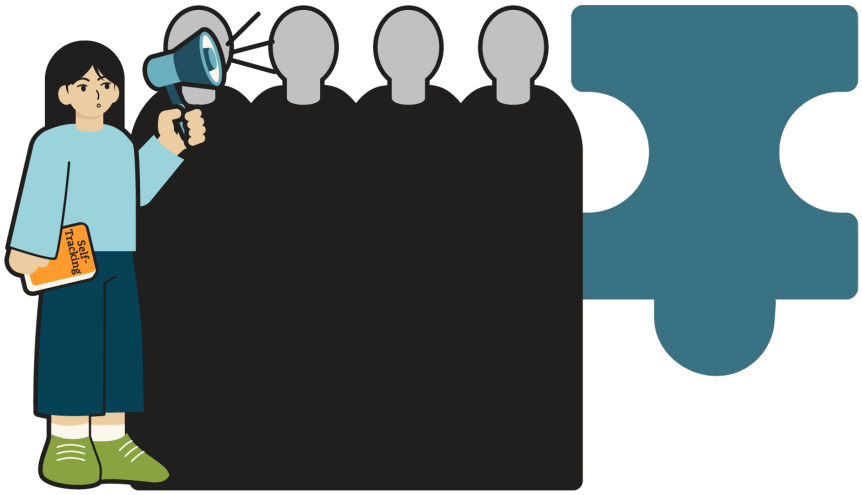
2.3.7 Where Are We Now?

This literature review demonstrates the need for in-depth research on the affordances of digital self-tracking for adolescents. Whilst there are playful and creative opportunities for the use of these tools, adolescents also express concerns that self-tracking could be stressful or too competitive ((Freeman & Neff, 2021; Rich et al., 2020)). By adopting an imagined affordances framework, I reveal the tensions between the affordances of digital self-tracking tools for adolescents and the assumptions that might have been made in the design process about the imagined adult users of these tools. So how might the adolescent context impact the everyday affordances of their self-tracking practices?

In my research, I cannot and do not attempt to address all aspects of young people's tracking practices. As highlighted above, there are important considerations around issues such as privacy and trust, and the quantification of childhood (Livingstone et al., 2020; Mascheroni, 2020) – to name only a few potential problems – that will not be examined closely in this thesis. Instead, I want to move away from a 'one size fits all' approach to adolescents' self-tracking (Freeman & Neff, 2021) and map the imagined affordances of digital self-tracking for adolescents – their expectations, fears, and uses of these tools – and use the findings to provoke further discussion. To do this, I explore what it means to have and to track an adolescent body during a global health crisis. How do adolescents situate self-tracking practices in the context of social relationships and psychological wellbeing?

And how can we do better for young people who engage in these practices? In the subsequent chapter I outline my methodological approach and methods used to address these questions.

3 Amplifying Adolescent Voices: Methodology and Methods



"Interestingly enough, when I did your survey, it was like a really good self-reflection 'cause I didn't realise how much I... not valued… but like I was really attached to the numbers." (Quinn, 17)

3.1 Introduction

The methodological choices for this mixed methods project have centred around the aim of this thesis, which is *to explore the affordances of self-tracking for adolescents' psychological and social wellbeing*. As I described in the literature review, there is an urgent need for work exploring adolescents' everyday self-tracking practices (Freeman & Neff, 2021), particularly in the context of the COVID-19 pandemic. To address this gap, I involved over 600 adolescents across the UK with varying levels of experience of self-tracking tools in several research activities: an online survey, semi-structured interviews, and co-design workshops. These triangulated methods take a step forward towards deepening our understanding of

adolescents' self-tracking practices and their social and psychological implications. Throughout my research, I have leant on the theoretical fabric described in Figure 2.1 in order to think deeply about these sociomaterial entanglements and affordances of adolescents' self-tracking practices, how I might best draw these out through my research methods, and what my data can tell us when seen through these lenses. Together, these methods show how key sociomaterial affordances (such as control) differ within and between adolescents, and they promote further consideration of how we might design resources with adolescents to better support young people's autonomous, positive engagements with self-tracking technologies.

In this chapter, I detail the impact of the COVID-19 pandemic on the research design and how the final methods are influenced by the theoretical, ontological, and epistemological foundations of the project. The sections of this chapter will therefore reflect on three key topics: justification for the methodological choices made and considerations of their relative strengths and weaknesses, ethical considerations, and an outline of the final methods of data collection and analysis.

3.2 The Challenge of COVID-19: Reimagining the Project

The impact of COVID-19 is not only apparent in the data collected (discussed later, in Chapter 4) but also how I made choices concerning data collection. When I proposed this project, it entailed three sequential stages: (i) in-person focus groups with adolescents, (ii) an online survey distributed to adolescents, and (iii) in-person co-design workshops. The originally planned recruitment strategy was to approach young people through schools. This framing enabled me to think through some of the institutional factors that shape the affordances of self-tracking tools for adolescents. Moreover, this approach would also have

lessened some of the ethical challenges surrounding recruiting young people by putting a gatekeeper in place (e.g., school principals or other figures of authority within the school). This would have allowed me to work with young people in the presence of teachers in a familiar environment, the school.

As was the case for many social scientists (Howlett, 2022), in-person methods became impossible in March 2020, after the onset of the COVID-19 pandemic. Schools were closed (see Figure 3.1), and although they reopened intermittently throughout the year, the practical, emotional, and time burdens on staff and students alike were too great to enable me to enter these spaces to conduct my research. I had to think carefully about how to reimagine the project in a way that still allowed for the collection of rich data in the context of a world in upheaval, whilst also ensuring the safety and wellbeing of the young people involved. I tried to reach out to schools to gauge interest during this time; however, this proved unsuccessful, and instead I adopted an alternative approach.



Figure 3.1. School closures in the UK as a result of the COVID-19 pandemic. Source: https://www.theguardian.com/world/2020/dec/13/greenwich-schools-to-close-covid-london-borough.

A shift to online methods[7] was the most practical option. As so much of life moved online, it made sense for my research to follow suit. In fact, these methods were particularly appropriate as the COVID-19 pandemic presented a unique moment to consider adolescents' everyday self-tracking practices outside of the physical bounds of the school institution.

It would be remiss of me to pretend that this reimagining came quickly or without any challenges. Nevertheless, the reconfiguring of this project and the move to using solely online methods opened the way for a number of exciting opportunities and advantages for this work. Firstly, by recruiting through social media rather than through schools, I was able to access a broader sample of young people who were attending institutions other than schools, including workplaces and universities, as well as adolescents who were home-schooled. Secondly, this approach removed geographic barriers (Shapka et al., 2016), and I was able to access participants from a wider geographical range in a way that would not have been possible previously with the time and resources I had available. Nevertheless, it should be noted that certain constraints remained. For example, this method required participants to have: access to the Internet, appropriate technology available to participate in the research, and a certain level of English language literacy to engage in the activities.

On the other hand, in-person interviews and workshops would have also raised a number of challenges for this research. I would have been restricted to working with certain

[7] Online methods are often referred to as remote methods (e.g., Engward et al., 2022). However, I hesitate to use the term 'remote' in this thesis as this foregrounds a distance between the researcher and the participants. This notion of distance does not align with my experience of online methods, because instead I found myself feeling closer to participants as they shared their experiences in personal spaces within their homes. Therefore, the term 'online' is preferred in this work.

schools and to having workshops take place within schools and with students who were already familiar with working with one another. Successfully facilitating conversations around potentially sensitive topics within these group dynamics would have required a great deal of thought and care. Instead, by moving the interviews and workshops online, I was able to create new and interesting groups of young people from across the UK. This opened up novel dialogues as I was able to bring together young people who otherwise would never have met, generating rich discussions and tensions between different experiences, which have provided wonderfully insightful data.

In moving to online methods, the project also became more accessible. Adolescents with various health challenges were able to participate in a way that may not have been possible offline. Participants also had control over how they participated and how much information about themselves they disclosed to the researchers and other participants. For example, adolescents were offered multiple ways to participate in the interviews and workshops, including audio, video, and text-based communication. This allowed them to share as much or as little of themselves to others as they felt comfortable to do.

My research is not necessarily better or worse than originally planned; it is just different, and I was able to gain different insights and draw different conclusions. It is important to recognise how these necessary changes and decisions have shaped the project and the opportunities and challenges that this has thrown my way. The description of methods below outlines the stages that took place, beginning with the rationale for the project, and Figure 3.2 outlines the timeline of the key relevant COVID-19 pandemic events that ran alongside this research project.

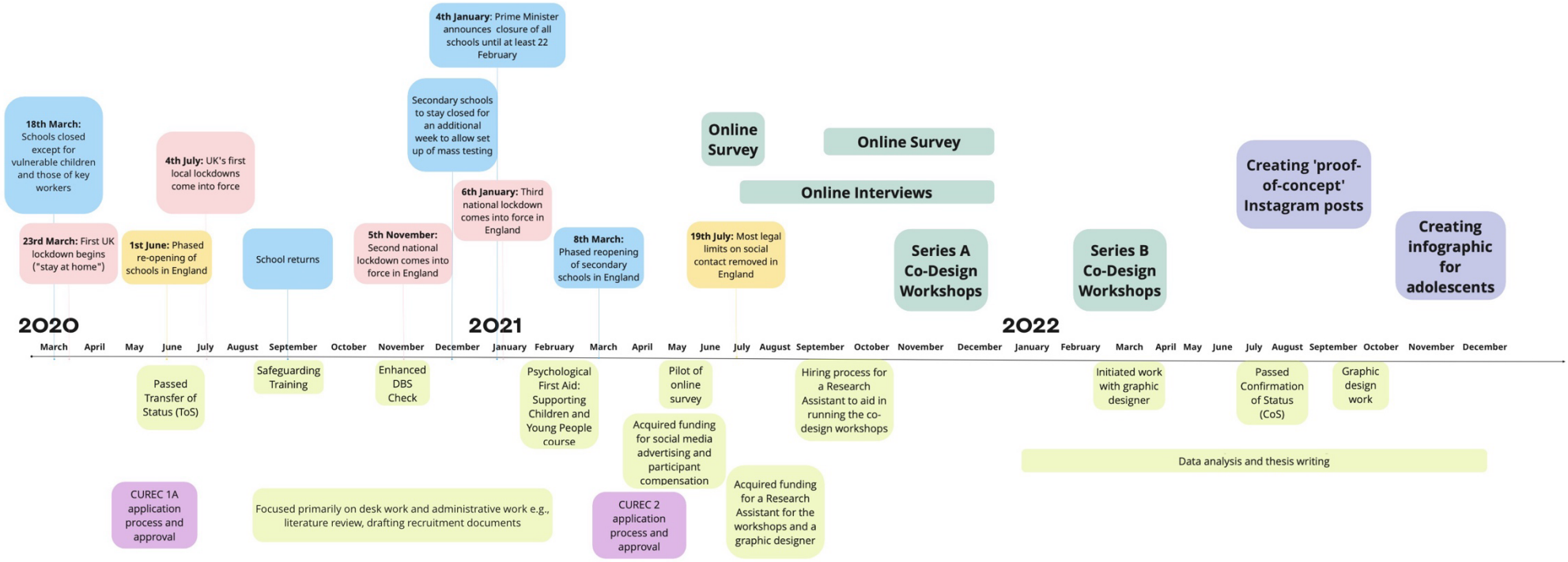


Figure 3.2. Timeline of COVID-19 pandemic events relevant to this study alongside research progress.

3.3 Rationale for the Current Project

Many aspects of life can be tracked; however, I have followed Goodyear, Armour, et al.'s (2018b) approach and have limited the focus of self-tracked data in this project to physical health and activity data. The advantage of restricting the scope in this way is that this allowed me to be clear about how to address my research questions and the data and analysis methods that were needed to produce rich data.

This project was designed to address some of the gaps in our understanding of adolescents' digital self-tracking practices outlined in Chapter 2, the previous literature review chapter. Adolescents are an understudied population in the area of self-tracking, and this work was undertaken with a view to explore young people's lived experience of engaging with self-tracking tools in their everyday lives. When I was selecting research methods, I placed particular emphasis on calling attention to adolescent voices in order to better understand the ways in which adolescents themselves think through the affordances of their digital self-tracking practices, the implications for their psychological and social worlds, and how they see the way forward regarding designing resources around these practices.

3.3.1 Methodology: The Suitability of a Mixed Methods Approach

Chamberlain et al. (2011) emphasise the importance of ensuring coherence between the research aims and purposes, philosophical, theoretical, and methodological assumptions, and methods in high-quality research. Therefore, I want to make clear how I thought through the coherence of the design of this project.

I used a mixed methods methodology, defined by Johnson and Onwuegbuzie as "the class of research where the researcher mixes or combines quantitative and qualitative research

techniques, methods, approaches, concepts or language into a single study" (2004, p. 17). A mixed methods design offered the flexibility to design my project so that it was based on careful consideration of the most appropriate methods that could be used to answer each of my research questions (Onwuegbuzie & Leech, 2005). Opening up this flexibility to utilise both quantitative and qualitative methods enabled me to consider several diverse lenses through which to view adolescents' digital self-tracking practices (Onwuegbuzie & Leech, 2005). In line with previous work on mixed methods research (e.g., Bryman, 2006; Johnson & Onwuegbuzie, 2004; Niglas, 2010; Tashakkori & Teddlie, 1998), my research questions informed my selection of research methods.

Secondly, Gilmore (2016), when thinking more deeply about the digital tools that support self-tracking practices, argues that the social capacities of these tools reshape quantitative self-tracked data into qualitative and social phenomena. Therefore, for digital self-tracking practices to take place in a meaningful way, individuals' quantitative self-tracked data and their qualitative experience must mutually reinforce one another (Gilmore, 2016). As this relationship between quantitative data and qualitative lived experience is fundamental to the design and understanding of these digital tools, it seemed appropriate that a similar approach be adopted in this project.

Mixed methods methodologies are commonly seen in research on digital self-tracking tools (Hamari et al., 2014) and therefore this approach is consistent with existing work in this area. I selected a mixed methods design with three research activities: an online survey, online semi-structured interviews, and online co-design workshops. Using Morse's (1991) taxonomy, I would describe this project as QUAL + quan. The '+' indicates that the quantitative and qualitative methods were triangulated simultaneously (rather than

sequentially), and the use of upper- and lower-case letters indicates the weighting (i.e., qualitative methods were primary and quantitative methods were secondary). The survey results serve to add context and complement the qualitative data; however, I want to emphasise early on that a large proportion of the findings chapters to follow will centre closely on the qualitative data from the interviews and on the co-design workshops. This foregrounds adolescent voices and experiences of self-tracking, in keeping with one of the core aims of this project.

As is common in mixed methods work, a pragmatist philosophy underpins this research (Johnson & Onwuegbuzie, 2004), and I have kept a clear focus on "what works" (Weaver, 2018, p. 1286). Johnson et al. argue that mixed methods research is "an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints (always including the standpoints of qualitative and quantitative research)" (2007, p. 113). The benefit of this, as described by J. Creswell and Plano Clark, is that "the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone" (2007, p. 5). By using this pragmatist approach to guide my research design, I did not commit myself to a single approach but rather decisions about the methods that would be used for this work were carefully considered to decide which strategy would best answer each of my four research questions (Onwuegbuzie & Leech, 2005).

One of the great strengths of a pragmatist approach is that it "moves beyond technical questions about mixing or combining methods and puts us in a position to argue for a properly integrated methodology for the social sciences" (Morgan, 2007, p. 73). A pragmatist approach is not committed to any single system of reality and has a practical and

outcome-oriented focus. Reality is understood to be ever-changing and this approach is focused on solving practical problems. This pragmatist philosophy offered me the great flexibility of using a combination of appropriate quantitative and qualitative approaches to examine adolescents' self-tracking practices through multiple lenses in dialogue with one another (Onwuegbuzie & Leech, 2005).

While pragmatism informed my overarching methodological approach and use of mixed methods, in this work, the methods and data analysis were weighted more heavily towards the qualitative. The qualitative element of my work was supplemented by a broadly interpretivist stance which was able to better foreground the voices and perspectives of the adolescent participants. Previous work has demonstrated the value of combining pragmatism and interpretivism in research (Goldkuhl, 2012). Interpretivism emphasises a relativist ontology, which is that reality in the world is seen through the lived experiences of different individuals engaging in social interaction (Klein & Meyers, 1999). Central to my research was the meaning that adolescents make from their self-tracking experiences, as told through their own stories in the survey, interviews, and workshops. Klein and Meyers write that "research can be classified as interpretive if it is assumed that our knowledge of reality is gained only through social constructions such a language, consciousness, shared meanings, documents, tools, and other artifacts" (1999, p. 69). As a researcher, I do not see myself as separate from my work and adopt a subjective epistemology (Guba & Lincoln, 1994). In this thesis, I recognise adolescents as actors in their own social worlds and seek to understand the meaning they ascribe to their self-tracking practices.

When I have tried to describe the journey of this mixed methods research, I have thought of myself as a tourist in a not-altogether-unfamiliar territory trying to understand the local

customs and culture. I describe my positionality later, in Section 3.8; however, when in the online 'field' and collecting data, I moved fluidly between 'insider' and 'outsider' positions as I tried to put together the pieces of the puzzle. The online survey served as somewhat of an excavation process. I was able to go in and get a lay of the land. I found the key landmarks, but the details were still unclear, like a simple outline of a map with a landscape that had yet to be filled in. The interviews allowed me to explore deeper. Here, the adolescents took me by the hand and guided me through the land I had excavated, filling in the colours and details of the map and explaining the terrain. They also showed me where I might have been incorrect in my initial map-drawing. They pointed to areas where I might have misjudged the terrain, or where there were additional areas of the territory I had overlooked. Finally, the workshops felt as if they empowered the adolescents to be in charge of their own land. I asked them if they liked the way the map was coloured and how they felt about the terrains we had explored together. What did they want to see look different? How would they draw their own, new maps? In doing this, I drew together different communities from the territory to reimagine their future landscape.

In my research, there was also close alignment between theory, methodology, and methods. The review of the literature in Chapter 2 highlights how I combined an affordances framework with a sociomaterial understanding to map out the variability in adolescents' self-tracking practices. In their work drawing together the concepts of sociomaterial practices and affordances, van Dijk and Rietveld (2017) emphasise the importance of 'zooming in' on individuals' first-person lived perspectives through methods such as interviews. Further, one of the strengths of the mechanisms and conditions framework of affordances is that it "centralizes variability, otherness, and difference" (J. L. Davis, 2020, p. 124). Through the use of an online survey, I aimed to better understand the scope of

these differences and to be able to identify patterns in the sociomaterial practices and affordances of digital self-tracking tools. The interviews allowed me to explore deeply the lived experience of self-tracking for adolescents and how they imagined the affordances of these practices in their own lives. Finally, the co-design workshops drew out adolescents' imagined affordances of digital self-tracking tools and resources to explore how adolescents might make sense of sociomaterial self-tracking practices and their implications. Each of these methods are described in detail in Section 3.6 below. As a summary, Table 3.1 describes how each of the research questions align with the relevant theoretical and empirical decisions in this project.

Table 3.1. The alignment between theory, methods, and research questions in this thesis.

Research question	Chapter	Key theoretical and conceptual underpinnings	Relevant data and research method(s)
How did adolescents experience self-tracking during the early stages of the COVID-19 pandemic?	4	• Sociomaterial practices (Orlikowski, 2007) • Affordances (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016; Moreno & Uhls, 2019; Nagy & Neff, 2015)	• Online survey (closed and open-ended responses) • Online semi-structured interviews
How are adolescents' relationships with the self and others seen with and through self-tracked data?	5	• Sociomaterial practices (Orlikowski, 2007) • Affordances (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016; Moreno & Uhls, 2019; Nagy & Neff, 2015) • Social Comparison Theory (Festinger, 1954) • Sociomaterial practices of choice and care (Mol, 2008; Mol et al., 2010)	• Online survey (closed and open-ended responses) • Online semi-structured interviews
How do adolescents make sense of the affordances of digital self-tracking practices for their psychological wellbeing?	6	• Sociomaterial practices (Orlikowski, 2007) • Affordances (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016; Moreno & Uhls, 2019; Nagy & Neff, 2015)	• Online survey (closed and open-ended responses) • Online semi-structured interviews
How might we co-design flexible resources to support adolescents' self-tracking practices?	7	• Sociomaterial practices (Orlikowski, 2007) • Affordances (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016;	• Online co-design workshops

		Moreno & Uhls, 2019; Nagy & Neff, 2015) • Youth participatory and co-design (Björling & Rose, 2019; Lohmeyer, 2020)	

3.4 Ethical Considerations

Ethical considerations are a principal aspect of research design (Brinkmann & Kvale, 2017; Tolich & Tumilty, 2020). The ethical considerations for this project have been central at every stage of the research process and have shaped all aspects of this work. This project went through extensive ethical review through the Central University Research Ethics Committee (CUREC), originally through CUREC 1A at the departmental level and then through the CUREC 2 process at the divisional level following the COVID-related changes described earlier in this chapter.[8] In view of the age of the participants in this study and the potentially sensitive subject matter, great attention is paid in this section to the ways in which I have upheld (and continue to uphold) principles of ethical research in this work in line with the British Psychological Society (BPS) 'Code of Ethics and Conduct' (2021), the Association of Internet Researchers (AoIR) 'Internet Research: Ethical Guidelines 3.0' (2020), and the British Educational Research Association (BERA) 'Ethical Guidelines for Educational Research' (2018), in addition to the Best Practice Guidance[9] provided by CUREC at the University of Oxford to ensure good practice when working with this young population.

[8] Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee Approval Reference: R75812/RE006. I would like to thank all of the administrative staff and reviewers, both at the departmental and at the divisional level, who took so much time and care to ensure that this work could be carried out.

[9] Examples of the Best Practice Guidance that informed this work include: BPG_01: Researcher safety, BPG_04: Research involving competent youths, BPG_05: Payments and incentives in research, BPG_06: Internet-based research (IBR), BPG_09: Data collection, protection and management, and BPG_10: Conducting research interviews.

3.4.1 Working with Young People

Working with young people is not a responsibility that I have taken lightly, and indeed, doing so in the context of a global pandemic raised unique challenges. For example, some of the participants I interviewed took part in the project whilst testing positive for COVID-19. I had to be very mindful to protect their wellbeing and maintain flexibility with rescheduling or cutting interviews short if necessary. In addition to causing difficulties, as discussed in the Introduction, the pandemic also made this work more urgent, given the increased uptake of connected fitness tools and the growing interest in self-tracking for health-related reasons. Consequently, I felt it would be doing a disservice to this population to not attempt to navigate these complex ethical challenges to ensure that I could carry out this research while working with adolescents safely and with integrity. In order to tackle this, before having any contact with research participants, I first applied for an official check to confirm to others that I was safe to work with children and undertook a number of training and safety courses, which were as follows:

- An Enhanced DBS check (November 2020)
- Introduction to Safeguarding training run by the Oxfordshire Safeguarding Children Board (September 2020)
- Psychological First Aid: Supporting Children and Young People course by Public Health England (February 2021)

Lohmeyer explains that "[y]outh research struggles with the dual discourses of youth […] Young people are simultaneously considered to be vulnerable and in need of protection, as well as capable and active contributors" (2020, p. 52). This tension influences ethical review boards and the willingness and ability of researchers to engage in research activities with this population. I certainly felt these tensions in my work and put much thought into

protecting the wellbeing of adolescents whilst simultaneously positioning them as "capable and active contributors".

3.4.1.1 Addressing Sensitive Topics

As discussed in the Introduction, the challenges of COVID-19 for young people's mental health and the disruption to their lives have been immense (Crawley et al., 2020; E. A. K. Jones et al., 2021; Kazi & Mushtaq, 2021; Magson et al., 2021; The Lancet Child & Adolescent Health, 2020). Conducting work at this time of global uncertainty and stress required careful thought and training. As highlighted above, in order to better equip myself to handle the participant-facing research work, I completed a three-week Psychological First Aid course run by Public Health England in response to the pandemic. This provided me with training on how to talk about a range of mental and physical health challenges (e.g., eating disorders, long-term health conditions, trauma, bereavement, domestic violence, neglect). Furthermore, I received a resource pack which I kept at hand to refer to in case I encountered such issues during interviews or workshops.

From the initial survey data that came in during the summer months of 2021, it quickly became apparent that the impact of the COVID-19 pandemic on adolescents was profound and that young people often needed a safe space in which to talk about these challenges. Because they were distanced from their friends and their routines, I was often one of the few people in their lives who had spent an hour being interested in them and allowing their voice to be heard for many months. As a result of this, before the interviews and workshops began, I was prepared for disclosures of struggles with mental health concerns and other challenging personal situations. In advance of these research activities, I developed an email template containing a list of resources that could be sent immediately

following the interview or workshop if required (see Appendix G). I was also aware that for many young people, these experiences are part of their everyday lives. I was mindful that it was important not to make them feel as if they were 'abnormal' or 'other' for disclosing such challenges. Many of the participants did in fact raise these issues during the interviews and workshops, and I ensured that they all had received appropriate support in place, whilst offering them an opportunity to share their story.

The nature of my research meant that it was necessary to address personal and sensitive topics such as health and wellbeing – both mental and physical – and social relationships in each of the research activities. I took a number of steps to ensure that participants were comfortable and felt in control of the information they disclosed, which were as follows:

1. For each research activity, I included links to relevant mental health charities and ways to receive help on the information sheet to point the participants to professionals who are qualified to deal with these issues if they came up.
2. Due to the sensitive and personal nature of some of the questions, in the online survey I used the Qualtrics software to ensure that there were no forced-response questions (i.e., there were not any questions that the participants were required to answer in order to progress with the survey). I also included a statement to make participants aware of this at the beginning of the survey: "You do not have to answer any questions that you do not want to answer".
3. Similarly, in the interviews and co-design workshops, I ensured that participants were aware that they did not have to answer any questions or disclose anything they would prefer to keep private. Participants were made aware that they were free to speak hypothetically, or they could refer to how they observed others if they were uncomfortable discussing their personal experience.

4. Participants were informed at the beginning of the interviews and co-design workshops that they were in control of their own participation and that they were free to choose to stop, to regroup (e.g., take a short break), or to move to a different section of the research activity at any time.

3.4.1.2 Considerations of Consent

One of the most significant barriers to young people's participation in research is the need for parental consent (Hokke et al., 2018). I was determined to design a consent process that did not place an undue burden on participants whilst ensuring that adolescents and, where appropriate, their parents were able to give free and informed consent. Indeed, perhaps one of the most considerable hurdles in transitioning this project into the COVID-19 context was the challenge of working through wholly *online* consent processes with young people and their parents or guardians. A sample of the information sheets and consent forms used in this study are available in Appendix F.

Online participant consent was given for those aged 16–18 years. In line with CUREC Best Practice Guidance, participants aged 16–17 years were considered competent youths (NHS Health Research Authority, 2018), that is, able to give free and informed consent. The consent process was clear and included a verbal briefing before the interviews and workshops to ensure that all participants understood what would (and would not) be involved in the research and that they could withdraw at any time without any penalty.

For those below the age of 16, both online parental consent and participant assent were sought. There was a risk here that adolescents below the age of 16 could have completed the parental consent form themselves. In their review of this issue, Hokke et al. (2018)

highlight how, when using either online or offline research methods, there is always the possibility that participants will be deceptive about issues such as obtaining parental consent. To manage this risk, parents were asked to provide an email address and a copy of their completed consent form was emailed to them. Provided the correct parent email address was shared, this allowed parents the opportunity to withdraw their child's data if their consent was given in error or without their knowledge.[10] Additionally, on the participant assent form for those aged 13–15, participants were also asked to tick a box to confirm that they had spoken to a parent or guardian about taking part in the study. It was hoped that these measures might encourage adolescents to consider what they were doing if they were falsely declaring parental consent.

The safeguards outlined above were imperfect solutions; however, there was no feasible alternative to the strategy just outlined given the resources available to me as a DPhil research student. Indeed, there is a lack of research that has been done with this important population of adolescents, in part because of such complexities. It was important that this work was done to better understand the role of self-tracking practices in adolescents' lives because they are becoming increasingly pervasive in the context of COVID-19. The most effective way forward for this study was therefore to require parental consent for those under the age of 16 and to include the steps detailed above. Furthermore, the research activities were reviewed carefully to ensure that discussions did not stray into areas like the participants' sexual identity or other topics that would be likely to trigger an intense emotional response.

[10] No requests were made by parents to withdraw their child's data throughout the course of this study.

Figure 3.3 outlines the separate consent processes for participants above and below the age of 16. This same consent procedure was followed for each activity such that any participants who participated in multiple activities provided new consent for each individual research activity.

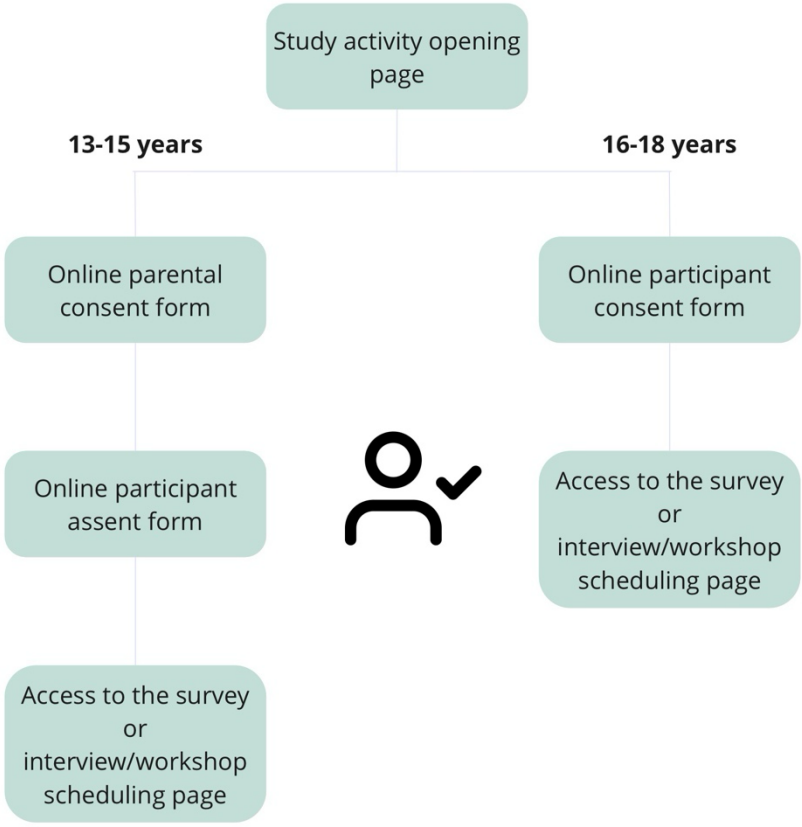


Figure 3.3. Overview of the two separate consent processes for each study activity.

3.4.2 A Comment on Online Work

One of the unique challenges of online research, compared with much in-person work, is that participants can be presented more choice regarding their participation. This has many benefits, including increased accessibility and flexibility in relation to the contribution. In

addition, this can make participants feel more comfortable, particularly if they are taking part from a familiar space, such as their own home. However, this geographic separation raised two key challenges in my research. Firstly, if a participant or someone else was at risk of harm, I had no way of knowing where the participant was located so could not call for help. As a result of this, I was cautious about asking questions that could raise sensitive issues, and I carefully monitored each of the participants during the activities to look for any signs of distress or unease. I also ensured that any participants who did disclose a mental or physical health challenge had told someone about this and that they had appropriate support in place.

Secondly, some participants chose not to turn their cameras on when participating in interviews, and others chose not to use either the camera or audio features in the workshops and instead elected to communicate through the chat functions and online whiteboard activities only. This made it impossible to verify that the participants were in fact 13 to 18 years old and located in the UK. I considered this decision carefully and contemplated making audio and video participation mandatory for this study. Ultimately, I determined that it was not in the spirit of this study to make specific styles of interacting compulsory. Instead, it was more important to include the voices of *all* adolescents who wanted to take part and to give them the freedom of choice over their mode of participation and control over their self-presentation than it was to eliminate the risk that a participant might be deceptive about their age and location.

3.5 Recruitment: Finding Adolescents in Their Space

As Prainsack highlights that just because access to health technologies is "no longer limited to a narrow elite does not imply, however, that everybody will use them. As the groups of

users are widening and diversifying, so are the reasons for non-use" (2013, p. 112). In light of this, I was determined to include adolescents with varied levels of experience in engaging in digital self-tracking practices and to not just recruit highly engaged users. The study was open to any 13- to 18-year-olds in the UK, regardless of their experience of or interest in self-tracking.

For this project, it was important to think about where adolescents were situated and about how I could meet them in 'their space'. I tried to access them through their physical space (the school), but because of the COVID-19 pandemic, this was not possible. Therefore, in the same way that many other life activities migrated online during the pandemic, I turned to the digital space to find adolescents. Here, it made sense to look to social media. A recent study of adolescents in the UK found that the average amount of time spent on social media daily is 4.4 hours (#BeeWell, 2022), and therefore the reach I was able to achieve by recruiting in this way was significant.

The recruitment material for this project was distributed through personal posts on social media channels (Facebook, Twitter, and Instagram). These posts were shared by others in my network, and I also organised a paid advertisement on Facebook and Instagram through Facebook Ads Manager (see Figure 3.4 for a sample post).[11] The advertisement was targeted at parents of UK adolescents aged 13–18 who used Facebook and at UK adolescents aged 13–18 directly on Instagram and Facebook. The survey was advertised as a "lifestyle survey" to mitigate the risk of self-selection bias for adolescents that had experience with or a particular interest in self-tracking. A comic image of a dog was

[11] I would like to express my deep gratitude to the team at the Oxford Internet Institute, in particular Mark Malbas and John Gilbert, for their invaluable assistance in designing and distributing the study advertisement.

selected to draw attention to the adverts on the Newsfeed and to ensure that the advertisement was gender- and age-neutral.

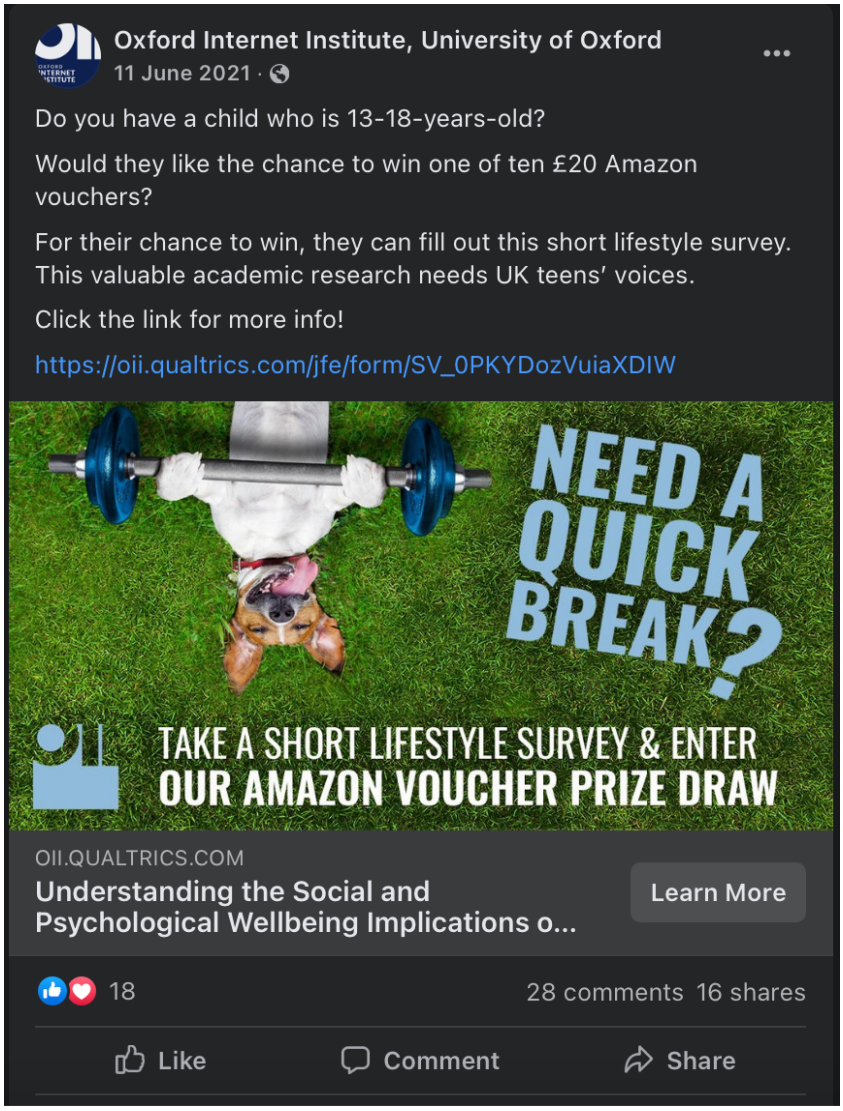


Figure 3.4. Sample of an Oxford Internet Institute Facebook post advertising the online survey and targeting parents of UK adolescents aged 13–18 years.

Participants (and, where appropriate, their parents) who took part in any of the research activities were able to optionally consent to the retention of their contact details so that I could get in touch with them later about participating in future research activities. The recruitment material was also shared by Generation R (a network of Young Persons

Advisory Groups (YPAGs)) and the NIHR Children and Young Person's Medtech Cooperative to reach adolescents in their networks. Young people who signed up for the study were also encouraged to forward or share the study advertisement with any adolescents they thought might be interested in taking part.

Nevertheless, recruitment for this project was extremely challenging, in part owing to the difficulty of recruiting everyday self-trackers. Describing a similar experience, Didžiokaitė et al. detailed their challenges in carrying out self-tracking research, noting that, "[e]veryday self-trackers can be difficult to recruit, as tracking is largely an individual and sometimes private practice" (2018, p. 1476). However, the challenges looked different in this project. For many adolescents, tracking was not individual but often a social practice; however, tracking was also not a passion but a more mundane habit or a routine; one participant described it as akin to *"eating"* (Miriam, 17). It may therefore have been difficult for adolescents to see the value of an interview about such a prosaic practice.

Moreover, 'Zoom fatigue'[12] during the pandemic has been well-documented by journalists and researchers alike (Wiederhold, 2020). The interviews and workshops for this project took place after lockdown restrictions were lifted, and thus it was hard to find adolescents willing to spend additional hours in front of a computer when they could be out doing other activities, especially when these had been off limits for so long. For example, one interview participant told me that our interview was the first time he had been online in weeks as he was *"taking a big break from the computer"* (Freddie, <16). Discussions of such

[12] 'Zoom fatigue' has been described as "tiredness, anxiety, or worry resulting from overusing virtual videoconferencing platforms" (Wiederhold, 2020, p. 437).

'digital detoxes'[13] were common amongst adolescents, and taking these breaks from technology was high on the agenda for many.

Reflecting on the sampling decisions made in my research is important as these impact the quality of the inferences made from the data collected. Such decisions are often more complex in mixed methods designs (Onwuegbuzie & Collins, 2015). Facebook advertisements have been used in previous health-related research as a cost-effective way of accessing populations who are sometimes difficult to recruit (Pedersen & Kurz, 2016). Facebook advertisements also allow for snowball sampling through the affordances of social media platforms where users may share the study advertisements with others in their network. Targeting Facebook and Instagram advertisements to adolescents and their parents helped to ensure that I reached the right population and allowed me to access adolescents across the UK. Additionally, in line with other researchers' use of community groups to recruit adolescents (Bröer et al., 2023), I worked with organisations such as Generation R and the NIHR Children and Young Person's Medtech Cooperative. It is important to acknowledge that sampling for the survey in this way limits the representativeness of the sample as this method may have resulted in an under-representation of certain groups, such as those who were not interested in fitness or those who were not active on social media. Furthermore, as has been noted by other scholars, online recruitment and data collection raises challenges around authenticity, such as verifying participants' location and self-reported sociodemographic details (Boydell et al., 2014; Ridge et al., 2023). In the COVID-19 context, this was a trade-off I had to make in order to recruit adolescents during lockdowns and I hoped to go some way to mitigate

[13] Interestingly, digital self-tracking technologies were largely exempt from digital detox practices. This will be discussed further in Chapter 6.

these risks by defining the audience in Facebook Ads Manager to help my study advertisement reach my target population of adolescents in the UK.

Participants and collaborators for the interviews and co-design workshops were sampled from adolescents who took part in the survey, as is common in mixed methods studies (Onwuegbuzie & Collins, 2015). Additionally, as with the survey, I collaborated with community groups to reach adolescents. Using this approach was practical given the time and resource constraints in this project and enabled me to engage with adolescents across the UK remotely. This strategy means that there was a largely nested relationship in the samples across the methods in this research whereby adolescents involved in the interviews and workshops were largely a subset of those in the survey. As such, the limitations of the survey sampling will also apply to the other methods. Furthermore, adolescents may have been more likely to self-select to engage in an interview or workshop if they had an interest in the area. When interpreting the data from these research activities, it is important to recognise that these sampling decisions may limit the knowledge claims that I make in this thesis. I discuss further limitations of this research in Section 8.5.

3.6 Data Collection

As explained earlier in this chapter, this mixed methods study involved: an online survey (695 participants; conducted from June 2021 to December 2021), online semi-structured interviews (29 participants; conducted from July 2021 to December 2021), and online co-design workshops (44 participants; conducted in November 2021 and March 2022). I will now explain each of these methods in detail.

3.6.1 Online Survey

An online survey was distributed through the survey platform Qualtrics. Participants were informed that as part of completing the survey, they could enter a prize draw to win one of ten £20 online shopping vouchers.[14] The first prize draw ran online from 11 June 2021 to 18 July 2021. After that, the survey was left open for participants to complete but it was made clear on the opening page that the prize draw had closed. With a break in August for the school holidays, a new prize draw of three £10 online shopping vouchers was launched on 23 September 2021 after the beginning of the new school year. The survey was taken offline on 1 December 2021.

The survey consisted of four key question blocks (see Figure 3.5) separated into the following areas:

1. Basic Demographics
2. Self-Tracking Practices
3. Impact of COVID-19 on Self-Tracking
4. Relevant Measures

[14] I would like to thank Duncan Passey, the Financial Officer at the Oxford Internet Institute, who so patiently and generously helped to facilitate the logistics of the distribution of participant compensation for this project.

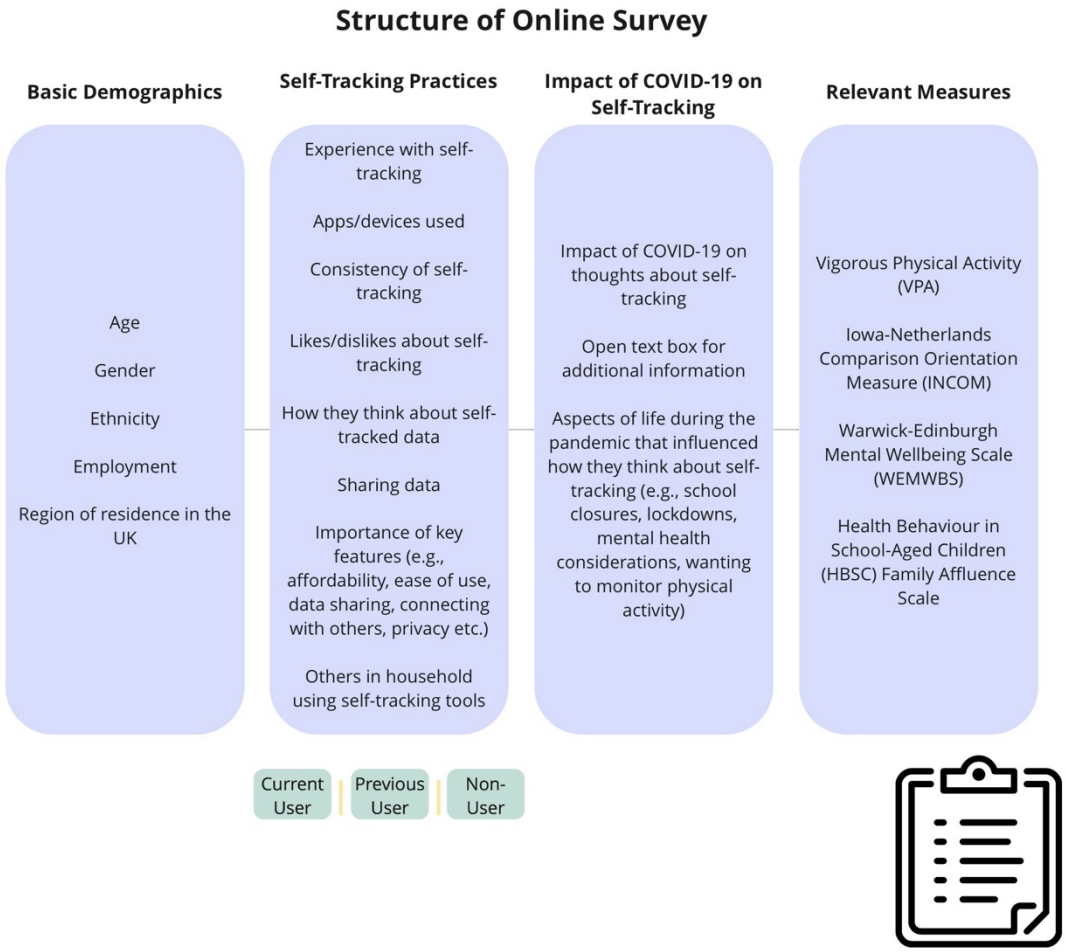


Figure 3.5. Structure of four key question blocks in the online survey.

At the beginning of the survey, participants saw the following definition of self-tracking:

> Self-tracking allows people to monitor, record and analyse information about their health and physical activity, such as sleep, calorie intake, heart rate and exercise. Have you ever looked at your phone to see how many steps you've taken in a day? Have you ever used a fitness tracker to find out how far or how fast you ran? That is self-tracking.

To ensure participants were shown relevant questions, there were multiple pathways through the second block of questions (Self-Tracking Practices) depending on the participant's self-reported experience of tracking. The three branches were current users, previous users, and non-users. For the survey in full, see Appendix C.

3.6.1.1 Pilot

The survey was piloted by 10 people (comprising eight UK adults and two UK adolescents). Those who pilot tested the survey tested the process from start to finish (including the consent forms). Following this pilot testing, a few minor alterations were made to the survey in order to simplify the language and improve readability; however, no major issues were raised during this process.

3.6.1.2 Relevant Measures

Four relevant measures were included in the survey to aid in the exploration of adolescents' experience of self-tracking: (i) vigorous physical activity (VPA) (Currie et al., 2014), (ii) the Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale (FAS) (Currie et al., 2008), (iii) the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (Tennant et al., 2007), and (iv) the Iowa-Netherlands Comparison Orientation Measure (INCOM) (Gibbons & Buunk, 1999). Where relevant, appropriate permissions were sought to use each of these scales for this project.

Vigorous Physical Activity (VPA) (Currie et al., 2014)

Two items related to frequency and duration of physical activity were drawn from the World Health Organization Health Behaviour in School-aged Children (WHO HBSC) study to measure VPA (Currie et al., 2014):

- Outside school hours: How often do you usually exercise in your free time so much that you get out of breath or sweat? (Never = 0; less than once a month = 1; once a month = 2; once a week = 3; two to three times a week = 4; four to six times a week = 5; every day = 6)

- Outside school hours: How many hours a week do you usually exercise in your free time so much that you get out of breath or sweat? (None = 0; about half an hour = 1; about one hour = 2; about two to three hours = 3; about four to six hours = 4; about seven hours or more = 5)

The words "outside school hours" were removed for participants who did not report being in school at the time of the survey (e.g., those in employment or those at university). These two VPA items have been shown to be valid and reliable for adolescents (Booth et al., 2001). The two items were analysed separately to capture both frequency and duration of VPA.

Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale (FAS) (Currie et al., 2008)

This six-item scale was devised for use with school-aged children as a measure of socioeconomic status (SES). The FAS has been validated as a highly stable and internally consistent self-report measure for adolescents (Boyce et al., 2006). It has been used for over two decades to research a range of health behaviours and indicators in the international HBSC study. As adolescents themselves possess little economic power, parents' SES is often used as a proxy (Currie et al., 2008); however, collecting such data can be challenging as adolescents are often unaware of their parents' SES or are unwilling to share this information with researchers (Currie et al., 1997; Wardle et al., 2002). Currie et al. (2008) use the concept of material goods in the household to construct items in the FAS. For instance, the scale was updated in 2014 to include items such as "How many computers does your family own (including laptops and tablets, not including games consoles and smartphones)?" (Currie et al., 2014).

The FAS summary score is taken as a sum of the scores for each of the six items (maximum score of 13), with a higher score indicating greater family affluence. In my research, three categories of SES – "Low SES" (0–6), "Medium SES" (7–9), and "High SES" (10–13) (Sigmund et al., 2018, 2020) – were calculated for the purpose of understanding the socioeconomic breakdown of the sample. This scale demonstrated good levels of internal consistency in my DPhil study (α = .76).

Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (Tennant et al., 2007)

This 14-item scale provides a measure of psychological wellbeing including both hedonic and eudemonic aspects such as positive affect, interpersonal relationships, and positive functioning (Tennant et al., 2007). Each item is scored on a 5-point Likert scale (none of the time, rarely, some of the time, often, all of the time); individuals are asked to select which option best describes their experience of the given statement (e.g., "I've been feeling optimistic about the future") based on a two-week recall period. All items are equally weighted, and individuals' scores are calculated by totalling the scores for each item, giving a minimum score of 14 and a maximum score of 70. This scale has previously been validated for use with adolescents with good internal consistency (α = .87) (Clarke et al., 2011) and has been used to explore the implications of digital practices for adolescents' psychological wellbeing (Best et al., 2015; Fahy et al., 2016). This scale demonstrated excellent levels of internal consistency in my study (α = .90).

Iowa-Netherlands Comparison Orientation Measure (INCOM) (Gibbons & Buunk, 1999)

This 11-item self-report scale was developed to measure individual differences in social comparison tendencies. Each item is scored on a 5-point Likert scale (I disagree strongly, I

disagree, I neither agree nor disagree, I agree, I agree strongly); individuals are asked to indicate the extent to which they agree with a given statement (e.g., "I often compare myself with others with respect to what I have accomplished in life"). This scale has previously been used to assess differences in adolescents' social media practices (e.g., Ozimek & Bierhoff, 2019; Yang et al., 2018). Following the reverse scoring of negatively worded items, the mean of the scores across the 11 items is taken for each individual, with higher values indicating a greater tendency towards social comparisons. This scale demonstrated good levels of internal consistency in this study ($\alpha = .71$) in line with previous findings ($\alpha = .78$ to $.85$) (Gibbons & Buunk, 1999).

It is important to note that the use of an online survey was not without its challenges. Whilst subjective, self-report scales are useful in this study, there are limitations to such measures. For example, value judgements were made when composing these scales regarding choosing which items to include and exclude so that the measure best reflects the authors' understanding of concepts such as 'family affluence', 'mental wellbeing', and 'social comparison orientation', and individual difference factors such as gender and cultural background could have influenced individuals' responses to the items included (Cieza et al., 2016; Lindert et al., 2015).

Nonetheless, the online survey methodology was the most practical way to reach a large number of adolescents. By triangulating the quantitative data generated through the self-report measures in this survey with the qualitative data from the semi-structured interviews and the co-design workshops, I had an opportunity to address multiple angles of the research questions. This mixed methods approach opened the way for a better understanding of the complex phenomena under investigation in this project, such as

psychological wellbeing and social comparisons. By incorporating the strengths of both quantitative and qualitative paradigms, I aimed to enhance the quality and transferability of the inferences drawn from my study (Teddlie & Tashakkori, 2009).

It is worth highlighting here that although these scales were included in the online survey, they are not all used heavily in the empirical chapters. I have, however, kept them in this Methods discussion for completeness. As an early-career researcher, one of the challenges I have been most struck by in mixed methods research is the craft of prioritisation. Throughout the course of this research, I have amassed considerable data, and to appropriately scope this thesis, I have had to make tough decisions concerning which data to include. I found that some of these scales did not help me to further my argument in this thesis. Having engaged with the adolescents involved in this project through the interviews and the workshops (discussed in further detail below), I decided to prioritise the data from these activities and use the survey data to support the rich qualitative insights, hence my quan + QUAL approach.

3.6.2 Online Semi-Structured Interviews

To build on and provide depth to the findings of the online survey, I conducted online semi-structured interviews with UK adolescents. These interviews took place on Microsoft Teams at a convenient time chosen by the participants using the scheduling tool Calendly. The interviews were conducted between 20 July 2021 and 8 December 2021. Participants were compensated with a £10 online shopping voucher for their time.

Although I seriously considered asking adolescents to bring their self-tracking devices along with them to the interviews, in line with previous work in the area of self-tracking

(e.g., Weiner et al., 2020), I ultimately decided against this approach. Having seen the incoming data from the online survey, it became clear that many adolescents faced significant challenges associated with their self-tracking data, including disordered eating, anxiety, and depression (discussed further in Chapter 6). Given the online nature of these interviews, I was concerned that I could not ensure adequate mental health support to participants should any activities involving these data cause distress. Furthermore, adolescents are often tracking intimate health data. Without very good reason to do so, I was reluctant to ask participants to share this with me in this setting. Finally, I wanted to ensure that participants felt in control of the interviews, and I was aware that there might be some data that they might not wish to share. Asking them to show me details from their tools raised the possibility of data appearing unexpectedly or by mistake, and I was not willing to take this risk of invading their privacy. As such, I chose not to include this as an activity in the interviews.

Semi-structured interviews were an important step in the research design, as they allowed me an opportunity to explore deeply personal reflections with adolescents. This required a great deal of work to build trust and rapport, and it was necessary to be very sensitive to the differences in each individual participant. As Brewer (2000) describes, there is a delicate balance to strike between maintaining a professional distance from participants but not reducing the rapport or inhibiting the adolescents' openness to sharing their experiences.

On the one hand, the online nature of the interviews was advantageous as participants were well-practised at communicating via videocalls, and so interviews were more 'natural' than perhaps they might have been prior to the COVID-19 pandemic. Also, I hoped that interviewing participants in their own homes would make them more comfortable than if

we had been in an institutional setting, like a school. However, the processes of scheduling and conducting interviews were challenged when participants tested positive for COVID-19, which became a more frequent occurrence in this project once schools returned to in-person learning. In these circumstances, some adolescents cancelled the interview; however, a handful chose to continue with the interviews whilst isolating at home.

Samples of the interview guides are available in Appendix D. Akin to the structure of the survey, there were three separate interview guides for current users, previous users, and non-users. There were also distinct interview guides for those under the age of 16 and those over the age of 16. The duration of the interviews differed between these two groups such that those below the age of 16 had shorter interviews (approximately 30 minutes) than those above the age of 16 (approximately 45 minutes). The interview guides were therefore adapted to fit with these timescales.

An overview of the structure of the online interviews is available in Figure 3.6. This structure served only as a guide, and I remained flexible and conducted the interviews to best suit the interactions I was having with adolescents. The key sections included in the interviews were as follows:

1. Introduction and Questions
2. Description of Self-Tracking Practices
3. Self-Tracking and Wellbeing
4. Self-Tracking and Social Relationships
5. Impact of COVID-19 on Self-Tracking
6. Any Additional Information
7. Check In, Questions, and Closing

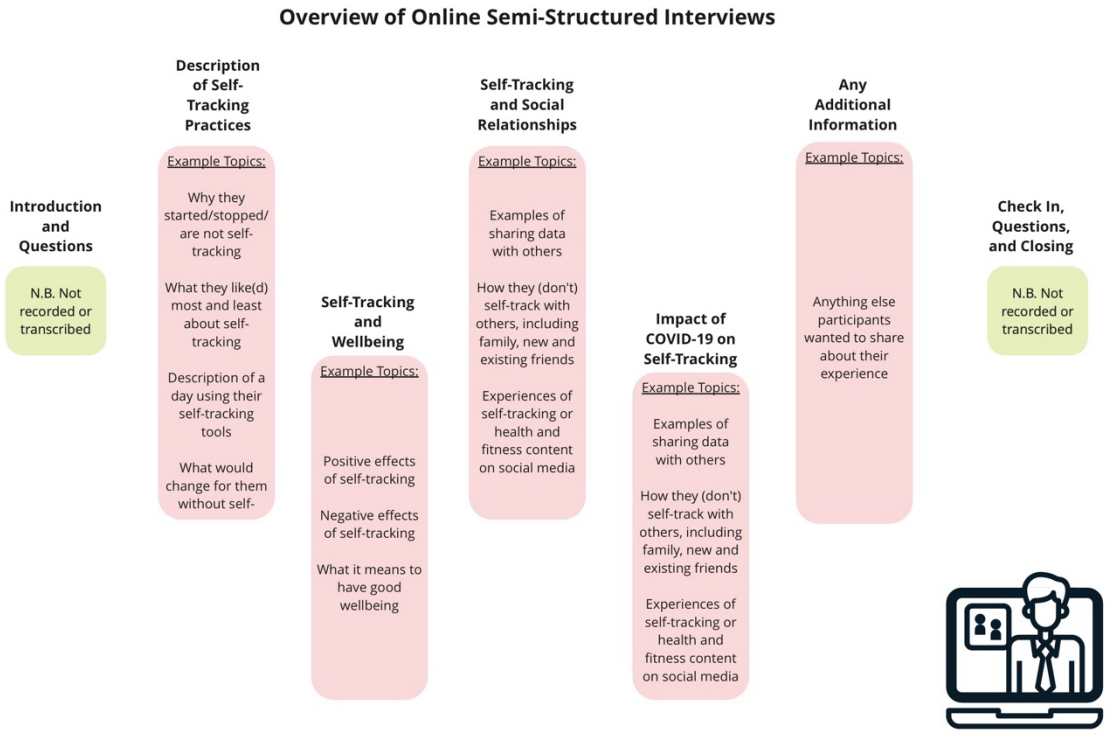


Figure 3.6. Overview of key topics and structure of the online semi-structured interviews.

I gave great thought to interviewing adolescents with no experience of self-tracking to ensure that they did not feel judged, or as if they were doing something wrong or had somehow missed out on an experience by not engaging with these tools. For instance, in the interviews, I took care to ensure that I was not visibly wearing any self-tracking tools (e.g., a smartwatch). The language used in the questions was also worded carefully to remind participants that this was about *their* experience, not any particular *correct* experience. Importantly, the 'Introduction and Questions' section also included information about confidentiality and safeguarding to highlight two important messages:

- Participants were in control of the interviews. They did not have to answer anything they did not want to and it was up to them how much they chose to share. Although it was not anticipated that any of the questions would be

upsetting, I asked them to tell me if they felt upset during or after the interview so that I could point them in the direction to receive appropriate support for this (see Appendix G). It is worth noting that none of the participants did this, and no participant declined to answer any of the questions.

- Participants' responses would be kept confidential and their anonymity would be protected. I only needed to break confidentiality if I was concerned that they or someone else was at risk of serious or imminent harm, and if so I would need to notify someone who could intervene. It is again worth noting that this was not necessary in any of the interviews.

The 'Introduction and Questions' and 'Check In, Questions, and Closing' components of the interview were not recorded in order to build rapport and trust with participants and to allow for a more free-flowing discussion. The introduction often involved finding out about their day, being introduced to various household pets, and sometimes speaking to parents. There was a notable change in participants' comfort levels following this introduction section and these openings and closings were important as rapport-building with adolescents often requires more time and work in online interviews than in person (Shapka et al., 2016).

The trade-off, however, was that sometimes participants would offer insightful reflections during these unrecorded moments in the interview. If it felt appropriate, I would sometimes ask the participant if they would mind if I started the recording again to capture their thoughts. However, at other times, I chose to allow the conversation to continue unrecorded and let the adolescents speak uninterrupted. As I mentioned earlier, it became clear through the research that many young people had spent a lot of the pandemic alone

because of working parents and distanced friends, and many enjoyed having a space to talk. I decided that in these cases, it was important to give them space to talk and express their experiences, particularly if they were sharing about challenges their feelings about, or personal challenges they faced during, the COVID-19 pandemic.

Through these interviews, I worked hard to reverse the 'teacher/student' power dynamic by asking adolescents to be my guide through their experience. Interviewing in the pandemic context required additional work to break through the conception of a 'teacher/student' relationship during the interview, as many participants were well-accustomed to engaging with teachers through videocalls. The impact of this role reversal is evident in some of the transcripts where the adolescents seemed to adopt a teacher-like persona when explaining their self-tracking practices. By working towards this goal, I hoped that the sense of empowerment would be rewarding for the participants as many articulated that they often felt left out of or overlooked in conversations concerning their technology use.

3.6.3 Online Co-Design Workshops

Following more recent work in HCI with a focus on adolescents and their use of self-tracking tools (Potapov et al., 2019; Potapov & Marshall, 2020), I ran two series of co-design workshops to explore how adolescents might imagine the design of a self-tracking user guide for young people. One of the key factors underlying the decision to run a series of workshops was the understanding that self-tracking practices are social. I was wary of relying solely on individual measures (e.g., online survey responses, individual interviews) and I wanted a way to explore how these practices are expressed and understood in social contexts.

Co-design methods have been used to democratically position participants as active agents in creative research, unlocking new insights and reimaginings of the design process. These methods can give a voice to populations that are often overlooked and offer them a real sense of agency in the process of design. There exists an expansive body of research on technology and wellbeing in which young people are engaged in co-design methods (e.g., Cibrian et al., 2020; Constantin et al., 2022; Honary et al., 2019; Potapov & Marshall, 2020; Winsall et al., 2018). Indeed, as Lohmeyer notes, "Youth participatory methods intended for doing research 'with', and not simply 'on', young people reflects an ethical orientation towards valuing young people as equal contributors to knowledge creation" (2020, p. 43). To emphasise the importance of doing research 'with' and not just 'on' these adolescents, in this stage of my research, adolescents moved from *participating* in the survey and interviews to *collaborating* in the workshops. In this spirit, I refer to adolescents as workshop 'collaborators' when discussing the co-design workshops to emphasise the participatory, reciprocal – rather than extractive – relationship I aimed to develop with young people through these workshops.

My aims with these workshops were to firmly position adolescents as experts in their own needs regarding a user guide and to empower them as designers to share their insights. Despite these aims, I am aware of some of the limitations here. Firstly, I designed this interaction as a researcher and invited adolescents to take part within the context of a research project. Furthermore, I cannot disregard the power relationships between a researcher and young adolescents that were at play during the workshops (Pitt & Davis, 2017). In line with principles of community-collaborative approaches (Cooper et al., 2022), I was eager to include adolescents from the outset in all stages of this project, including identifying key research questions, designing a project, and analysing data; however, the

practical constraints of a DPhil project made this challenging. In the future, I will endeavour to do just that. I learned so much about collaborating with young people through this work, and this is the first small step that I have taken of what I hope will be a long and vibrant partnership with young people.

Björling and Rose (2019) outline six principles for participatory research with adolescents: contextual validity, participant-centred methods, collaboration, engaging and active methods, researcher flexibility, and trust and transparency. Furthermore, in their work on synchronous online co-design methods employed with children, K. J. Lee et al. emphasise the need for researchers to be "agile and swift" in online research spaces where "unexpected situations" (2021, p. 2) can emerge frequently. I harnessed this guidance when designing and carrying out our workshops to ensure that I was "engaging teens in a thoughtful, ethical, and appropriate way" (Björling & Rose, 2019, p. 12). I explain how I followed this guidance in the following paragraphs.

The workshops took place using the videoconferencing software Microsoft Teams and the online whiteboard platform Miro. Participants were able to use the chat, video, and audio functions in Microsoft Teams or the functionality of Miro to participate, depending on what they felt most comfortable with (see Figure 3.7 for examples of how adolescents could choose to participate). Adolescents could choose their own usernames on Microsoft Teams, and I was careful not to use any names other than the usernames adolescents had chosen for the activity. Additionally, I decided to allow all collaborators to contribute on Miro anonymously as this meant they did not have to create an account and granted greater freedom in discussions around sensitive topics. Adolescents were therefore given guest

identities, such as 'Guest Artist' and 'Guest Editor'. Given this anonymity, adolescents' usernames on Microsoft Teams could not be linked to their guest identities on Miro.

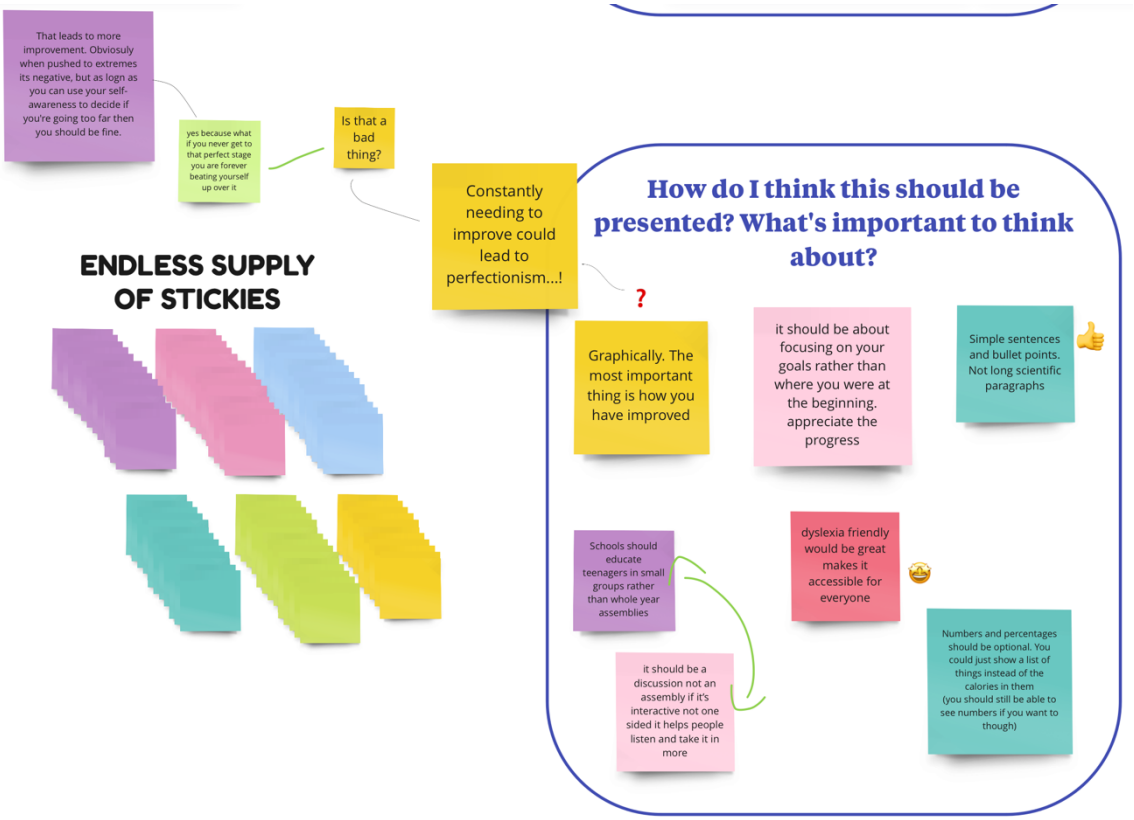


Figure 3.7. A screenshot of Workshop 4 demonstrating the various ways in which collaborators could share and connect their ideas (e.g., emojis, sticky notes, drawing arrows).

I found that the sticky note and emoji functionalities of Miro encouraged playful engagement and encouraged greater dialogue between the collaborators. I provided a 'bank' of different emojis so that participants could have low-touch reactions to others' comments. Some collaborators chose to respond to stickies via the comments feature, allowing them to provide direct, anonymous feedback on others' ideas. Some adolescents chose to use the built-in arrow feature to connect different stickies together, whilst in other

workshops, collaborators chose to directly draw on the board to underline, emphasise, and expand on key points. The adolescents who worked together were quick to explore different affordances of the online whiteboard tool. These features allowed a sense of exploration and a real sense of *co*-creation and collaboration as adolescents could see the ideas build and evolve in real time.

I ran the workshops alongside a Research Assistant (Amanda Curtis), and another researcher (Gulraj Grewal) was present in four workshops to take notes. Given the online nature of this work, I met with these other researchers prior to the workshops to discuss some of the challenges I anticipated we might face. Online methods allowed me to bring together participants who very likely would have never crossed paths, let alone work together, to create meaningful conversations. I had some initial hesitations about assembling such disparate groups and the ways in which we might be able to build trust with our collaborators. I also had some concerns about how the adolescents would engage with one another with respect to sensitive topics. I was worried that some conversations around these topics would derail, leading to potentially vulnerable participants no longer feeling safe and empowered. After discussing these concerns with the other researchers, I decided to establish clear ground rules for the workshops to ensure that adolescents respected others' opinions and were sensitive to different experiences.

Letting adolescents control the narrative was paramount to the design of these workshops; however, the establishment of ground rules was important for giving collaborators this control. It was challenging to do so in a way which was not patronising; however, I was determined that setting boundaries was important to ensure that adolescents felt safe and secure in the online environment I created. This, in turn, would give them more freedom

to participate creatively once they had an understanding of the perhaps unfamiliar workshop structure. In the end, I did not encounter any such moments of concern during the workshops. Instead, collaborators continued to promote a welcoming, empowering space themselves. During each of the activities, I opened up space for critical discussion and reflection on the contributions to draw out any points of tension or agreement amongst the adolescents. When I did this, I was careful to foster an environment of respectful curiosity and reflection and I was pleased with the result. Where they disagreed with one another, adolescents did so in ways that were productive and spoke to their spirit of curiosity.

Thinking critically about the space I was constructing in these workshops beforehand was fundamental to my research design; however, I lost much of the control over these unpredictable workshop spaces once others entered them. Inevitably, no workshop progressed exactly as I had predicted. This was where back-up plans and alternative methods for engaging with participants were essential. For instance, as part of cultivating these welcoming and diverse environments, I purposefully did not rely on just one online space. Technical issues and different means of access were anticipated and flexibility was embedded in the design of the workshops to account for this. For example, I had multiple back-up options for online engagement, including Word documents and PDF versions of Miro boards. Not all participants could see the Miro board embedded in Microsoft Teams, so I gave them a link to use in a new window. Some were unable to successfully navigate Miro (particularly those who joined on mobile devices), so I provided the same questions on the board in the Microsoft Teams chat and PDF versions of the visual board displays in workshops where this was an issue. Figure 3.8 shows an example of how these technical challenges manifested in the workshops. Being open to using multiple online spaces and

deftly moving between them was integral to the smooth running of the workshops and ensuring that participants felt comfortable and assured that the technical aspects of the workshop were being competently dealt with.

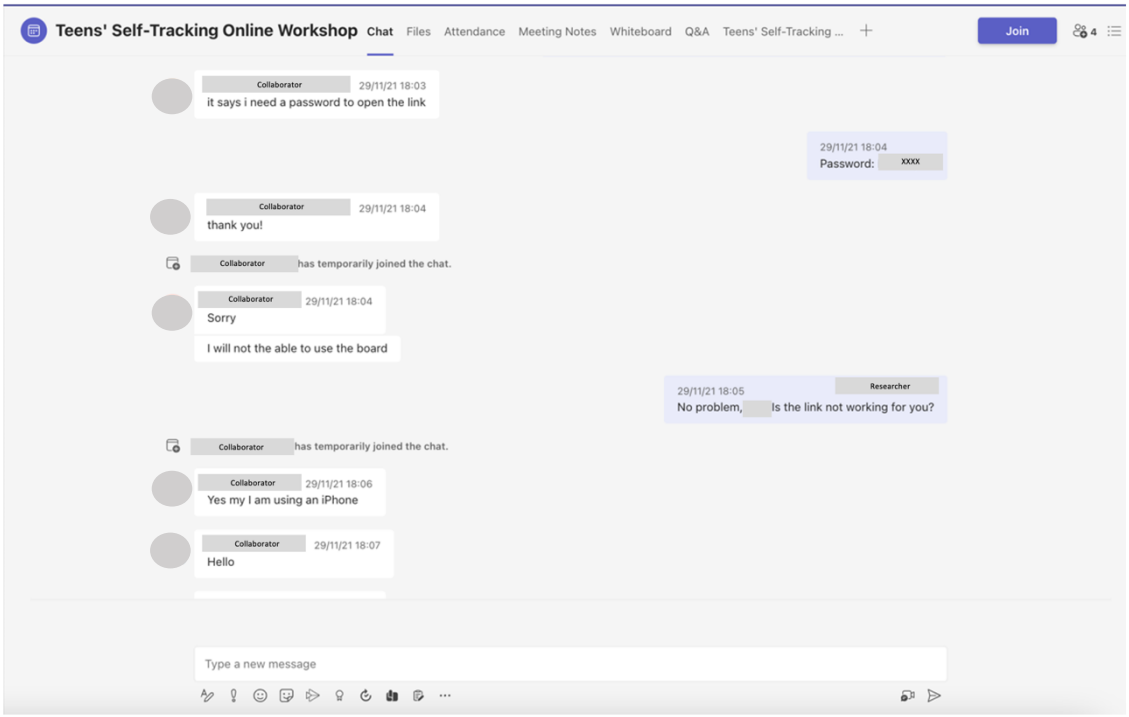


Figure 3.8. A Microsoft Teams excerpt (screenshot) from Workshop 5 demonstrating some of the technical challenges faced during the workshops. Any identifiable details have been redacted.

It is worth noting that although I hoped that the anonymity of Miro would reduce fear of social pressure and allow the adolescents the ability to contribute more freely than if their names were attributed to their responses, this had certain limitations for the data analysis. Not knowing who was reacting, posting, and replying meant that I could not know the true complexities of the dialogues that occurred. I was unable to objectively tell whether all the sticky notes were created by one person, two people, or even all of the collaborators. Ultimately, I decided that the value of anonymous contributions for these sensitive discussions outweighed the drawbacks of this uncertainty. Moreover, many adolescents

chose to contribute through other means, such as via Microsoft Teams chat and audio and video. I can therefore say with a good degree of certainty that the workshops involved true conversations among collaborators.

Just as it was important to cultivate the online space for the adolescent collaborators carefully, it was also critical to think about the online space I created for researchers during the workshops. I created a shared online Word document for notes with three columns, so that each researcher could take notes in real time while simultaneously reading what the other researchers were writing. In this way, we co-created field notes incorporating both practical action comments (e.g., timings and structure) and reflections on the workshop (e.g., common themes) that served as a valuable source of data following the workshops. Figure 3.9 gives an example of a section of this shared notes and communication document.

	Jaimie Lee Freeman	Amanda Curtis	Gulraj Grewal
Activity 2 (Important features and effects of self-tracking tools. How are these connected?)	Interesting that they're adding stickies to the feature clouds. That's nice! AMANDA – Do you want to jump in first with the questions this time? Just to shake things up I'm going to stop this activity at 6pm I think to give us enough time on Activity 3	Glad to see [redacted] participating! I don't think [redacted] is here Sure!! Ill jump in They seemed very open to talking about difficult subjects Yeah – they seem very open to talking about it, I'd love to hear their thoughts on how things could be improved regarding that	Great awareness about EDs and how calorie counting can spiral quickly. Catering to everyone's preferences seems impossible – interesting, esp as he goes on to talk about people with disabilities. Confusing to know how much to do – the point of obsession brought up again.

Figure 3.9. An excerpt (screenshot) from the collaborative researcher notes Word document relating to Workshop 1. Any identifiable details have been redacted.

3.6.3.1 Series A Workshops (Exploratory Content Co-Design Workshops)

I ran five Series A workshops in November 2021. Each workshop lasted 90 minutes. At the beginning of the Series A workshops, the following definition of self-tracking was available for adolescents, consistent with the survey:

> Self-tracking allows people to monitor, record and analyse information about their health and physical activity, such as sleep, calorie intake, heart rate and exercise. Have you ever looked at your phone to see how many steps you've taken in a day? Have you ever used a fitness tracker to find out how far or how fast you ran? That is self-tracking.

These Series A workshops consisted of four key activities (summarised in Figure 3.10). When I designed these activities, I drew on previous co-design work with adolescents that used personas to help foster empathy and agency (Honary et al., 2019; Nicholas et al., 2012) and sticky note activities to prompt reflection (Jessen et al., 2018; Roquet et al., 2022). The activities were as follows:

1. **Introductory Activity**: familiarising adolescents with the online whiteboard (Miro) and letting them get to know one another.
2. **Persona Exploration:** working with personas (developed from the online survey and interviews) to uncover a variety of adolescent experiences with self-tracking tools (including reasons for tracking, frequency of engagement, opportunities, challenges).
3. **Feature Reflection:** identifying key features of self-tracking tools and their effects to understand pain points and opportunities for improvement (including features of interest, features of concern, and social and emotional affordances of self-tracking technologies).
4. **Designing an Adolescent-Centred 'User Guide'**: expanding on Activities 2 and 3 to identify key design considerations for a user guide (e.g., content it should include, how it should be formatted, and how it should be shared).

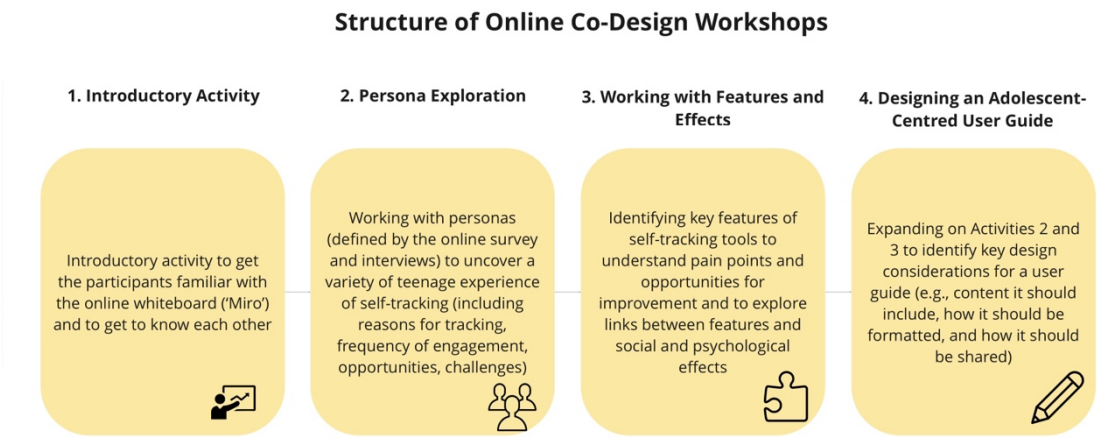


Figure 3.10. Structure of four key activities in the Series A co-design workshops.

An example of one of the co-design activities can be seen in Figure 3.11 and complete templates of each of the workshop activities are available in Appendix E.



Figure 3.11. Screenshot example of the introductory ice-breaker activity for the Series A co-design workshops to introduce the participants to Miro and to each other.

3.6.3.2 Series B Workshops (Reflexive Prototype Design Workshops)

Finally, in March 2022, I ran two one-hour co-design workshops with a selection of adolescents from the Series A workshops. I also ran these sessions alongside my Research Assistant (Amanda Curtis). All adolescents who had engaged and been responsive in the workshops were contacted to participate in these co-design workshops. In a similar way to the Series A workshops, the Series B workshops took place using the videoconferencing software Microsoft Teams and the online whiteboard platform Miro. Adolescents were able to use the chat, video, and audio functions in Microsoft Teams or the functionality of Miro to participate in whatever way they were most comfortable with.

Following the Series A co-design workshops, Amanda Curtis and I used the graphic design tool Canva to build a series of mock-up Instagram posts to serve as a self-tracking user guide, based on adolescents' contributions in the workshops (see Figure 3.12 for an example). These formed the foundation of the Series B workshops where adolescents were shown this series of sample Instagram posts and were asked for their feedback on the content, design, importance, and distribution considerations for such a user guide.



Figure 3.12. Examples of the Instagram posts shown to adolescents in the Series B co-design workshops.

During the Series B workshops, the collaborators reflected on their current experience on social media: the types of posts with which they liked to interact, and any existing Instagram guides they knew of and liked or disliked. The mock-up Instagram posts were shared with adolescents, and we thought together about the content, design, tone, and distribution considerations for such a resource. Once again, the workshop collaborators were positioned as co-designers and experts in their own needs and experiences.

The adolescents were repeatedly reminded that the ideas were not finalised and that these posts were intentionally left underdeveloped to encourage them to share how they would change the content or design. They could choose whether to share their ideas on mocked-up posts that were highly detailed and colourful or on posts that were more stripped back and greyscale if they found the details too distracting. The collaborators were encouraged to share how they thought these posts would fit with their existing social media feeds, what topics they thought were most important for the user guide to cover, and how they believed it would be best to capture the attention of young people.

Following this design activity, I worked with a graphic designer (Weezy Dai) to create the final proof-of-concept Instagram designs. These were not mirror images of mock-up Canva designs; rather, they were evolved versions based on the designs our workshop collaborators co-created in Series B workshops. Where the adolescents resisted the designs presented to them, or shared that the direction was not helpful to them, I worked with them to iterate the designs to better meet their needs and expectations. As with many DPhil projects, these methods were constrained by time and money available to compensate adolescent collaborators. Given more resources, I would have involved adolescents throughout the entire process; however, it was necessary for me and my Research Assistant to build some basic designs to give the adolescent collaborators a springboard for the Series B workshops. Then, I worked with the graphic designer to produce the final Instagram outputs. This hybrid model, moving between creations and insights from adolescents to analysis and synthesis from researchers, allowed me to work within my constraints whilst continuing to ensure that their voices were heard and incorporated throughout every stage of this workshop process.

These workshops were an important concluding step in the data collection for this project. Firstly, they ensured that the final ideas stayed close to adolescents' experiences and contributions throughout these research activities and allowed further refinement and exploration (Pitt et al., 2021). Further, they allowed an additional dialogic opportunity for me to test any assumptions I may have made in my analysis with adolescents and to clarify any inconsistencies or inaccuracies I may have come across in my data so that I could better learn from adolescents' experiences and identify key design implications.

3.7 Data Analysis

In the following section, I outline the data analysis process for the quantitative and qualitative data. I also detail how I integrated these data in my mixed methods research.

3.7.1 Quantitative Data Analysis

The quantitative data were transferred from Qualtrics to The Statistical Package for the Social Sciences (SPSS) Version 28 (IBM Corporation, Armonk, NY) for analysis. To ensure high-quality, valid responses, participants were removed from the analysis if they met the following condition: *the participant straightlined two or more scales (i.e., WEMWBS, INCOM, or FAS) OR the participant's time to complete the full survey fell below the tenth percentile) AND the participant failed to answer the open text question.*[15] If participants passed this validation check but chose not to answer some questions, their responses were included for the questions they answered. Responses to closed questions were analysed using descriptive and inferential statistics.

Across the chapters, six exploratory hypotheses were being tested by the inferential statistics in this thesis, formulated based on my literature review. They were as follows:

Hypothesis 1: Adolescents' SES and the level of experience they have of using self-tracking tools are related: adolescents with a higher level of self-reported SES are more likely to have experience in using self-tracking tools.

[15] In this research, 'failed to answer' meant leaving the answer box empty, answering 'no' or 'yes', or entering a nonsensical string of characters (e.g., 'FKOJFIJD').

Hypothesis 2: Adolescents' social comparison orientation and how much they liked social comparison features of self-tracking tools are related: adolescents who report liking comparison features of self-tracking tools *most* will have a higher level of self-reported social comparison orientation than adolescents who report liking comparison features of self-tracking tools *least*.

Hypothesis 3: Adolescents' gender and how much they liked social comparison features of self-tracking tools are related: male adolescents are more likely to report liking the comparison features of self-tracking tools *most*.

Hypothesis 4: Adolescents' experience with using self-tracking tools and having someone in their household who has self-tracked at some point are related: adolescents who have had someone in their house who has ever used self-tracking tools are more likely to have experience with using self-tracking tools themselves.

Hypothesis 5: Adolescents' experience with using self-tracking tools and psychological wellbeing are related: the mean psychological wellbeing scores will differ between those who report currently using self-tracking tools at the time of the survey, those who previously used self-tracking tools, and those who have never used self-tracking tools.

Hypothesis 6: Adolescents' self-tracking consistency and psychological wellbeing are related: current adolescent self-trackers who report tracking more consistently will have a higher level of psychological wellbeing than those who report a lower level of consistency in their tracking.

The key inferential statistics used to test the hypotheses in this project were: independent samples *t*-test, chi-squared test of independence, one-way analysis of variance (ANOVA), and Spearman's rank-order correlation. Where appropriate, assumptions for valid statistical analyses were checked prior to the data analysis. In cases where any assumptions were

violated, appropriate steps were followed to address this. Appendix H outlines the tests used to confirm that the quantitative data from the online survey met the assumptions for the relevant statistical tests.

It was important to confirm that the sample size of this survey was sufficient to offer appropriate power for these tests. A power analysis was conducted using G*Power 3.1 (Faul et al., 2009; Kang, 2021) to estimate the minimum sample size required in this research to detect a medium-sized effect with a power of .80 or greater. For the chi-squared tests of independence, the largest contingency table was 3x3 with four degrees of freedom. For this test to have a power of ≥ .80 to detect a medium-sized effect (w = .30), a total sample size of 207 was required. For the Spearman's rank order correlation test to have a power of ≥ .80 to detect a medium-sized effect (r = .3), a total sample size of 85 was required. For the independent samples t-test to have sufficient power to detect a medium-sized effect (d = .5), a minimum total sample size of 88 was required. For the ANOVA with three groups, the minimum total sample size required was 252 to have a power of ≥ .80 to detect a medium-sized effect (f = .25). The total sample size in the survey was well above these minima, so I determined that the tests had sufficient power.

3.7.2 Qualitative Data Analysis

The qualitative data from the open-ended survey question were transferred from Qualtrics to NVivo 12 (QSR International Pty Ltd., 2019) for analysis. Only responses written in English were included in the qualitative analysis. The interviews were video-recorded and transcribed verbatim using Microsoft Word. The transcripts were transferred to NVivo 12 for analysis. The co-design workshops were also video-recorded and transcribed verbatim

using Microsoft Word. The transcripts and Microsoft Teams chat histories were transferred to NVivo 12 for analysis. Miro board contributions were analysed directly on Miro.

To analyse the qualitative data from the online survey, interviews, and co-design workshops, I chose to use Braun and Clarke's reflexive thematic analysis (TA) (Braun & Clarke, 2006, 2022). This approach was appropriate for this work as it reflects "a desire for understanding that is about nuance, complexity and even contradiction, rather than finding a nice tidy explanation" (Braun & Clarke, 2022, p. 7) and highlights that the researcher is not objective but an important actor in the production of knowledge (Braun & Clarke, 2022). Indeed, Berger describes such researcher reflexivity as the

> turning of the researcher lens back onto oneself to recognise and take responsibility for one's own situatedness within the research and the effect that it may have on the setting and people being studied, questions being asked, data being collected and its interpretation. (2015, p. 220)

This idea of reflexivity challenges the view of knowledge production as independent of the researcher producing it and of knowledge as objective. In line with standards and good practice in reflexive TA, I analysed the data as a single coder (Braun & Clarke, 2022), moving recursively through the six phases of the process: familiarising oneself with the data, generating initial codes, generating (initial) themes, reviewing potential themes, defining and naming themes, and producing the report (Braun & Clarke, 2006, 2022). Within these stages, the use of theory (namely sociomaterial practices and affordances) was central to my analysis and interpretation of the data. As Merriam and Tisdell argue, "The sense we make of the data we collect is equally influenced by the theoretical framework. That is, our analysis and interpretation—our study's findings—will reflect the constructs, concepts, language, models and theories that structured the study in the first place" (2016, p. 88). Drawing inspiration from Campbell et al.'s (2021) previous work in qualitative

health research, Table 3.2 outlines in more detail the use of this method of data analysis in the project and how theory was used at various stages of this analytic process.

Table 3.2. The various stages of the process of thematic analysis *(Braun & Clarke, 2006)* in the qualitative data analysis for this project. Table adapted from Campbell et al. *(2021, pp. 2014–2015)*.

Analytic Phase	**Description**	**Actions**
Familiarising oneself with the data	• Immersing oneself in the data to understand depth and breadth of the content • Searching for patterns and meaning begins	• Transcribing qualitative data from online interviews and workshops. Interview data was imported into NVivo and transcriptions from the workshops were combined with existing text data on Miro • Exporting qualitative survey data from Qualtrics into NVivo • Reading data multiple times and noting first impressions in a research diary
Generating initial codes	• Generating initial codes to organise data, with full and equal attention given to each data item	• Coding the data from the survey, interviews, and workshops separately • Originally, there were 316 codes for the interview data, 121 codes for the survey data, and 38 codes for the workshop data
Generating (initial) themes	• Sorting codes into initial themes • Identifying meaning of and relationships between initial codes	• Integrating the data from the survey and the interviews at this point to begin to collate the initial codes into themes • Collating data relevant to each theme using NVivo for the survey and interview data and Miro for the workshop data
Reviewing potential themes	• Identifying coherent patterns at the level of the coded data • Reviewing entire data set as a whole	• Generating a rough thematic map by hand from each of the themes to observe patterns between the codes and to ensure that the codes made sense in relation to one another • Reviewing the entire data set to ensure that data captured under each theme accurately represented the data and important meaning had not been lost in the analysis process
Defining and naming themes	• Identifying the story of each of the identified themes	• Iterating the theme names to ensure that they accurately represented the coded data extracts contained within each of

	• Crafting the broader story of the data set to respond to the research questions	the themes and that each of the theme names told a story • Theme names were mapped by hand to begin crafting the broader story of the data and how the themes addressed the research questions within this project
Producing the report	• Presenting a concise and interesting account of the story told by the data, both within and across themes	• Writing and revising the report about the themes in this thesis to ensure concision and the crafting of a clear narrative • Selecting illustrative quotations from adolescents to bring life to the story and to point to relationships within and across the key themes • Creating a short infographic highlighting the key themes of the data that is accessible to adolescents and others outside of academia

When considering the quality of qualitative work, Tracy (2010, p. 840) recommends using eight big-tent criteria: is the work about (i) a worthy topic, does it have (ii) rich rigour, (iii) sincerity, (iv) credibility and (v) resonance, does it make a (vi) significant contribution and comply with the relevant (vii) ethics, and does it have a (viii) meaningful coherence. I will briefly explain how I have addressed each of these criteria in turn.

Firstly, I have demonstrated that this is a *worthy topic* in Chapters 1 and 2. Particularly in the context of the COVID-19 pandemic, it is urgent that we better understand adolescents' engagement with digital self-tracking technologies and the affordances of self-tracking for adolescents' social and psychological wellbeing. I have demonstrated *rich rigour* by clearly identifying key theoretical constructs for this research in Section 2.2 in Chapter 2 and by providing a detailed explanation of the context of the research in addition to my data collection and analysis processes in Chapter 3. Having *sincerity* requires researchers to be self-reflexive and transparent about the methods used for and the challenges of the

research. I have included a separate section on Reflexivity (Section 3.8) in this chapter, but I have also been very open about the various challenges and limitations I faced along the way in this research journey. *Credibility* is demonstrated by thick description, triangulation, and multivocality. I have worked to ensure that these features will be evident in each of the empirical chapters to follow (Chapters 4–7). *Resonance* is perhaps a little harder to pinpoint, but this criterion refers to a researcher's ability to affect an audience; to build empathy for the lived experience of those described in the research. Writing to share adolescents' voices has been a key goal of my research and I hope to have done this evocatively throughout this thesis.

Research that demonstrates a *significant contribution* can do so theoretically, practically, morally, methodologically, or heuristically. This work's key original contributions are: a deeper theoretical understanding of the psychological and social affordances of self-tracking for adolescents, a practical educational guide to empower adolescents in their self-tracking practices, and a description of online research undertaken with a vulnerable population at a time of global upheaval and uncertainty. The ethical criterion for excellent qualitative research has been discussed in depth earlier in this chapter in Section 3.4. *Ethics*, including ethics around the dissemination of research, have been central to this work from the outset. Finally, the criterion of *meaningful coherence* relies on a researcher successfully integrating literature, research questions, methods, findings, and interpretations to allow the study to achieve what it purported to do. At the start of this chapter, I clearly laid out how the selection of methods was informed by the literature and research questions, and I return to this discussion in Chapter 8 to draw in the findings and interpretations of my work.

In order to maintain the authenticity of adolescent voices in this project, I have not edited the transcripts to exclude filler words or false starts. Equally, any written contributions (such as text from chat histories or the Miro board) have been left unedited, including any spelling or grammatical errors. All survey responses have been anonymised and interview and workshop participants have been pseudonymised to protect their anonymity. Quotations from surveys are denoted in the form "(Gender, Age)". Quotations from interviews are denoted in the form "(Pseudonym, Age)". Quotations and contributions from workshops are identified by workshop number only (i.e., "(W2)" denotes a collaborator from Workshop 2).

3.7.3 Integration in Mixed Methods Research

Having undertaken a mixed methods research project, it is important to consider how the data were integrated in the research process. Throughout this thesis, the data from each of the methods are brought into dialogue with one another and used to paint a more holistic picture of the affordances of self-tracking technologies for adolescents (Bryman, 2006). According to Onwuegbuzie and Teddlie's (2003) framework for analysing mixed methods research, both the qualitative and the quantitative data analysis undertaken here were *exploratory* rather than *confirmatory*. As I discussed in Section 3.3.1, I foregrounded the qualitative data in line with my interpretivist stance in that element of my research and my aim of highlighting adolescent voices. Qualitative and quantitative data were then integrated at the points of analysis and interpretation (J. Creswell et al., 2003), with the quantitative data being drawn in to offer a different perspective on the meaning that adolescents make from their experiences and understandings of self-tracking.

The qualitative data from the survey and the interviews were initially analysed separately and then brought together under common themes (described in Table 3.2). The qualitative data from the co-design workshops were analysed separately to those from the survey and the interviews; however, the design of the workshops was informed by the analysis of the survey and interview data. Furthermore, in Chapter 7, the interview and survey data are used to provide a context for some of the data from the online workshops. The decision to analyse the co-design workshop data separately was made because the purpose of these co-design workshops was distinct from that of the survey and interviews and so it did not make sense to analyse these data together. Making this decision regarding the data analysis allowed me to use the data from the survey and interviews to inform the design of the co-design workshop activities.

3.7.4 Knowledge Translation

I reflect on knowledge translation further in Section 8.6.1 in Chapter 8; however, this was an important stage in my methods. Braun and Clarke argue that thematic analysis is valuable as it "offers a toolkit for researchers who want to do robust and even sophisticated analyses of qualitative data, but yet focus and present them in a way which is readily accessible to those who aren't part of academic communities" (2014, p. 2). I was keen to leverage this opportunity to present my findings in a way that was "readily accessible" to adolescents and to ensure that they also benefited from this work by having access to a tool that might spark some reflection or social change. As one of the final stages of data analysis, I worked with an illustrator (Weezy Dai) and condensed the key insights from this research to create a short infographic to share with adolescents (and others within and outside of academia) who were interested in the findings of this research.

Creating this artefact served as an important moment of reflection and a reminder of the reasons I began this research: to work alongside adolescents to imagine better technological futures. The process of doing this was important for ensuring that in the course of writing the thesis, the findings had not lost meaning for the community for whom this research was carried out. Given the opportunity, time, and resources, I would have loved to produce this infographic *with* adolescents. This simply was not possible in this project; however, I hope to be able to do so in future research.

3.8 Reflexivity

It is important to acknowledge here my own positionality as a researcher. This is particularly relevant to the interviews and co-design workshops; however, my own experiences, curiosity, and assumptions will have also informed the development of the online survey, my broader research questions, and the study design more generally. This interrogation of my positionality is of central importance to my use of reflexive TA as it emphasises my recognition that my subjectivity as a researcher is an important data analysis tool (Braun & Clarke, 2022).

These reflections were ongoing throughout the research process, and I kept brief notes in a research diary as they evolved (Nadin & Cassell, 2006). Through this process, I noticed that these considerations became more pronounced once I started engaging in participant-facing work (e.g., interviews and workshops), and I reflected deeply on these ideas throughout my data analysis. Although these reflections were complex, I would like to discuss two key elements in this section. Taking inspiration from feminist literature, these centre around Wilkinson's (1988) interrelated ideas of personal and functional reflexivity.

Starting with personal reflexivity, in many respects, I moved dynamically between my positionality as an 'outsider' and an 'insider' (Brewer, 2000). I was often an 'outsider' in my participant-facing research activities. I was asking young people to guide me through their experiences of adolescence. I had not thought that it was so long ago that I was in their situation, but I quickly became aware that I was being led through an unfamiliar landscape (although perhaps more familiar than they sometimes thought!). In moments when participants asked if I had ever heard of TikTok or when they described their likely physical decline and ageing in their twenties, it became apparent that they firmly positioned me as an 'outsider' who was far more distanced from their experience than I had imagined.

However, in other moments, I was positioned as an 'insider' as I also engage in self-tracking practices. This 'insider' knowledge helped with rapport-building by expressing similar frustration with specific self-tracking tools. This demonstrated that I was actively listening to their responses but also ensured that participants knew I was on 'their side' rather than representing any particular technology company or interest. This gave them some assurance that they were allowed to make criticisms or speak candidly about their experiences with specific tools.

I was also very aware of issues concerning power and authority when engaging with adolescents; however, never did I reflect on my position as a researcher and authority figure more deeply than when one young participant joined our interview dressed in a full suit, whether by coincidence or intentionally for the interview. Other participants also used the time at the end of the interview to find out more about the university experience and what they should be doing to make a competitive application to my university. In these situations, it was evident that I served as an authority figure for them as they navigated

higher education, and it was sometimes challenging to disentangle this from the content of the interview.

Thinking more deeply about functional reflexivity, the online nature of my interaction with adolescents shaped the production of knowledge in this project. In many cases, other people (such as parents and siblings) were often listening in or even participating during the online interviews. Moreover, when participants chose to take part in research activities with their video off, I became aware that I asked more closed questions, or offered them 'ways out' of questions. Upon reflection, in the absence of body language cues, I could not see how my questions were being received and I took an extremely risk-averse approach in these situations to avoid causing any upset or harm that I could not see on the screen.

I am aware, therefore, that these challenges certainly coloured my responses and approach to interviewing. This is clear from my frustrations during the data analysis process, as described in one of the excerpts from my research diary below:

> I had imagined that immersing myself in my data would make things clearer. But rather as I pour over the transcripts again and again, I am overwhelmed by the avenues I should have explored; the questions left unasked, and silences cut too short. In many cases, I know the reasons for these decisions, but I can't help but think "what if" …
> – 7 December 2021

Overall, my reflexive considerations have been an integral element of this project, and at many times it has been quite confronting to contemplate my own research practices and challenge myself to question my own role in the project. Whilst challenging, this has also been one of the most stimulating parts of the project and I will return to this later in the Discussion in Chapter 8.

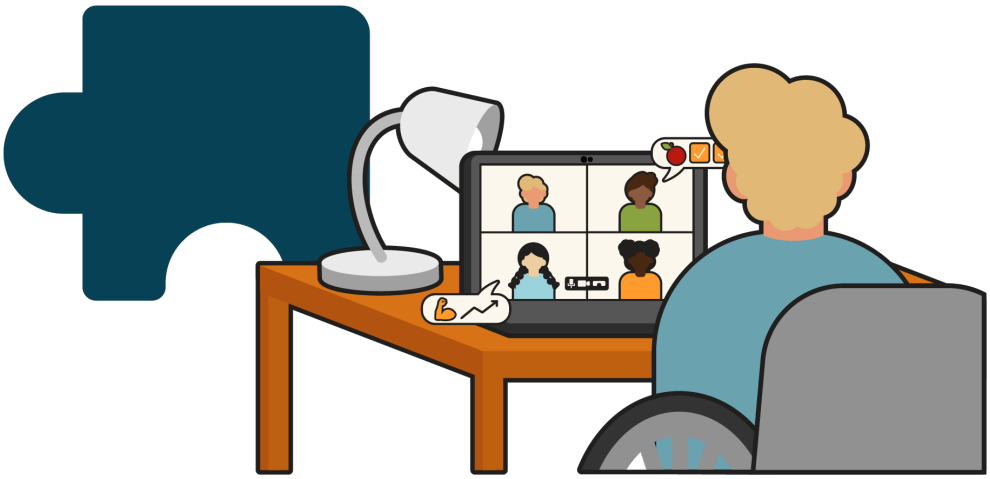
3.9 Recognising the Limitations of this Study and Looking Forward

Before exploring the results of this study, I feel it is important to emphasise that I am aware that the methods I used are limited. Being clear about this is an ethical consideration, as the topic of this research taps into sensitive, topical, and deeply personal challenges. There are clear links between this work and the recent academic and media attention that has been given to the potential negative mental health impacts of social media on adolescents' mental health, such as work on the relationship between adolescents' use of Instagram and their body image (e.g., Kleemans et al., 2018). Academic scholars have undertaken extensive work to call into question the associations between adolescents' use of technology and lowered psychological wellbeing (e.g., Odgers, 2018; Orben & Przybylski, 2019). It is not, however, the purpose of this study to determine whether digital self-tracking *causes* any social or psychological effects (be those positive or negative); indeed, the methods used here do not allow me to make any such claims. Instead, through this research I am trying to understand and analyse some of the different adolescent experiences of self-tracking and what these tools might afford adolescents in their particular circumstances. Whilst this will include serious consideration of emotional and social affordances, where cause and effect are concerned, this thesis can only point to areas for future researchers to explore. Where any causal language is used, for example when Ophelia (17) commented that self-tracking *"became an obsession throughout the lockdowns and ultimately cause me to have an eating disorder"*, this will reflect adolescents' perspectives of cause and effect only.

As this chapter highlights, I used a mixed methods approach to address the following broad research question: *What are the affordances of self-tracking for adolescents' psychological and social wellbeing?* Additional research methods, including observational methods (e.g.,

walkthroughs (K. M. Jørgensen, 2015; Light et al., 2018)) or analysing usage data (e.g., Hartman et al., 2018) would have enabled me to capture *actual* engagement rather than relying on self-reported experience. Whilst these methods have an important place in our understanding of young people's engagement with self-tracking tools, they were not the most appropriate for addressing my research questions. In the context of this study, it made sense to understand how adolescents think about their practices before trying to measure them. For example, it might be that many of their self-tracking practices take place offline, such as around the dinner table or in school playgrounds, limiting the usefulness of usage data. Nor were these observational methods appropriate in the context of data collection during COVID-19 lockdowns as I was wary of asking participants to share their data remotely or having them unintentionally share intimate health data they wanted to keep private. Therefore, the methods I selected allowed me to ensure that the focus of this research remained centred more closely on adolescents' experiences of self-tracking as I firmly believe that their experiences are valid, important, and worth sharing. In what follows, I share what I have learned about these experiences across four empirical chapters.

4 The Changing Context of Tracking: Adolescents' Tracking During the COVID-19 Pandemic



"Being healthy allows me not to be afraid of COVID-19." (Male, 18)

4.1 Introduction

I did not conceive this study with an intention to focus on COVID-19; however, the pandemic changed the landscape so dramatically that I felt it was necessary to establish the context of the COVID-19 pandemic before moving into the subsequent empirical findings chapters. In many ways, this chapter serves as an exposition, both of the central characters of this thesis (adolescents) and of the central conflicts in this story.

The COVID-19 pandemic magnified the relationships between adolescents, their bodies, and technology as young people grappled with being physically distant from – but

technologically present with – friends, teachers, and family. Ways of communication, connection, and learning were fundamentally altered for young people, and, in large part, have become more technologically mediated, or "digital by default" (Stoilova et al., 2020, p. 197). More specifically, approaches to physical activity and self-tracking saw interesting shifts as recommendations to maintain fitness became much more centred on the space of the home (Schwendinger & Pocecco, 2020). Clark and Lupton capture this in what they term "pandemic fitness assemblages" (2021, p. 1224), which encompasses human–digital encounters including "the home and associated spaces, [sic] fitness gear, other people and other living things as well as digital technologies such as apps and platforms" (p. 1224). By understanding these evolving sociomaterial arrangements, we can start to interrogate the different affordances of self-tracking tools for adolescents.

This new sociomaterial environment intensified the roles that technology played in young people's lives and their understanding of how their bodies are changing and growing. For example, the intimate entanglements between health and technology became all too apparent, from the rapid emergence of COVID tracking apps (Sharma & Bashir, 2020) to a swell in the adoption of self-tracking tools like wearables (Osborne, 2021). The health behaviours acquired in adolescence are often carried through to adulthood (Manganello, 2008; Skopelja et al., 2008). These effects during periods of lockdown may well last throughout the rest of adolescents' lives. By examining closely an extreme situation (such as the COVID-19 pandemic), I was able to pay careful attention to the what, how, who, and why of self-tracking for adolescents.

Such an extreme situation can helpfully highlight details that might otherwise be obscured by 'normal' daily lives and routines. The language of affordances is central here as I

consider how the changing conditions (namely cultural and institutional legitimacy) of the sociomaterial environment influenced how self-tracking technologies might request, demand, allow, encourage, discourage, or refuse different functional, cognitive, social, emotional, or identity affordances imagined by adolescents (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016; Moreno & Uhls, 2019; Nagy & Neff, 2015). The different dynamics at play – including lifestyle restrictions and changes to routines of schooling – in this unique and extreme context illuminate the complexities of self-tracking practices and allow me to study them at a deeper level than I might have been able to previously. Here, I consider what the affordances of self-tracking might mean for adolescents at this critical stage of development. I argue that these insights might help inform how we think about adolescents' self-tracking in other (less extreme) contexts, as I will explore later in Chapter 8, the concluding chapter of this thesis.

Before looking to understand the complexities of how self-tracking might be embedded into adolescents' psychological and social worlds, it is perhaps helpful to take a step back and explore the landscape. In this chapter, I address RQ1: **How did adolescents experience self-tracking during the early stages of the COVID-19 pandemic?** This chapter establishes the context by providing a picture of the patterns and scope of adolescents' digital self-tracking practices during the early stages of the COVID-19 pandemic, including periods in and out of lockdown in the UK (from June – December 2021). In what follows, I explore the scale of the issue: how many adolescents were tracking, what this tracking looked like, and how adolescents perceived that the COVID-19 pandemic influenced these behaviours. If this chapter achieves one thing, I hope it demonstrates clearly that not all people interact with self-tracking tools or information in the same way; the affordances of self-tracking technologies for adolescents are not fixed.

This chapter primarily brings together quantitative and qualitative data from the online survey, along with supporting qualitative data drawn from the online interviews. I begin with an introduction, exploring the descriptive statistics to describe the sample of adolescents involved in this project and to set up what is to come. Then I explore five themes that capture the impact of COVID-19 on adolescents' self-tracking, titled: Filling the Void; Opportunities for Self-Tracking?; Seeing Through Data Glasses; Tracking Towards Control; and The More Things Change, The More They Stay the Same. I draw on the concepts of imagined affordances and sociomaterial practices to explore the activities made possible by self-tracking tools in an environment marked by disruption and change. These concepts informed the data analysis and provided a means for me to connect data from the online survey with data from online interviews. Perhaps a reminder about how quotations from surveys will be denoted is useful here: the form will be "(Gender, Age)". Quotations from interviews will be denoted in the form "(Pseudonym, Age)".

4.2 Describing the Sample

I would like to begin by introducing our adolescents. In this section, I will describe the adolescents involved in each of the three key stages of this project: the online survey, online interviews, and online co-design workshops.

4.2.1 Online Survey

Overall, of the 827 returned surveys, 695 valid responses were included in the analysis (see Section 3.7.1 in Chapter 3, the Methodology and Methods chapter, for a summary of how valid responses were determined). A breakdown of the participant demographics is available in Table 4.1 and a map showing the distribution of participants across the UK is illustrated in Figure 4.1. below. The mean age of participants was 16.71 years and a graph

of the age distribution of participants is illustrated in Figure 4.2 below. With respect to gender, 56.83% (n = 395) of adolescents identified as male, 39.14% (n = 272) as female, 2.30% (n = 16) as non-binary/third gender, and 1.73% (n = 12) chose not to disclose their gender. Most adolescents (n = 456, 65.61%) were secondary school or college students. As shown in Table 4.1, the ethnicity composition was more diverse than the population of young people in the UK (Office for National Statistics, 2018). The overall mean (SD) social comparison orientation score was 3.38 (.55) as measured by the Iowa-Netherlands Comparison Orientation Measure (INCOM; scoring is described in Section 3.6.1 in Chapter 3). This is similar to overall mean (SD) scores seen recently in research conducted with adolescents in the United States: 3.15 (.06) (Mann & Blumberg, 2022).

The overall mean (SD) score for adolescents' psychological wellbeing was 48.04 (9.22) as measured by the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS; scoring is described in Section 3.6.1 in Chapter 3). This mean score is similar to scores seen in previous large-scale studies of adolescents in the UK: 48.8 (8.66) (Clarke et al., 2011) and 48.74 (8.66) (Bell et al., 2019).

Within this sample, most adolescents fell into the SES categories of 'Low' and 'Medium' as measured by the Family Affluence Scale (FAS; scoring is described in Section 3.6.1 in Chapter 3). In terms of vigorous physical activity (VPA), the median frequency for adolescents was 'once a week' and the median number of hours per week engaging in VPA was 'about one hour'. This falls far below the WHO guidelines (2022) for children and adolescents aged 5–17 years which suggest that adolescents

- should do at least an average of 60 minutes per day of moderate-to-vigorous intensity, mostly aerobic physical activity across the week.

- should incorporate vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone, at least 3 days a week.
- should limit the amount of time spent being sedentary, particularly the amount of recreational screen time.

Table 4.1. Participant demographics.

Number of participants (*N*)		695
Age in years, mean (*SD*)		16.71 (1.42)
Gender, *n* (%)	Male	395 (56.83)
	Female	272 (39.14)
	Non-binary/third gender	16 (2.30)
	Prefer not to say	12 (1.73)
Ethnicity, *n* (%)		
	Asian or Asian British	124 (17.84)
	Black or Black British	88 (12.66)
	Mixed	64 (9.21)
	White	416 (59.86)
	Other	1 (.14)
	Prefer not to say	1 (.14)
Employment, *n* (%)*		
	Secondary school/college student	456 (65.61)
	University student	152 (21.87)
	Apprentice	29 (4.17)
	Part-time employment	82 (11.80)
	Full-time employment	42 (6.04)

	Not currently employed	30 (4.32)
	Other	7 (1.01)
Region of residence in the UK, *n* (%)		
	Scotland	116 (16.96)
	North East	43 (6.29)
	Northern Ireland	50 (7.31)
	Wales	46 (6.73)
	North West	57 (8.33)
	Yorkshire and the Humber	44 (6.43)
	West Midlands	46 (6.73)
	East Midlands	59 (8.63)
	South West	44 (6.43)
	South East	69 (10.09)
	Eastern	27 (3.95)
	London	83 (12.13)
Social comparison orientation, mean (*SD*)		3.38 (.55)
Psychological wellbeing, mean (*SD*)		48.04 (9.22)
Socioeconomic status, *n* (%)	Low	317 (45.61)
	Medium	260 (37.41)
	High	117 (16.83)
Vigorous physical activity, median	Frequency	"Once a week"
	Hours	"About one hour"

**Multiple responses permitted.*

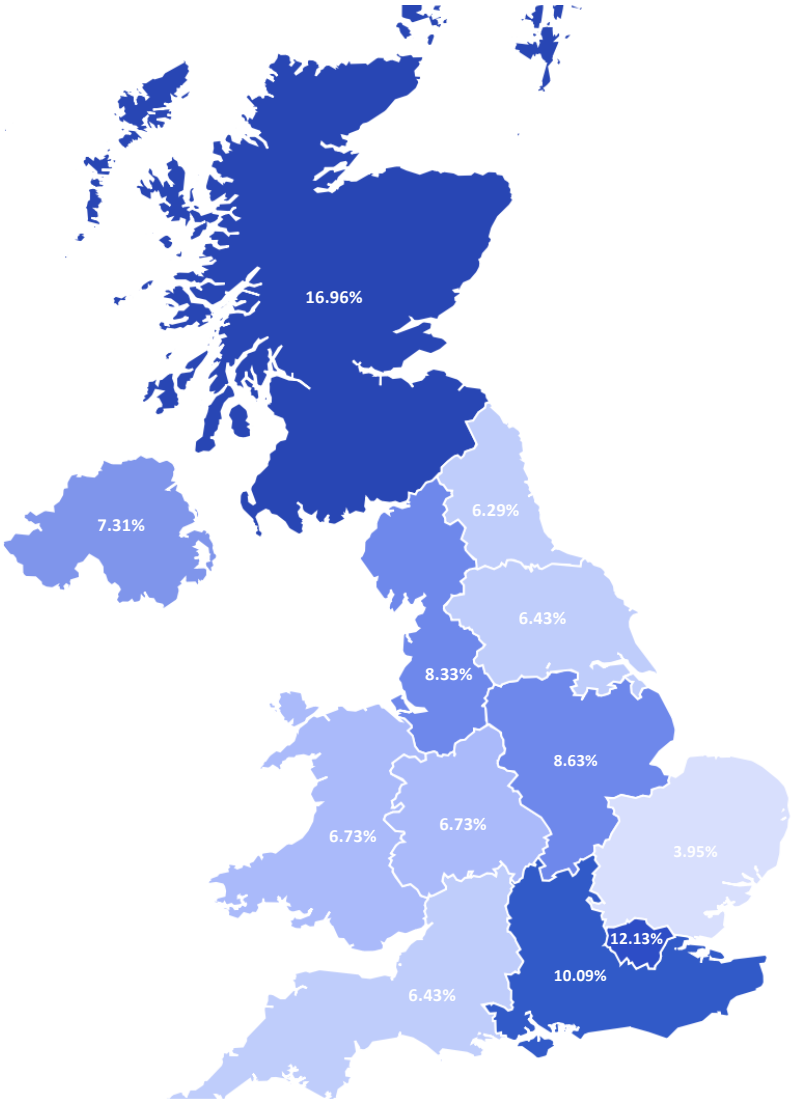


Figure 4.1. A map of the UK showing the distribution of participants in the online survey. Darker shades indicate regions with a higher proportion of participants.

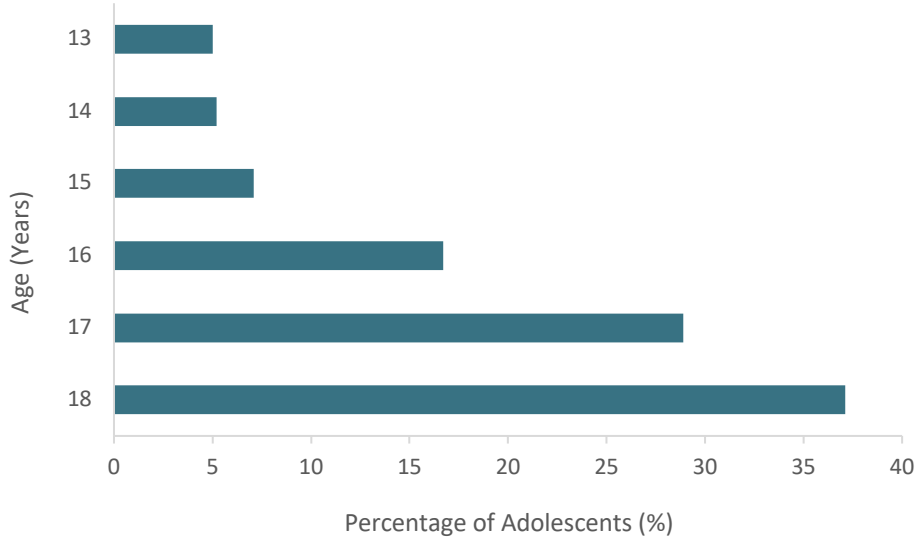


Figure 4.2. Distribution of the ages of adolescents who took part in the survey.

Of the 695 adolescents included in the survey, 643 (92.52%) had used digital self-tracking tools at some point; 501 (72.09%) were current users at the time of the survey, and 142 (20.43%) were previous users but had stopped (see Figure 4.3). Only 52 adolescents (7.48%) had never used a device or app to track their health and activity data. Most commonly, adolescents that had ever used self-tracking tools had used smartwatches or wearable devices (n = 429, 66.72%) and smartphone apps (n = 361, 56.14%), but fewer adolescents reported having used connected health equipment such as weight scales (n = 190, 29.55%) and connected exercise equipment such as Peloton bikes (n = 114, 17.73%). This material preference for smartwatches and wearables contrasts with the findings of Lee et al. (2014) who found that adolescents resisted using conspicuous wearable devices in favour of less noticeable tools, such as apps.

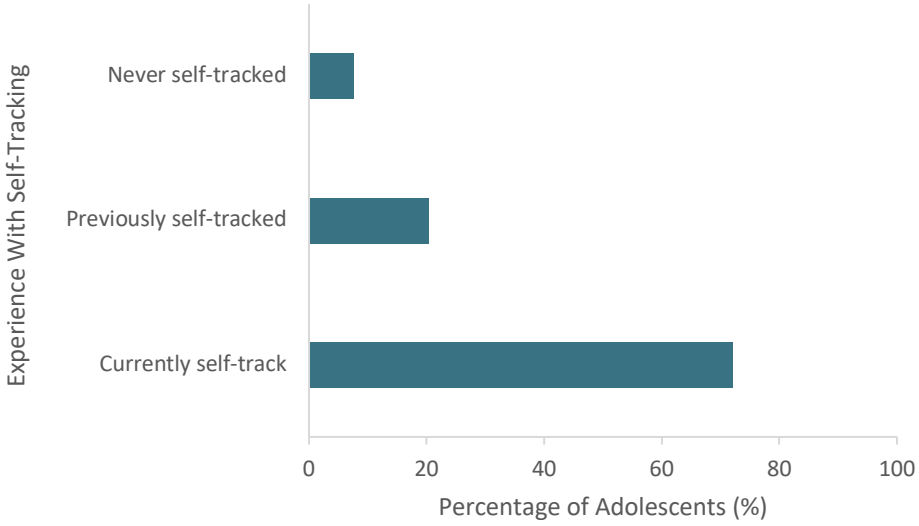


Figure 4.3. Adolescents' experience with self-tracking at the time of the survey.

Given the high cost of many self-tracking tools (e.g., wearables and connected exercise equipment) and the devices used to access free apps (e.g., smartphones), in Section 3.7.1 in Chapter 3, I hypothesised that adolescents' SES and their experience of using self-tracking tools would be related (Hypothesis 1). That is to say, adolescents with a higher self-reported SES would be more likely to have had experience in using self-tracking tools than adolescents with a lower self-reported SES. Interestingly, there was no significant relationship between SES (measured by the FAS) and experience with self-tracking tools. A chi-squared test of independence was performed to examine the relationship between adolescents' SES (categorised as 'Low SES', 'Medium SES', or 'High SES') and their experience with self-tracking tools (categorised as current users, previous users, or non-users). The relationship between these variables was not significant: $\chi^2(1, N = 694) = 1.84$, $p = .77$ (see Figure 4.4).

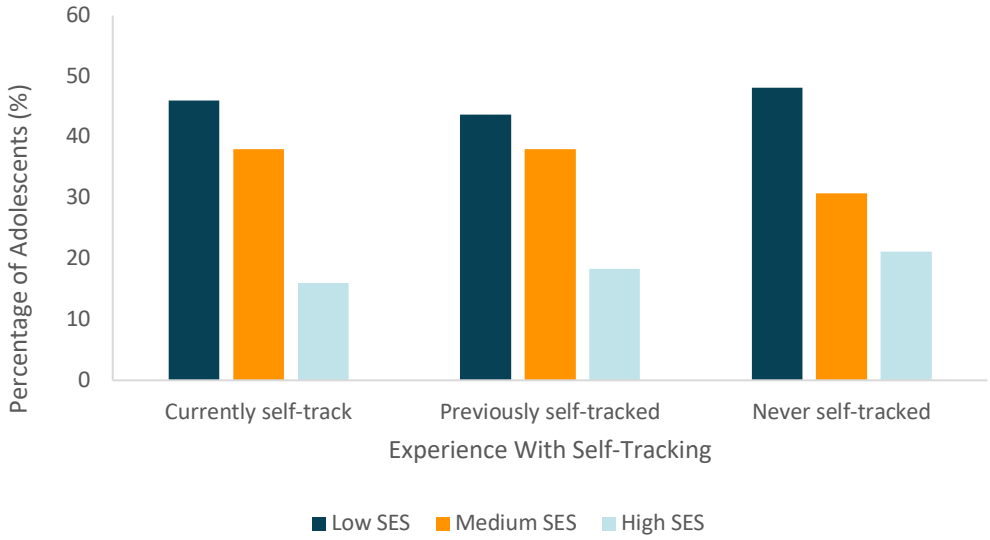


Figure 4.4. Adolescents' experience of self-tracking according to socioeconomic status (as measured by the Family Affluence Scale).

As depicted in Figure 4.5, 91 (18.16%) adolescents who were self-tracking at the time of the survey had been tracking for a few years; however, most (n = 408, 81.44%) current self-trackers had been tracking for a few months or less – in other words, since the start of the COVID-19 pandemic. By comparison, when reporting on how long they used to track for, fewer previous self-trackers had tracked for a few years (n = 10, 7.04%) or a few days (n = 23, 16.20%), whilst most had tracked for a few months (n = 55, 38.73%) or a few weeks (n = 54, 38.03%) before stopping.

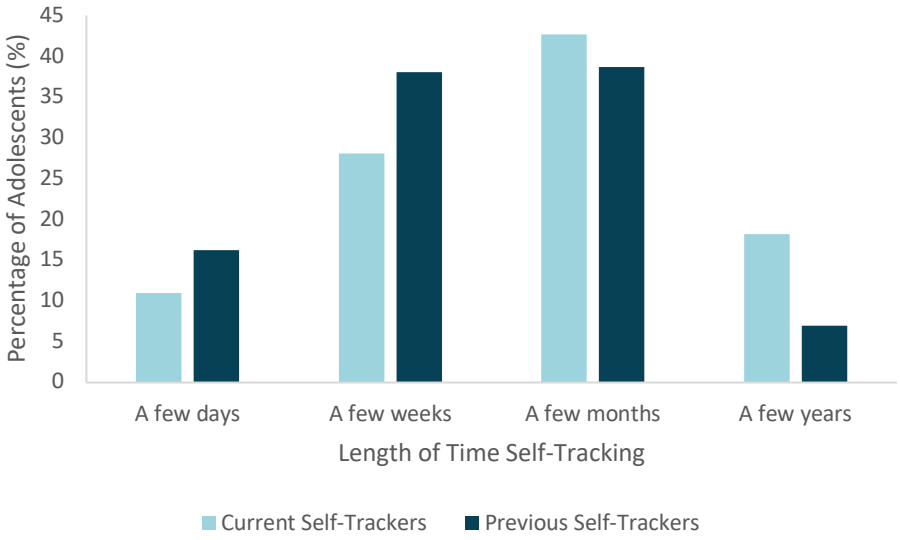


Figure 4.5. The length of time spent self-tracking by the adolescents who were self-tracking at the time of the survey and the adolescents who had previously self-tracked but subsequently stopped.

Figure 4.6 below shows that, overall, adolescents' descriptions of their data did not differ dramatically between those who were self-tracking at the time of the survey and those who had previously self-tracked but had stopped; however, there are a few notable insights that can be gained from these data. Adolescents who were using self-tracking tools at the time of the survey (n=278, 55.49%) and those who had previously used these tools (n=59, 41.55%) most frequently described the motivational affordances of self-tracking. A higher percentage of adolescents who were self-tracking at the time of the survey said that self-tracking helped them achieve their goals (n=219, 43.71%). Two interesting descriptors – more commonly identified by previous self-trackers – were "don't/didn't think about it much" and "makes/made me feel judged". Previous self-trackers described these more negative and disinterested descriptions of their self-tracked data, and this may have contributed to their experiences of the affordances of these tools. In turn, these experiences might have contributed to their decision to stop tracking, although future work is needed to explore this further.

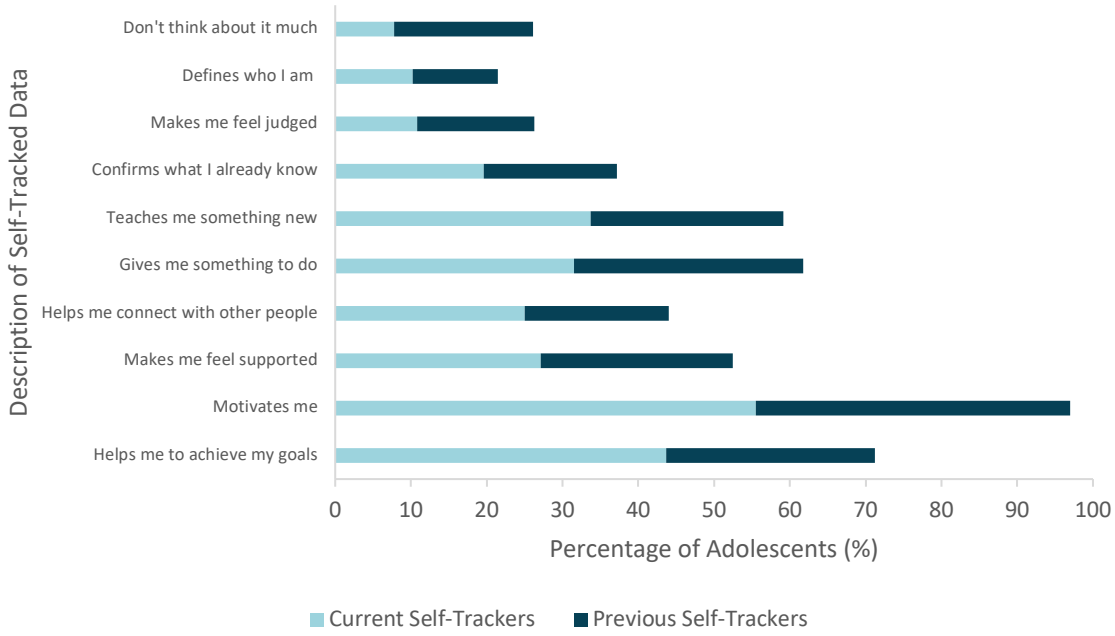


Figure 4.6. Adolescents' descriptions of their self-tracked data for adolescents who were self-tracking at the time of the survey and those who had previously self-tracked but subsequently stopped. Adolescents were permitted to "select all that apply".

4.2.2 Online Interviews

In total, 29 adolescents participated in an online interview. Of these, 12 were aged 13–15 years (41.38%) and 17 were aged 16–18 years (58.62%). In terms of gender composition, 14 identified as female (48.28%), 11 identified as male (37.93%), one identified as non-binary (3.45%), and three did not disclose their gender (10.34%). Further, 16 were using self-tracking tools at the time (55.17%), eight had previously used self-tracking tools (27.59%), five had never used self-tracking tools (17.24%). A diagram showing the geographic spread and self-tracking experience of these interview participants across the UK can be seen in Figure 4.7. A complete summary of these interview participants and their stories is available in Appendix A.

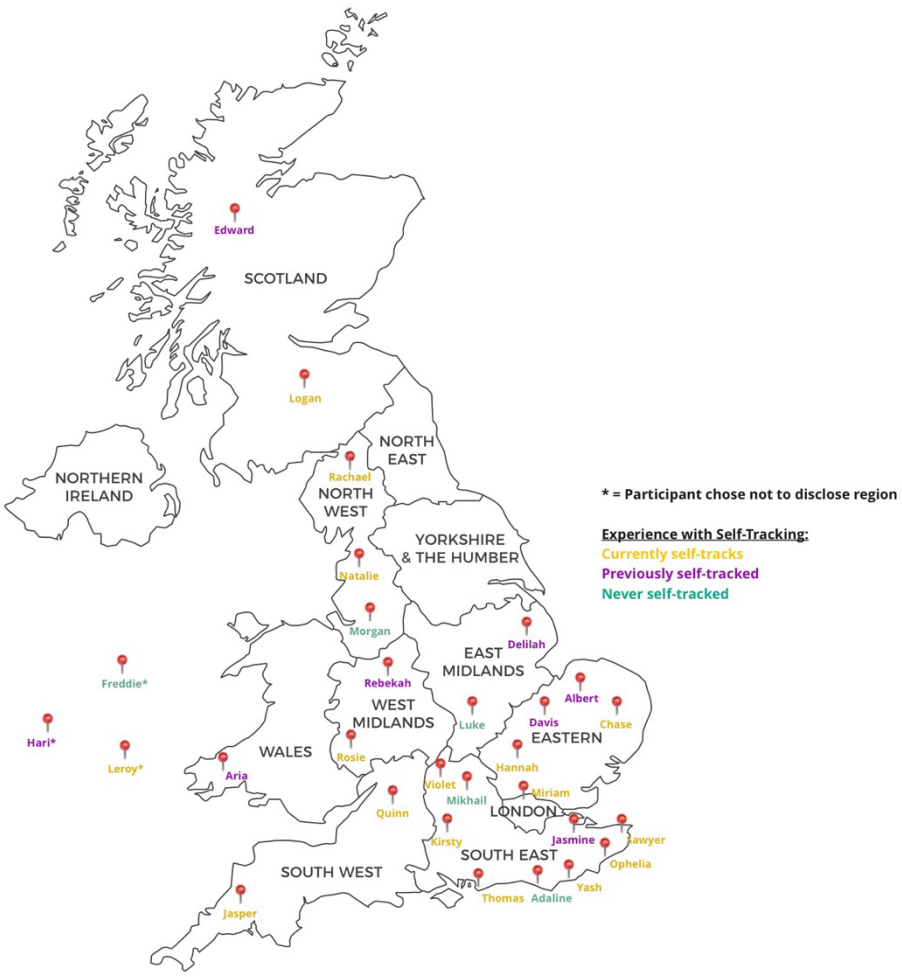


Figure 4.7. Geographic distribution and self-tracking experience of online interview participants.

4.2.3 Online Co-Design Workshops

In total, 76 adolescents signed up to participate in the Series A workshops, 44 of whom successfully completed a workshop. Of these, 13 identified as female (29.55%), 20 as male (45.45%), and 11 did not disclose their gender (25.00%). Of these 44 adolescents, 23 were using self-tracking tools at the time (52.27%), 10 had previously used self-tracking tools (22.73%), three had never used self-tracking tools (6.82%), and eight did not disclose their experience of self-tracking (18.18%).

Eight adolescents signed up for a Series B follow-up workshop and three of these successfully returned to take part in a workshop. Of these, two identified as female (66.67%) and one as male (33.33%). Two were using self-tracking tools at the time (66.67%) and one had previously used self-tracking tools (33.33%).

4.3 The Impact of COVID-19 on Adolescents' Self-Tracking

Having now described the adolescents involved in this project, in the following sections, I draw on data from the online survey and interviews to explore the affordances of self-tracking for adolescents navigating their changing sociomaterial environments during the COVID-19 pandemic.

In the survey, most adolescents (n = 601, 86.47%) reported that COVID-19 had changed the way they thought about self-tracking, at least to a small extent (see Figure 4.8).

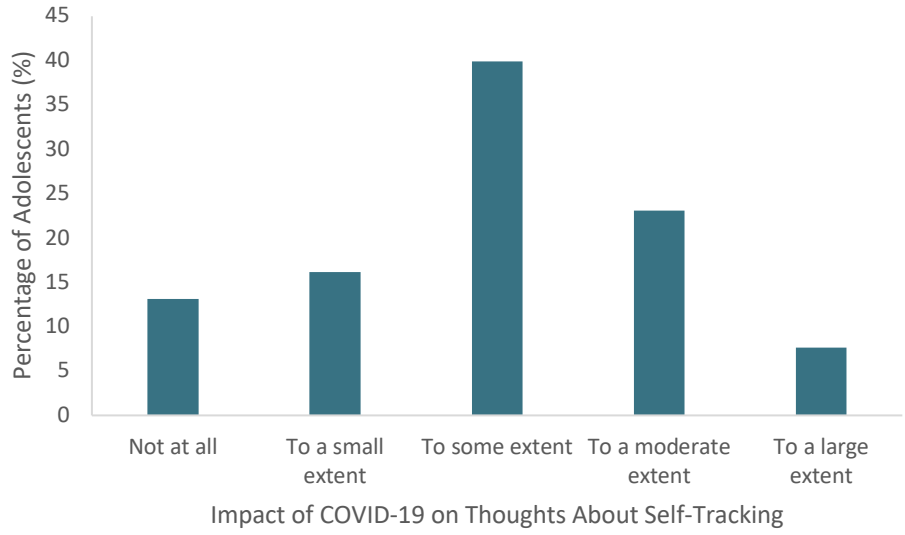


Figure 4.8. Adolescents' perceptions of the impact of COVID-19 on their thoughts about self-tracking.

As illustrated in Figure 4.9, the top factors that influenced this change were lockdown restrictions (n = 274, 39.42%) and school/university/work closures (n = 262, 37.70%). In line with this, the interview data revealed that school/university/work closures and lockdown restrictions transformed adolescents' lives in significant ways. Some of these impacts included changing routines around physical activity (both with respect to sports and more everyday incidental activities such as walking between classes); lack of access to resources and spaces that were previously available; and an increased use of digital technologies to navigate social, academic, and leisure activities.

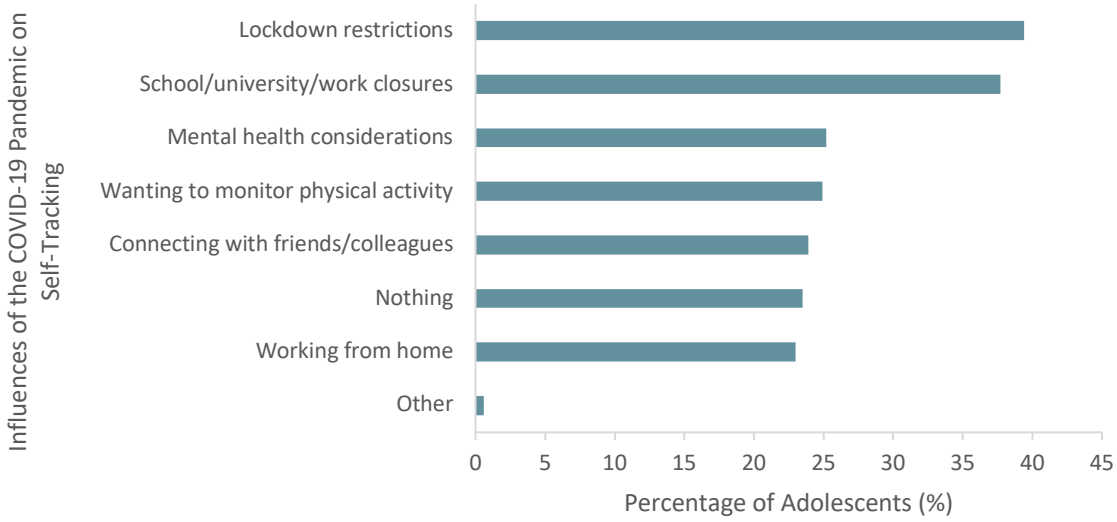


Figure 4.9. Adolescents' perceptions of the key influences associated with the COVID-19 pandemic which influenced their thoughts about self-tracking.

4.3.1 Filling the Void

Many adolescents said that without the distractions of 'normal' life, when they *"didn't have much going on"* (Rachael, 17), the tracking of their bodies took on new importance: *"It was something to do, and my weight and health consequently became one of the most important things in my life at the time"* (Male, 14). At this time, their data became valuable as a much-needed focus in the absence of the familiar structure and routines of everyday life. Here, the affordances of

self-tracking for adolescents were conditioned by new cultural and institutional legitimacies. This encouraged increased body awareness and a deeper understanding of the importance of their physical and mental health. One adolescent commented, *"I feel so much more aware of my body and my weight"* (Female, 15).

Under these new constraints caused by schooling taking place at home, some adolescents described having more time for both physical activity and tracking during periods of lockdown, which allowed them to increase their engagement with the tools or to become more detailed in their data tracking. Adolescents described that this was often out of boredom, when tracking became more appealing as a form of entertainment as *"there's nothing much better to do"* (Female, 16). Or, as Thomas (13) noted, *"I've discovered more things that my watch can do, so I've just been bored and sat there, just messed around with it."* Moreover, it was not just the tracking practices themselves that adolescents had more time for; they also described having more time to think about and reflect on their data.

This was not true for everyone, however, as some adolescents found that their engagement with self-tracking tools decreased. The physical and cognitive effort required to track was too much for some in the midst of the early stages of the pandemic: *"Lockdown sometimes made me not have the energy to track my exercise"* (Male, 15). Similarly, Sawyer (16) said that whilst they kept tracking, they lost interest in the data they were collecting: *"I just couldn't really be bothered to track food or if I did, it was out of a place of more boredom than like actually wanting to know or being interested".*

In the absence of other distractions, the risk here was that this apathy could swing the opposite way and adolescents' self-tracking could become *"obsessive"* (Female, 17).

Concerns about this possibility influenced adolescents' approach to self-tracking during the COVID-19 pandemic. For example, Jasmine (17) commented that she was wary of tracking too frequently or focusing too much on her data as she imagined that the design of self-tracking tools could encourage this obsession: *"I'm also scared like it's just gonna like pull me in and I'm going to get so obsessed with the numbers and everything"*. Some adolescents were extremely self-reflexive and aware of their particular vulnerability to these cognitive and emotional affordances of obsession with self-tracking because of their personalities: *"I feel like the type of person I am […] for me, it definitely would be easy to become like fixated on it"* (Quinn, 17). Similarly, Adaline (16) described her wariness of starting self-tracking and finding herself becoming too focused on it:

> *As soon as it becomes obsessive I think it's not a good thing, and that's kind of the reason I haven't downloaded one is cause I know from experience with umm Duo Lingo. I know if I do not reach my thing […] I'll be like "Oh no!" like at 12:00 pm, I will be like "Oh no, I haven't done my streak!", run to get it and so I can imagine if you get like that with the fitness app.*

For some, this was more than just a risk, and they described their personal experience of being *"obsessed"* (Jasmine, 17) with tracking during the COVID-19 pandemic. For example, Ophelia (17) shared the challenges she faced:

> *It's very easy to slip into obsessive calorie counting, obsessive calorie burning and things like that umm which is what happened to me […] it was so unhealthy but you don't really realise it until it's kind of too late and you have to get help for it 'cause you can't do it on your own any more.*

Adolescents said that this increased emphasis on tracking data – which often began in lockdowns – could have lasting negative psychological and physical health effects. I explore further in Chapter 6. When *"there was nothing to think about"*, one adolescent described these lingering emotional affordances as, during periods of lockdown, she *"began to think a LOT about the small things. Like hitting 10,000 steps each day and running twice a week. The stress became slightly obsessive and the effects are lasting into today"* (Female, 17).

Once lockdown restrictions were lifted, the sociomaterial assemblages started to shift. As other distractions and routines, such as in-person schooling, returned, a number of adolescents found that their focus shifted away from self-tracking. For example, one adolescent stated: *"This interest [in self-tracking] disappeared when school started and I didn't quite care how many calories I burnt that day or how many steps I walked"* (Female, 16). In a similar way, Edward (17), who started self-tracking during the lockdowns as his walking increased, mentioned that his tracking decreased once he could *"go out and actually see people"*; his physical activity and self-tracking during lockdowns had been *"more of like a lonely thing"* and he was keen to rekindle in-person social relationships. Thus, whilst self-tracking was of central importance in his life during periods of social isolation where there were gaps to be filled, its role shifted as new priorities emerged and self-tracking no longer encouraged the social affordances he sought.

4.3.2 Opportunities for Self-Tracking?

For some, the lifestyle changes that emerged during periods of lockdown opened up new opportunities for self-tracking. Many adolescents replaced activity done during organised sports and PE classes with runs, walks, or home workouts. The use of connected exercise equipment to track activity was a popular choice for home workouts: *"I also use a peloton bike which I have used more during covid"* (Female, 17). Some adolescents said that the change in routine and the loosening of the constraints of school, university, and work meant different, often more autonomous, physical activities were available to them, some of which lent themselves more readily to self-tracking. Chase (16), a long-time tracker on smartphone apps and wearables, remarked that he enjoyed the freedom to exercise and self-track on his own terms: *"I was at home. I wasn't kind of going into school, so I had time and the ability to exercise on my own more […] It was easier […] when I've not kind of got other things going*

on". Similarly, Aria (18) told me that her shift to remote schooling opened up the flexibility to engage in physical activity in ways that were not possible within the structure of the school institution: *"I had a bit more free time because of the way that college was structured during COVID […] I've got no excuse, I'll go out for this half an hour where I would have been at lunch or whatever"*.

Adolescents described how self-tracking tools often privilege certain types of activities (e.g., walking, running, cycling) over others (e.g., gymnastics, climbing), in J. L. Davis and Chouinard's (2016) terms they 'request' such activities. Walking and cycling were common activities for adolescents who were tracking during periods of lockdown: *"With lockdowns I could go out and cycle or walk more so I would track it more than before the pandemic"* (Female, 16). These activities were often social, involving family members and friends. Interview participants described how sometimes this would lead to discussions about the data collected during these shared activities. These collective tracking experiences, highlighted here by the context of the COVID-19 pandemic, sit at the centre of Chapter 5.

These new opportunities for self-tracking sometimes came in a more organised form, including the promotion of self-tracking by schools and other charity events on social media, such as the 'Run 5 Donate 5' challenge on Instagram. As one adolescent explained, *"I also downloaded Strava and started using it since my school started a charity event using it over lockdown"* (Female, 17). In the absence of formal Physical Education classes, a number of interview participants said that their schools also ran competitions involving self-tracking. Jasmine (17) found that this was a helpful way to stay in contact with her peers whilst they were physically distanced:

> *Our school actually did a competition on Strava so umm it was like a couple of like competitions like oh who could like run this amount umm fastest or you know, like team challenges and things like that […] I think it helps you keep connected with friends as well. Umm 'cause it is like a social media thing you can like share pictures of like where you ran or like a nice like the nice scenery […] like it's a way to keep bonded.*

Others found that self-tracking was less appropriate during lockdowns when the options to move their bodies were more limited: *"There's been no point during lockdown because you can't go to the gym or anything"* (Female, 17). For some, other boundaries discouraged, or even refused, their engagement in self-tracking practices. For example, some parents would not allow them to leave the house during lockdowns, and others, such as Logan (15), were extremely clinically vulnerable to the virus and thus were 'shielding' (i.e., facing tighter restrictions on their movements to protect them from COVID-19): *"Err the first lockdown because I was shielded, yes it [self-tracking] stopped"*. Without places to walk to or gyms to visit, some adolescents felt that there was *"no need to use"* (Female, 13) self-tracking tools and thus they did not feel that they played an important role in their lives at the time.

4.3.3 Seeing Through Data Glasses

Some adolescents found that tracking allowed them to quantify the impact that the movement and lifestyle restrictions, associated with periods of lockdown, had on their activity levels. They described their use of self-tracking tools to monitor and record lifestyle changes related to COVID-19: *"I was curious as to if the pandemic affected my sleep schedule, stress factors being caused from it (not seeing friends, school being changed around etc)"* (Non-binary/third gender, 16). Hannah (16) described how self-tracking allowed her an increased awareness of the changes to her life throughout lockdown: *"I guess it's made me more aware of how little I do. So like just staying at home in lockdown. I didn't do very many steps, so that made me aware of like how important being outside is"*.

For adolescents that had a more negative experience with tracking, their self-tracked data became an unwanted and uncomfortable reminder of the negative impact of lockdown on their bodies: "*My daily steps drastically decreased and my caloric intake increased. Seeing this reflected on my tracking app was disheartening as I felt I was loosing my routine which helps me stay calm"* (Male, 16). Adolescents described emotional affordances of a sense of disappointment and failure when they saw downward trends in their activity data, and some felt that this negatively impacted their self-image and self-esteem.

The cognitive affordances of increased awareness had differing effects for adolescents. For those who found that tracking exacerbated the negative effects of lockdown, their tracking decreased as they did not want to see the data: *"I have stopped a lot of physical activity and ate a lot, so my weight has increased meaning I don't use tracking devices as much as I did as I feel self concious"* (Female, 18). For others, however, it had the opposite effect, and the cognitive affordance of enhanced bodily perception of these lifestyle changes motivated them to start tracking: *"Covid 19 made me want to track health and phyactivity because I was aware I had become very unfit and inactive during lockdown, as I would spend all day at home"* (Female, 16). Thus, the affordances of self-tracking for data reflection differed across adolescents and contexts.

4.3.4 Tracking Towards Control

Those who were actively engaged in organised and school sports before the pandemic appreciated self-tracking as a way to control their levels of physical activity. For many, being able to track in this way had a positive effect on their mental wellbeing. One adolescent said that *"Not being able to do as much physical exercise in clubs and in school, I valued the step counter more as a way to tell myself if I did enough physical exercise in a day",* which made him *"feel mentally better not doing a lot of sport"* (Male, 16). In this way, adolescent athletes were able

to take control of their own training and physical health. This was important as it helped adolescents to maintain their sense of identity and mark achievements and progress: *"being able to track and see my activities and data really uplifted me when the going got tough with mental health it helped me be able to continue my training positively to stay on track"* (Female, 16). Similarly, Rosie (14) imagined that self-tracking could be a way of combatting the negative mental health effects of COVID-19:

> *Yeah, so I feel like COVID affected lots of people's mental health. So like whilst you're like you might feel a bit like sad that you're in COV- you're in lockdown but then going for a run and then having seen that you've burned this many calories or you've done like further than you usually have done will make you feel even better.*

Some adolescents described how, either as a consequence of their changing routines or of having been infected with COVID-19 themselves, they took the opportunity to initiate significant lifestyle changes, set new goals, and take control of their bodies: *"The time gave me a chance to look at my physical health and do what I could to improve it"* (Female, 15). The goal of 10,000 steps was an important benchmark of 'normality' for many adolescents. For example, Quinn (17) said that *"in COVID it was all about make sure you get the 10 because then you've achieved something in the day […] you're not going to let your fitness slide like if you go to 10, you're good, that's normal."* However, adolescents stressed the importance of setting achievable goals as they felt that the tools could be *"toxic tho if u find achievements hard to reach"* (Female, 15). Some also described losing control of their self-tracking behaviours as they strived to reach these goals: *"It is a compulsive part of my routine and I don't feel able to change it"* (Female, 16).

Young people's drive to self-track and control their health and wellbeing was sometimes directly linked to the risk of contracting the virus. Adolescents described new additions to their tracking practices, including recording COVID-19 test results: *"since when I was at school*

[…] we had the little tests that we had to do every so often so you know that was kind of like self-tracking" (Luke, 16). For adolescents, the fear of COVID-19 was real – *"It's scary. People are scared"* (Female, 18) – and Logan (15) explained that *"if like first lockdown happens again then I don't want to be stuck unhealthy in the house"*. Some of them explained that self-tracking offered emotional affordances of health security: *"Being healthy allows me not to be afraid of COVID-19"* (Male, 18).

For many adolescents, it was not just fear for their own health that drove their self-tracking practices; self-tracking allowed them to have a sense of security regarding the health of others too. In this way, self-tracking was a way for adolescents to demonstrate care towards their loved ones. Delilah (13) described how she saw tracking as a way to protect her family: *"I wasn't too anxious about myself getting it because I know that the risk for children isn't as big. I was a bit more worried about giving it any of my family members"*. Tracking to protect her family gave Delilah (13) *"peace of mind"*.

Adolescents felt that the pandemic had made people more concerned about their health generally, and Albert (16) noted that *"it's definitely made me have more precautions"*. Adolescents used self-tracking to *"take control"* (Female, 18) of their health to *"reduce the possibility of getting sick"* (Female, 16):

> *I'm an extrovert so I found it really difficult and I think I just almost like wanted a way to like be able to stay in control of something and it was more difficult to like exercise and have the motivation to like exercise and eat healthy when you weren't like seeing your friends and like being able to go to a gym and stuff. So I think it was just kind of, you know, a way of trying to keep some sense of normal, you know, if that if that makes any sense.* (Quinn, 17)

Self-tracking allowed adolescents to have a perception of control over their health during a time of global crisis. At times when their behaviours were being tightly controlled, such as

during periods of lockdown, self-tracking also allowed them *"to be able to stay in control of something"* by tracking their autonomous choices about their exercise and eating habits.

4.3.5 The More Things Change, the More They Stay the Same

Still, for some adolescents, the affordances of self-tracking did not shift considerably in response to the changing sociomaterial environment of the COVID-19 pandemic: *"I didn't like it before and I don't like it now"* (Female, 13). Particularly for non-users, the idea of self-tracking did not even come to mind during periods of social restrictions: *"I don't think I have thought about self tracking over the pandemic"* (Male, 16).

Adolescents who engaged in self-tracking practices described tracking habits that spanned months or years prior to the pandemic found that these practices were largely unaffected by COVID-19 and associated restrictions. Similarly, those such as Jasper (14), who had outdoor spaces readily available, found that they were able to continue tracking in the same way during the periods of lockdown: *"I'm quite fortunate for tracking and COVID and everything to be living out where there isn't many other people so I can walk, go walk in fields and everything and that was still a possibility during lockdowns"*. Geographical environments and access to certain spaces were important factors that influenced the affordances of self-tracking for adolescents.

Importantly, even for those who did maintain their self-tracking practices throughout the pandemic, this did not always lead to a change in their knowledge or awareness of their bodies. Whilst the cognitive affordances of self-tracking tools might often be positioned as educational opportunities for adolescents to learn about health and fitness (Casey et al., 2017; Depper & Howe, 2016; Goodyear et al., 2019; Goodyear & Armour, 2018; Pang et

al., 2018), this was not always the case for these young people. For example, Albert (16), who had tracked a range of data over many years, when asked what he thought it meant to be 'healthy', responded: *"Can my answer be: I don't know?"*. Therefore, for some, self-tracking remained a mundane routine of daily life.

4.4 Conclusion

This chapter brings together quantitative and qualitative data to paint a picture of adolescents' self-tracking during the early stages of the COVID-19 pandemic, encompassing periods of lockdown and re-emergence post-lockdown. Here, I have presented glimmers of the key issues that will emerge over subsequent chapters, including control, social relationships, and psychological wellbeing.

Perhaps the most striking finding in this chapter is the substantial shift in many adolescents' engagement with self-tracking tools as a result of the COVID-19 pandemic and the ways in which this engagement is entangled with the broader impacts on their lifestyle as a result of the pandemic. In contrast to previous studies that have placed the prevalence of UK adolescents' use of digital self-tracking tools at between 35 and 60% (Freeman & Neff, 2021; Goodyear, Armour, et al., 2018b; Rich et al., 2020), in my study, almost all of the adolescents had some experience using digital self-tracking tools[16] and most current self-trackers had started after the onset of the COVID-19 pandemic. The landscape is clearly changing, and this warrants further exploration.

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[16] As mentioned in Section 3.5 in Chapter 3, although every effort was taken to mitigate the risk of self-selection bias when designing the recruitment strategy and materials, it is possible that adolescents with some experience with self-tracking (or health and wellbeing more generally) would have been more interested in the study and therefore might have been more likely to sign up to participate. This could mean that a larger proportion of adolescents who took the survey had experience with self-tracking than in the general population.

The impact of COVID-19 on adolescents' engagement with self-tracking was far from uniform across the sample. Remaining cognisant of these individual differences is essential for approaching the remainder of the thesis. For those that did self-track, it was clear in adolescents' responses that they found creative ways to navigate their new or existing self-tracking practices through the early stages of the COVID-19 pandemic and the consequent changes to their lives. For some, new physical activity opportunities emerged which more readily allowed possibilities for self-tracking, and they benefited from having additional time for physical activity and tracking in the absence of other distractions. Conversely, adolescents also articulated ways in which they were able to navigate the pandemic and moments in and out of lockdown through their use of self-tracking tools. These tools allowed adolescents to maintain a sense of control over their health and ultimately lower their perception of their risk of contracting the virus.

However, these findings also reveal that, for many, self-tracking was much more than a way of keeping a record of, or a way to improve, health and activity. Rather, these tools offered adolescents many and varied functional, cognitive, emotional, social, and identity affordances; a way to navigate the trauma of a global pandemic; establishing new routines, staying connected to friends and family; and protecting their sense of control over their health and wellbeing. For many, the COVID-19 pandemic revealed new intimacies with technologies. As Morgan (16) explained, *"since March of last year, everyone's been a lot closer to their devices […] like a lot more data is being tracked than it was in 2019"*. The data in this chapter emphasise how many adolescents were both physically closer to their self-tracking devices and emotionally closer to them, or *"attached to the numbers"* (Quinn, 17).

It is hard to convey on paper the emotion behind so many of these adolescents' deeply personal reflections on and insights into their lived experience. Taken alongside the quantitative data from the survey, these reflections demonstrate that the COVID-19 pandemic has, and continues to have, a very real impact on adolescents' way of life, physical health, and psychological wellbeing (Crawley et al., 2020; C. Creswell et al., 2021; The Lancet Child & Adolescent Health, 2020). As is evidenced by the varied individual responses from participants in this study, tracking the adolescent body is complex, especially during this tumultuous early period of the pandemic, and it is important to move away from a 'one size fits all' approach to adolescents' self-tracking (Freeman & Neff, 2021).

The findings in this chapter highlight the urgent need for more research into adolescents' use of self-tracking tools and the importance of working with educators, parents, and healthcare professionals to equip adolescents with the support and resources to facilitate the positive use of self-tracking tools to mitigate the risk of harm to their physical or mental health. For example, thought should be given to appropriate data literacy education and ensuring that adolescents understand what, how, why, and when they might (not) choose to track their data to ensure they maintain autonomy over their choice to use these tools. I return to this in Chapter 7.

In what follows, I explore more deeply the social and psychological affordances of adolescents' self-tracking practices. All of the data analysed in the subsequent chapters were collected during various stages of the COVID-19 pandemic and it is worth keeping this backdrop in mind throughout the remainder of the thesis. In this chapter, I have demonstrated how urgent it is for us to carefully consider a nuanced account of

adolescents' self-tracking practices. Control is a central theme when considering adolescents' self-tracking experience and this is particularly evident in the context of the COVID-19 pandemic where adolescents articulated that so much felt outside of their control. Adolescents in this chapter described how self-tracking practices allowed them to connect with others in new and interesting ways. It is these social affordances that sit at the heart of the next chapter.

5 Moving Beyond the Self: Self-Tracking and the Social



"People compare everything. It's insane." (Sawyer, 16)

5.1 Introduction

Self-tracking is sometimes mistakenly understood as a practice that is always private and personal (Lupton, 2014b). Whilst it is *sometimes* private and personal, scholars have time and again emphasised the "fundamentally social" (Neff & Nafus, 2016, p. 8) nature of self-tracked data as it has become "a socialised phenomenon and communal trend" (Ajana, 2018, p. 126). Indeed, the 'show-and-tell' sharing of insights and data from self-tracking practices in a community setting is an essential element of Quantified Self meet-ups (Barta & Neff, 2015; Lupton, 2021b; Nafus & Sherman, 2014). Previous self-tracking work with adolescents has emphasised the centrality of social concerns (Ploderer et al., 2022). The potential relational affordances of self-tracking (Kristensen et al., 2021) sit at the centre of

this chapter as I consider how the interplay between the social and the material in adolescents' everyday practices reveal a range of social affordance possibilities.

Here, I take a conscious step away from a focus on the individual and instead concentrate on the collective nature of self-tracking practices. The term 'self-tracking' itself is perhaps misleading as it overemphasises the tracked 'self' and in doing so obscures the wider sets of social relationships in which tracking practices are entwined. I therefore look beyond more 'passive' ways of sharing data (e.g., adding 'friends' on Fitbit or Strava) and instead consider how, through various sociomaterial arrangements, adolescents actively position self-tracked data in their relationships and connection with others. With whom do adolescents choose to share their data? What data do they choose to share, how, and why? As described by Hardey, "digital forms of health interaction create new opportunities for social practice" (2022, p. 2), and these opportunities are my central concern here.

In this empirical chapter, the language of affordance theory (e.g., mechanisms and conditions (J. L. Davis & Chouinard, 2016)) and the concept of sociomaterial practices allow me to better consider Weiner et al.'s question: "How are networks of people and things involved in the practices of self-monitoring?" (2017, p. 19). More specifically, I leverage two additional lenses through which to analyse my data: social comparison theory (Festinger, 1954) and sociomaterial practices of choice and care (Mol, 2008; Mol et al., 2010). These two theories, briefly introduced in Chapter 3, are used to inform the qualitative data analysis and to provide a language that I can use to bring my qualitative and quantitative data together. These theoretical concepts allow me to theorise about peer comparisons as well as to bring into tension notions of care and choice in adolescents' self-

tracking practices. Here, I explore what happens once self-tracked data are collected. How might we understand the social life of these data?

In doing so, this chapter addresses RQ2: **How are adolescents' relationships with the self and others seen with and through self-tracked data?** In this chapter, I bring qualitative data from the online interviews into dialogue with relevant data from the online survey. I consider three key themes under the titles: The Complexity of Comparison and Competition; Keeping Control of the Narrative; and Crafting Sharing Communities. It is probably useful to remind ourselves here that quotations from surveys are denoted in the form "(Gender, Age)". Quotations from interviews are denoted in the form "(Pseudonym, Age)".

5.2 The Complexity of Comparison and Competition

5.2.1 Chase's Story

Chase (16) used to use a smartwatch to track his data but has since moved to tracking on his phone because he found the watch to be *"impractical"* and prefers more *"passive"* tracking. He uses this to track *"how many steps or how much distance I've covered compared to friends"*. He has added *"between 30 and 50"* friends on his health app with whom he shares data. He enjoys looking at the leader board and finds this competition to be a good way to stay motivated to be more active – particularly when he is at the top of the board!

5.2.2 Walking the Line

For Chase (16), comparing his data with that of his friends on his phone was a central component of his self-tracking practice and an important benchmark for his own performance and identity. Indeed, social comparisons are particularly important during the

adolescent developmental period as young people strive to affirm their individual and collective identities (boyd, 2014; K. Davis, 2012a). Using social comparison theory (Festinger, 1954) to inform this analysis, my research suggests that the social comparison affordances of digital self-tracking tools were far from straightforward for adolescents. In line with the findings of Goodyear et al. (2019), adolescents did not reach a clear consensus on what encouraged healthy comparison or competition rather than more negative comparison experiences. Instead, adolescents described ambivalent, messy exchanges and renegotiations of data and relationships.

When data comparisons existed in a trusted community, adolescents found that *"competitions between my friends"* (Hari, <16) could bolster relationships. For example, Quinn (17) described how she was looking forward to engaging in a Fitbit competition her friends had organised on their return to school after the holidays. The comparison opportunities encouraged by self-tracking tools were attractive. Thomas (13) commented that his favourite aspects of self-tracking tools were the social affordances that allowed him to compare his data with that of others. He found this motivating, and explained, *"I like to beat everyone else with my step goal"*. Processes of downward comparison encouraged a bolstering of self-esteem – or self-enhancement (Wood, 1989) – and allowed Thomas (13) to self-present as superior amongst his friends. Adolescents imagined that this *"showing off"* could be a way *"to either compete with others or connect with others […] then you're getting validation from other people as well"* (Adaline, 16).

Nonetheless, making comparisons was far from a simple process. Adolescents were acutely aware of the need for comparisons to be context-dependent and appropriate, taking into account individual differences in ability, circumstance, and physiology, because *"no body is*

the same" (Rebekah, 15). Adolescents recognised that it would be *"ridiculous"* to *"compare yourself to grown athletes as you know, a child that hasn't had any previous training"* (Delilah, 13), but it was not always easy to carefully consider context when faced with comparison data and the design of these tools often refused such reflection. Instead, the participants recognised this challenge for themselves, and they were able to recraft how they shared their data with others. They were eager to ensure that their shared data did not discourage others from taking physical activity and were careful that *"when I do compare, it's not in a negative way, if that makes sense, like I mean no harm from it"* (Hannah, 16).

Many adolescents acknowledged the importance of context and engaged in complex, multidirectional comparison processes. By comparing their data with friends' data to determine *"how much above them you were or below them"* (Hari, <16) they were, adolescents were able to reflect on their own identities. Mikhail (17), a young weightlifter, is a good example of this. Mikhail compared data with friends, competitors, and his father but he recognised that his physiology impacted his data: *"if I have arms that are like 10% longer than somebody else […] I'm probably doing about 10% more work when I'm bench pressing because I'm having to lift it 10% further"*. In order to address this, he was keen to be strategic in his comparisons and to *"kind of use their... other people's progress for you know inspiration and motivation but trying not to do the direct comparison"*. He used these processes to understand his own identity and more accurately self-evaluate his skill. He described the differing affordances of both upward and downward social comparisons allowed by data sharing, depending on the relevant comparator:

> *I've got one friend who I lift fairly similar numbers to so that way it's more you know comparison but also a bit of competition, I'd say, you know. And then there's others who I lift substantially more than so that's more for the sake of comparison, you know, you know. And you know, it's just both something we're interested in, so we both want to talk about it. And my dad, it's yeah, more for the*

sake of kind of comparison, I'd say I think you know. And also just, uh, I, I'd say a bit of inspiration as well. (Mikhail, 17)

These comparison processes encouraged by self-tracking tools extended beyond the interface of the app or device. For many adolescents, comparisons were intimate and physical, centring on body image and appearance. Many adolescents, and more commonly females, described comparing their weight (loss) with others. We know that data surrounding weight is often morally loaded (Spoel et al., 2012) and this was echoed by the adolescents in my research. For some, this was exacerbated by the COVID-19 pandemic in periods of lockdown, when concerns about body image became more pronounced. For others, the change in routine and move away from the in-person school setting reduced the number and frequency of these comparison processes: *"I stopped comparing myself to everyone because I didn't see anyone. Like I'm perfectly healthy, but when I compare myself, I feel less so when I see someone like, especially at school"* (Hannah, 16).

The in-built comparison features of self-tracking tools sometimes demanded that the adolescents engage in competitions with others. For example, Rachael (17) generally didn't *"feel comfortable"* with the idea of communities on Fitbit. She explained that her Fitbit sends a weekly email that *"compares all of your health and fitness information with your family"*. Rachael (17) shared her negative experience of this, saying *"I haven't found that most positive, because […] I'm usually kind of second to last or last"*. Rachael (17) found this quite distressing and said that she would have preferred it if this feature did not exist so that she could avoid these upward comparison processes.

Nonetheless, adolescents disagreed on whether such comparisons were a good motivator for self-improvement: *"I think I might get like results and stuff quicker if I had that, but I also think that they'd be less likely to like be permanent as well because I think I would be doing it for somebody else, not for myself"* (Kirsty, 15). Some strongly resisted comparison processes and felt it was important to model positive attitudes and steer others away from comparing themselves with others. Ophelia (17) remarked that it was important *"definitely not to compare myself to other people […] Like everyone should enjoy things and try and encourage each other to be healthy but not make someone feel bad when they don't want to do something"*. It was clear that these comparisons were far from simple for adolescents.

Here, it is valuable to consider how the quantitative data from the survey might contribute additional insights on this topic. In Hypothesis 2 (laid out in Section 3.7.1 in Chapter 3), I hypothesised that adolescents who reported liking comparison features of self-tracking tools *most* would have a higher level of self-reported social comparison orientation than adolescents who reported liking comparison features of self-tracking tools *least*. Perhaps unsurprisingly, the data revealed that this was indeed the case. Adolescents who liked the comparison affordances of self-tracking tools most scored more highly for social comparison tendencies than adolescents who liked these affordances least. An independent-samples *t*-test was conducted to compare social comparison orientation (using the INCOM scale) for adolescents who reported liking the comparison features of self-tracking *most* with social comparison orientation for adolescents who reported liking the comparison features of self-tracking *least*. There was a significant difference between the INCOM scores for those who liked these comparison features most (M = 3.48, SD = .52) and the scores for those who liked these comparison features least (M = 3.23, SD = .48); $t(270) = -4.21$, $p = <.001$, such that those who liked these comparison features *most* scored

more highly for social comparison tendencies than those who liked these features *least* (see Figure 5.1). This demonstrates the need for flexibility in design; the social comparison emotional affordances allowed, or even encouraged, by self-tracking tools had great appeal for those who demonstrated greater social comparison tendencies; however, those who were not inclined towards comparisons did not value these affordances. There is no 'one size fits all' approach when it comes to comparisons for adolescents (Freeman & Neff, 2021).

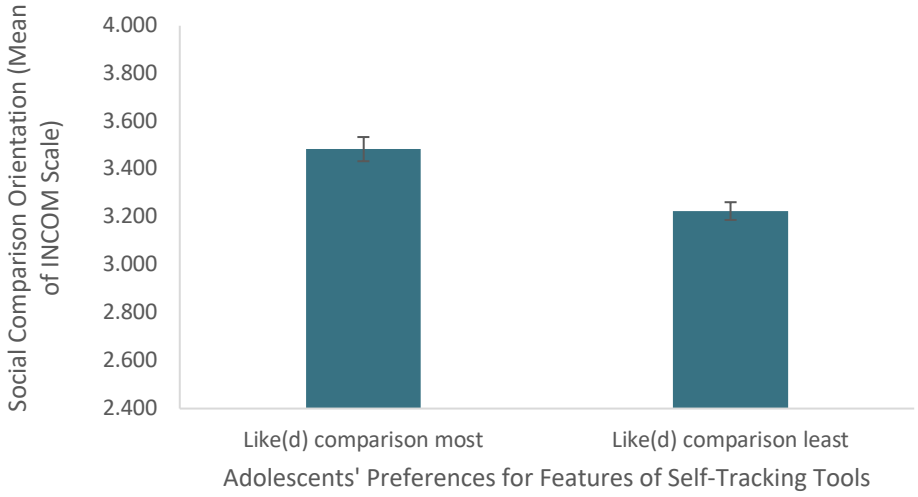


Figure 5.1. Adolescents' preferences for the social comparison features of self-tracking tools against the mean score on the INCOM scale. The error bars represent standard errors.

The digital materialities of self-tracking tools reinforce competitive structures rather than allowing adolescents the opportunity to compare in more contextually situated ways. Self-tracking platforms are often context-insensitive (Lupton, 2016b) in that biometric data that is shared does not take into account offline circumstances that may impact an individual's physical activity metrics (e.g., illness, injury, caring for children, work schedules). For example, leader boards on Fitbit and Strava provide no context for tracked data (see Figure

5.2 for an example). In response, many adolescents in this research had to delicately negotiate comparisons in other spaces (both digital and non-digital) to engage *"innocently"* and ensure that no one *"took it the wrong way and thought they were bragging instead"* (Luke, 16). Many who did describe processes of comparison were keen to emphasise that this was *"never kind of in an unhealthy way of comparing each other"* (Ophelia, 17).

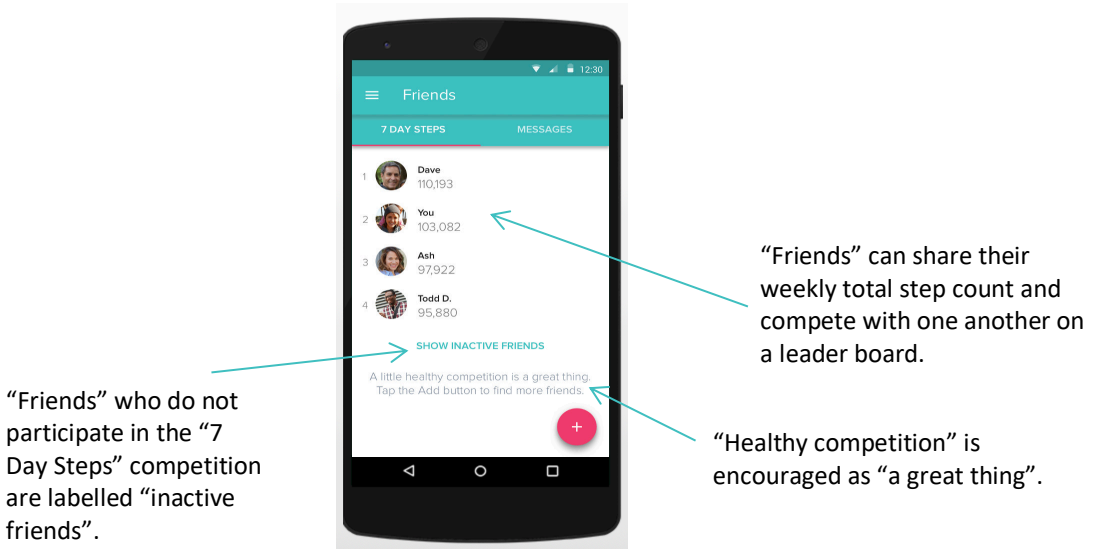


Figure 5.2. Annotated screenshot of a "7 Day Steps" competition between "Friends" in the Fitbit "Community" Feature'. Source: https://www.fitbit.com/uk/app.

Under these circumstances, comparisons and competition were encouraging for some, and leader boards were found to be *"a fun, competitive way to kind of be more active"* (Chase, 16). It was more common for male participants to describe these motivational processes that stemmed from such competition: *"it's kind of it's fun to kind of see yourself at the top of a leader board. You know, that that's nice. I guess I… I don't know the science behind it, but I guess it's just human instinct to kind of try and be the best so"* (Chase, 16). Upward comparisons (i.e., comparing themselves with those who were performing better) could be aspirational and

motivating. For example, Mikahil (17) said, *"I do compare myself to my dad a bit in terms of trying to get as strong as him"*.

It is worth exploring these gender differences quantitatively. In Hypothesis 3 (detailed in Section 3.7.1), I contended that adolescents' gender and their liking of comparison features of self-tracking tools would be related; male adolescents would be more likely to report liking the comparison features of self-tracking tools *most*. A chi-squared test of independence was performed to test this hypothesis and to examine the relationship between gender[17] and adolescents' preference for the comparison features of self-tracking tools. The relationship between these variables was significant: $\chi^2(1, N = 265) = 14.32, p = <.001$. Male adolescents were more likely to favour the comparison features of self-tracking tools *most* when compared with female adolescents (see Figure 5.3).

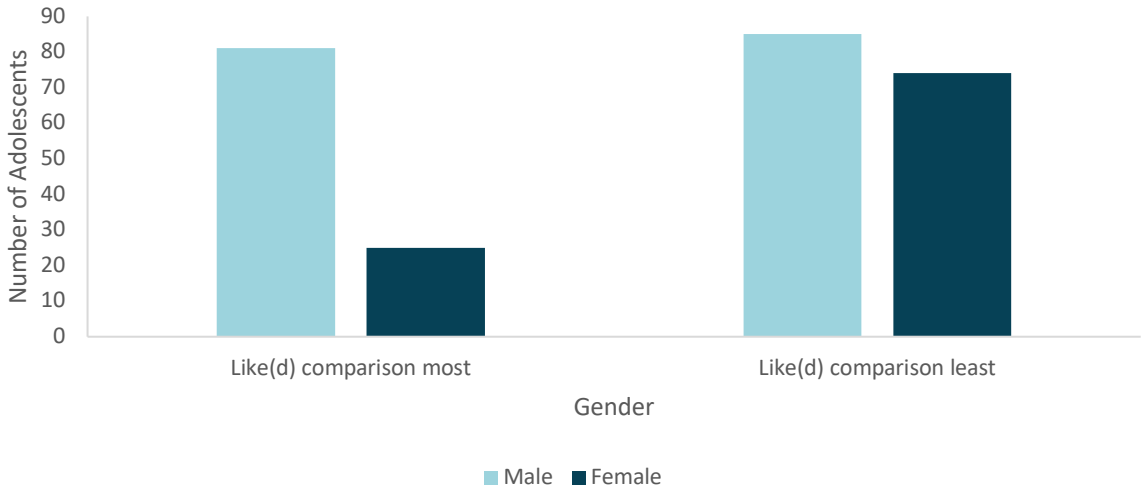


Figure 5.3. Adolescents' preference for the social comparison features of self-tracking tools according to gender.

[17] Unfortunately, due to a low number of respondents identifying as non-binary or choosing not to report their gender, these groups were removed from the analysis. Further research is necessary to explore these gender trends more deeply beyond a male/female binary.

This finding is not unexpected as research has shown adolescent males are often more motivated to engage in physical activity by competition and social recognition than adolescent females who are more motivated by more personal factors such as weight control and appearance (Portela-Pino et al., 2020). For example, Burgess et al. (2010) highlight that sport has historically been a masculine enterprise and adolescent masculine identities often centre around ability within competitive sports activities. This suggests that male adolescents were more likely to favour the comparison of self-tracking tools most as this aligns with existing social norms of masculinity (Sumpter, 2015). Similarly, Stewart et al. (2020) found that for adolescent boys engaging in Health and Physical Education, competition was linked closely to success, status, and personal achievement. This male preference for comparison features aligns with the findings from the online interviews and demonstrates the importance of considering how different social data-sharing affordances might benefit some groups whilst disempowering others.

5.2.3 "Comparison is the thief of joy" (Theodore Roosevelt)

Some adolescents acknowledged the benefits of social comparisons and competition; however, the vast majority identified the potential for comparisons to be *"stressful"* (Hannah, 16) and to cause harm. Adolescents also recognised that comparisons with others had to be done carefully and that individuals should benchmark themselves against appropriate comparators. This aligns with previous work on social comparisons; social data comparisons are more motivating, applicable, and informative if they relate to demographically similar groups (Wood, 1989). The adolescents in this work discussed how they imagined that inappropriate comparisons could have *"damaging"* (Rebekah, 15) physical and psychological effects. Perhaps unsurprisingly, adolescents articulated that processes of upward comparison could have negative effects on their psychological wellbeing: *"they could*

be like pushing themselves really hard to umm to a certain level which just isn't attainable for them. And then it would, you know, be bad for their health and mental health" (Edward, 17).

In particular, adolescents discussed the risk of comparisons for vulnerable young people managing disordered eating behaviours or body image dissatisfaction. A number of participants engaged in lengthy, often quite harrowing discussions about unhealthy comparison processes that could lead to a decline in physical and mental health. For example, Ophelia (17) shared her concerns about competition within eating disorder communities: *"it's competition. It's comparable, so if someone's burnt 500 calories you're like OK. Well, I need to burn 600. And things like that".*

Adaline (16) described similar processes on Tumblr on which she found that there are *"communities of people with eating disorders trying to be sicker than the other one […] they'll be cheered on by other people in the community via these apps and stuff".* Adaline (16) expressed concern for the welfare of the young people engaging in these processes, and articulated that adolescence is a time of particular vulnerability for this competition:

> *It becomes a competition. And especially if you have bad mental health, especially in kind of my age group, it becomes very competitive, extremely competitive […] people will go there and they'll use it to say "you're not as sick as me" or "you're not... you're not as healthy as me because you're eating more of X" or it becomes a competition with people trying and then lowering the numbers with each other.*

The words in the quotation that opened this chapter, spoken by Sawyer (16), are incredibly apt here: *"People compare everything. It's insane."* Adolescents were acutely aware of the prevalence of comparisons amongst their peers, and there was a real sense of ambivalence regarding the impacts of these comparison and competition processes. For some, these were largely motivating and offered a way to connect with friends. For others, upward comparisons were more harmful and were particularly concerning for those who were

vulnerable to body image dissatisfaction or disordered eating behaviours. Overall, the digital materialities of self-tracking tools did not always support the more nuanced, contextually situated comparison processes that adolescents sought, so adolescents found new sociomaterial arrangements to support these exchanges.

5.3 Keeping Control of the Narrative

5.3.1 Edward's Story

Edward (17) uses the Health app on his iPhone to track his steps. He started tracking during the first period of lockdown of the COVID-19 pandemic because he wanted to monitor his walks. He has found that tracking has slowly *"lost its novelty"* and he no longer checks his steps as much as he used to. Edward used to compare his step count with his sister as part of friendly *"sibling rivalry"*. He found he would often share his step count with his family around the dinner table; however, he would only do so if his step count was very high or very low. He believed very high step counts were impressive and allowed him to share successes whilst very low step counts were humorous and he used these to encourage laughter amongst his family. In this way, Edward controlled his data-sharing practices and curated the data he was happy to make visible to others.

5.3.2 Selective Sharing

The self-tracking practices of most adolescents like Edward (17) were in some way social. In the interviews, most of them said they engaged in data-sharing practices of some kind, and many demonstrated that they gave great thought to whether and, if so, how they mobilised these data across different contexts. Similarly, it quickly became apparent from the online survey that data sharing was common amongst adolescents; 506 (72.81%) participants stated that they had ever shared their self-tracked data with someone at some

point. Most commonly, adolescents shared their data with friends (45.04%), parents/carers (41.30%), and siblings (37.00%). It was less common for adolescents to share their data on social media (17.12%), with sports coaches or teachers (15.97%), or with healthcare professionals (14.39%). See Figure 5.4 for the different networks in which adolescents reported sharing their self-tracked data.

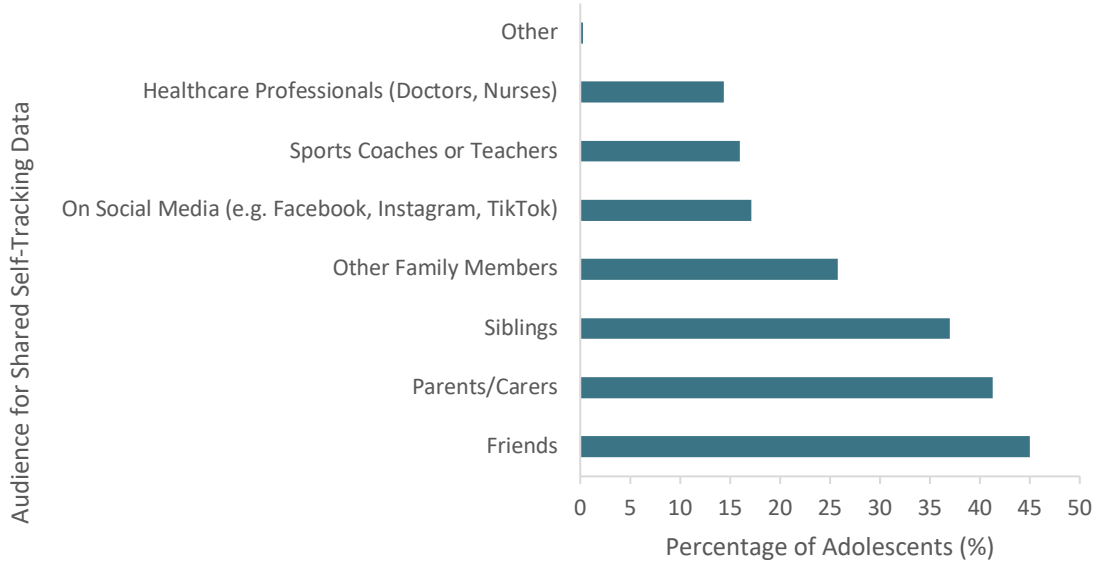


Figure 5.4. Adolescents' networks for sharing self-tracked data.

During this study, it was evident that many adolescents were very deliberate in terms of their sharing practices. They demonstrated great care in selecting the data they chose to share with others. It was common for adolescents to describe processes of selective sharing, whereby they would share their data with others *"if it was a high number I would say or if it was really low"* (Edward, 17). For many, understandings of 'high' and 'low' numbers centred around the value of 10,000 steps and trying to *"get the 10"* (Quinn, 17):

> *it would have to be tens and tens of thousands really. I mean because, you know, um, it's quite commonly said that you should do 10,000 a day, so I wouldn't consider that impressive 'cause that's like just what you're supposed to do. You know, that's like the bare minimum really.* (Aria, 18)

Aria (18) further described that by working towards *"tens and tens of thousands"* of steps, she would have *"earned the right to share it"* with others. In this way, sharing data was a *"right"* bestowed upon adolescents who *"earned"* it by achieving a level of activity that was *"something slightly out of the ordinary"* (Jasper, 14) or *"something amazing"* (Thomas, 13). By controlling their data sharing in this way, adolescents engaged in an identity performance in which they imagined they could present an aspect of their identity as lean and fit; demonstrating that they had bodies that were "portrayed and regarded as morally just" (Lupton, 2016b, p. 51).

Potapov and Marshall argue that "when personal data is framed as playful and expressive, it can act as a 'ticket to talk', helping the user to connect with others and share aspects of their identity" (2020, p. 8). Impression management (Goffman, 1959) was an important identity affordance of the sharing practices that adolescents creatively crafted when setting boundaries around their shared data. By actively situating their *"amazing"* (Thomas, 13) data in this way, adolescents were able to present their bodies through data in a way that made sense to them and aligned with the identity they wished to share with others: perhaps an adolescent body that would be rewarded according to the neoliberal ideals of 'healthism' (R. Crawford, 1980) for being "morally just" (Lupton, 2016b, p. 51).

Conversely, very low levels of activity were sometimes employed as comic devices with which adolescents could entertain friends: *"if I did anything above 25,000 or like 20,000/15,000, something above the 10, I'd maybe go like 'Oh guess what?' Or, on the other hand, if I did like under 1000 steps, I might say 'guess what...'"* (Quinn, 17). Adolescents described finding data such as low step counts to be humorous and would laugh with friends saying, *"I cannot believe I've only done 600 steps today!"* (Edward, 17). By controlling the comedic narrative

around their data, adolescents were able to find ways to share that did not invite criticism or judgement. For example, when explaining their reasons for hesitating to share *"ordinary"* activities with others, Sawyer (16) said: *"I would definitely only do if it was a higher number because, I don't know, I'd feel like I would be judged if it was a lower number, which isn't a good way of thinking but I guess it is what it is"*. Jasmine (17) echoed these concerns and found that when she was recording her runs as part of a school competition, she preferred to select which data to share and which to keep private:

> *There was a bit of pressure like on days where I felt off, I'd be like, oh, I don't want people to see how slow I'm running 'cause they'll show like the pace per kilometre as well umm and so if it was anything above like 6 minutes per K [kilometre], I'd just be like ugh I don't really want to like log that on or make that public, you know? Umm so there was a bit of that kind of thing, like I'd rather just keep it private.*

Therefore, adolescents' use of data for comedic effect was balanced delicately with their concerns about being *"judged"* (Sawyer, 16) for engaging in low levels of activity. If they did not frame their data as being 'comically bad', adolescents expressed fear that certain data would not *"necessarily reflect positively"* if people saw they had *"spent a week being lazy"* (Aria, 18). This concern was also particularly prevalent for food-based or calorie tracking. For example, Sawyer (16) compared sharing calories and step data and concluded: *"I would be more uncomfortable sharing my calories just because I would kind of worry about the response"*.

In order to balance this effectively, adolescents' autonomy over their data-sharing decisions was an important affordance refused by some of the automatic data-sharing features built into many self-tracking tools. For example, Apple allows iPhone and Apple Watch users to invite friends to share their data, including data relating to active calories, exercise minutes, steps, and workout information. These data are then available to friends on their own devices to view at their leisure. Such indiscriminate and passive sharing was resisted by

adolescents as they were concerned about others' judgements if they did not have control of the framing of these data: *"I don't think it's necessarily universal that like anyone that you showed it to would have a negative view of it. But you know, there's definitely some people who would probably judge you for that"* (Aria, 18). Instead, it was important for them to maintain flexibility and control over the mobilisation of their self-tracked data and to be able to explain the context surrounding their data.

Highlighting the importance of having flexibility over how to present their data, some adolescents described exaggerating their data when sharing with certain others. Akin to how young people might engage with other forms of social media (Park & Lee, 2014), this manipulation of data enabled adolescents to engage in processes of impression management (Goffman, 1959) to present a particular aspect of their identity they wanted others to see and to artificially create processes of downward comparison. For example, whilst Mikhail (17) did not exaggerate his data when he shared it with his father, for a friend he imagined as a competitor, he embellished his weightlifting results. He explained that he was more advanced than his friend and so he felt justified in exaggerating his achievements to establish himself as a superior athlete:

> *I kind of took that and gave myself, you know, kind of what is it – carte blanche – or something, you know. I basically just gave myself freedom to basically say, "OK, well, he's not doing it to anywhere near the same difficulty level as I am", you know, so you know. If I slight – if I say I can do kind of a bit more, I think that's probably kind of fair enough.*

What is evident here is that the built-in social data-sharing affordances of digital self-tracking tools have the potential to refuse adolescents the ability to maintain ultimate control over the framing of their shared data by restricting their narrative choices. Instead, adolescents imagined new, creative sharing affordances that allowed them greater flexibility and a choice regarding the framing of their data.

5.3.3 (Not) Sharing is Caring

The concept of care, in particular self-care, is present throughout much of the self-tracking literature and scholars have argued that individuals who engage in self-tracking enact self-care (Fotopoulou & O'Riordan, 2016; Schüll, 2016). Annemarie Mol (2008; 2010) calls for an understanding of care as a sociomaterial practice, that is, recognising the entanglements between technologies and human factors. Mol brings the 'logic of choice' (emphasising the libertarian ideal of patient autonomy and empowerment) into tension with the 'logic of care' (emphasising the practices embedded within healthcare systems and social networks that are involved in caring for patients e.g., counselling, encouragement, support) in healthcare, demonstrating circumstances in which adhering to the 'logic of choice' can result in poor care. In my research, choice was central to adolescents' care practices; however, the affordances of self-tracking technologies made some choices possible but not others and, as mentioned in Section 1.1.2 in Chapter 1, individual 'choice' was often mediated by social norms and expectations within adolescents' sociomaterial environments. Through adolescents' decisions about how to share, we can see that social practices beyond the action of *self*-tracking might be considered demonstrable acts of care, both for the self and for others. Adolescents' practices of care were made visible to some through the thoughtful sharing of data and were intentionally kept invisible to others by not sharing. In this case, the act of not sharing was an intentional care practice in itself, rather than simply the absence of sharing.

A key theme that I identified was adolescents' taking care not to cause *"harm"* (Jasmine, 17) to others by sharing their data. In particular, adolescents emphasised the importance of not sharing data with friends whom they knew were managing disordered eating behaviours or living with mental health challenges: *"maybe my friends who like track unhealthily because I*

wouldn't want them comparing anything to me and I don't know, I guess it unless it wasn't part of conversation, I wouldn't, I wouldn't say yeah" (Sawyer, 16). Adolescents clearly saw the possibilities for young people to track *"unhealthily"* – often characterised by obsessive tracking and a focus on data in defining one's identity and self-worth (see Chapter 6 for more on this) – and were concerned that these data could be *"triggering"* (Ophelia, 17) to vulnerable others and could encourage harmful tracking habits:

> *If I knew that my stats would negatively impact them, I would definitely not want to share it with them, right? So like if I knew that someone was struggling with an eating disorder or with body image or self-esteem, or like if I thought that they would get discouraged by seeing like my data then obviously I wouldn't want to kind of like harm that or like try and trigger something that would cause them to, you know, have a negative response.* (Jasmine, 17)

As a specific example, adolescents recognised the potentially harmful effects that sharing self-tracked data on social media can have. Ophelia (17) said, *"I don't like to put it on social media because I know that when people do it triggers me and I don't want to be triggering anyone else"*. By being selective regarding their chosen vehicle for mobilising their data – in particular, data around calorie intake and output, weight, and running speed – adolescents enacted care for those both known and unknown. They were aware of the broad reach that social media has and were wary of the vulnerability of those who might be viewing their content. When they reflected on their caution regarding sharing their data on social media, a number of adolescents were influenced by experiences they had had at an earlier age when they encountered self-tracked data on social media without being equipped with the knowledge to understand the meaning of this content: *"When I was young, when I was a bit younger, when I was like 14/15, I'd see it and I'd think, 'Is that normal for some people?'"* (Quinn, 17).

It was not only thinking about how to care for others that led some adolescents to express their hesitance to share their data. In line with work on adult self-trackers (DiCosola et al.,

2022; Rapp & Cena, 2016), some adolescents were careful to demonstrate self-care by keeping their data private and choosing not to share it with others. Whilst adults might have sophisticated strategies for addressing this, such as intentionally choosing not to use tools that they know their friends and colleagues engage with (DiCosola et al., 2022), many adolescents simply chose to keep all of their data hidden. For these adolescents, self-tracked data was experienced as *"more of a private thing"* (Edward, 17) and they would *"probably feel self-conscious about sharing that"* (Aria, 18) or were wary of getting caught up in competitions and setting unrealistic goals for themselves as a result. Consequently, considerable thought was given to caring for their own privacy and their performance of health through data.

One striking example of this was Miriam (17), who tracked her menstrual cycles to better understand her polycystic ovary syndrome (PCOS) and described her tracking as *"really personal"*. For her, sharing or comparing data with others was entirely inappropriate: *"I don't know why I would need to share it because it's like everybody's body is different and I don't want to kind of like push the idea that if I have this then you should have this too"*. For Miriam (17), keeping her data private was an outward care practice to discourage others' misplaced comparisons, in addition to a self-care practice that was essential to managing her health effectively.

Keeping control of the narrative around their data was central to adolescents' positioning of self-tracked data in their social relationships. For some, this meant not sharing their data at all. For others, like Edward (17) and Mikhail (17), this meant selectively sharing data in order to perform a certain identity or present a particular body. Central to this notion of control was the idea of care. Through these controlled practices of (not) sharing data,

adolescents demonstrated caring about vulnerable others, as well as about their own privacy.

5.4 Crafting Sharing Communities

5.4.1 Ophelia's Story

Ophelia (17) tracks her data using her iPhone, an Apple Watch, and MyFitnessPal, amongst other apps. In the short term, this has been motivating for her but in the long term she *"wouldn't like say it's a good thing"* and she has had to stop some of her tracking habits as the sense of *"competition"* has led to *"unhealthy habits"* such as obsessive exercising and has impacted her eating behaviours. She has therefore stopped tracking her food and weight and now only tracks her steps. She tries not to encourage her friends to share their data directly within apps because she worries this could be triggering for others like it has been for her. Instead, she intentionally shares with only *"less judgemental"* friends who *"barely exercise at all"* and has *"disconnected"* from others because she does not want to compare herself to them. By intentionally crafting this sharing community, Ophelia has found a way to maintain connections with friends whilst caring for her own mental health and wellbeing.

5.4.2 Who's In and Who's Out

Ophelia's story reminds us that tracking is often a community practice. Nevertheless, not all adolescents in my research shared their data in the same way. Some were not so selective about who they allowed to enter their sharing communities. Particularly when engaging with the inbuilt sharing affordances of self-tracking tools, they readily shared their data with anyone. For example, Delilah (13) said, *"I think I am fairly open about my life if anybody asked me, I'd show them"*. Similarly, Chase (16) described his process of sharing his data with

"between 30 and 50" friends on the leader board on his tracking app: *"you know with social media everyone is kind of connected so you kind of just add friends on the app […] it was really easy"*.

For those who were more selective, like Ophelia (17), the sharing of self-tracked data extended far beyond the tracking interface and instead was more *"casual"* (Sawyer, 16): *"it comes up in conversation a lot of the time. Just how long, how far we've walked, what we've done"* (Yash, 15). These conversations often happened *"in person in school"* (Yash, 15) or through other media *"like FaceTimes during COVID and stuff"* (Violet, 15). Thus, much like the "institutionally unbound element" (Sanders, 2017, p. 44) of the material self-tracking tool, the sharing of data allowed tracking practices to travel across the boundaries of school and home.

Adolescents discussed different communities that existed around their self-tracking, which traversed digital and non-digital spaces. For some, this idea of community was central to the appeal of self-tracking. For example, Adaline (16), who despite not having ever self-tracked herself exhibited a keen awareness of tracking communities, described the draw of community for young self-trackers:

> *Young people are downloading it 'cause there's an advertising thing saying like "Share your goals" or they'll download it as... I know step trackers or what... that can like a group of friends will download a step tracker together and then they'll compete against people for steps like it becomes... they're very much marketing it as a community in itself, that people then want to join.*

Despite recognising the draw of a community encouraged by self-tracking tools, Adaline (16) felt that she was excluded from self-tracking groups: *"Umm it's not really in my circle because I'm not in a very looks-based circle, if that makes sense. I think a lot of it is looks-based and community-based and if you're not in those communities to start with […] you're not going to interact with them at all"*. In this way, from the outside, there was a sense that adolescent self-trackers

existed in a relatively closed community; they were populated by young people who were occupied by *"looks-based"* considerations of how their body was being presented to the world and those who could afford to take part: *"Self tracking is extremely important but I can't afford it"* (Female, 17). This social concern about assumptions relating to wealth is echoed by Lee and Briggs' (2014) work with adolescent self-trackers in a high school setting, although it sat in contrast to the survey results in Section 4.2.1 in Chapter 4 which suggested that there was no significant relationship between adolescents' SES and their experience with using self-tracking tools. This perception of division contrasted the perspective of adolescents who were engaging in self-tracking practices and felt that *"tracking isn't like a one shoe fits all kind of situation"* (Miriam, 17). Thus, the materiality of owning tracking devices created ingroup and outgroup divides (Freeman & Neff, 2021), where those in the 'ingroup' could see individual differences between self-trackers, but those in the 'outgroup' assumed that there was a level of homogeneity amongst self-trackers (Quattrone & Jones, 1980).

Adolescents who were part of the 'ingroup' of sharing communities stressed the importance of showing sensitivity to what data was shared and how it was shared. They recognised that data sharing was a complex communicative exchange that reached far beyond numbers alone. Much like on social media, adolescents shared an understanding of sharing behaviours that were socially appropriate, and they were careful to adhere to these social norms. This was not just reflected in their own practices but also in their perspectives on others' behaviour. Hannah (16) shared her own frustrations with her friend's boastful presentation of intimate health data: *"she wore an Apple Watch to track her heart rate, and she was often bragging about how fast her heart was beating, and occasionally it made me really annoyed because I was like, 'Why should they be proud of that?'"* Such acts were seen as

uncaring and counter to how many adolescents chose to enrol their data in the negotiation of their social relationships.

Data sharing was an important way for adolescents to cultivate relationships with others. Luke (16) said that *"sharing out with like the wider world […] doesn't really matter"* and instead he described the value of establishing *"a smaller community […] so sharing what we've kind of been exercising and doing generally"*. In this way, many adolescents carefully crafted sharing communities in which they felt safe to share their data with others in meaningful ways: *"I mean there are some people that I definitely would say I'm more happy to share with than others because I don't know... I feel like not to be rude to anyone... I feel like the people I share with are less judgemental so it's just kind of easier"* (Ophelia, 17). These communities were often built out of friends with similar interests and levels of physical activity, or those whom they felt would not be *"judgemental"*.

The proprietary social networks in self-tracking tools were often resisted by adolescents as they allowed unknown others to engage with them and see their activity: *"I find it a bit weird when different people, random people are just like, 'Oh hey, let's be friends!'"* (Quinn, 17). When I questioned Leroy (>16)[18] about whether he shared his data on his tracking app, he responded *"Oh no no no no"*; however, he went on to say that he readily shares his data in conversation with friends and family. Indeed, when asked, none of the adolescents recounted experiences of establishing new relationships through sharing self-tracked data and instead all of their sharing experiences centred around existing networks, primarily

[18] Please note, some participants chose not to disclose their demographic details. In these cases, ages are indicated by the consent forms used (i.e., >16 is an adolescent over the age of 16, <16 is an adolescent under the age of 16.

their families and friends at school in offline settings. Sharing communities were therefore crafted more carefully than the affordances of in-built social networks and adolescents largely adopted creative methods outside of the tools themselves to build these trusting relationships.

For some, the sharing of data was more strategic. For example, some of the adolescents described creating communities with coaches or teachers to demonstrate their progress in their chosen activities: *"It was a way of showing my coach I was still training hard during the periods of time where we weren't allowed to train together due to Covid restrictions"* (Male, 16). Distinct from their sharing communities with friends, in these relationships, the sharing of data was usually one-sided and more transactional. Adolescents did not describe such transactional sharing as being imbued with the same emotion – or fostering connection in the same way – as relational sharing with friends. Instead, this one-way sharing served a clear purpose: to demonstrate skills or abilities. This enabled adolescents to perform the identity of a hard-working student of sport. During periods of lockdown throughout the COVID-19 pandemic, the material affordances of data-sharing capabilities allowed adolescents to shift in-person demonstrations of progress to the online space.

Sharing communities were of particular importance during the COVID-19 pandemic. The sharing of data became an important way to connect with others during phases of lockdown and self-tracking tools became vehicles through which they could connect with other physical bodies whilst being physically distanced:

> *I think it helps you keep connected with friends as well. Umm 'cause it is like a social media thing you can like share pictures of like where you ran or like a nice like the nice scenery. Umm and also, like it's a way to keep bonded* (Jasmine, 17)

Sharing self-tracking data often allowed adolescents an avenue through which to find common ground in their relationships with others. During these times of social distancing, self-tracking data offered a window into others' lives and adolescents described enjoying being *"nosy"* (Jasmine, 17) and using the data to *"find out what other people were doing during the COVID-19 pandemic"* (Female, 17). Like adults (Karapanos et al., 2016), when others showed interest in their tracking, this invoked feelings of social affirmation and popularity. This sharing of data allowed them to *"have more things in common with your friends"* (Male, 17). The sharing experience often extended beyond the data alone and adolescents took opportunities to take part in physical activities with their friends. The data became a new way for adolescents to understand these shared experiences, particularly when there were discrepancies between the data collected by different friends: *"I would say like I'd go on a walk with my friend and we'd get completely different step counts"* (Jasmine, 17).

Sometimes these communities were encouraged by ongoing social media trends, such as a 5-kilometre (5K) running challenge in which adolescents tagged other friends and built connections through a shared goal. For others, the materiality of self-tracking tools opened up conversations and a community around tracking. These network effects often encouraged tracking practices to spread through social groups. For example, Thomas (13) explained that a few of his friends have started tracking since seeing his smartwatch:

> *That inspired a few people and now there's like quite a few people tracking, and if people see me… I think two or three people that I sit next to have seen my watch and they've been like how many steps have you done? And I'm like not too many and they're like well you did more than me, so there's… there's a bit of community to it.*

Tracking is not just an individual practice but can be a collaborative one (Pina et al., 2017). An interesting phenomenon that adolescents discussed in these interviews was not just tracking with others but tracking the self through others, or tracking by proxy; Pina et al.

call this "second-hand tracking" (2017, p. 2310). This was often the case for adolescents who did not own their own devices and instead relied on their parents to provide data about their activity. For example, Freddie (<16) completed a series of 5km runs with his father during lockdown and said that he knew his speed and distance and could see his progress because *"my dad would keep track on his exercise watch"*. Similarly, Damian (13) described not needing a self-tracking tool *"because my mum has a Fitbit and she was tracking all of our walks. So we knew how far we'd walked"*.

By tracking others' movements in this way, shared data acted as a tool that adolescents used to connect with others and foster connection. For example, when she was working as a server in a restaurant, Hannah (16) was able to build relationships with work colleagues when she shared her step counts with them to show how much movement they were accumulating during shifts. Her colleagues were *"surprised"* (Hannah, 16) to find out how much they were moving on a shift and this opened the way for a new, shared understanding of their work experience.

In the same way, Rebekah (15) went on walks and runs with a friend during lockdown and explained, *"I used to track it for us. So it would be like a couple of conversations where like how much we did and like how far it was sort of thing"*. In this way, data sharing opened up conversations about a shared experience. This was particularly important during the COVID-19 pandemic when the usual rituals and routines of connection were largely stripped away: *"I've had less time to exercise and less social interaction because of the outbreak"* (Male, 17).

Moreover, the material tools were not separate from these social communities and in fact some adolescents described feeling a form of social connection or intimacy with the self-

tracking tool itself. This perhaps demonstrates some naiveté on the part of adolescents about the commercial interests of the companies that produce self-tracking tools. This is discussed further in Section 8.4 in Chapter 8. The language used by adolescents around self-tracking tools was often imbued with a sense that they wanted to feel cared for by the self-tracking tool. Adolescents sought positive relationships with self-tracking tools to enhance their tracking experience. Leroy (>16) enthusiastically described his personal connection with his anthropomorphised tracking app:

> *It felt like you know I have a umm a personal trainer you know who is always there for me, so that's the main part. You know, having like something or somebody you know who is there you know to just, you know, to talk to you or sometimes just feel down and then sometimes I… I could actually, you know, just get the app up.*

Similarly, Miriam (17) described how she once received an email from her menstrual cycle tracking app, *Clue*, about PCOS (a condition that she has been diagnosed with). By creating this personal connection, Miriam (17) felt as if she was part of the community: *"I was like, wow, that's cool they're talking about me"*. Feeling supported and understood by the tracking tool were important affordances for adolescents to feel part of a positive tracking community, even if the community was made up of just themselves and their tracking tool. Nonetheless, the emotional affordances of feeling cared for were discouraged when adolescents were asked to pay to use the self-tracking tool: *"it can be frustrating because it can almost take away that like that like that almost like that feeling like apps really care about you"* (Kirsty, 15). For adolescents to feel 'cared for' by material self-tracking tools, they expressed a desire for encouragement, support, and a *"gentle approach"* (Ophelia, 17) to physical activity. They wanted to feel as if the *"apps really care"* (Kirsty, 15) about their health and wellbeing – both mental and physical – and that this care is unconditional (i.e., not subject to payment or their physical performance).

5.4.3 (Anti-)Social Media

Many self-tracking tools encourage the sharing of data on other social media platforms, such as Facebook and Twitter. In interviews, most adolescents described having seen others' self-tracked data on social media, and this mirrors the survey data, in which 581 participants (83.60%) reported that they had seen someone else's self-tracked data shared on social media.

Although adolescents widely reported seeing others engage in this practice of broad social media sharing, as described earlier, when it came to their own data, they said they were extremely selective about the audiences they deemed it appropriate to share data with. Many adolescents chose not to use the in-built data sharing affordances of self-tracking tools. In line with previous findings regarding adults (e.g., Rapp & Cena, 2016; Rooksby et al., 2014), there was also widespread hesitance to expose their activity data on social media. In the survey, only 119 (18.51%) participants who had ever self-tracked reported that they had shared their data on social media. In the interviews, adolescents explained that social media was not considered an appropriate place to share mundane, *"unextraordinary"* (Mikhail, 17) data. In large part, this was due to adolescents' perceptions of the size of the audience on social media which sat in tension with the personal, intimate nature of self-tracked data.

In parallel with what I found with adults in a previous study (DiCosola et al., 2022), many adolescents said that their hesitance to share data on social media was largely in response to their own feelings towards others posting their data on social media: *"I've never liked people just announcing what they're what they're lifting if it's fairly kind of un- unextraordinary, so I've… I've just never done it myself, really"* (Mikhail, 17). Some considered these behaviours on social

media to be anti-social and were wary of sharing too much on these fora. Participants said that seeing others' information and exercise achievements is irrelevant to them and *"annoys"* (Morgan, 16) them, and they were hesitant to be viewed as an irritation in their social networks. For example, Aria (18) explained that she does not care about other people's step count and so would be reluctant to broadcast her own on social media. By controlling who was part of their sharing community, as well as the ways in which their data was presented, the adolescents carefully crafted their self-presentation to maintain control over their shared data and to curate audiences for these data.

Whilst few of the participants shared their data on social media, many of them created smaller communities in which they felt safe and comfortable sharing it, such as communities that consisted of trusted family, or friends with similar interests:

> *Umm I don't know. I guess it's just kind of like sharing what you've done and with like online, I don't know 'cause it seems like it's private information, but they're still... well kind of private in a way, but then at the same time you know you can kind of share it around. But and online I guess it's just kind of like I don't know, it doesn't seem like the right place I guess to do it 'cause it's like sharing out with like the wider world, which you know doesn't really matter. But umm in like a smaller community, you know you could kind of like share stuff with other people.* (Luke, 16)

5.4.4 It Runs in the Family

In the interviews, many adolescents described social-tracking practices used by members of their family and within their households. This parallels the findings of Goodyear, Armour, et al. (2018b), who found that family members were strong influences on adolescents' use of health-related apps and devices. Indeed, 582 (83.74%) of the adolescents who completed the online survey reported living with someone who uses a self-tracking tool. In Hypothesis 4 (laid out in Section 3.7.1 in Chapter 3), I hypothesised that adolescents who have had someone in their house who has ever used self-tracking tools are more likely to have experience with using self-tracking tools themselves. A chi-squared test of

independence was performed to examine the relationship between having a household member who uses a self-tracking tool and whether adolescents had ever used a self-tracking tool. The relationship between these variables was significant: $\chi^2(1, N = 695) = 58.32$, $p = <.001$. Adolescents living in a household with someone else who self-tracks were more likely to have self-tracked at some point themselves (see Figure 5.5).

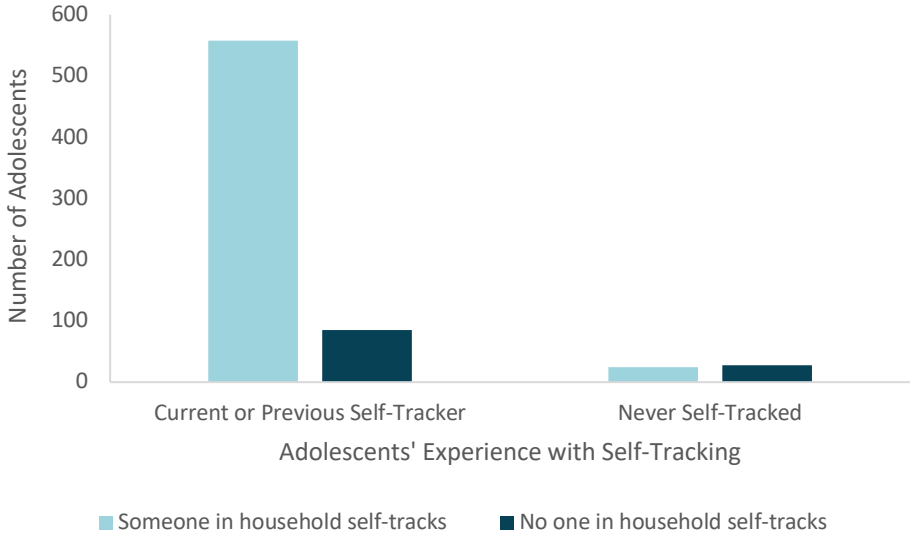


Figure 5.5. Adolescents' experience with self-tracking according to whether someone else in the household also used a self-tracking tool.

This intra-household tracking was also seen in the qualitative data. For some adolescents, this was very natural and was a continuation of well-established family habits. Kirsty (15) described being aware of tracking practices, such as step tracking, within her family *"from when I was little"*. Families were often spaces that included *"friendly competition"* (Logan, 15), in contrast to competitions with friends, which could be *"a lot more intense"* (Logan, 15). Parents were primarily (but not solely) described as sources of support and encouragement, whereas siblings were more commonly viewed as friendly competition. Indeed, sibling rivalry was clearly visible in these communal tracking practices. Edward (17) said, *"I would*

compare it with uhh my sister sometimes, but her step count would always be higher than mine 'cause I've got long legs!" Similarly, Hari (<16) described how her brother would look at her *Strava* data *"and he'd say, 'Oh, you're running too slow' or something like that"*.

The sharing of data within families was sometimes, but by no means always, accomplished through the data-sharing affordances built into self-tracking tools. Violet (15) described how, *"whenever I've done long runs, my mum might like message on the thing [Strava] like 'Oh, well done!'"* Rachael (17) also mentioned that her family would often set a *"weekly challenge"* using a Fitbit feature through which *"you can join a family so umm me, my mum and dad, my sister, my auntie and her partner are all like in a family"*. Like adults (DiCosola et al., 2022; Weiner et al., 2020), adolescents also shared data more informally, and they reported that it was more common for them to do so – through text messages, phone calls, and conversations around the dinner table – than to use the data sharing functionalities incorporated in their self-tracking tools. In view of the role of materiality in sharing practices, more informal and creative data-sharing practices were particularly important when there was incompatibility between family members' devices. Rebekah (15) said that she shares her data with her mother, *"mainly verbally 'cause we both have like these different watches"*.

Tracking practices often became visible in the space of the home through bodily movements. For example, both Edward (17) and Rebekah (15) described their awareness of their respective mothers' self-tracking practices. Edward (17) said that his mother *"used to like walk around the house if it had got to like 10 o'clock and she hadn't got like 10,000 steps […] I thought that was funny"*. Rebekah (15) found her mother's self-tracking practices to be motivating and would compare her steps with her mother's, who *"cares a lot about the steps"*. Rebekah (15) also said that *"it did help because she had more steps than me"*, and so Rebekah's

(15) self-tracking practices became visible within the home as she *"did kind of like do a couple laps around the house"* in order to increase her step count and keep pace with her mother.

Tracking practices were not only visible in individual bodily movements. These practices also fed into and out of other physical activities and connections with family. Thomas (13) explained that in his family *"all of us have a step tracker"* and he described playful moments of *"fun"* and connection when, during periods of lockdown, his family *"went on a few like evening walks and stuff to try and get out a bit more"*. Many such outdoor activities were initiated during times of social distancing when physical activity became a way to connect intimately with those in the same household. For instance, Aria (18) described how such activities became a *"shared experience"* in her family.

The tracking practices of members of the same household are deeply social (Hardey, 2022). For adolescents, shared tracking practices and data became an important way to connect with family. Similar to what has been found in previous work (e.g., Pina et al., 2017), there were often ripple effects of tracking that were felt through the generations, and these were described by the adolescents. Quinn (17) summarised this by saying:

> *Since I started using the Fitbit, my grandparents are now kind of dipping into getting Fitbits and getting steps and they kind of boast to me about their steps as well. It's quite interesting that the older generation, 'cause I assumed it was more the younger generation but actually older generations are now really looking into it. I think that's quite interesting.*

Considerations of safety were other reasons adolescents cited for collective family tracking. Violet (15) described a new *"beacon"* feature on Strava that *"sends out a text to my mum and my dad and they track my activity as I go"*. This feature not only encouraged emotional affordances of commendation and praise from her parents but was also a *"safety feature"* (Violet, 15) that allowed them to care about their daughter's wellbeing. This was mutually beneficial for

Violet (15) and her parents, because, on the one hand, *"My parents can see like where I am in case I like come off my bike and so they can see like where I am and if like I've stopped for a long time, they'll like give me a call […] it lets them feel safer with me going out"*, but it also encouraged Violet's (15) parents to grant her additional freedoms, as she explained: *"a while ago I mean, I wouldn't… I wasn't allowed to go out like it's like mountain biking on my own, but now I can sort of go for a ride and it's just I yeah I can just do the tracking"*.

In another act of care that was achieved through sharing, Natalie (16) similarly described using her tracking data to ease her mother's worries about her health, and more specifically her asthma:

> *We can send her information about how we're doing and that makes her feel more secure […] me and my little brother, we we're both asthmatic so she can check what our vitals are […] so I feel like it does give a sense of safety to people as well.*

Natalie (16) was careful about which metrics to share, however. She also said that she intentionally did not share her sleep-tracking data with her mother as she was aware that her sleep patterns were erratic and this could be a concern for her mother.

Nevertheless, there was a tension here for adolescents who were striving towards autonomy and independence. Adolescents were aware that sharing their tracking data with their families could sometimes afford them greater freedoms; however, they also felt frustrated by being surveilled in this way. For example, Natalie (16) explained this as follows:

> *Sometimes especially like at my age, you kinda do want your own privacy. I do understand where she's coming from because like obviously you might get stranded somewhere, it sends location straight away and stuff like that. But for a period of time, I did feel like it was quite intrusive, because obviously I want to live my life. I wanna, you know, have my own freedom and get to do what I want so it was kind of just coming to terms with that.*

Particularly for younger adolescents, parental control of tracking devices raised challenges. For many, this parental control was necessary during their first engagements with self-tracking tools, as many devices require parents to have control of children's accounts until the age of at least 13 years (Mackintosh et al., 2019). Albert (16) described a loss of autonomy over his sleep pattern through his mother's control of his Fitbit alarm that he *"couldn't turn off for a while because my mum had the app and I didn't"*. Albert (16) shared that his mother used to *"set the alarm for around maybe 6am […] I couldn't stop it until I got the app for myself"*.

The desire to keep data hidden from parents' surveillance was not common across all participants. Some described that they wanted to keep their data private; however, parents were often included in descriptions of appropriate people with whom to share data, such as data concerning step counts and new personal bests on runs. Indeed, some said they would share their data with *"only my parents"* (Rebekah, 15). As Rosie (14) confirmed, *"I just feel like it's just like privacy, like I'll share with my… my parents or stuff, but I wouldn't share it with anyone else, just 'cause I don't know. It's just like for me"*.

5.4.5 Schooling and Sharing

Previous work has shown that adults find a sense of belonging and social support through self-tracking (Karapanos, 2016). And sharing personal self-tracking data and experiences also opened the way for young people to build connections by offering informational support to others in my research. For example, Rosie (14) described using her tracking as a way of educating her friends about health and fitness: *"sometimes like if I use it in PE or something, I'll be like, 'I've burnt this many calories' and some friends know what it's about. But some friends like I explain it to like what it means"*.

Through these educational exchanges, some adolescents demonstrated great care for others who were tracking in ways that they considered to be harmful. In doing so, they attempted to build relationships and trust with potentially vulnerable friends. Often drawing on their own challenging experiences of self-tracking, adolescents sought to *"open up conversations"* (Ophelia, 17) around difficult topics; however, they often found that friends in these positions were unable to understand their perspective and ignored their warnings:

> *With my friend, I've come cause I don't think he's doing in a particularly healthy way, so I kind of say like you can't really measure this like there are discrepancies in calorie labels and God knows if the app has the same numbers as the label. You know I've tried to like reason with him, but then I feel like it comes from the wrong place as in that isn't like from reason, so you can't really reason with someone who is not thinking straight in the first place.* (Sawyer, 16)

When considering different tracking environments, adolescents were divided on whether schools were an appropriate place to create positive sharing communities. Miriam (17) felt that such an exercise would be *"disastrous"* and would encourage harmful, inappropriate comparisons:

> *It's so so easy to compare yourself with other people if you just see someone's Fitbit and it has like a really high number. I don't actually know how Fitbits work, but let's say if a higher number means doing like a bunch of exercise or something, and then you look at your own and it's like nothing. Then you kind of feel like oh, I guess I need to be there too, because they're in my class, they're in my age group. If they can do it, why can't I and things like that. And yeah, just comparing yourself overall is just like a really bad thing to do. So yeah no.*

Similar to some adolescents' descriptions of *"friendly competition"* (Logan, 15) outside of school, some of them felt that tracking in Health and Physical Education classes could encourage positive experiences of movement and motivate students to push themselves: *"people would try harder 'cause they want to do better than their friends, which would make them realise how fun PE is"* (Freddie, <16). These social and emotional affordances of data sharing were considered important elements of students' enjoyment of and engagement with physical activity in the school setting.

Nonetheless, some participants compared sharing tracking data to other experiences of quantification within the school setting. They worried that sharing data in this way could be *"shameful"* (Leroy, >16) for those who did not live up to the standards, and this was seen as a catalyst for *"how issues start with like anorexia and stuff like that"* (Natalie, 16). By way of an example, Albert (16) expressed concerns that engaging in processes of upward comparison could make students *"feel inferior"* to those whose data was higher than theirs:

> *I suppose if it's measured in some sort of competition or something, you wouldn't want to show people. Like I recently got my school grades and there's some people who haven't got as good grades so they haven't... they don't want to talk about it. So I suppose if fitness was something that was measured in a competition, then they might... they might not want to show anyone.*

Much like the sharing affordances allowed by self-tracking tools, the adolescents imagined that the social institution of the school prevented them from having the flexibility regarding data sharing that they desired. Although they emphasised the importance of having autonomy to choose to track or not track within school so they're *"not forced to use it"* (Quinn, 17), none of the participants imagined that schools would enable them to control their sharing. Compulsory – or 'imposed' (Lupton, 2014c) – tracking and data sharing were considered to be *"quite invasive"* (Chase, 16) and *"a bit forceful, a bit mean"* (Quinn, 17). For some, such as Ophelia (17), who had experienced detrimental effects to their psychological wellbeing and eating behaviours as a result of their tracking practices, the presence of imposed data sharing in schools was a worrying prospect: *"I think it's just so bad. I can't, I can't even begin to say how bad I think it is"*.

Some adolescents were concerned that the sharing of data at school could *"kind of get a bit out of hand […] obviously like the number one thing at school is competition"* (Rebekah, 15). They stressed that the pressures of the school environment would make them reluctant to introduce new sociomaterialities that might encourage competition that could be

detrimental to students' health and wellbeing: *"Yeah, I think it's unnecessary. I think everyone works at their own pace and especially in secondary school, everyone's so insecure. So I think step counting is the least of everyone's worries"* (Hannah, 16).

Beyond controlling the narrative around their data, adolescents also carefully crafted their sharing communities, within families and friendship groups and across a range of sociomaterial environments. In doing so, they curated the audiences for their self-tracked data in order to better control their identity performance and to demonstrate care. By exploring the sociomaterial nature of these communities, it is clear that adolescents adopt a range of strategies to organise these audiences, but they hesitate to do so in social institutions like schools where power structures and routines may prohibit them from selecting their own sharing communities.

5.5 Conclusion

All too often, the terms used to describe self-tracking belie the social nature of these practices. By moving beyond solely focusing on the school setting and using a broader lens through which to consider the different environments where adolescents self-track, I found that adolescents' social-tracking practices were complex and existed within differing power structures. We know that self-disclosures online can be important for adolescents' identity development and sense of belonging (K. Davis, 2012a), and I saw the same here. Self-tracked data exist in adolescents' social communities and can be seen in relationships with peers, family, friends, medical professionals, and sports coaches, among others. These were highly social and carefully curated sharing practices.

This chapter drew out three key themes: The Complexity of Comparison and Competition; Keeping Control of the Narrative; and Crafting Sharing Communities. By drawing these themes together, I can begin to paint a picture of the complex ways in which self-tracked data are enrolled in adolescents' social relationships and identity performances. These ideas are all interwoven and they turn on the core ideas of *care* and *choice*; two logics that Mol (2008) sets in tension with one another. Mol (2008) argues that patient choice in healthcare, although often idealised, is problematic as it can be burdensome for patients. Further, Mol (2008) posits that often individual choice is in fact a myth as the sets of choices are predetermined by other actors (e.g., doctors, healthcare systems, pharmaceutical companies). The logic of care, on the other hand, is interactional rather than transactional; it is a collaborative process involving people, technologies, knowledge, and other artefacts. Similarly, in self-tracking, choice is sociomaterially constituted in the interactions between, for example, technology, adolescents, and their social environments. When self-tracking technologies allowed adolescents choice in their data-sharing practices, they were better able to demonstrate care for both themselves and others. Here, choice and care worked together within adolescents' complex and carefully curated sharing communities. Adolescents understood "the communicative value of self-tracking within [their] social groups" (Hardey, 2022, p. 10) and, like adults (Kristensen et al., 2021), harnessed this to build connections and demonstrate care towards both themselves and others in their data-sharing practices.

Returning to the research question set out at the beginning of this chapter, 'How are adolescents' relationships with the self and others seen with and through self-tracked data?', I argue that self-tracked data are mobilised by young people as a narrative devices and are enmeshed in caring relationships with the self and others. It is apparent that

adolescents do not share a single common practice of data sharing. Instead, for many adolescents, sharing was a much more thoughtful practice, filled with care for both the self and others, which was demonstrated through the sociomaterial relations that I identified in their sharing practices. Many adolescents carefully crafted their sharing communities, and even within these only certain data were shared and these data were presented in thoughtful ways (e.g., if they were deemed impressive or comically 'bad').

Together, the quantitative and qualitative data here point to important gender differences that are worthy of exploration when designing for diverse populations. Rather than reinforcing gender stereotypes and power structures through design, perhaps self-tracking technology designed with new social affordances in mind should move away from a focus on social comparisons and competition and open up additional opportunities for more care-filled and care-ful contextual sharing (Mol, 2008; Mol et al., 2010). It is clear just how much the social, emotional, and identity affordances of self-tracking can differ between and within adolescents and how important it is to include multiple perspectives in the design process.

In Sharon's discussion of the social nature of data, she highlights that "digital self-tracking tools usually have built-in functions that enable and encourage users to share and compare their findings with others, via social media and specially created platforms" (Sharon, 2017, p. 111). Nonetheless, the adolescents in my research rarely used the built-in data-sharing functions of self-tracking tools, preferring to maintain autonomy and control over their shared data by mobilising it in more creative ways, or via what Weiner et al. term "digital DIY networks" (2020, p. 13). Adolescents' descriptions of informal sharing practices, including verbal and WhatsApp communication, align closely with findings relating to

adults (DiCosola et al., 2022; Lomborg et al., 2018; Pink & Fors, 2017; Weiner et al., 2020). Weiner et al. state, "Compared with tracking apps, we suggest these are perhaps more straightforwardly discreet because sharing is more readily limited" (2020, p. 13). I, however, argue that adolescents harnessed these creative sharing practices, not only to control the audience of their shared data, but also to maintain control over the narrative of their data. In doing so, this allowed them the flexibility to manipulate the data or provide context to it depending on what they saw as appropriate for their purposes.

More than this, the existence of these informal sharing practices reveals something important about the materiality of digital self-tracking tools. Not only was it challenging to share data between ecosystems (e.g., between Fitbits and Apple Watches), but these tools also reinforced comparison and competition processes that were not appropriate for many. Instead, adolescents had to put in great effort to make social data sharing work for them by creating their own "digital [and non-digital] DIY networks" (Weiner et al., 2020, p. 13). Adolescents' data-sharing practices were dynamic and constantly renegotiated in response to the unpredictability of social actors and technology (Mol, 2008; Mol et al., 2010). Ophelia (17) revised her list of accepted 'friends' and Edward (17) considered carefully which data points he would offer at the family dinner table. What, then, would be the consequences of designing a more dynamic social-data-sharing tool? As a next step for researchers, this study could be extended by working with adolescents to co-design new social-data-sharing experiences that are more responsive to their needs.

What is perhaps most interesting in my research is that data sharing was so much a part of the natural language and conversation for these adolescents. Even those who did not track talked about conversations with others who did and were aware of the communities built

around these practices. Community-building is an important part of the adolescent experience (boyd, 2014) and, for many, families became particularly important sources of relationship and community during the COVID-19 pandemic (Tso et al., 2022). Hardey describes the phenomenon of "co-tracking" (2022, p. 7) within households. In their study, data sharing was used to create intimacy and closeness and was built in as a way of communicating users' care practices. This powerful joint-interview study found that "the motivation to share health data and engage in co-tracking activities reflected a desire to look after and care for each other" (Hardey, 2022, p. 7). Nonetheless, in line with the findings of Will et al. (2020), what I saw was not only how adolescents demonstrated care through "co-tracking" but also the ways in which adolescents demonstrated care by specifically choosing to *not* co-track.

The findings in this chapter help us to extend the existing theoretical framework of the sociomateriality of sharing practices to better understand the centrality of care and control affordances. Extending far beyond the materiality of the digital self-tracking tool, adolescents created "spaces of care" (d'Hoop, 2021, p. 577) within their digital and non-digital networks: around a dinner table, on social media, and in conversations with friends. Here, adolescents mobilised different, carefully controlled sharing and narrative practices within these spaces. This sense of care was lost when adolescents found themselves in disempowering arrangements, such as within the social institution of the school, or when they received an unwanted email detailing their physical activity in comparison to that of their family.

It is important to highlight the messiness of my data and the strength of the mixed method approach of this research in helping to draw out these important complexities. The

adolescents involved in my research engaged in many different data-sharing practices. In so doing, they were negotiating a range of social and material entanglements, situating their data in unique – and sometimes contradictory – ways. For example, whilst Chase (16) shared and compared his physical activity data with 30 to 50 friends, such comparisons were inappropriate for Miriam (17), and she kept her menstrual cycle data private. This raises a real challenge for designers who are aiming to capture the needs of such a diverse user group. As things stand, "current personal informatics designs that generally emphasize a single average or ideal" (Pina et al., 2017, p. 2307) fail to capture the diversity of adolescent users. However, using the affordances of control and care as touchstones might offer us a way in. I make the case that these findings should make us question assumptions that the gamification and competition features built into many of today's self-tracking technologies are sufficient for adolescents' purposes. Instead, designers could harness these insights to better understand young users' understandings of how and why they might share data, and how we might reimagine design to afford users the ability to better control their data narratives and audiences, allowing them to foster connections with and care for others through their data sharing.

Ultimately, adolescents' sharing of self-tracked data teaches us an important lesson about how we think about all social media, or "all the technologies we use to connect" (Morris, 2018, p. xx). Using adolescents' self-tracking as a way to think about these connections, we can see that, much like users curate their social media profiles on spaces like Instagram (Márquez et al., 2022), they also curate their intimate tracking data (Weiner et al., 2020). Empowered data sharing can operate as a narrative tool, enabling people to do important identity work by deciding what they might share and what they might hold back. However, when social and power structures prohibit users from having control of their data

narratives and audiences, this can be problematic and potentially harmful to psychological and social wellbeing. Thus, keeping these notions of care and control at the centre of design considerations for data sharing tools is essential. I argue that if we designed better digital-sharing affordances for adolescents, we would be designing better technologies for everyone.

Having firmly established the complexity of adolescents' social self-tracking practices, I now turn to focus on the affordances of self-tracking for adolescents' psychological wellbeing in Chapter 6.

6 A Complicated Tale: The Psychological Affordances of Self-Tracking Practices for Adolescents



"I don't think there's anyone I've seen on one of these social medias that has an eating disorder that hasn't used a self-tracking app at some point." (Adaline, 16)

6.1 Introduction

This chapter has been the most challenging one to write. I have spent many hours reflecting on why I have wrestled with this section more than any other. Understanding the complex relationships between physical and psychological wellbeing and digital self-tracking practices is not a simple task. While reflecting on the data relevant to this chapter, I was once again struck by the profound challenges faced bravely by these young participants. The interviews and the data analysis for the chapter were two of the most difficult aspects of this DPhil process for me as a researcher. I feel very honoured to have

been trusted with their stories; however, this has come with a great responsibility. At times, I have felt struck by a sense of powerlessness and a desire to help. I have taken great care to do my participants' stories justice and to not shy away from some of the more painful stories. In that vein, this chapter touches on topics including depression, anxiety, disordered eating, and body image dissatisfaction. Any readers for whom such topics might be triggering are welcome to rejoin me in Chapter 7. For those embarking on this chapter with me, I sincerely hope that we can work together towards change.

Whilst much of both the academic literature and the wider marketing around self-tracking tools has centred on physical health, increasingly there has been a focus on the entanglements between self-tracking practices and psychological wellbeing (e.g., Etkin, 2016; Feng et al., 2021; Karapanos et al., 2016; Kelley et al., 2017). Indeed, there is much evidence in the literature to suggest that physical activity can have positive effects on psychological wellbeing (e.g., Biddle & Asare, 2011; Chekroud et al., 2018; McMahon et al., 2016), and this concept is leveraged heavily in marketing for self-tracking tools (see Figure 6.1). Academic literature has shown that increased motivation to exercise and increased self-efficacy and autonomy around physical activity can have positive effects on psychological wellbeing (Karapanos et al., 2016). However, many companies have taken this a step further and developed innovative ways to track physiological data that are more specific to psychological wellbeing (Dalmeida & Masala, 2021). Whether that is tracking stress levels or a person's emotional state (such as through Amazon's 'tone of voice' tracking in its Amazon Halo wearable), or more purpose-built tools such as UpMood, which is designed to use "a revolutionary method to measure biometric patterns of the heart to track, monitor and quantify your emotions" (UpMood, 2021), the self-tracking industry has quickly harnessed the close relationship between physical and psychological

wellbeing and embedded this in the tools available on the market today. However, it is worth noting here that these tools often capitalise on physical markers to draw conclusions about psychological wellbeing in ways that can be tenuous and misleading, such as relying on average heart rate, which is less accurate in detecting stress than other measures such as heart rate variability (Hickey et al., 2021).

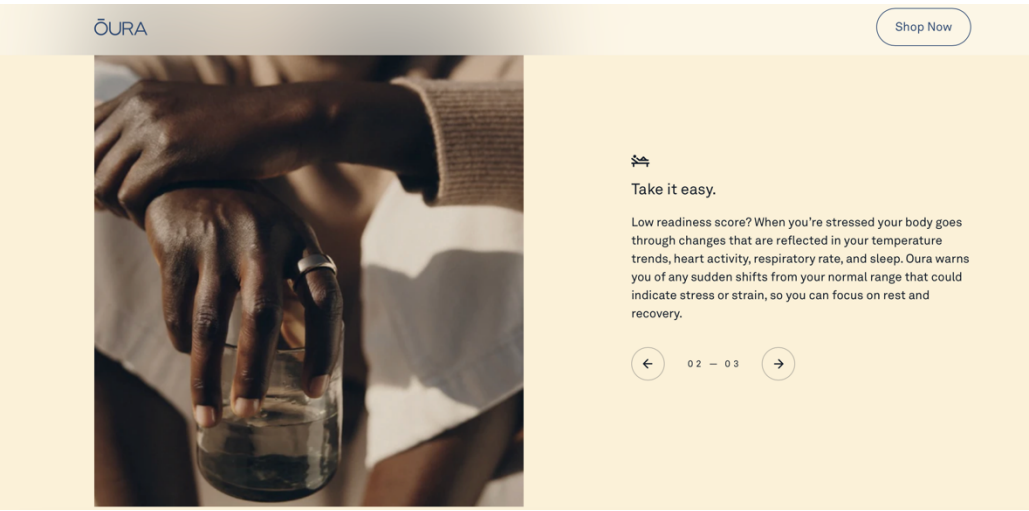


Figure 6.1. An example of a wearable self-tracking tool (Oura) promoting the ability to track metrics related to stress. Source: https://ouraring.com/oura-experience#activity.

On the other hand, one body of academic work has paid more attention to the darker side of self-tracking. Existing research has demonstrated the ways in which physical health and fitness tracking might be entwined with harmful behaviours such as disordered eating and body image concerns (Eikey et al., 2017; Eikey & Reddy, 2017; Gittus et al., 2020; Hahn et al., 2022; Honary et al., 2019; Kelley et al., 2017). One quantitative study found that adult self-trackers were significantly more likely than those without experience using self-tracking tools to report being diagnosed with a mental disorder such as depression, burnout syndrome or bulimia either at the time of the study or within the preceding five years (Findeis et al., 2021).

Positive effects of self-tracking might not be sustained in the long run. For example, Etkin (2016) found that although step tracking led participants to walk more, they reported less enjoyment of walking. Etkin (2016) argues that the quantification of steps detracts from the intrinsic rewards of walking activities and instead feeds external motivation (Deci & Ryan, 2000), making exercise feel more like 'work'. Similarly, Attig and Franke (2019) demonstrate that self-tracking can be perceived to be externally rewarding and can create a dependency on tools such that motivation for physical activity is impaired when self-tracking tools are not available. Therefore, in the absence of self-tracking feedback that bolsters autonomy, intrinsic motivation, and self-determination, it may be challenging for users to sustain positive engagement with self-tracking tools.

Previous literature on this topic has yet to coalesce around a single, clear description of the relationship between self-tracking and psychological wellbeing. Nevertheless, it is evident that there is a delicate balance to be struck between promoting positive behaviour change and negatively impacting psychological wellbeing (Eikey et al., 2017). This balance is particularly important for adolescents, who have been recognised as a vulnerable population because of their reduced psychological wellbeing (Bonell et al., 2014; Chanfreau et al., n.d.). This has considerable implications for this age group as reduced psychological wellbeing can have negative impacts on many facets of adolescent life, including: social relationships, academic achievement, and physical health (Kern et al., 2016).

Throughout this chapter, there is a strong focus on calorie- and food-tracking and related eating disorders and body image dissatisfaction. These topics were not specifically prompted in my study; however, these were the stories that adolescents wanted to share. This is perhaps unsurprising given that the majority of eating disorders first develop during

adolescence and early adulthood (Keel et al., 2010). It is important to acknowledge that self-tracking tools do not sit in a vacuum but are part of the broader social context that adolescents contend with daily. In their survey of 13- to 18-year-olds in the US, Wartella et al. (2015) found that fitness/exercise and diet/nutrition are the two most popular health-related topics that adolescents search for online. Recent media reports and academic research have spotlighted the potential relation between social media content and adolescents' psychological wellbeing (Keles et al., 2020; Mabe et al., 2014; Padín et al., 2021). There has been a particular focus on 'fitspiration'[19] and pro-anorexia and pro-bulimia content and their negative effects on self-esteem, disordered eating behaviours and body image dissatisfaction (Boepple et al., 2016; Tiggemann & Zaccardo, 2015, 2018). As Kent (2020) argues, self-tracking tools in combination with other social media can exacerbate the internalisation of normative body images. Consequently, when reading the remainder of this chapter, it is important to remember that self-tracking tools are but one piece of this highly complex puzzle.

In this chapter, I look beyond the impact of self-tracking on physical health and focus more closely on the implications for adolescents' psychological wellbeing. In this chapter, I address the research question: **How do adolescents make sense of the affordances of digital self-tracking practices for their psychological wellbeing?** (RQ3). To address this question, I lean on my mixed methods approach and consider together both quantitative and qualitative data from the survey in addition to adolescents' lived experiences as expressed in the qualitative data from our semi-structured interviews. Once

[19] 'Fitspiration' is considered to be 'fitness inspiration' content intended to motivate individuals to pursue healthy lifestyles through exercise- and diet-related images and quotes (Boepple et al., 2016). It is sometimes also associated with 'thinspiration' ('thinspo', or images of dangerously thin bodies), and is often found within pro-eating disorder content (Borzekowski et al., 2011).

again, I draw on the language of the mechanisms and conditions of affordances (J. L. Davis, 2020; J. L. Davis & Chouinard, 2016) to better understand the psychological affordances of self-tracking technologies for adolescents. I outline three key themes that echo the arc described by some adolescents in their relationship with self-tracking and psychological wellbeing. These themes are titled: The Numbers Game; The Slippery Slope; and The Battle for Control. As in previous chapters, quotations from surveys are denoted in the form '(Gender, Age)'. Quotations from interviews are denoted in the form '(Pseudonym, Age)'.

6.2 The Numbers Game

6.2.1 Kirsty's Story

Kirsty (15) has tried a number of different apps throughout the period she has spent self-tracking, but has found MyFitnessPal to be the only one she has been able to sustain her use of. In contrast to other apps, she likes that everything is kept in one place and finds that MyFitnessPal is intuitive to use. She enjoys monitoring her progress and finds that her data give her a *"sense of security"*. She describes herself as someone who puts herself under a lot of pressure and has previously set *"unrealistic goals"* with her tracking. Reflecting on this, she is aware that her personality might predispose her to become fixated on her data and so she is careful with what she does to ensure that this does not happen to her. For example, she chooses not to share her data with others as she is worried it would be too easy to become competitive. Whilst Kirsty currently self-tracks, she is grateful she did not start earlier in life when she feels she may not have been equipped to engage in these practices positively.

6.2.2 Get Psyched! The Positive Psychological Affordances of Self-Tracking

Some adolescents described positive experiences of how self-tracking could benefit both their physical and psychological wellbeing: *"It can make the body and mood a little better"* (Male, 17). Ophelia (17) described how, despite battling *"a lot of mental health issues"*, self-tracking has *"always been able to help me in some way, shape, or form"*. Adolescents' sense of the 'objectivity' of the data was comforting for some adolescents and, like Kirsty (15), they found a *"sense of security"* in the numbers. For example, Ophelia (17) said that:

> *it kind of like helped with my mind so I could see instead of thinking 'cause when I thought it would be like 'Oh no, you have achieved your goal.' You haven't done this, but being able to see it and seeing whether or not I've achieved it kind of put my mind at rest.*

Similarly, Miriam (17), who tracked a long-term health condition (PCOS), found that self-tracking *"just kind of helped to like put me at ease, I guess"*; rather than *"speculating"* about what might be happening with her body, she could rely on the data to tell her. Adolescents described that this improved their sense of wellbeing as they used the data to help them to ease their anxieties about their bodies and health.

Participants described how self-tracking could help reduce anxiety, particularly as they were managing the unfamiliar environment of the COVID-19 pandemic (e.g., lockdowns, re-opening after lockdowns): *"It gave me something to do and less anxiety in the face of this pandemic"* (Female, 17). For some, simply having a focus beyond worrying about the virus was positive. Others looked to self-tracking to mitigate the effects of reduced physical activity on their psychological wellbeing: *"I valued the step counter more as a way to tell myself if I did enough physical exercise in a day and making me feel mentally better not doing a lot of sport"* (Male, 16). Some adolescents described the identity affordances of self-tracking tools which allowed them to maintain their identity as athletes and had positive effects on their wellbeing:

"During lockdown, being able to track and see my activities and data really uplifted me when the going got tough with mental health" (Female, 16).

Nevertheless, stories of long-term positive effects on psychological wellbeing were rare, and instead, adolescents painted a much more complicated picture of the relationship between their self-tracking practices and psychological wellbeing.

6.2.3 Widening the Lens

When designing this project, I had perhaps hoped for data that told a clear, consistent story. But this story – like the most compelling of tales – is full of twists, turns, and puzzles. In particular, the quantitative and the qualitative data paint different pictures, and although I will explain my hypotheses as to why this might be the case, it is worth highlighting up front that this chapter will embrace the contradictions in these data.

When asked during interviews to explain what they understood by the term 'wellbeing', the adolescents did not agree on a single definition; however, many of them saw both physical and mental health as necessary components of good wellbeing: *"having good wellbeing means that you're physically healthy, but you're also mentally healthy and satisfied and happy with your life"* (Jasmine, 17). The word *"balance"*[20] (Rachael, 17) was prevalent in descriptions of both self-tracking and wellbeing. When the term 'balance' related to self-tracking it was often described as meaning *"to not aim to do a ridiculous amount of steps a day but not to aim to do too little either, just to get a really comfortable amount"* (Jasper, 14). In line with the WHO definition of

[20] The prevalence of this term across, the survey, interviews, and workshops is a notable finding and worthy of future research to more clearly define what 'balance' might look like across a range of adolescents and contexts.

health: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (2020, p. 1), adolescents articulated that good wellbeing was not just about the absence of *"bad days"* (Ophelia, 17) or *"unhealthy habits"* (Ophelia, 17) but about a general contentedness level both *"mentally and physically"* (Quinn, 17).

Attempting to strike this balance is where the relationship between self-tracking and wellbeing became complex for adolescents. They saw how self-tracking practices could impact both their physical and their mental health (often in antithetical ways). As one adolescent articulated so astutely: *"I know it's bad for my mental health but I also like the challenge of losing weight and seeing the results at the end"* (Female, 17). They also expressed that the psychological effects of self-tracking could be inconsistent:

> *I have anxiety and Covid19 and the 1st lockdown meant that this was affected hugely. I've found that I need to exercise to help.my mental health but it also be ones a weapon to beat myself up with if I don't exercise. The app doesn't let me pretend I've exercised.* (Female, 15)

Here, it is helpful to take a step back and consider the broader picture. This is where the quantitative survey data are helpful as it can reveal general trends in the relationship between self-tracking practices and adolescents' psychological wellbeing. In Hypothesis 5 Section 3.7.1 in Chapter 3, I hypothesised that the mean psychological wellbeing scores will differ between those who report currently using self-tracking tools at the time of the survey, those who previously used self-tracking tools, and those who have never used self-tracking tools. The 473 participants who were self-tracking at the time of the survey had a mean psychological wellbeing score of 48.52 out of 70 (SD = 8.97), the 129 participants who had previously self-tracked had the lowest mean psychological wellbeing score of 47.21 (SD = 9.24), and the 48 participants who had never self-tracked had the highest mean psychological wellbeing score of 49.88 (SD = 10.99). However, a one-way analysis of

variance (ANOVA) demonstrated that the overall effect of the level of experience with self-tracking tools on psychological wellbeing was not significant F (2, 683) =1.96, p = .14 (see Figure 6.2).

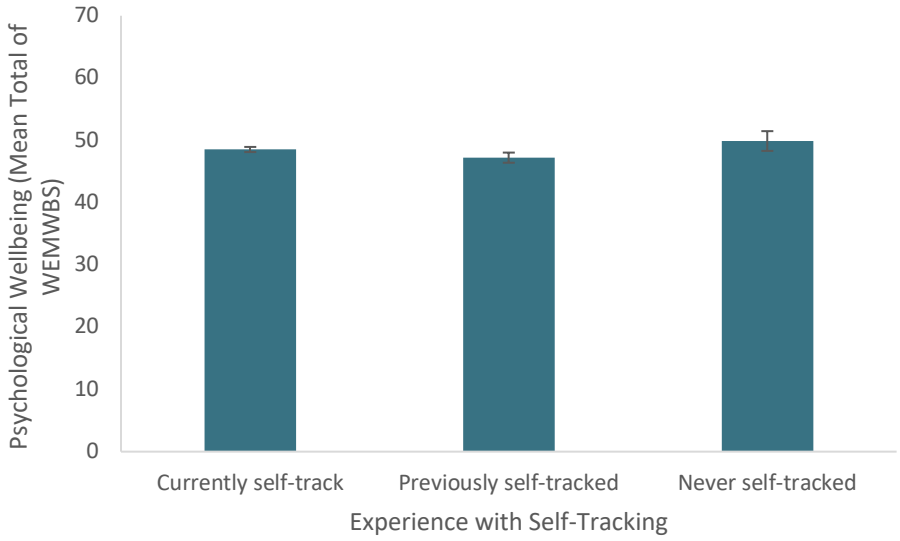


Figure 6.2. Adolescents' psychological wellbeing (measured by the WEMWBS) according to their experience of self-tracking. The error bars represent standard errors.

Finally, in my previous work with colleagues, I have shown that the role of tracking consistency as an important factor in the relationship between self-tracking and psychological wellbeing (DiCosola et al., 2022). In Hypothesis 6 (laid out in Section 3.7.1 in Chapter 3), I contended that current adolescent self-trackers who reported tracking more consistently would have a higher psychological wellbeing score than those who reported lower consistency in their tracking. This was tested using Spearman's rank order correlation as self-tracking consistency was measured as an ordinal variable (on a self-reported scale of "0 (Not consistent e.g. I do it once in a while)" to "10 (Very consistent e.g. I do it about everyday)") and was not normally distributed (see Appendix H). For adolescents who reported currently self-tracking at the time of the survey, there was a significant positive

relationship between consistency of self-tracking and psychological wellbeing such that those who reported tracking more consistently reported a higher level of psychological wellbeing, r_s (491) = .281, p = <.001 (see Figure 6.3). Although it is not possible to determine a causal direction of this effect, the data might suggest that tools which encourage more consistent tracking might have more positive effects on adolescents' psychological wellbeing, or it may be that individuals with higher levels of psychological wellbeing are better equipped to track consistently. Future research is needed to unpack this further, and I will return to this in Section 6.4.2.

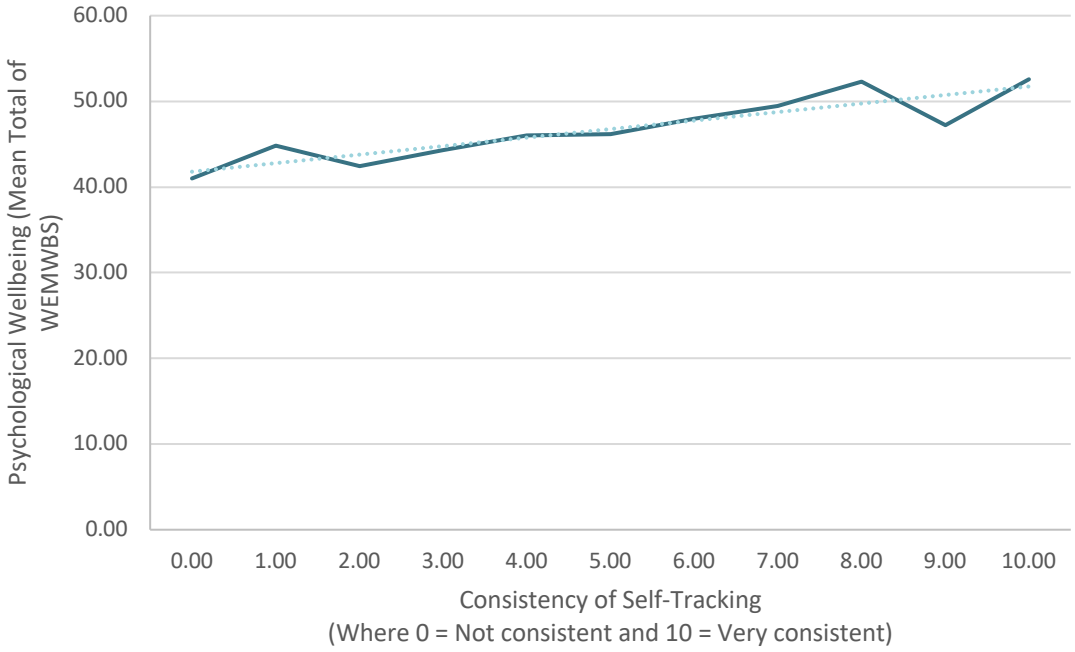


Figure 6.3. Adolescents' consistency of tracking in relation to their psychological wellbeing (measured by the WEMWBS).

Ultimately, the quantitative data provide an interesting window into the relationship between self-tracking and adolescents' psychological wellbeing; however, they do not tell the whole story. This is where a mixed methods approach is valuable. The qualitative data in this chapter has already hinted that the situation that adolescents see is more complex. It is therefore important to examine adolescents' own experiences through the qualitative

data from the interviews to ensure we can understand more holistically the challenges at hand.

6.3 The Slippery Slope

6.3.1 Miriam's Story

Miriam (17) uses a menstrual cycle tracking app, Clue, to manage her polycystic ovary syndrome (PCOS). She was diagnosed at the age of 12 and was offered little support from doctors so felt that she had a responsibility to learn more and to start tracking her health. Miriam has found that tracking has stopped her speculating as much and allows her to plan her life around her PCOS. She finds the tracked data reassuring. Nevertheless, Miriam has also tried using calorie trackers but found that this experience was quite detrimental to her psychological wellbeing. She set out with the intention of gaining weight but through her tracking her goal slowly shifted, and she found herself instead trying to lose weight. She also began to get anxious about eating in social settings where she could not meticulously weigh her food down to *"every single grain of rice"*. Miriam now vocally opposes calorie-tracking behaviours and has since stopped tracking calorie data herself.

6.3.2 No Appetite for Calories

Beyond the initial excitement and novelty of self-tracking, adolescents saw the potential for tracking to take a darker turn. Whilst none of the survey or interview questions asked specifically about the tracking of food and calories, this topic came up time and again, without prompting, as a key catalyst for a potential downward turn in the relationship between adolescents' wellbeing and self-tracking practices. Calorie-tracking was viewed as decidedly distinct from other forms of self-tracking and as a type of tracking that raised a number of complications for adolescents' wellbeing.

In contrast to adolescents' descriptions of the motivating nature of physical health tracking that could encourage new and exciting physical activity opportunities, they saw calorie- and food-tracking as more *"constricting"* (Rachael, 17). Quinn (17) described this as follows:

> *if you start tracking your food, you're taking that away from the experience of eating and if you start, you know it's all the same. I mean, it's different if you tracked food, I feel that would take away from the experience of eating and enjoying yourself whereas if you tracked your running and stuff, I feel that motivates you more rather than takes it away, yeah.*

For Quinn (17), whilst the experience of eating felt somehow instrumentalised when it was being measured, she found that the measurement of physical movement enhanced the experience of physical activity. This difference between calorie-tracking and activity-tracking emphasises the importance of not assuming that tracking automatically reduces activities to metrics (or what is quantifiable). Instead, this suggests that different sociomaterial arrangements offer different affordances for adolescents.

Many of the adolescents in this study were particularly concerned about the prospect of calorie-tracking, which is consistent with previous work (Potapov et al., 2021): *"I would definitely say that calories are the biggest problem. Whether it's tracking how many calories you're eating or tracking how many calories you're burning"* (Ophelia, 17); *"the whole calorie thing… I think there's like a million and ten different negatives and downsides to that"* (Miriam, 17). For adolescents, calorie-tracking represented a slippery area of self-tracking that could lead to problematic relationships with food and their bodies. This feeling was widespread across the group of interview participants; however, more participants who identified as female shared these kinds of stories. This parallels findings from studies with adults, where those who identify as female have been argued to be disproportionately vulnerable to these negative psychological affordances of self-tracking (Berry et al., 2021). There was not a single, straightforward positive case of calorie-tracking in this study.

Whilst in Chapter 5 I showed that adolescents often oriented their comparisons of step count around the value of 10,000 steps, for calorie-tracking there was little sense of an established 'normal': *"with steps there are 10,000 and that's kind of universally agreed on. Then I think with calories it's like, there are different opinions on each thing, and it's kind of like different levels of how good you've done"* (Sawyer, 16). In the absence of these norms, many female adolescents described trying to keep the number as low as possible and eat *"virtually nothing and lose weight"* (Ophelia, 17), reflecting hegemonic ideals of 'thinness' (Greene & Brownstone, 2021). Adolescents felt that there was *"a different social response"* (Sawyer, 16) around these data such that the moral imperatives and value judgements made about calorie- and food-tracking stood out as different to other types of physical health tracking. As Lupton emphasises:

> The body that is unable to be contained, over which its owner seems to have little control, is an object of pity, ridicule and disgust. In contrast the tightly contained body, associated with a lean and fit body shape, good health and vigour, is portrayed and regarded as ideal and morally just. (2016b, p. 52)

In a similar way, Mau eloquently discusses these culturally constructed standards of self-tracking in his work on metrics:

> In the arena of mutual observation, interpersonal influences are inevitable; which behaviours prevail is determined by the hegemonic cultural models. In a society where activity and performance are highly valued, it is the active and the high-performing who set the standard. (2019, p. 109)

For adolescents, these moral judgements and standards were most strongly felt around calorie-tracking. This was revealed in stories of complex relationships between self-tracking and psychological wellbeing.

6.3.3 Tracking Alongside Existing Vulnerabilities

Adolescents saw their particular stage of life as a time of unique vulnerability to the negative psychological effects of self-tracking practices. They were wary of the dangers of tracking for their age group*:*

> *It isn't marketed as dangerous, and there's a lot of stuff like that in the diet and track- like community like that […] like the diet teas and the detoxes and stuff […] I think these self-tracker apps are going to be the next ones which are gonna kind of come out as being we shouldn't be letting kids have access to these apps. And I use kids vaguely... up to 18.* (Adaline, 16)

The above quotation illustrates that the adolescents were aware that they often lacked the appropriate support and resources to effectively use these tools that had not been designed for them. Miriam (17) articulated these challenges and focused closely on the types of tracking goals that adolescents often set for themselves. She felt that adolescents were often inclined to set unachievable goals – particularly around calorie-tracking – and imagined that this was the cause of a lot of harm:

> *So like with adolescents, I'm sure you know like stuff around like body image is like really, you know like a big thing I guess for us and umm you know, there's like kind of this really weird thing that skinny is better and bigger is not, even though that's not true. And so when people come to counting calories they can get really obsessive after a while […] it's like 'I want to look like this person. I want this body shape or whatever and to get there I need to get there I need to be eating a certain amount or I need to be restricting a certain amount' or something like that and it can just be really destructive with us.* (Miriam, 17)

This *"destructive"* (Miriam, 17) side of self-tracking was top-of-mind and concerning for the participants. For many of the reasons I have discussed in Chapters 4 and 5, the adolescent period is filled with challenges – from navigating social relationships to managing the profound effects of a global pandemic. As mentioned in Chapter 4, this more *"destructive"* (Miriam, 17) aspect of tracking was perhaps magnified by the COVID-19 pandemic and periods of lockdown, when adolescents became more *"attached"* (Quinn, 17) to their metrics and *"thought too much about them because there was nothing else to think about"* (Quinn, 17).

One adolescent shared some of her story and saw direct links between self-tracking practices and disordered eating behaviours: *"It became an obsession throughout the lockdown and ultimately cause me to have an eating disorder"* (Female, 17).

For adolescents who described living with eating disorders (such as anorexia nervosa and bulimia nervosa), calorie-tracking was a particular challenge. The link with eating disorders and self-tracking was clear to the participants. As Adaline (16) remarked in the opening quotation of this chapter*: "I don't think there's anyone I've seen on one of these social medias that has an eating disorder that hasn't used a self-tracking app at some point"*. Similarly, Hannah (16) said, *"I know calories has had a big impact on like my age group in particular with umm eating disorders and stuff"*. Natalie's (16) story is particularly powerful here. Natalie (16) shared her personal struggle with bulimia and how her self-tracking practices became entwined with challenges around food:

> *With my bulimia, when it came to like recording what I've eat and stuff like that, I'd think 'Oh have I eat too much?' Or if I searched it up and see how many calories I'd be like, 'Oh my gosh no I can't have that, I can't have that'. It got to a point where like whatever I was eating, I knew the calories and I knew how much exercise to do to burn it off straight away.*

Natalie (16) went on to describe how, under these circumstances, the presentation of tracking data became an external presentation of bodily sensations of inadequacy and failure:

> *Obviously being bulimic, when things don't go your way or if you're having a bad day they do make it worse because you kind of feel like a failure when you do see that thing in front of you. Like you can already feel it within yourself but… but being able to just pick up your phone and it being there and like it's right in front of it, it does make you feel bad after a while.*

It is important to recognise that for these adolescents, self-tracking was about much more than just numbers. For them, self-tracking was interwoven with challenges they faced in

their environment and emerged in complex relationships between their sense of self and other concerns such as nutrition and mental health vulnerabilities.

6.3.4 Too Little is Never Enough

Whilst many adolescents problematised calorie-tracking and questioned the scientific value of tracking calories, they nonetheless felt bound by social pressure to strive towards having an idealised body (Kent, 2020). As Kleemans et al. (2018) highlight, adolescents often feel a great deal of pressure to work towards achieving a societally valued ideal of thinness – reinforced by manipulated images online – which is often unrealistic and unachievable. They often do this by changing their calorie intake and physical activity and, as Carrotte et al. (2015) found, the internalisation of a normative, thin body type as ideal is associated with increased compulsive exercise and negative moods.

Adolescents in my research found the presentation of calorie data allowed by self-tracking tools to be demotivating and preferred alternatives: *"rather than calories burnt, make it more like positive reinforcement and make it like how much stronger you've gotten"* (Hannah, 16). Hannah's suggestion points to a curious tension in the self-tracking behaviours described by the adolescents in this study. Where tracking physical activity was often presented as having more positive effects on psychological wellbeing, many of the adolescents described tracking aspects such as steps, distance, or weights lifted as having a focus on growth and getting *"stronger"* (Hannah, 16). They strove to drive these numbers to be as high as possible. By contrast, many of the calorie-tracking behaviours described by adolescents centred around keeping calories consumed as low as possible, and this goal was often associated with a negative impact on psychological and physical wellbeing. The directionality of the tracking goals and motivations for self-tracking therefore raised

challenges for adolescents when they were striving towards a number that was as low as possible.

Many adolescents spoke about the particular challenge of aspiring to have an idealised body type that is often unachievable:

> *trying to reach that sort of ideal body type, which actually doesn't exist. And you know, it's just it's kind of hard to reach something that isn't actually in existence 'cause then you're just kind of pushing yourself until the limit of forever.* (Miriam, 17)

It is here that other social media content also comes into play (Kent, 2020). Images on social media were often viewed through the lens of self-tracking data such that adolescents saw images of influencers, other celebrities, and even their peers and imagined what their activity levels and calorie intake might look like to enable them to have this idealised figure. In some cases, the relevant self-tracked data were available for them to peruse and compare with their own when others posted their achievements on social media.

As discussed previously, the slippery slope of calorie-tracking was a common theme amongst adolescent girls. Like Miriam (17), many described a disconnect between their initial intentions when they started to track their calories and the obsessive place in which they landed. Ophelia (17) shared a similar story of striving towards this ideal and the harmful effect this had on her mental health:

> *I first started as I was trying to lose a bit of weight and so I was counting my calories, seeing how much I was eating during the day to see what I would need to maintain weight and to lose weight and then that ended up never being enough and so I kept cutting down and cutting down and it was so unhealthy. But you don't really realise it until it's kind of too late and you have to get help for it 'cause you can't do it on your own any more.*

When adolescents were chasing this ideal body *"until the limit of forever"* (Miriam, 17), a failure to reach their goals could be particularly damaging to their sense of self-efficacy and

wellbeing. They found themselves frustrated and disillusioned when they did not see the progress they were hoping for: *"I'm doing this for a long time and then I– I'm not seeing changes"* (Leroy, >16). The emotional affordances of seeing that they had not reached these goals were extreme – *"devastation and guilt and like worry within myself"* (Ophelia, 17) – and this could be *"overwhelming"* (Sawyer, 16). After falling down this slippery slope of calorie-tracking, desperately chasing an ideal body, many adolescents found that their relationship with self-tracking fundamentally changed, and they felt as if they had spiralled out of control.

6.4 The Battle for Control

6.4.1 Hannah's Story

Hannah (16) self-tracks using her phone. She previously used a Fitbit but she found that this was too readily available and meant that she was checking her data too often, which negatively impacted her psychological wellbeing. At one time, she tracked her calorie intake but found she was too preoccupied with these data and that they were not serving a positive purpose for her. She found this negatively impacted her relationship with food and she would feel *"guilty"* after eating. She discussed her step count with her colleagues and used this to build relationships at work.

6.4.2 When Tracking Takes Over

In parallel with Chapters 4 and 5, control was once again a dominant concept when adolescents considered the impact of self-tracking on their psychological wellbeing. A loss of control was signalled by a feeling of no longer actively making autonomous choices about their tracking behaviours. They described a threshold point past which they lost control of their tracking and that this could have detrimental effects on their psychological wellbeing. They resisted the idea of continuous tracking or *"the idea that we always need to do*

it" (Miriam, 17) and they worried that *"if you're really obsessive over it, it can just like backfire on you"* (Miriam, 17). It is interesting that these insights sit in such stark opposition to the quantitative data above which show that more consistent tracking was associated with a higher level of psychological wellbeing for adolescents. Instead, in the interviews, adolescents said that they wanted to maintain choice regarding when they self-tracked and advocated the importance of having breaks from tracking to maintain a healthy relationship with quantified data: *"it's like anything, if you obsess over it just gets to a point where you need to take a break and step back from it because it's all you're thinking about"* (Morgan, 16). This aligns with Gorm and Schlovski's (2019) notion of episodic tracking whereby users freely move in and out of active tracking to best suit their needs.

As identified in work I previously conducted with colleagues (Freeman & Neff, 2021), *"the pressure everyday to reach the numbers"* (Quinn, 17) was considered *"dangerous"* for some adolescents as it could encourage them to become fixated on data. This loss of control was often associated with obsession (two concepts which also emerged in Chapters 4 and 5). Many adolescents were reflective about when they had crossed the threshold and lost control of their tracking: *"I definitely think I've kind of gone too far into it"* (Sawyer, 16). They flagged the dangers of continuing to self-track beyond the point at which they felt in control: *"The tracking was in control of me. So yeah, I guess that's why I didn't like it 'cause it didn't really feel like I was in control, which kind of defeats the whole purpose of self-tracking"* (Miriam, 17). For some adolescents, self-tracking started to take away the enjoyment of their usual activities, such as exercising, eating, and spending time with family and friends.

Adolescents expressed concerns about what happens when *"everything kind of revolves around it [self-tracking]"* (Luke, 16) and felt that existing tools did not allow them to take meaningful

steps to remain in control. This was at odds with the marketing and behaviour change ('nudge') models built into the tools that adolescents were engaging with. They described experiences of being *"slightly too concerned about you know the numbers in the gym"* (Mikhail, 17). It was here that guidance and empathy were key in protecting adolescents from the harm of losing control: *"there's never been a serious problem for me, you know? But I could definitely see how it could be a serious problem for someone who doesn't have a dad who also does shot put constantly telling them you know, don't obsess about the numbers"* (Mikhail, 17).

Some adolescents were wary that this loss of boundaries regarding quantification could make them lose touch with their bodies: *"I think trackers can sometimes take away from that intuition and your ability to kind of read your own body"* (Jasmine, 17). This sat in tension with the core ideals underpinning self-tracking and the Quantified Self's promise of "self-knowledge through numbers" (Quantified Self, n.d.). Ironically, in many ways, gaining these personal, bodily insights made adolescents feel more alienated from themselves and their bodies; Mau argues that "the production and availability of data are gradually eroding the enigmatic aspect of the body and mind" (2019, p.100). Adolescents were hesitant to become *"dependent"* (Quinn, 17) on self-tracking tools or for their bodies to be reduced to numbers because they were aware that when it comes to digital self-tracking, *"it doesn't have all the answers"* (Quinn, 17). Instead, as I have shown previously, adolescents were determined to remain in control of their self-tracking practices and emphasised the importance of choice regarding how they intuited their bodies' signals.

The rigidity of the behaviour change design of self-tracking tools prevented (or 'refused' in J. L. Davis and Chouinard's (2016) terms) adolescents from enjoying the activities they were looking to engage with: *"I'd rather be more relaxed about health and fitness"* (Rachael, 17).

The 'rewards' from self-tracking tools could lead to negative effects: *"ohh congratulations, you've burnt this many calories and you feel like oh I better not eat anything because I've burnt extra calories"* (Hannah, 16). Ophelia (17) described being *"hurt"* by apps telling her that she was eating too much: *"it just makes you feel bad about yourself even though you're eating what everyone else is eating".*

6.4.3 Seeing the World Through Data

The consequence of losing their sense of control over tracking was that adolescents began to view their worlds through the lens of data alone. When tracking data moved beyond the materiality of the device it began to *"take over your life"* (Adaline, 16) such that adolescents would *"constantly be on those apps 24/7"* (Ophelia, 17). Some adolescents offered astute guidance on how to detect *"unhealthy"* tracking based on the lens used to view activities and the impact this could have on the enjoyment of everyday life:

> *I think when you get too like strict with like again, when you get bogged down in the numbers and you forget to listen to how your own body is feeling and when it detracts from your enjoyment of the experience, so it's like if you force yourself to go out for a walk just to hit that step count, not because you actually want to go for a walk. If you spend half the meal, kind of like worrying about how many calories you're consuming when you know you should be talking to the people around you. Umm you know or or if you get so worried that you like… like you know when you get so worried that you're not going to have enough sleep that it stops you from sleeping so you get less sleep. I think that's when it gets unhealthy.* (Jasmine, 17)

Jasmine's (17) guidance echoed others' experiences wherein they found that they began to prioritise viewing their daily activities through this lens:

> *Like when I was working and things and… and my priority would be I've got a burn this amount whilst I'm working and things like that. You know it should be about doing the best work I can rather than... or like enjoying my day instead of worrying about what I'm eating and how much I'm exercising.* (Ophelia, 17)

Both Ophelia (17) and Jasmine (17) described situations in which everyday routines of work, walking, and eating could become obscured by a data-centric view and that this

could detract from the enjoyment and feelings of success that might normally be tied to these activities.

Once again, this was particularly true of calorie- and nutrition-tracking, which shaped the way that some adolescents viewed food and the world around them. Tracking could mask the enjoyment or experience of the activities themselves, and ordinary objects were often seen through the lens of data: *"when you go around a supermarket, you can look at this stuff and go 'Ohh that has X amount of calories' because you put it into the app enough times that you know"* (Adaline, 16), or *"every time we go to a restaurant you can't look at anything without going, "Oh, I'd need to run 5 minutes to get rid of that"* (Adaline, 16). Adolescents described in detail how food became tied with exercise; they would pay penance for eating by being sure to burn off any calories consumed.

Unfortunately, these associations did not disappear if adolescents stopped using tracking devices or apps, and instead they were *"kind of hard to shake off"* (Miriam, 17). Like other young adults (Clark et al., 2022), the participants in this project described how self-tracking tools encouraged a notion of deeply internalised tracking whereby they had tracked for so long that they instinctively knew how many calories were in different foods or were burned through different activities. Ophelia (17) described this: *"it's just kind of like those numbers end up getting stuck in your head, and so when you next go to eat it, you just see those numbers instead of the food that it is"*. The quantification of food consumption was a common experience shared by many adolescents:

> *I can still look at an apple and be like, oh, that's so many calories. Or like look at a piece of bread and be like oh that bread's got that many calories but that bread's got this many calories and things like that because of... I've just learned it now and I've gotta... it's going to take time to forget it.* (Ophelia, 17)

Whilst for some, internalised tracking could be a helpful shortcut and a sign of learning and growth, in these circumstances, the consequences were darker. This *"changing perspective of food"* (Sawyer, 16) was common amongst adolescent girls. The impact of this was that negative emotions were often tied with food, and adolescents described a sense of shame regarding their eating practices: *"I never got to the point where I stopped eating the packet of crisps, but it definitely, I felt guilty afterwards"* (Hannah, 16).

This data-focused lens could also have an impact on their social relationships, even when their tracking practices were private. For example, Miriam (17) said,

> *I noticed that slowly I started in enj- not enjoying things that I used to previously enjoy it like umm I used to get a lot of anxiety around like going out with my friends to eat and stuff. Because I'd feel like, oh I don't have my weighing scale on me, I can't measure what I'm going to eat or the menu doesn't show the calories and stuff and I can't put it into my tracker and whatever, yeah.*

Like others, Miriam (17) described how self-tracking began to unduly influence her choices in social settings, and thus she lost a sense of control over her self-tracking practices.

6.4.4 Taking the Reins

Adolescents clearly articulated approaches they had used to combat negative psychological effects of tracking and regain control of their tracking in a way that was most useful to them. This has been shown in adults too, where users creatively resist the standard and orient towards the personal; they 'hack' self-tracking tools to collect new data (Neff & Nafus, 2016) and engage in "episodic use" in order to ensure that the tracking still suits their needs (Gorm & Shklovski, 2019, p. 2505). For some adolescents, the fight for control centred around the materiality of self-tracking tools and putting strategies in place to limit the visibility of their – and others' – data, such as deleting apps or ceasing to use wearables: "*I've deleted apps and I've kind of got rid of some of my tracking because I... it led into unhealthy habits*

for me" (Ophelia, 17). Similarly, in the story at the beginning of this section, Hannah (16) described starting to just track her data on her phone as they were too readily available on her Fitbit:

> *I felt I was looking at it too much in a way, maybe. It being constantly on my wrist was sort of like I was always checking and like even just out of boredom. But I guess that sort of played a psychological effect.*

Some adolescents found after they had lost their sense of control over their self-tracking, they were able to continue to track; however, they had to modify the availability of their data. For some, this meant restricting the metrics that they chose to track. For example, like Hannah (16) described intentionally stopping her tracking of calories but continuing to track steps and other physical activity data. Here, Hannah stopped engaging in active tracking behaviours (e.g., calories) whilst retaining more passive tracking (e.g., steps). The adolescents were extremely reflective when they were aiming to understand the nuanced meaning that different metrics had for them, and used various methods to adapt their use of tracking tools. They were able to look beyond 'self-tracking' as a broad practice and instead incisively pointed to the particular types of tracking that were more problematic than others.

Moreover, control over the materiality of devices extended beyond simply ceasing to use them temporarily or permanently. Instead, adolescents experimented with structuring their data environments so that tracking captured less of their day-to-day attention. For instance, Ophelia (17) said that when she felt out of control of her tracking, her calorie count was omnipresent in her day-to-day activities: *"when I was at a point that was bad, my like my watch face was just how many calories I'd burned during the day so it was all I would see"*. Nonetheless, Ophelia (17) devised a strategy to regain some control over her tracking: "*I changed my watch*

face to something that like a photo so it would be a lot nicer". Here, we can clearly see how the affordances of self-tracking tools are sociomaterially constituted and that these arrangements allowed adolescents opportunities to set personal boundaries for their engagement with these technologies and to reimagine the affordances of self-tracking tools to reassert their control.

It is apparent that for some adolescents, a sense of losing control was not necessarily a permanent state of being. They were aware of approaches they could use to regain command over their bodies and their data through active choices; however, some remained concerned about those who might not be as adept at implementing such strategies. They warned of certain sociomaterial arrangements that could lead someone to be disproportionately susceptible to these negative psychological affordances: *"if you are prone to kind of wanting to control that aspect of your life, then I don't think you should because it will just lead to bad places"* (Sawyer, 16).

Some adolescents were self-aware of particular vulnerabilities they may have to losing control of their tracking, and their strategy for maintaining control was to intentionally avoid engaging in those practices, particularly those around calorie-tracking: *"I've kind of like stayed away from that whole area because I'm not gonna lie, it kind of scares me"* (Rebekah, 15). They had seen *"problematic"* (Rebekah, 15) outcomes for people who *"relied on it"* (Rebekah, 15) and did not want this for their own lives so they *"don't touch those"* (Quinn, 17) areas of tracking.

6.5 Conclusion

6.5.1 It's More Than Just a Numbers Game

In sum, self-tracking is a double-edged sword for adolescents. Whilst the quantitative data suggests that there is no overall negative relation between self-tracking and psychological wellbeing, when we more closely examine the qualitative data, the picture becomes more complex. Self-tracking systems are not set up for adolescents, and they have insightful reflections on this, particularly when they are facing challenges like the COVID-19 pandemic and existing psychological vulnerabilities.

The quantitative data were firmly in tension with the qualitative data in my research. Whilst the quantitative data suggested that there was no overall relationship between self-tracking experience and psychological wellbeing, there was indeed a significant, positive relationship between consistency of tracking and psychological wellbeing for adolescents. This sat at odds with the lived experience of many adolescents as expressed in the interviews, where they shared their view that too much tracking can be detrimental to their wellbeing. This friction provides a framing to contribute to long-standing critiques of the differing strengths of quantitative and qualitative data.

The survey data here provides an important lens through which to view the broad trends we might see that are related to self-tracking and adolescents' psychological wellbeing. These data offer particular value when considering the research question at hand as they reveal important patterns in adolescents' behaviour. For instance, by leveraging an established quantitative measure of psychological wellbeing, I have explored the association between higher self-tracking consistency and increased psychological wellbeing for adolescents. This provides an important lens on this topic. There are, however, several

factors that should be considered when appraising the quantitative data in this work. For example, it may be that adolescents presented themselves differently in the survey to in the interviews. Because they could not provide context to their answers, there may have been stronger social desirability bias in their responses to the survey. However, at the same time, adolescents were more 'anonymous' in the survey than they were in the online interviews, which might have made them more comfortable about sharing information honestly. Furthermore, it may be that their understanding of psychological wellbeing was not captured by the measurement scale (WEMWBS), leading to challenges concerning reconciling the different data sources. Therefore, whilst the quantitative data are very valuable in this work, this is not the only approach that we might consider using to rigorously analyse this issue.

The qualitative data, on the other hand, are suited to offer a deeper account of the lived experiences of individual adolescents. That is not to say that the data were collected without the effects of social desirability bias, selection bias, or other limitations; however, the benefit of the interviews was the ability to probe deeper into some of these issues and untangle some of the complexities that adolescents saw. Together, the quantitative and qualitative data in this chapter paint an intricate picture of the situation. This chapter really establishes the nuances of the relation between qualitative and quantitative data and emphasises why a mixed methods approach was appropriate for this research.

The qualitative data itself might help us start to consider why this tension between quantitative and qualitative data might exist. Adolescents described a threshold beyond which self-tracking might have harmful effects on their psychological wellbeing. This threshold was centred around a feeling of loss of control, often precipitated by a slippery slope of existing vulnerabilities or the tracking of food and calories. This threshold point

may be hard to capture in quantitative data without a clearer idea of its basis. Is this about the importance of data in their lives? Or is it about the frequency or intensity with which they check their self-tracked data? As self-tracking is often a continuous, physical practice, it is hard to capture frequency of use or similar constructs. This makes self-tracking distinct from other types of social media engagement where more objective measures of behaviour exist, such as screen time. Interrogating this concept further is an important task for future mixed methods research and qualitative insights have the potential to strengthen future work undertaken to quantify such a threshold point.

In my work, adolescents clearly articulated a difference between calorie-tracking and the tracking of other physical activity data. We have seen that self-tracking can promote adolescents' engagement in physical activity and we know that physical activity has a positive effect on psychological wellbeing. As such, in my quantitative data, this potential positive relationship could be counterbalancing any possible negative psychological effects from calorie-tracking. Future studies might consider asking more specifically about tracking calories to see if the relationship differs from what we have seen here when asking about general health and fitness tracking. Additionally, future research is needed to better understand how, when, and why tracking consistency is positively related to psychological wellbeing.

Whilst I can speculate on some of the reasons we might see these differences, this chapter cannot solve all of these tensions. Instead, it points to the value of continued mixed methods research pursuits in this area. Instead, in what follows, I consider the narrative arc of this chapter to point to important directions for future interventions and research.

6.5.2 A Winding Path

By narratively following some of the adolescents' journeys through self-tracking from initial excitement to the slippery slope of calorie-tracking and eventually to a loss (and potential regain) of control, I have been able to uncover the circuitous trajectories that self-tracking can take in relation to adolescents' wellbeing (see Figure 6.4). For some, this initial excitement and positivity around self-tracking remained; however, others were more concerned about the long-term effects of self-tracking: *"in the short term I would say, uh, nice, but in the long run I wouldn't like say it's a good thing"* (Ophelia, 17). During these journeys, long-term tracking could have harmful effects on psychological wellbeing and could lead to a feeling of disconnection from one's body. Adaline (16) explained one potential path for adolescents:

> *At the end of the day you get a big thing going, well done, you've reached your goal. That's going to like give you a good buzz and then you end up stuck with that and you end up with a situation where people can't cope without these apps and it gets more and more extreme until they're actually like a danger to themselves or that kind of stuff.*

By recapitulating the structure of this chapter (summarised in Figure 6.4), this narrative journey points to two key points that should be considered in relation to interventions that would support adolescents when they are navigating their own paths towards what they imagine to be positive engagement with self-tracking tools. The adolescents in this research showed that at the beginning of the tracking journey, seeing improvements can boost self-esteem and have positive effects on their psychological wellbeing. For some, this relationship continues to be positive. For others – particularly when calorie-racking or existing vulnerabilities are involved – this relationship can start to take a darker turn.

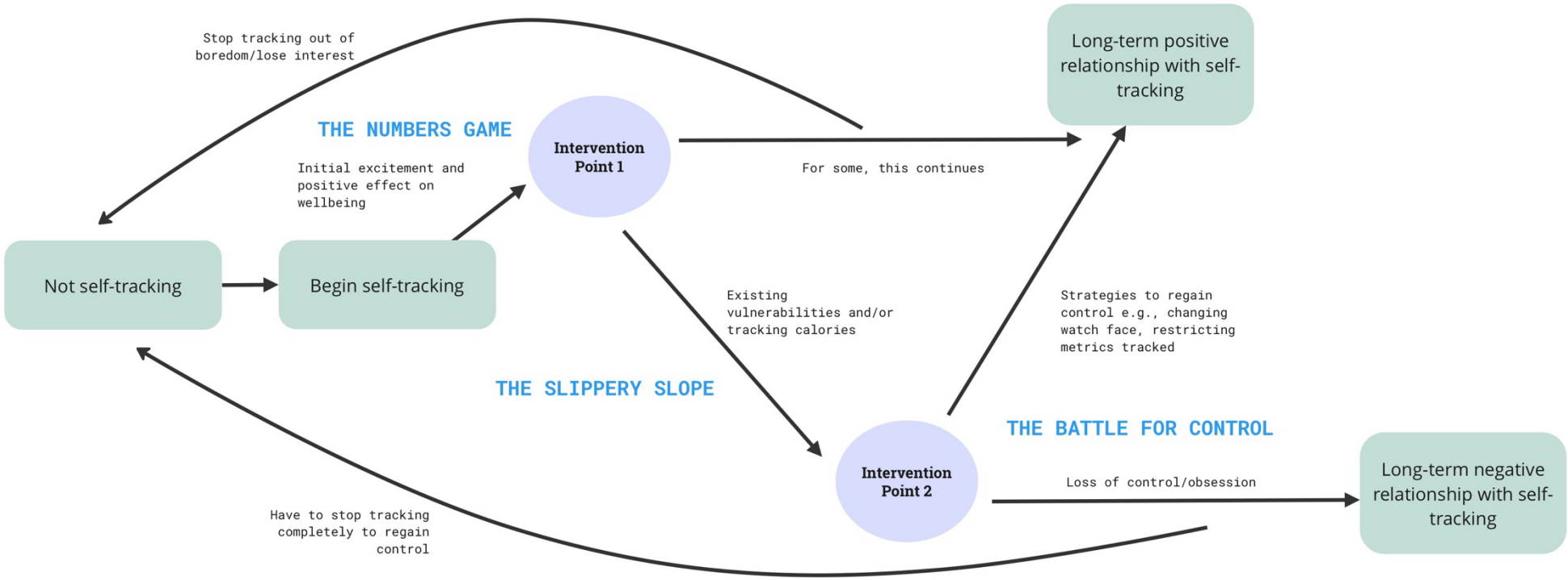


Figure 6.4. The changing relationship between adolescents' psychological wellbeing and self-tracking experiences.

It is worth remembering here that the affordances of and motivations for self-tracking are not static. Adolescents do not necessarily move linearly through the stages in the diagram shown in Figure 6.4 and instead their positions within this can change based on their personal circumstances, feelings, and their environment. We must therefore provide continued support for adolescents throughout their self-tracking journey and be careful not to make assumptions about their experience or position.

Surveying this journey, the first moment of note is the critical juncture between positive and negative experiences of tracking. How can we support adolescents who are engaging in calorie-tracking or tracking alongside existing vulnerabilities to promote and protect them from *"unhealthy habits"* (Ophelia, 17)? We have seen how clearly adolescents distinguish calorie-tracking from other forms of self-tracking. Are different resources required for this type of tracking to protect adolescents' wellbeing? How might we think about catching adolescents before they fall down this slippery slope so that we can set them up with the best possible chance of a long-term positive self-tracking experience?

The second important moment I identified is the point after which adolescents feel they have lost control of their self-tracking. Whilst some adolescents in my research were keenly aware of the strategies that they could put in place to regain their self-management of these practices, this was not universal. Here, it is important to consider how we might bolster adolescents' feelings of autonomy and self-efficacy so that they can manage their own choices and behaviours. We know that simply taking away access to devices does not work for adolescents; this would restrict their opportunities and do a disservice to their critical use of these tools (Livingstone & Helsper, 2010). Instead, we need to consider what is at stake here for adolescents and assess how we might reconfigure the emotional affordances

of self-tracking tools to promote control and balance and provide a system that is designed with and for adolescent self-trackers.

It is also important to consider the overlaps between what we learned in Chapter 5 about the association between self-tracking and adolescents' social relationships and what we have seen here about adolescents' psychological wellbeing. How can we leverage positive communities of care to support adolescents in their self-tracking to help them maintain or regain control of these practices?

6.5.3 The Language of Consumption

This thesis was not written with the intention of focusing on calorie- and food-tracking; however, this theme that was omnipresent in the interviews and survey responses. Whilst adolescents perceived step counts and distance to measure something uncontested and 'objective', calories capture something more complex and morally loaded. It is clear that this is integral to many adolescents' self-tracking experiences, and it is worth considering how adolescents' descriptions of these practices is so intricately entwined with food and consumption.

When I was analysing the data for this chapter, I was struck by the language and metaphors that adolescents used around self-tracking and the broader social media ecosystems embroiled in these practices. Although adolescents carefully controlled their calorie and food intake through self-tracking, they described being 'fed' by social media content; for some, nutrition went digital. Conversations around 'consuming' content and social media 'feeds' permeated the interviews. Edward (17) described satirical Instagram workout videos as *"the only fitness content I consume"*. When adolescents had overindulged in this online space,

they often engaged in digital 'detoxes' (a period of time away from social media and the consumption of 'unhealthy' content); however, interestingly, self-tracking tools were largely exempt from these detox practices.

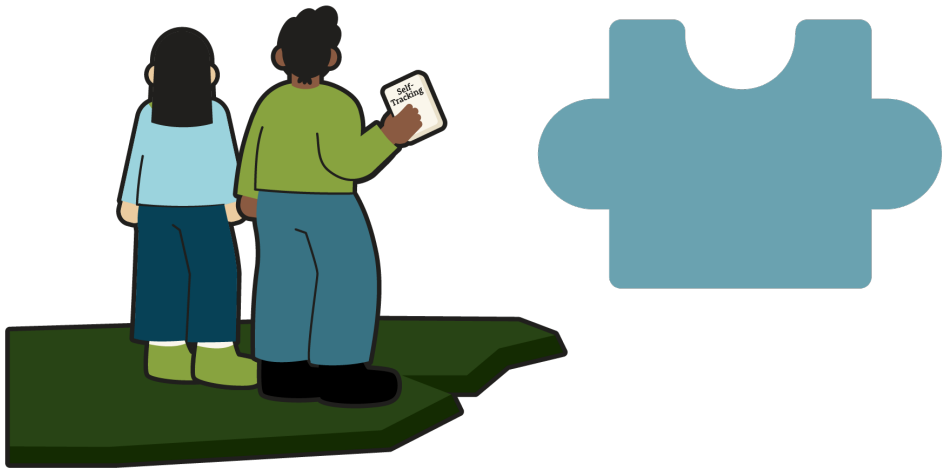
Adaline (16) felt that social media companies offered a generic content diet before the algorithms became more personally calibrated to unique tastes and dietary requirements. She described her experience with TikTok: *"when you download the app, the first things you see are 'Oh here's a video of someone with a kitten and some food and then a fitness video'. Those are kind of the sort of platter that they provide for you at the start"*. We know that adolescents describe changing their health behaviour in response to online content (Goodyear, Armour, et al., 2018a) and this was evident in adolescents' relationship with these content feeds. Overconsumption of this *"platter"* of health and fitness content could present challenges for adolescents: many responded to this indulgence by restricting their 'offline' food diets.

Even adolescents who were more cautious with their online 'diet' sometimes found this content creeping in: *"I don't follow any pages specifically for health and fitness, but on my feed it has quite a lot"* (Jasper, 14). It is here that the old adage 'you are what you eat' might hold some water. Adolescents described how the content consumed online could shape their sense of self, their very identity, and for some, this could contribute to harmful experiences, such as disordered eating behaviours and body image concerns. Seeing the ways in which these consumption metaphors streamed into adolescents' language about health and fitness content on social media more generally, it seemed that there was little escape. Food is a critical component of these messy relationships, and future research should focus more closely on adolescents' experiences of using calorie-tracking tools and the affordances of these technologies for their psychological wellbeing.

Owing to the participants' ages, the online nature of my research, and the potential sensitivity of the topic, I did not explicitly ask adolescents about issues concerning body image dissatisfaction or disordered eating. Nevertheless, as is evident in this chapter, these topics sat at the heart of some young people's experiences of self-tracking with respect to their psychological wellbeing. Future research would benefit from a deeper exploration of this topic to tease out *how* self-tracking tools might be entangled with these complex challenges.

This chapter has laid out some of the real challenges faced by adolescents as they work through their personal tracking experiences. The stories they shared left me heavy-hearted and galvanised my intention to make a difference. Adolescents are able to clearly explain the situation as they see it before them, but they still have hope that change can happen. *"It doesn't necessarily have to be that way",* Sawyer (16) said. They are optimistic about better self-tracking futures. This will be the centre of my focus in the following chapter: what do adolescents imagine different types of support for self-tracking could look like?

7 One Small Step, One Giant Leap: Co-Designing Digital Self-Tracking Resources with Adolescents[21]



"it's called SELF tracking not compare yourself to others tracking" (W4)

7.1 Introduction

We have seen in the preceding chapters that adolescents demonstrate an acute awareness of how affordances of self-tracking vary depending on individual circumstances and motivations. In particular, I have highlighted some of the different ways in which self-tracking might be entwined with adolescents' social relationships and psychological

[21] The following chapter is based on work previously published or accepted to be published in Freeman & Curtis (2022, 2023). The last author copies of these texts are available in Appendix I.

wellbeing. These complex relations were brought into sharp relief by the COVID-19 pandemic as adolescents contended with new challenges and changing ways of life.

In this chapter, I draw inspiration from the field of human–computer interaction (HCI) and focus on the data from the co-design workshops with adolescents to explore RQ4: **How might we co-design flexible resources to support adolescents' self-tracking practices?** This chapter will consider how young people's self-tracking practices could be scaffolded with resources beyond the material tracking tools themselves. As discussed in Section 3.6.3 in Chapter 3, to underline that adolescents were valued as equal partners in this research process (Lohmeyer, 2020), in this chapter, I refer to the adolescent 'participants' as 'collaborators' to emphasise the participatory and reciprocal relationship (rather than an extractive one) that I aimed to develop with adolescents through these workshops. Calling them 'collaborators' is a reminder that, in these co-design workshops, researchers and adolescents worked jointly on this design project. Similarly, when discussing the workshop activities, I use first-person plural pronouns like 'we' and 'us' more frequently in this chapter to capture the collaborative partnership between researchers and adolescents. It is worth recognising that there were certain parameters I had to set around the interactions during the workshop (such as establishing ground rules); however, insofar as was possible, the adolescents were encouraged to share their insights in whatever ways were most comfortable for them. Together we worked to create an environment of design partnership between adolescents and researchers in each of the workshops.

These co-workshops are described in detail in Section 3.6.3 in Chapter 3. As a reminder, there were two series of workshops with different activities:

i. Series A Workshops (90-minute Exploratory Content Co-Design Workshops)

1. **Introductory Activity**: familiarising adolescents with the online whiteboard (Miro) and letting them get to know one another.
2. **Persona Exploration:** working with personas (developed from the online survey and interviews) to uncover a variety of adolescent experiences with self-tracking tools (including reasons for tracking, frequency of engagement, opportunities, challenges).
3. **Feature Reflection:** identifying key features of self-tracking tools and their effects to understand pain points and opportunities for improvement (including features of interest, features of concern, and social and emotional affordances of self-tracking technologies).
4. **Designing an Adolescent-Centred 'User Guide'**: expanding on Activities 2 and 3 to identify key design considerations for a user guide (e.g., content it should include, how it should be formatted, and how it should be shared).

ii. Series B Workshops (60-minute Reflexive Prototype Design Workshops)

1. Reflecting on **current experience on social media**: the types of posts with which they liked to interact, and any existing Instagram guides they knew of and liked or disliked.
2. Thinking through **mock-up Instagram posts** with a particular focus on content, design, tone, and distribution considerations for such a resource.

Owing to the anonymous nature of many of the adolescents' contributions to the workshops, here, quotations are identified by workshop number only (i.e., "(W2)" denotes a collaborator from Workshop 2).

Given the future-oriented nature of this chapter, I have chosen to centre the findings in this final empirical chapter around four critical questions: (i) Who are we co-designing for?, (ii) What are we co-designing with?, (iii) What are we co-designing?, (iv) Why are we co-designing? These key questions drive towards a final Instagram guide, developed as a proof-of-concept resource that could support positive tracking experiences for adolescents.

I made the decision to consolidate all of the findings from both series of workshops and confine them within this final empirical chapter. As such, the survey and interview key themes and insights from the preceding empirical chapters are used to support the workshop findings here. Clarifying and deepening my understanding of these themes through the workshops (Pitt et al., 2021) was an important part of the research process. The first question in particular, "Who are we co-designing for?", draws in key findings from Chapters 4, 5, and 6 and describes how these experiences provided the background to the workshops and informed the conversation and design of these activities. Having this previous context allowed me to put collaborators at ease as I had some insight into the language and considerations of self-tracking that might be relevant. I designed the activities using as much of the language from the interviews and survey as possible to keep adolescent voices foregrounded across the research.

7.2 Who Are We Co-Designing For?

In this section, I explore how adolescents think about the different affordances of self-tracking tools. As part of the introductory activity in Series A workshops, adolescents were asked to share some questions they had about self-tracking and any words they associated with the practices. This helped to establish the tone of the workshops and drew out their existing understandings of and associations with self-tracking. Following this, we worked

through a persona exploration activity to uncover the variety of adolescents' imagined experiences with self-tracking tools. I suggested four initial personas based on the different experiences I had learned about in the survey and interviews: (i) "A keen teenage athlete who plays sports competitively at school", (ii) "A teenager who doesn't normally enjoy physical activity but decided to start tracking during lockdown", (iii) "A teenager who is interested in tracking food/calories", and (iv) "A teenager who is just curious (e.g. phone was doing it anyway)". Collaborators were encouraged to create their own personas as well to help them think through how the affordances of these tools might differ within and across contexts. This exercise was critical for allowing me to think about the nuanced experiences different adolescents have with self-tracking tools and resources in their lives.

7.2.1 What Can Go Wrong?

Adolescents were quick to highlight the more challenging affordances of self-tracking for adolescents' psychological wellbeing that might be addressed through an educational resource. In parallel with some of the interviews, there was a decidedly negative tone from the outset of many of the workshops. Most commonly, adolescents associated words such as *"gloomy"* (W4) and *"stressful"* (W5) with self-tracking. In parallel with the findings in Chapter 6, many of these negative associations centred around potential mental health implications of self-tracking. They felt that self-tracking could be *"addictive"* (W5), possibly resulting in adolescents becoming *"paranoid"* (W4). Some shared personal stories of these *"obsessive and damaging"* (W5) experiences and adolescents were particularly concerned that self-tracking *"can lead to eating disorders especially without medical advice"* (W5). This led to personal disclosures of disordered eating associated with self-tracking, accompanied by stories of the toll that unconstrained self-tracking could take on adolescents' social lives: *"When i was tracking my calories it really badly impacted my social life. I was so scared to go out to eat with friends […] just seeing a*

fork would worry me" (W2). It is notable that these accounts, told in a much more social setting of a workshop, closely aligned with what I had heard in the interviews and had read in the open text responses in the survey, which were considerably more private.

In line with the findings in Chapter 5 concerned with *"stressful"* (Hannah, 16) social comparisons, adolescents were wary that self-tracking technologies could encourage harmful comparison and competition between peers or within sports teams as young people worked to *"achieve their 'ideal body'"* (W2). They saw worrying links between such comparisons, lowered self-esteem, and adolescents' mental health: *"Comparison can be detrimental to an adolescent's mental health and can make them feel bad about themselves if they aren't doing as much as others"* (W2). Adolescents feared that these experiences could make people *"more self conscious"* (W1), *"feel guilty"* (W5), or *"feel disappointed in yourself"* (W5). Some young people shared their own experiences of the ways in which self-tracking *"magnifies my insecurities"* (W1) and *"often makes you feel like you could always be doing better and you're never good enough"* (W5). Like in the interviews, these conversations were persistent throughout the workshops, and adolescents were keen to stress the gravity of the situation they saw before them. They sought resources that could help them understand when comparisons might be appropriate and how to maintain healthy competition.

Much like the *"damaging"* (Rebekah, 15) comparisons discussed in Chapter 5, adolescents described how the affordances of self-tracking tools encouraged young self-trackers to *"end up comparing themself to social media"* (W5). The adolescent collaborators could clearly see how self-tracking data sat within a broader information ecosystem that could inform their understandings of their body and health. The adolescents were quick to acknowledge the important role that social media might play as a place to distribute any such educational

resources that aim to support adolescents who are self-tracking. Social media was described as a driver that could lead young people to self-track, even if they felt they did not want to:

> *It can be bad for their mental health if they are aiming to mirror a certain body type that they may have come across online. I think that this is really common for adolescents given the amount of social media exposure we get.* (W2)

7.2.2 What Works Well?

Conversely, in line with the findings presented in Chapter 4, self-tracking could also encourage adolescents to engage in increased physical activity and improve their body awareness: *"I feel so much more aware of my body and my weight"* (Female, 15). In the workshops, many adolescents also imagined positive affordances of self-tracking and saw how these practices could be *"Helpful"* (W5) for *"Keeping fit"* (W5), *"monitoring"* (W5), and staying *"Organized"* (W4). These positive experiences often centred on the promotion of physical health, in contrast to the more negative experiences, which focused on the potential mental health implications of self-tracking. It was these positive practices that adolescents were keen to see promoted in an educational guide.

The adolescent collaborators appreciated the cognitive affordances of self-tracking of increased self-awareness and identity, as *"self tracking helps realise our strengths and weaknesses"* (W5) and *"could help someone understand their body and how it response to exercise or food etc"* (W1). As I discussed in Chapters 4 and 6, for some, self-tracking was a way to feel "*a sense of control"* (W4) over their bodies. This awareness was critical, especially during such a transitional phase in their lives – *"the best thing about it is being able to know what my body is about"* (W2) – and during periods of social distancing during the COVID-19 pandemic, as it *"helps seek progress in a difficult and monotonous time"* (W5), which is in line with the findings in Chapter 4.

These benefits of self-knowledge applied to physical activity and fitness, but also to adolescents' health more generally. In these workshops, this manifested in imaginings of improved agency in healthcare situations, more self-aware goal-setting and progression-tracking, and increased understandings of the relationship between their actions and their health. This aligns with Miriam's (17) story of how she used self-tracking to help her manage her PCOS (see Section 6.3.1 in Chapter 6). In the workshops, adolescents who imagined using self-tracking to monitor health conditions saw how it could enhance communication between doctors and patients, allowing continuous monitoring outside of the clinical setting. Indeed, they imagined that *"Some can self track instead of unneeded doctors appointments"* (W5). This was seen by many to be a positive self-tracking experience as it allowed young people greater agency in their own healthcare. The adolescents were keen to see guidance on how to support others when they were exploring different affordances of self-tracking data across different contexts they might encounter.

As evidenced in the interview and survey data, adolescents were also quick to imagine how self-tracking could be beneficial in monitoring progress and fostering motivation. They felt a great sense of achievement and self-efficacy when they saw they were *"achieving their goals"* (W1). Particularly for adolescents engaging in competitive sports, they imagined that self-tracking might offer physical health benefits, as it *"helps them keep fit and can improve easily"* (W4). For them, the ease with which self-tracking tools were integrated into their lives was important: *"It almost becomes part of a routine"* (W2).

Positive social and emotional affordances of these practices were closely linked to this increased self-awareness. Adolescents drew out the relational experiences opened up by *"sharing data"* (W5) with others. They imagined that an adolescent who engages in competitive

sports *"Probably shares data with coach and teammates"* (W4). Similarly, adolescents saw how competition with friends and family could create communities and motivation to continue to track: it *"could be a positive thing to get moving with your friends outside"* (W4) and could foster a community of like-minded others *"who also care for exercise or tracking"* (W1). The findings in Chapter 5 highlighted the nature of self-tracking as a "co-present activity" (Rooksby et al., 2014, p. 1170). These workshops uncovered how self-tracking connected adolescents and encouraged co-located activities: *"my friends and I go on walks together to achieve daily goals"* (W5). Adolescents were keen to see such discussions about community included in an educational guide.

Nevertheless, adolescents were clear that there was a difference between *"healthy and friendly competition"* (W1) and unhealthy competition. They felt that healthy competition experiences were possible with the right community and support. Many spoke of how tracking allows them to *"Feel proud at my progress"* (W5) and they felt that *"if i am more healthy i tend to have more fun"* (W2). These insights were thought to be central to any resource designed to support adolescents' positive explorations of self-tracking.

7.2.3 What Are We Assuming?

In the workshop setting, many adolescents questioned what the self-tracking experience meant (or should mean) to them. They expressed ambivalence or scepticism about the value of self-tracking, recognising that it *"Can be both useful and harmful"* (W4) and sharing concerns that it can be *"glorified by the media"* (W4). Adolescents' open questions about self-tracking centred around two key themes: (i) should we question the assumption that self-tracking is 'good': *"is it actually beneficial?"* (W5), and (ii) how can we determine whether self-tracking is

appropriate: *"why are we still using self tracking devices if we know that they are harmful. Especially in this generation"* (W4).

This section corroborates the findings from the previous chapters and clearly demonstrates that adolescents recognised that they walk a fine line between positive and negative experiences with self-tracking: *"the pedometer gives me a feeling of pride or self doubt"* (W1). This was particularly the case for social experiences and comparisons, and they acknowledged that *"where there is motivation and inspiration there is also the problem of people feeling worried that they are not keeping up with "normal" people"* (W1). Seeing the close connection between the workshop data and that of the survey and interviews was encouraging. Taken together, the data showed that there was no single approach to self-tracking that all young people followed. Instead, adolescents were eager to question assumptions regarding whether and, if so, how they should be engaging with these tools. The workshop collaborators highlighted the ways in which self-tracking may be both beneficial and detrimental and how readily this can shift across people, contexts and time. They stressed that any resources for self-tracking must address this complexity. This is the focus of the following section.

7.3 What Are We Co-Designing With?

Adolescents imagined a variety of use contexts for self-tracking and could clearly see how the affordances of these tools might vary for different individuals and for different motivations for tracking. By combining our persona exploration exercise (Activity 2) with one that thought through different features and effects of self-tracking technologies (Activity 3), I was able to collaborate with adolescents to piece together this complex puzzle.

7.3.1 Rigidity of Design Does Not Make Sense for Adolescents

The collaborators in these workshops did not subscribe to a rigid approach to self-tracking, and they felt that the designs of many self-tracking tools were not flexible enough for their purposes. They were frustrated by *"Not having features that work for me"* (W1) and instead wanted to *"have more options for different situations"* (W1). They wanted alternative presentations of data, such as graphs, because often, the quantitative data presented was not aligned with their individual needs: *"the numbers and words can be confusing to understand"* (W4). They called for additional guidance to support their exploration of and reflection on data to better understand how to make these processes useful in their unique contexts.

The prescriptive approach of common self-tracking tools (e.g., wearables, apps) was also challenging for adolescents, as *"they often tell you how you should feel about yourself i.e. whether you have exercised enough"* (W5). They felt that the feedback from these tools was commonly filled with *"critizism"* (W4) and could even be *"Manipulateive"* (W4). Workshop collaborators were wary of *"apps like myfitnesspal telling you you've eaten too much or haven't burnt enough calories"* (W5) without taking their individual context into account. The marketing language and lack of transparency around data use that surrounded self-tracking tools often led adolescents to feel as if they were being dehumanised: it *"Makes me feel like a lab rat as I do not know how the data is stored"* (W4). They felt that they were being told what to do rather than supported in their unique experiences by self-tracking tools. Therefore, they were determined that any resources should be supportive rather than prescriptive.

7.3.2 You'll Understand When You're Older

Some adolescents stressed that the lack of age-appropriate support made self-tracking challenging. They suggested that stricter age limits and better education around self-tracking

were critical to their own discovery paths with these tools: *"maybe some of these apps like MyFitnesspal should have an age limit or like something that would mean that people understand what they are doing if they go onto the app"* (W4). This spoke to a concern and an awareness that adolescents' experiences differed from those of adults, and that therefore without additional scaffolding, the use of off-the-shelf self-tracking technologies could present challenges for young people. Importantly, adolescents emphasised age as an important consideration in the tracking experience and questioned whether appropriate support was available for young people who were interested in tracking: *"Is it right that children are getting self tracking devices from such a young age? (Eg fitbits)"* (W4).

For example, adolescents repeatedly raised the prevalence of social comparisons at this formative stage of life. In the absence of adequate age-appropriate support and resources that would enable them to think critically about personal data and understand relevant comparisons, adolescents saw how positive aspects of self-tracking could become negative for young people: *"It can be positive if the comparison can motivate someone to continue with their own self tracking journey but it also runs the risk of trying to replicate someone else's data which would be inaccurate"* (W2). This emphasised the need for new, targeted educational opportunities for young people around self-tracking that spoke to the most pressing concerns of adolescents. Next, I turn my attention to potential targeted educational opportunities.

7.4 What Are We Co-Designing?

Drawing on the insights noted above, I worked with the workshop collaborators to design an adolescent-specific educational experience to support their self-tracking practices (Activity 4). I found that although in the first workshop activities were designed more specifically around self-tracking tools and their features, a theme that came through strongly

was the acute need to reimagine the support and resources needed for self-tracking tools for adolescents. Specifically, they highlighted that having or not having such support and resources often made the difference between having 'good' and 'bad' self-tracking experiences respectively. Those with proper support and education and healthy boundaries found self-tracking more fulfilling and useful. This is where the idea of a self-tracking user guide came in as adolescents recognised that some *"may ned someone else to assist in tracking"* (W5), particularly if they were tracking to help them handle a physical or mental health condition.

As adolescents discussed different features and effects of self-tracking tools, they focused on broad themes and practices rather than highlighting aspects that would be unique to one type of tool, person, or experience. This was a promising insight suggesting that, if designed thoughtfully, a single educational resource might be leveraged for adolescents rather than needing to create individual, personalised guides. So together with the adolescents, I grappled with the challenge of designing resources and experiences that were broad enough to encompass different perspectives but also personal enough to not be superficial, providing instead beneficial insights for this population. Here, I focus on two key considerations: the content and distribution of such a resource.

7.4.1 What Do Adolescents Want to Learn?

7.4.1.1 Why Self-Tracking? Acknowledging Individual Experiences

Adolescents were cognisant of differing self-tracking experiences and acknowledged the importance of discussing these tensions in a user guide. For some, self-tracking was an important part of their routine and self-care; others felt the use of self-tracking tools was, or could be, detrimental to their psychological wellbeing. Critically, adolescent collaborators

addressed the importance of different reasons for self-tracking in understanding different experiences: *"Ask yourself WHY you want to track yourself - if not positive then don't do it!"* (W4).

For example, this question of *"WHY"* (W4) was prominent when discussing calorie-tracking. Collaborators highlighted the benefits of calorie-tracking for some, such as for adolescent athletes, whilst others were staunchly against the practice: *"if someone asked me if they should start tracking calories my answer would be a big resounding NO"* (W2). The reasons given for resisting the promotion of calorie-tracking echo the findings in Chapter 6: *"I know calories has had a big impact on like my age group in particular with umm eating disorders and stuff"* (Hannah, 16). Despite differences of opinion, adolescents were clear they wanted a space for nuanced, *"not judgmental"* (W2), conversations about challenges such as body image dissatisfaction and disordered eating. As one adolescent stated, *"Tracking is for everyone and also not for everyone. It's helpful for people who can bear listening or knowing about their health status"* (W3). Adolescents wanted the user guide to be unafraid to address these tensions.

The collaborators agreed that it is not only adolescents who need to be better educated on self-tracking. They argued that a user guide should expand this non-judgmental space to include parents and schools as well. The adolescents articulated that young people, educators, and parents need to be aware of individual reasons for engaging in self-tracking and the nuanced experiences, both positive and negative, that emerge for those reasons.

7.4.1.2 How Might I Self-Track? Caution Around Obsessive Behaviours

Adolescents repeatedly used cautionary language when describing self-tracking, including phrases such as *"be careful"* (W5). The collaborators acknowledged the benefits of self-tracking, but many were concerned about it being a slippery slope: *"it is so easy to become obsessed*

with" (W5). This word *"obsessed"* has permeated each of my findings chapters and was clearly a prevalent concern for adolescents that they wanted a guide to address. Somlse e wanted to warn others about the dangers of tracking beyond a certain threshold of use: *"dont get too drawn in"* (W1) and *"keep an eye out for obsessive tracking"* (W5). Adolescents argued that often the dangers of obsession were related to the reasons for using self-tracking tools: *"i think that self tracking can be good for competition with peers, as in fitness goals and prepping for competitive sport, however it can definitely effect you negatively if you become obsessed with your aims, especially if they're unhealthy obsessions/habits"* (W5). Collaborators also referenced the role of following social media influencers in prompting obsessive tracking behaviours.

Short of defining when too much is too much, adolescents agreed that each individual should determine their own balance: *"Obviosuly when pushed to extremes its negative, but as logn as you can use your self-awareness to decide if you're going too far then you should be fine"* (W4). Adolescents were eager for a guide to encourage them to think critically about their own experiences and make personal judgements about the balance that worked best for them.

7.4.1.3 How Might I Share the Tracking Experience? Self-Tracking as Community-Building

In support of the findings around positive communities of care in Chapter 5, some adolescents stressed that a sense of community can be important for countering obsessive habits: *"track with friends and family who will support you when you are doing well, but also inform you when you are doing too much and becoming unhealthy, physically or mentally"* (W1). The collaborators felt that the user guide should provide resources and guidance for identifying and addressing obsessive habits, such as how to foster supportive communities.

Adolescents agreed that this community-building was important for healthy self-tracking practices and suggested that the user guide could promote this community orientation. For some, this community involved competition. Others simply imagined a space for conversation and support: *"The community shouldn't just be competitive.it should be a community where you can relate easily with other people in the community"* (W3).

Adolescents discussed the role that moderators and the absence of leader boards could play in facilitating healthy self-tracking communities both online and offline. The concept of moderator presence in these communities – whether third parties, older students, or peers – was contentious, with no consensus reached. Adolescents broadly agreed that leader boards were more detrimental than helpful and were wary of the promotion of these in a user guide: *"Teens liek to comapre, please don't piush that agenda because it can harm mental health"* (W2).

Adolescents often disagreed on the role of competition in healthy self-tracking practices, resonating with the diverse comparison experiences explored in Chapter 5. Nonetheless, most adolescents felt that the role of competition should be determined by one's reasons for tracking. Some held a firm stance that everyday self-tracking should only be an individual activity without competition or comparison: *"That is why it's called SELF tracking not compare yourself to others tracking"* (W4). On the other hand, workshop collaborators acknowledged that for adolescents tracking for clearly defined reasons, such as athletes, competition can play an important role in their practices: *"i think that self tracking can be good for competition with peers, as in fitness goals and prepping for competitive sport"* (W5). They were keen for a user guide to offer guidance on both individual and healthy community self-tracking practices.

7.4.1.4 What Does it Mean? Importance of Context in Self-Tracked Data

When thinking more specifically about self-tracked data, for many adolescents, numbers were not everything, and they emphasised how important it is to understand the holistic context of self-tracked data. Workshop collaborators believed that quantitative data from self-tracking should not be the only measure of wellbeing: *"Numbers don' define you and don't take the full picture into account"* (W4). The fact that leader-board style data often lacked this important context was one reason that some adolescents gave for moving away from this type of data.

Adolescents felt that the user guide should switch the framing from monitoring numbers alone to more dynamic goal-setting which considers other measures of health and wellbeing. They wanted the guide to remind young people *"that it's not all about the numbers humans aren't numbers so don't base you of that or define yourself of that"* (W4). Adolescents wanted others to be aware that quantitative data are often limited and inaccurate. When describing self-tracked data, one collaborator said they *"Should always been taken with a pinch of salt, nothing is 100% accurate!"* (W4). Adolescents were keen to be part of these discussions to encourage others to think critically about what their data mean.

Adolescents wanted a guide to remind them to be careful about how much they constructed their identities through quantified data: *"my weight and fitness level is the least interesting thing about me"* (W5). Instead, one adolescent described reimagining self-tracking goal-setting by shifting their language use: *"if you don't hit a goal, it does not mean that you're a disappointment or you should give up, it means you have room to grow and become better"* (W5). Just as collaborators intentionally used cautionary language around self-tracking, they wanted the user guide to

purposefully use *"gentle"* (W5) language when considering the wider contexts of adolescents' engagement with self-tracking tools.

7.4.1.5 Who's There? Balancing Privacy and the Need for Tailored Support

Adolescents also wanted the user guide to address the role of third-party actors. Whilst in the interviews and survey, there was little discussion of the commercial interests of technology companies (see Section 8.4. in Chapter 8), it was clear that a great deal about these topics felt unknown for adolescents. They had questions, not answers. The collaborators were unsure of how their personal data was kept private, both by technology companies and within their social groups, and they wanted the user guide to answer questions such as *"how is data stored"* (W4), *"is our data used for studies, do our devises save our data"* (W5), and *"how secure is the data"* (W4). More pressingly, the collaborators believed that their privacy should be respected and they sought guidance on how to keep their tracking private from peers and family if desired: *"i would love people to respect my privacy"* (W2).

Whilst the adolescents were wary of others accessing their private data, they wanted to be directed to information about ways they could engage with third-party support. For example, many emphasised that the user guide must include resources for mental health support. Collaborators drew on their knowledge of other digital tools to make these suggestions: *"meetwo also has this section where you could reach out to third parties for support which is also nice"* (W2).

These resources were not only imagined to be useful for adolescents but collaborators also emphasised the importance of improving parents' understanding of the complex relationship between self-tracking and mental health, such as anxiety and issues relating to body image.

As a collaborator in Workshop 1 warned, *"be careful who your buying them for because if it is a particularly anxious child then its best just to give them direct advice about excersise"*.

7.4.2 How Do Adolescents Want to Learn?

In these workshops, I then focused the conversation on a consideration of the tone and presentation of such a user guide. Adolescents wanted the user guide to be simple, with straightforward sentences or bullet points, and to use *"peaceful"* (W4) language. They wanted to leverage language to positively reframe the goals of self-tracking away from a focus on inadequacy: *"it should be presented as a way to improve how already amazing you are"* (W5). Further, they argued that it was important that the user guide should employ cautionary language around self-tracking practices. As one collaborator suggested, *"it should viewed as a inovative product with a few cautions like anything from caffeine to perscription drugs"* (W1).

Adolescents disagreed on how data should be visually presented and wanted the user guide to inform them about different ways of tracking their data. Mirroring their concerns with the accuracy of quantitative data in Section 7.4.1.4, a preference for the presentation of data and information often hinged on adolescents' ideas around possible reasons for self-tracking. Some felt that graphical representations of quantitative data were most useful, whereas others wanted an explanation of qualitative tracking and contextual options to be included in the user guide, such as using emojis. As discussed in Chapter 5, adolescents sought a greater focus on the context of self-tracked data and some expressed that the guide should emphasise that quantitative data are insufficient for capturing this context: *"Numbers should be accompanied by a comment reflecting how you're feeling in the moment eg 10km run but miserable or 5km run and happy"* (W4).

7.4.3 Where Do Adolescents Want to Learn?

The collaborators were divided over the distribution methods of the user guide. Some had strong opinions on the best ways to share this information, while others believed the communication strategy was less important than ensuring the information could be made widely available. As one adolescent said, *"There are different ways of passing the information. It could be with a video or poster or whatever. It doesn't matter, it's just about the information being passed"* (W1).

Some adolescents believed that schools were the ideal places in which to present this information, though in small, interactive discussions rather than in large assemblies. Whether these discussions should be compulsory or not was controversial. One collaborator described possible unintended effects of schools discussing this topic: *"since we normally associate schools with our normal school subjects then learning about tracking may imply that it is also an obligatory subject and students may feel pressured to partake in it"* (W2). Discussing this topic in schools was seen as potentially encouraging self-tracking, which some adolescents were wary of: *"honestly i would say schools and parents shouldn't encourage tracking at all"* (W5) as this detracted from their autonomy to choose their own self-tracking practices (as discussed in Chapter 5). Conversely, some believed that whilst partaking in self-tracking practices should be optional, education around self-tracking tools should be obligatory: *"i think it needs to be talking about full stop I know in my experience I have never had a conversation with someone about tracking"* (W4). Adolescents flagged that they felt as though they were missing this support and were eager to open up dialogues about their self-tracking practices.

Most adolescents agreed that they would be more comfortable with external experts discussing self-tracking rather than their teachers: *"I think it should be an expert that comes into schools to talk about it. I wouldn't feel comfortable with a teacher commenting on how I ate/exercised"* (W4).

This parallels the findings in Chapter 5, where only 15.97% of adolescents had ever shared self-tracked data with sports coaches or teachers. Further, many felt that teachers were not well-educated on the subject. They therefore proposed that having an informed expert would provide students with a safe environment in which to discuss the complex topics in the user guide.

Many felt that social media was another helpful place for sharing the user guide, as it was accessible and comfortable for adolescents to use. Adolescents also appreciated how social media allowed anonymity in accessing this information. Social media was where many had come across self-tracking for the first time, and therefore they felt it would likely have a large reach: *"I think also on social media, because that's probably where most people pick up ideas about self tracking"* (W5).

7.5 Why Are We Co-Designing?

Following adolescents' recommendations to consider social media as an important space for distributing additional, supportive resources around self-tracking, I deliberated with my Research Assistant (Amanda Curtis) to consider how to action these recommendations and to design a series of Instagram posts that would be appropriate for young people. In what follows, I describe the process of collaborating with adolescents to co-create a guide that aligned with adolescents' recommendations in the Series A workshops.

Reflecting on the fact that many adolescents questioned the assumption that self-tracking is good or healthy and were wary of young people their age being encouraged to track, I thought carefully about the tone of a potential guide. I decided to avoid the idea of creating a practical 'how to' guide for self-tracking and instead reframed the language and focused

more on a technology-neutral and practice-focused 'how might you' guide. In doing so, I acknowledge that there are open questions around the value of self-tracking for individuals and aimed to equip young people with the skills and knowledge to question any broad-stroke assumptions. It was important that the guide would give adolescents a sense of autonomy and control over their self-tracking, that is, a freedom to explore different affordances within their own unique sociomaterial contexts. I understood that it was imperative that this guide captured different use contexts and experiences whilst providing tools to support young people as a group in making their own assessments about healthy practices and balances. It was important that this was done without dictating a 'right' or 'wrong' way to engage in self-tracking.

To achieve these aims, in the Series B workshops, I iterated on a series of mock-up Instagram posts that Amanda Curtis and I had designed using the graphic design tool, Canva (see Section 3.6.3.2 in Chapter 3 for further details). Figure 7.1 depicts examples of the designs used in the Series B workshops and collaborators' responses. Below, I describe the co-design process with adolescents that enabled us to produce a short series of proof-of-concept Instagram posts.

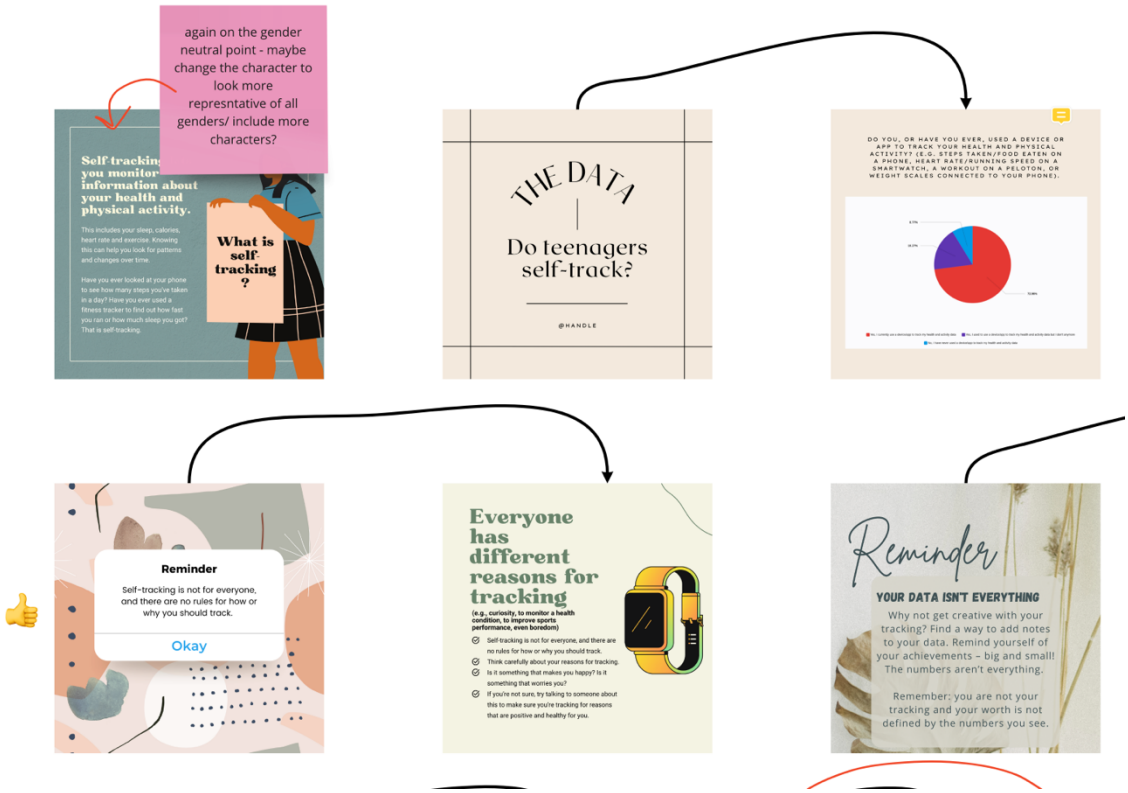


Figure 7.1. An example (screenshot) of the mock-up designs used in the Series B workshops from Workshop 7. Adolescents emphasised the types of posts that they found most useful.

7.5.1 Who Are You Speaking To?

In the Series B workshops, adolescents acknowledged the complexity of social media as a means of distributing information to diverse audiences whilst simultaneously making the content feel personally relevant: *"I do like the idea of reaching a more personal level"* (W7) but *"if you don't know the person, it's kind of hard to make a connection with your audience"* (W6). Drawing on the different adolescent personas we had discussed in the Series A workshops, I worked together with the adolescents to think through how we might address this challenge and ensure that the guide would reach a broad audience without feeling out of place in their feeds: *"its important to acknowledge that different people have different needs and its important to make the posts accessible to everyone?"* (W7).

One of the collaborators reframed this challenge and encouraged us to use the affordances of Instagram to target posts at specific groups to avoid a overly generalised approach: *"I think having certain… certain groups of of posts for different types of people will be quite good […] you don't have to create one post that aims at everyone but tries to talk to them individually. But actually talking to them all individually"* (W6). To facilitate this, adolescents felt that it might be useful to signpost in the image captions that not every post would be applicable to everyone:

> *I don't think you should say this post is not for you. I think you should say this post might have some useful information in it if you want to read it, you can, but there are other posts that might suit you better.* (W6)

Adolescents clearly saw how design decisions could also reveal the intended audience of posts and were critical of how this might impact young people's willingness to access this content. For example, in Workshop 7, one adolescent said, *"You often see these types of like formats and um colours and images on sort of health blogs and stuff like that […] it's a very targeted audience"*. They were keen, not only that the visuals of the posts were leveraged to signal the content but also strategically designed to ensure that certain audiences were not excluded from this resource: *"being 'non specific' in your posts could be good. eg. for a post on tracking fitness maybe avoid having images of a fitbit or something because it can alienate some people who may not have access to certain resources"* (W7). Further, they wanted to see themselves reflected in the posts, and mentioned that *"if you include little avatars/characters on posts then i think making them diverse and representative of a range of demographics would be good"* (W7). The collaborators stressed that design could be used strategically to achieve this delicate balance between addressing young people as a group and acknowledging individual differences in self-tracking experiences.

7.5.2 Who is Speaking to Me?

Adolescents were focused on the tone of content and sought a relatable authorial voice. They were eager to see something that was not *"patronizing"* (W7), which emphasised their autonomy: *"It's not really telling you what to do, it's just telling you what you can do"* (W6). Our co-created 'how might you' content was considered to be a good model of this as it marked a positive step away from a more paternalistic 'how to' guide. Collaborators liked posts that did not underestimate their intelligence and instead highlighted the choices adolescents have concerning *why* and *how* they might self-track: *"I don't really like being told what to do, but umm I do… I do have common sense […] If I'm trying to do something new. I do read on it. I do my research and stuff like that"* (W7).

When it came to testimonials and *"more personal stories"* (W7), adolescents were eager to hear from *"someone famous or like someone around… close to my like age, definitely someone who's not an adult though, definitely"* (W6). This aligns closely with findings from my previous work that adolescents often trust health information on social media from celebrities or those that seem relatable, such as people the same age or gender (Freeman et al., 2022). Adolescents wanted a relatable voice that did not feel like a teacher or a parent: *"if it's an adult, you've just feel like it's your like like it's your parents telling me to do the same thing over and over again and you start to zone out more and more"* (W6). However, testimonials from people close to their age were controversial as this *"can be a very slippery slope with regards to leading adolescents to compare themselves with someone theyve never met"* (W7).

When adolescents engaged with health content online, they were wary of commercial voices and instead were keen to hear from other authoritative, expert voices, mirroring what I have seen previously (Freeman et al., 2020). The collaborators felt that the use of testimonials was

"most effective when they're personal. too often testimonials are about selling some kind of product and quite generic" (W7). For example,

> *A qualified umm dietitian or doctor or someone like that that umm you can sort of rely on […] there's like a lot of lies and a lot of fake advertisement that goes through. Umm so having something that's backed up medically umm does help a bit.* (W7)

Adolescents felt this would help them to determine the trustworthiness of the information in the guide as they navigated the often overwhelming quantity of other health information available on social media.

7.5.3 Say What? Finding the Right Message

Adolescents felt that it was important for the guide to present *"non biased information"* (W7) as *"swaying towards one way or another could impact people's choice in deciding to self track or not"* (W7). High-quality content was central to adolescents' decisions around whether to engage with a guide like this: *"I think the content and the quality of the content is one of the most important things, and that would make me follow it"* (W6).

Despite the prevalence of imagined negative self-tracking experiences in the Series A workshops, when it came to co-designing an educational guide in the Series B workshops, adolescents felt that overly negative content could be read as patronising: *"When you wanna start doing something for your own benefit, you don't wanna be bombarded with like all the things or the negative things that could happen to you"* (W7).They felt that this removed adolescents' ability to weigh up risks and benefits in their own mind: *"I feel like people aren't stupid, they do know their limits, and so it's not everyone that will end up having eating disorders or obsessions and stuff like that"* (W7). Such content could be viewed as *"demoralizing"* (W7) or *"an attack to what I'm doing"* (W7) and instead adolescents wanted the guide to offer a balanced perspective addressing

both the pros and cons of self-tracking. They felt a 'how might you' guide was well-positioned to achieve this balance.

For any content that related to potentially sensitive topics such as mental health, weight, or calories, adolescents were keen to see trigger warnings or other signifiers so that vulnerable young people might choose to move past the post without engaging. The collaborators were particularly fond of including a slide in every post to remind young people of where they can go for help (see Figure 7.2) and wanted this to be carefully designed to ensure maximum engagement from adolescents when needed, as they felt this would be *"helpful for people that do need it to have that constant reminder and then people who don't will gloss over it because they don't need it"* (W7).



Figure 7.2. An example of adolescent collaborators' responses to sample content providing guidance on mental health resources around self-tracking from our Miro board for Workshop 7.

7.5.4 What Does it Look Like?

Reflecting on the sample posts that were created for the Series B workshops, adolescents felt that these were consistent with the other content they engaged with on social media and would not feel out of place on their feeds: *"i think all of these are very 'Instagrammy' and the type of content that i look at on ig [Instagram]"* (W7). A few shared that they were feeling uninspired by the content they were seeing on their existing feeds and were excited by the prospect of a visually appealing guide to break up the monotony: *"that would be enough to like draw me in, cause a lot of the Instagram pages nowadays aren't like very interesting. So umm I think that would be enough to draw me in to watch and read what it's got to say"* (W6).

Eye-catching visual designs and images were key for adolescents, because, as one of them said, *"when im looking through insatgram i dont usually read, i tend to gravitate towards the pictures and vedios"* (W7). The adolescents were drawn to colour schemes that were bold and unexpected but appeared gender-neutral. When designing the colour scheme for these posts, they felt that together we had *"completely nailed it […] like in this one it's uhh like it's like I didn't think of it being like these two colours, but they fit so perfectly together"* (W6).

Drawing these considerations together, adolescents felt that a 'how might you' Instagram guide had the power to be impactful for young people and that the information could stay with them as they went about their daily routines. They saw real value in a skilfully designed resource and felt confident that if a sensitive and age-appropriate approach was used, its reach could be wide.

7.6 Conclusion

7.6.1 A Balancing Act

The broad picture that the workshop collaborators painted in these workshops revealed the delicate lines adolescents walk in the threshold space between childhood and adulthood (boyd, 2014), and this was reflected in their desires for self-tracking resources. Adolescents in this research were deftly navigating various balances between healthy (but not obsessive), educational (but not patronising), and flexible (but not structureless) self-tracking practices and wanted the autonomy to decide on the most appropriate balance for them. This aligns closely with the importance adolescents attach to their sense of control over their self-tracking practices, as seen across the previous three chapters. In this research, they described themselves as a group that often feel underrepresented, and they desired resources dedicated to helping them work through these complexities of balance, health, and wellness.

From conversations concerning health, it is clear that the balance between healthy and obsessive habits is also intrinsically linked with nuances between physical and mental health. Healthy self-tracking habits could include achieving realistic fitness goals, whereas unhealthy behaviours could be identified by an undue focus on physical appearance or strict calorie-counting. Adolescents identified different ways that self-tracking could influence mental health, from building a supportive social network, to becoming happier through being healthier, to becoming fixated on numbers and lowering their self-esteem. These nuances could be difficult to articulate, but adolescents were well aware that there is no prescriptive approach to 'good' self-tracking or 'healthy' behaviours. This is why a 'how might you' guide is so valuable, as it offers designers, researchers, and other stakeholders an opportunity to consider individual differences and move beyond a rigid 'how to' approach to self-tracking.

The workshop collaborators were very clear when we discussed the notion of the 'how might you' guide that they wanted a *balance* between positives and negatives. In initial conversations in the Series A workshops, much of the discourse was skewed towards a negative view of self-tracking, with critical reflections on the role of self-tracking habits in different people's lives. Adolescents are all too aware of these potential harms, but at the moment, they lack educational resources to help them explore what 'healthy' and 'unhealthy' can look like for them and how the complexities of this balance may translate into self-tracking behaviours. Adolescents do not want an educational resource telling them what is right and wrong; instead, they advocate a balanced presentation of information and experiences which preserves their autonomy and personal judgement.

7.6.2 Putting the Self in Self-Tracking

The concept of the 'self' sat at the core of these workshops, and although there is an important social component of many adolescents' self-tracking behaviours (see Chapter 5), they still recognise that choices around self-tracking are often highly personal. They therefore wanted resources which equally valued individual and social experiences. This can be seen in their approaches to resource content, testimonials, and empowering other voices. The workshop collaborators initially expressed their thoughts on self-tracking through imagined personas. When they placed themselves in the proverbial shoes of someone else, together we were able to construct complex dialogues around what self-tracking is and how it manifests for different people. The findings from these workshops highlight the need for self-tracking researchers to simultaneously recognise the social and reprioritise the self in future work.

The rigidity of today's self-tracking tools (Spiel et al., 2018) makes such personalised practices difficult, if not impossible, for young people to achieve. For this reason, adolescents imagine real potential in a guide which opens up avenues to be creative and playful. Despite the narrow conceptions of health often encouraged by self-tracking tools (Depper & Howe, 2016), adolescents do not want to be fed ideas of normalised health, such as quantified metrics which lack context and personalisation (e.g., achieving 10,000 steps a day). Adolescents imagine that an ideal guide would prioritise these notions of personalisation and individual experiences through a balance of offering professional resources and testimonials from peers. These more personal touches create a sense of intimate conversation, in opposition to firm 'how to' guides that are intended to serve everyone.

Online spaces (e.g., Instagram) are valuable as distribution sites when designing such resources. It is more familiar and provides a space for young people to engage in (often difficult) conversations. Adolescents are resistant to the idea of being lectured and seek relatable, empathetic voices. They want self-tracking to find them in their space (e.g., in schools or on Instagram). They want to see people who look and sound like them working through these challenges. By creating resources in an environment that adolescents are comfortable with and feel creative in, we can help cultivate adolescents' sense of feeling heard and valued in conversations around self-tracking. Moreover, these spaces allow adolescents to be active distributors of – and contributors to – resources themselves. They can post, share, comment, and participate in potentially more democratic ways that spaces like official government health websites might discourage. As noted previously, these spaces can give adolescents a voice.

These workshops teach us that in order to design resources around sociotechnical practices for populations for whom these tools are not explicitly designed, it is critical to think about how to balance a variety of perspectives, positives and negatives, and to promote an awareness of unique, personal experiences. Schools, organisations, and other spaces can also leverage these points of balance and celebrate individual differences in resources designed to support adolescents' engagement with self-tracking tools.

7.6.3 Resources, Not Retooling

For populations who might be overlooked in design processes, part of the purpose of an educational resource can be providing information that can be used to critically assess assumptions and arguments. For my research, this included questions such as: Does self-tracking work for everyone? Do I have to self-track to be healthy? Should adolescents self-track? Adolescents express a strong desire for spaces that foster *conversations* – not instructions – and that acknowledge the complexities of health and balance and allow space for personal experiences rather than generalisations. Adolescents highlight that these educational tools can make the difference between having positive or negative experiences with self-tracking. If well designed, the power of these resources is potentially even greater than redesigning the tools themselves, with a much lower financial cost for stakeholders.

Even if one lacks the power to redesign tools, there can be great impact in offering age-appropriate, effective resources to better support practices for these populations. In many cases, the technologies we have are acceptable, but what is lacking is the means to educate people on how to make these tools work *for them*. I learned from these workshop collaborators that there are difficult balances that need to be struck when deciding whether and, if so, how to incorporate self-tracking into one's regular routines. This balance is deeply

personal and requires an individual, tailored approach. How might we imagine a single tool that can be repurposed easily to be appropriate across a range of use cases and experiences? This is what makes resources valuable, as they are inexpensive and efficient to produce, allowing for more diversity in the types of information, experiences, and use cases that are shared. Resources are an important step forward, but they cannot and should not be designed without first listening to and hearing the people we are seeking to design for.

To turn these findings into action, I worked with a graphic designer (Weezy Dai) to create a series of proof-of-concept Instagram posts that bring together the insights from all seven of the workshops. Many of the design recommendations made by adolescents could in fact be incorporated into a user 'how might you' guide (see Appendix B for the full set of posts). This was exciting as it could mean a more immediate output and potential that could come from my work. Alongside my Research Assistant (Amanda Curtis), I curated a list of the key insights offered by our collaborators and shared this with the designer to ensure that the adolescent voice was reflected in every stage of the design process.

The result of this was a series of posts that captured adolescents' needs in terms of the content, design, and distribution of an education resource on social media (see Figure 7.3 for an example of these posts). Working through the challenges alongside adolescents, I saw just how reflective young people are about their social media habits and needs. This led us to engaging, dynamic, and fruitful discussions and a useful output that encapsulates the core insights from these workshops.



Figure 7.3. A sample Instagram post from our co-designed 'how might you' self-tracking guide for adolescents. These designs were grounded in the insights from adolescents from across the Series A and B workshops. Graphic design work by Weezy Dai.

I hope that this chapter provides insights into how to design resources for young people – namely by addressing the delicate balances they face in their lives, prioritising the personal, and providing educational resources that serve as 'how might you' guides. I also hope that these findings also help others co-design with for other 'voiceless' populations that are often underrepresented or are not considered enough in technological decisions. If my chapter succeeds in doing this, I hope it encourages others to consider the power of educational resources for different populations as we work together towards promoting holistic, individualised, and positive technology experiences.

8 On the Right Track: Conclusion



"my weight and fitness level is the least interesting thing about me" (W5)

8.1 A Personal Reflection

This research was conceived at a time that now feels like a distant past. Plans were made before masks, before school closures, and before I had even a basic understanding of COVID virus variants (see Figure 8.1 for an image that captures this changing context). Reconciling my imagined DPhil project with the final experience has been one of the greatest challenges of my academic life to date. However, the project that emerged has changed me irrevocably – both as an academic and as a person.



Figure 8.1. An image that represents my experience of this DPhil project. Source: https://www.reuters.com/world/uk/uk-needs-tighter-covid-rules-avert-new-catastrophe-epidemiologist-warns-2020-12-29/.

The privilege of learning from young people has also made this the most fulfilling research experience I have ever had. These participants, spread across the UK, demonstrated such resilience, shrewd insight, and generosity in their reflections; I have been left both awed and inspired by their inquisitive and optimistic spirit. I cannot advocate strongly enough the value of running research projects with adolescents. I feel humbled to have been trusted by these young people with their experiences, but it is a great responsibility to bear. It is here that I sometimes stumbled as I wrote these chapters: how could I ensure that I did justice to their stories?

As my final stage of data collection, at the end of the Series B workshops, I left five minutes for adolescents to anonymously reflect on the workshops and provide feedback. I wanted to better understand what adolescents thought of the design of these activities as a springboard to future work that would include adolescents in the entire research process. I received some helpful, constructive feedback here, such as the timeboxing activities being a

success and *Miro* being difficult to use at first for some. I then asked participants to list words to describe how they felt during the workshops and it was these results that brought possibly the most satisfaction during this research: *"heard and listened to"* (W7); *"influencial"* (W7); *"included"* (W6); and *"encouraged"* (W6). I am so thrilled that these adolescents described feelings of inclusion and influence about the future of this project, and this response has inspired me to keep pursuing this path of research.

It is important to emphasise that my research findings do not imply that adolescents are incapable of sophisticated self-tracking practices, nor that the risks of adolescents' self-tracking data work are insurmountable. On the contrary, adolescents' unique skills and expertise in navigating new technologies and the social and institutional contexts in which they live mean that their imagined affordances of these tools look different to those imagined by adults. It is important to consider these imagined affordances to help us recognise the opportunities that may exist for adolescents' positive use and enjoyment of these tools.

As someone with my own experience of self-tracking, I have learned from the creative ways in which adolescents engaged with these tools. This research has been an important reminder to not make assumptions that other people will do things the same way that I might. This is why I adopt an attitude of cautious optimism towards self-tracking technologies and their role in young people's social worlds. If researchers can ask the right (contextually grounded and relevant) questions, gather thoughtful and rigorous data, think critically about what these data might be telling us, and communicate effectively to those who might sit within and outside of academia, then we will be well-placed to harness some of the exciting opportunities these technologies allow for.

Over the past seven chapters, I have painted a picture of the varied affordances of adolescents' self-tracking practices and what these might mean for their social and psychological wellbeing. In this final chapter, I hope to bring together the key learnings from this project. These teach us important lessons about adolescents' use of self-tracking tools and more broadly about how different user groups might engage creatively with tools that are not designed with their particular needs and circumstances in mind.

8.2 Summary of Findings

In surveying the existing literature, I was struck by the need for recognition of the unique experiences of adolescents in our understanding of self-tracking. Despite the evidence that adolescents are critically engaging in these practices (Potapov et al., 2019) – although not always without encountering challenges (Freeman & Neff, 2021; M. S. Jørgensen et al., 2016; Potapov et al., 2021) – there is a surprising dearth of work highlighting the adolescent perspective. The need for such work was made all the more urgent following the onset of the COVID-19 pandemic. This research found its place in a time when self-tracking practices grew in households at unprecedented speed. For example, throughout 2020, Strava users grew by around two million each month and global activity rates on the platform saw record high increases, with weekly uploads of workout activities exceeding 30 million in May 2022 (Strava, 2020b). With adolescents suddenly taken out of their well-trodden routines of school, work, and social activities, it was important to understand what their self-tracking practices looked like. I wanted to explore what worked well for them and what challenges they faced in their self-tracking, particularly with respect to their social and psychological wellbeing.

Benefitting from a mixed methods approach, this thesis provides a unique contribution to our understanding of adolescents' self-tracking practices. Chapter 4 offered a window into the scale of UK adolescents' self-tracking during the early stages of the COVID-19 pandemic. Following a description of the sample and an exploration of the prevalence of these practices, I explored how adolescents believed that the COVID-19 pandemic had impacted their thoughts about self-tracking. This chapter established how much COVID-19 has changed the landscape of adolescents' self-tracking, introduced the central role of control in adolescents' self-tracking practices, and highlighted the importance of not underestimating the power of self-tracking practices to influence many facets of adolescents' lives.

In Chapter 5, I examined some of the complex entanglements between self-tracking and adolescents' social lives. Here, I demonstrated that adolescents' self-tracking practices are often highly social because they are built within carefully curated sharing cultures. The sharing of self-tracked data is important for establishing adolescents' identities and sense of belonging within communities. Nonetheless, control of these data-sharing practices and the care-ful and care-filled fashioning of self-tracking communities are central to positive social experiences. Without this control, there is a risk that these sharing practices could disempower adolescents and negatively impact their psychological wellbeing.

Owing to this, I then turned my attention to more closely to psychological wellbeing in Chapter 6. We narratively followed adolescents' self-tracking journeys from their initial excitement and the positive impacts of self-tracking through to the potential slippery slope leading towards a loss of control. I uncovered two key points for resource intervention: the top of the slippery slope (i.e., before adolescents engage in calorie-tracking) and boosting adolescents' armour in the battle for control to enable them to regain their autonomy. This

chapter demonstrated the potential dangers of adolescents viewing the world solely through a data lens and ended with a provocation for researchers to consider how we could use the findings from Chapters 5 and 6 when we are thinking about building resources and positive communities of care to support adolescents in their self-tracking. This led us to think about positive resource design.

Finally, Chapter 7 laid the groundwork for the future. Here, I described the findings from a co-design process that was undertaken with adolescents to produce a resource for young people who are interested in self-tracking. Laying out recommendations for components such as design, content, language, and distribution, this chapter provided a clear roadmap for how we might foster positive and fulfilling self-tracking experiences for young people in the future. This chapter concluded by detailing how the co-design process produced a tangible output: a series of Instagram posts designed to offer adolescents a 'how might you' guide to empower them in their autonomous decision-making around their self-tracking practices (see Figure 8.2 for a collection of these posts).



Figure 8.2. A collection of the Instagram posts co-designed with adolescents to produce a self-tracking 'how might you' guide. Graphic design work by Weezy Dai.

Below, I present a summary of the key findings of this research project, explore some of the limitations of this project, and point to important areas for future research. I will pay particular attention to the common threads running across the empirical chapters and what these might teach us about the importance of inclusive design.

8.3 Discussion

In what follows, I draw out the key implications of this work and what this means for theory, other researchers, and product design. The key ideas here are titled as follows: Celebrating Individual Differences; Prioritising Control; Leveraging Opportunities for Social Support and Community-Building; Inclusive Resource Design. The success of future work in this area hinges on communication and collaboration between all stakeholders

invested in this issue. In Figure 8.3, I offer a summary of these recommendations, each of which are discussed in turn across the following pages.

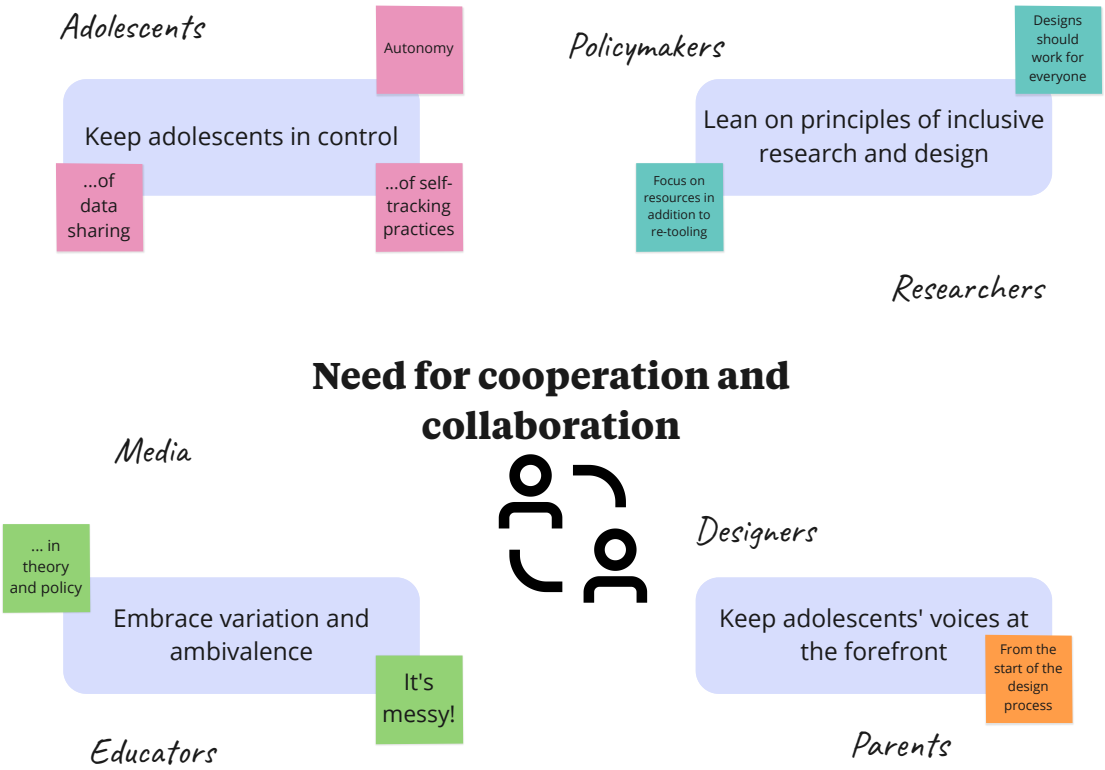


Figure 8.3. A summary of the key recommendations from this study.

8.3.1 Celebrating Individual Differences

Perhaps the clearest finding from this thesis is that no two adolescents think about self-tracking in the same way. Whilst there are clear overlaps in themes, it is important that we do not paint with a broad brush and consider 'the adolescent experience' of self-tracking before adolescents' experience*s* of self-tracking. Previous work has examined various sociodemographic factors – and their entanglements – that influence individuals' relationships with self-tracking technologies (Findeis et al., 2021) and it is important that theories about adolescents' self-tracking practices keep these differences at their centre. As

K. Davis et al. argue, if we make decisions around adolescents' technology engagement that "are shaped by descriptions of the average young person (who doesn't exist) or the most extreme youth, they will inevitably fail to address the needs of those youth whose everyday technology experiences are particular enough to not be well represented by broad generalizations" (2020, p. 3).

This thesis underlined findings from my previous work that one size does not fit all when it comes to adolescents self-tracking (Freeman & Neff, 2021). The effects of the COVID-19 pandemic are not uniform. For some adolescents, the pandemic has opened up new opportunities for self-tracking and amplified the importance of data in their lives. For others, lifestyle restrictions closed down opportunities for physical activity and they soon stopped self-tracking because they were bored with it. Similarly with social and psychological wellbeing, the same features and materials could reveal antithetical experiences for adolescents: some found leader boards to be motivating and a boost to their self-esteem, whilst others found that they fuelled disordered eating, depression, and anxiety.

Finally, these differences came into sharp relief during the co-design process. The challenge of designing *with* everyone *for* everyone was no easy task. One collaborator in Workshop 1 expressed this eloquently:

> *I think that umm if you try and cater to everyone and everyone's different situations that can become virtually impossible […] I think once you open up to a wider uh, to people with a wider sit- situation area, there's no limit to how much you can do, and then there's always going to be that thing that people want more of […] there's only so much you can do.*

Whilst it may be that there is ultimately *"only so much"* (W1) we can do, we can always strive to do more. A key first step is recognising that there are differences in tracking experiences

and dispel any assumptions that all adolescents track in the same way. As I discovered when trying to analyse the data from this study, adolescents' experiences are messy, contradictory, and non-linear. Whilst there were points of convergence, no two stories were the same, and that made this project particularly exciting. I want to encourage researchers not just to *acknowledge* these differences but also to *celebrate* them. By leaning into this diversity, we can uncover pockets of creative practices, new ways of thinking, and a deeper understanding of the breadth of self-tracking experiences at adolescents' fingertips. Whilst painting a holistic picture may be more challenging because of these differences, it will certainly be more vibrant and compelling in the long run.

8.3.2 Prioritising Control

The concept of adolescent control permeates each of the empirical chapters: control over health, control over the sharing of data and crafting of communities, control over their own tracking practices, and control over their engagement with self-tracking resources. When it comes to self-tracking, control and choice are linked. When the designs of self-tracking technologies allow users to make autonomous choices (around every aspect of their practice – data collection, sharing, reflection), adolescents are more able to feel in control of their self-tracking practices. The absence of this choice can lead adolescents to feel disempowered and subject to the undue control of others.

Despite individual differences in self-tracking experiences, one common thread in adolescents' reflections is that there exists a threshold after which one might lose a sense of control over one's tracking practices. It is beyond this point that some imagined that adolescents might start to experience negative social and psychological effects from self-tracking. Whilst this point might look and feel different depending on unique

circumstances, many adolescents described discomfort when they felt they had lost control with respect to any aspect of their self-tracking experience.

My use of a sociomaterial lens (discussed in depth in Section 2.2.1) is an important contribution of this work. By considering "the role played by material artefacts in social relations and the construction and negotiation of meaning" (Lupton, 2017, p. 12), I have been able to emphasise the complexities of adolescents' sense-making of their self-tracked data in relation to their social and psychological lives. In particular, I used this lens to consider concepts of care, choice, and control in relation to self-tracking (Kristensen et al., 2021; Mol, 2008; Mol et al., 2010; Will et al., 2020). For example, drawing on this theoretical lens in combination with affordance theory allowed me to interrogate how the social affordances of material self-tracking tools (e.g., Fitbit Communities) might refuse adolescents' sense of control over their data collection, sharing, and reflection. Adopting these lenses in combination has been essential in considering how personal self-tracking practices and material tools might be situated within adolescents' broader social structures.

Understanding the importance of control is central to the development of any resources, policies, and research centred on adolescents' self-tracking. Future research should consider exploring various sociomaterial factors that might precipitate a feeling of a loss of control. Control offers a way into this problem, and using this flexible construct upon which to hang educational resources, research plans, or policy might ensure that we are keeping adolescents' autonomy front of mind in this work.

8.3.3 Leveraging Opportunities for Social Support and Community-Building

Whilst choices around self-tracking are personal, self-tracking is a communicative practice (Lomborg & Frandsen, 2016) and is often deeply social (Neff & Nafus, 2016). In this work, I have shown the complex ways in which self-tracking practices are entangled in adolescents' social lives. Whilst ill-considered social engagements can lead to reduced psychological wellbeing for adolescents, self-tracking communities, when arranged thoughtfully, can bolster a sense of belonging, self-esteem, and psychological wellbeing. Self-tracking tools do not exist in a vacuum. Any development of theory relating to adolescents' self-tracking should recognise the ever-evolving social ecosystem where these tools sit. The data in this study clearly demonstrate the intimate ties between self-tracking tools and other forms of social media (such as Instagram), providing parallels to other research in this space (e.g., Kent, 2020). Networked communities should not be overlooked in considerations of the social implications of self-tracking.

There is a real opportunity here to consider how to leverage social affordances of self-tracking as a means of supporting adolescents' positive engagement with self-tracking tools. Adolescents are positive about the idea of building communities around self-tracking and see real value in connecting with others and learning from their experiences. Additional research is needed to better understand the flexible structures that best promote adolescents' curation of communities, but this openness to establishing a sense of social support should not be ignored, especially in the design of self-tracking resources for adolescents.

8.3.4 Inclusive Resource Design

Principles of inclusive design (Clarkson & Coleman, 2015; Coleman, 1994) are helpful here as we consider adolescents' self-tracking futures. Inclusive design refers to a process of ensuring that any service or product is designed for as many people as possible, regardless of any user diversity, such as age, disability, gender, or language. Inclusive design pays particular attention to groups who are often excluded from design processes and, importantly, stresses that these groups should be able to engage with the product or service "without the need for special adaptation or specialised design" (British Standards Institution, 2005). As Microsoft Design (2016, p. 12) explains, "Designing inclusively doesn't mean you're making one thing for all people. You're designing a diversity of ways for everyone to participate in an experience with a sense of belonging." The importance of a "sense of belonging" is even more pivotal with self-tracking tools which track deeply personal information. Adolescents must feel in control and as if they belong in their own bodily data spaces when navigating life with and through self-tracking tools.

The concept of inclusive design is not new and is often associated with ensuring that products are usable and accessible for individuals with disabilities (Clarkson & Coleman, 2015). Nevertheless, the principles of inclusive design resonate with the findings of this project. The Inclusive Design Research Centre (n.d.) emphasises three key dimensions of inclusive design methodologies, which reflect the three themes I referenced above (Celebrating Individual Differences; Prioritising Control; Leveraging Opportunities for Social Support and Community-Building):

1. Recognise, respect, and design with human uniqueness and variability.
2. Use inclusive, open, and transparent processes, and co-design with people who represent a diversity of perspectives.

3. Realise that you are designing in a complex adaptive system, where changes in a design will influence the larger systems that utilise it.

It is here that we see the real power of strategic resource design for adolescents' self-tracking. There is an important balance to strike between demonstrating that adolescents are incredibly self-reflective and critical of self-tracking tools, whilst at the same time ensuring that this does not lead to apathy or an assumption that adolescents do not need additional support. I believe that underlining the need for support to enhance critical thinking around self-tracking tools helps us maintain adolescents' autonomy and control in decision-making that concerns their own behaviours (i.e., not simply denying them access to tools or providing heavily structured ways of engaging with them) and also leaves space for individual differences in engagement and motivations. This is essential for ensuring that all adolescents who choose to self-track can feel a sense of belonging in their deeply personal tracking experiences.

As Pina et al. (2017) found, if a tool is easy to use, children do not need a 'child version' of a self-tracking artefact but instead can successfully engage with an adult tool. In their study, children reminded the researchers that they do this frequently in everyday life, for example with mobile phones. Pina et al. emphasise the importance of inclusive design:

> Although children and adults have different levels of knowledge and information processing abilities, the same tracking artifact can still support both of them. For example, a design might support varying granularity according to who is tracking: a parent might track at a fine granularity, while the same artifact might also support a child tracking at a more appropriate granularity. (2017, p. 2306)

I want to be clear here that this does not suggest that adolescent tracking might be less sophisticated than that of adults. Indeed, some adolescents might want to track at a finer

granularity than their parents. This is where resourcing can provide support to help young people make informed choices about how they want to track. The point is that the granularity should be *appropriate* to the users' needs and circumstances and the design should be flexible enough to open up a range of different affordances to suit these needs.

The value of inclusive *resource* design is that it underlines adolescents' support needs in relation to critical thinking whilst maintaining their autonomy and control in decision-making that concerns their own behaviours. This strikes a careful balance between demonstrating that adolescents are incredibly self-reflective collaborators in this work whilst at the same time ensuring that adolescents are recognised as critical users of technology. By focusing on resources, we are leaving space for individual differences, designing a range of ways for self-tracking participation, and looking towards an inclusive experience for all.

8.3.5 Revisiting the Objectives of This Work

In Section 1.2, I outlined the five key objectives of this project. I will now take each of these in turn and briefly note how they were accomplished in my work.

The first objective was to lay out what UK adolescents' self-tracking practices looked like during the early stages of the COVID-19 pandemic. This was the focus of Chapter 4 but permeated each of the empirical chapters.

My second objective was to combine an affordances framework with a sociomaterial understanding of self-tracking. These lenses were essential to each of the empirical chapters and framing the findings of this work. I underline the value of leveraging these theoretical

perspectives in considering how we can prioritise adolescents' control in their self-tracking practices in Section 8.3.2.

Building on this, I was determined to use the above framework to map out the variability in adolescents' self-tracking practices and how they intersect with adolescents' social relationships and psychological wellbeing. I did so throughout the four empirical chapters where I have foregrounded how the sociomaterialities of self-tracking open up a range of affordances for adolescents, such as monitoring lifestyle changes in response to the COVID-19 pandemic, social data sharing, or contributing to concerns around body image and disordered eating behaviours.

Fourth, I aimed to outline design recommendations for resources (e.g., educational guides) concerning self-tracking specifically for adolescents. This sits at the heart of Chapter 7 describing the insights from the co-design workshops with adolescents, as well as in my firm recommendation to prioritise inclusive resource design for adolescents' self-tracking.

The final objective was to demonstrate to adolescents and other stakeholders the value of young people's contribution to self-tracking research. To do this, I endeavoured to highlight adolescents' voices in the study design and throughout the writing of this thesis. I also undertook important knowledge-translation work, such as creating an infographic for adolescents. This is discussed further in Section 8.6.

8.4 Silence: What Was Left Unsaid?

I have dedicated much of my energy in this thesis to ensuring that I do justice to adolescent voices. I have long hoped that one of the key outcomes of this thesis is demonstrating the

value of including adolescents in research, that is, listening to and learning from their lived experiences. Doing research *with* and not just *about* adolescents has been a central ambition of mine during this research process. Nevertheless, when analysing the vast and rich data for this project, I have been struck by some of the things that adolescents did *not* talk about, particularly in the online interviews and workshops. It is these moments that will sit at the centre of this short section. This section is not large enough to warrant its own findings chapter; instead, I use this as a segue into the limitations and future directions of this research. My aim here is not to speculate on why these topics were not discussed deeply; these are questions that this research cannot answer. Instead, I hope this contemplative moment might provide inspiration for future research or theory development. Now, if you will indulge me, let us take a brief journey through the unspoken.

Throughout the interviews and workshops, there was notably limited discussion around the consequences of large technology companies collecting adolescents' personal data and the potential monetisation implications of these companies selling their data. Adolescents were much more concerned about those in their immediate circles (e.g., friends and family) having access to these data. The privacy and selling of data were topics included briefly in interviews for 16- to 18-year-olds where there was scope for a longer interview duration but these questions were excluded in the short interviews for 13- to 15-year-olds. I made this decision as these issues were not a central concern of this thesis (as explained in Section 2.3.7 in Chapter 2). Nevertheless, it is worth mentioning the emerging findings here to provoke further research.

As Mau emphasises, "Self-tracking is therefore rarely an exclusively private affair, and involves users – often without their knowledge or consent – in the generation of a vast and

constantly growing mass of data" (2019, pp. 101–102). Nonetheless, discussions around the selling of data (i.e., "surveillance capitalism" (Zuboff, 2019, p. 8)), so often associated with self-tracking technologies, did not emerge spontaneously in the interviews. This aligns with previous work which suggests that commercial privacy is less likely to feed into young people's conceptions of privacy than more intimate relationships, such as protecting themselves from the surveillance of parents (K. Davis & James, 2013). When asked more explicitly about third-party surveillance of data, many adolescents said that this is *"not really anything that plays on my mind"* (Quinn, 17), either because they assume that everything is being shared, or that nothing is being shared. For example, although Edward (17) commented *"I just assume that all of my data is probably being like sold already, so I don't give it much thought"*, Ophelia (17) did not pay surveillance much mind but for a very different reason: *"I don't usually worry about it too much because I presume it's private"*.

Other adolescents expressed uncertainty about what value their tracked data could offer a company: *"I am not sure what they would do with how far I ran or anything like that"* (Albert, 16). Similarly, Luke (16) described his future concerns about the surveillance of self-tracked data; however, these worries were centred on a *"dystopian future"*. When he instead thought about the present, he reflected: *"I think at the stage it is now, it's kind of just you know, just for personal. Even if the information is being used, it can't really be used like maliciously 'cause it's just like you know, they can't really do much with like how many steps you've done in a day"* (Luke, 16). These findings align with Stoilova et al.'s (2020) work on children's digital privacy in which children aged 11–16 also found it hard to imagine what value their data could offer to companies.

The stakes for these data, however, may be even higher when it comes to personal health details. Firstly, these data are often particularly sensitive as they can reveal intimate information on an individual's health status. Furthermore, as individuals share geolocation data for activities such as running or cycling, they may inadvertently give away details such as their home address (e.g., if a daily morning run starts and ends at home), or about running routes that they habitually follow in their local area. There is a safety risk here as there is potential for other agents (e.g., other users, third parties) to access, misinterpret, or even misappropriate such information to the detriment of the user (Munson et al., 2013). The possible privacy implications of sharing these data may not be immediately apparent to adolescents but could pose significant safety and security risks. For example, these data might permit or restrict access to future resources (e.g., health insurance), employment, or specific social groups (Lupton, 2016b).

Specifically, scholars have raised alarms about a loss of digital privacy protection during the COVID-19 pandemic as a proliferation of tracking apps captured personal data including location, temperature, heart rate, oxygen, and blood pressure (Sharma & Bashir, 2020). Few adolescents discussed these privacy risks. One exception was Natalie (16), who, in line with strategies described by other adolescents (K. Davis & James, 2013), described her creativity in ensuring her privacy on social media by falsifying personal information: *"I know I shouldn't but sometimes I tell little tales when I'm signing into stuff, just so like it can… it can be as secure as possible"* (Natalie, 16). This approach is much harder to do with self-tracked data as it is challenging to falsify or *"tell little tales"* (Natalie, 16) about location and movement data. Future work might consider exploring the strategies used by adolescents to maintain control of their data flows and the affordances of self-tracking tools for adolescents' privacy.

Overall, adolescents' sphere of concern remained close to home – family, friends, peers – and there was less focus on the roles of third-party actors such as large technology companies. Whilst these topics were not prevalent in the interviews, they did emerge as questions in the co-design workshops that adolescents wanted answers to: *"how is data stored?"* (W4) and *"how secure is the data?"* (W4). As discussed in Chapter 7, adolescents had questions but not answers about these topics. These topics arose when they were in a position to ask questions, rather than being asked questions themselves in an interview or survey. Future work would benefit from unpacking adolescents' assumptions about their self-tracked data – what it means and where it goes – to better understand how data education might support adolescents in their self-tracking experiences.

It is important to recognise that just because these discussions were not present in this research does not mean that they do not matter to adolescents. Rather, there are more and different questions that we might work through alongside adolescents. This section serves as a prompt for us to take a step back and consider what might be at the top of adolescents' minds when they are thinking about self-tracking and to uncover areas for future research to focus on. This reflexive exercise has allowed me to consider what I might do differently if I were to run this project again. For example, given the centrality of control in the research findings, a deeper exploration of the ways in which adolescents imagine their ability to make choices about their self-tracking and their imaginings of the control of third parties would be fruitful. This leads me to a more in-depth discussion about the limitations of and future directions for this work.

8.5 Limitations and Future Research

Reflecting on limitations is important for producing high-quality research (see Tracy's (2010) *sincerity* criterion in Section 3.7.2 in Chapter 3). It can also help me to identify avenues more clearly for rich future research. A more in-depth exploration of some of the methodological limitations of this project is available in Chapter 3 (Amplifying Adolescent Voices: Methodology and Methods). As with any study, hard decisions were made around which methods and questions to prioritise and how and when to draw different types of data into dialogue with one another, and this shaped the kinds of knowledge that I produced through this work.

Firstly, whilst age is an important consideration in inclusive design (Coleman et al., 2003), there are many other factors that contribute to the diversity of adolescent experiences. For example, previous work has also considered the design implications of self-tracking technologies for neurodiverse populations, such as children with attention deficit hyperactivity disorder (ADHD) (Ankrah et al., 2022; Cibrian et al., 2020; Doan et al., 2020). Adolescents with additional mobility, cognitive, and environmental considerations might have different needs, challenges, and creative uses for self-tracking technologies (Elman, 2018; McPherson et al., 2019). I did not capture data on whether any participants might identify as having a disability that could impact their self-tracking practices. On self-tracking platforms whose content assembly turns on physical activity data, thought should be given to how concepts of 'disability' are understood in this space. The forms of data that many self-tracking devices and apps are designed to track and share (e.g., number of steps taken, distance walked, speed) all too often reinforce a problematic binary understanding of 'able-bodiedness' and 'disability' (Elman, 2018). Thus, only those for whom these data might be valuable and meaningful metrics of physical wellbeing are

granted access to socialise and construct their identities within this community. The ethical implications of this exclusion are profound as certain individuals are denied access to the opportunity to use these tools for personal identity construction simply on the basis of their position within this 'able-bodiedness'/'disability' binary. Further work is needed to understand the true breadth of adolescent experiences with self-tracking tools. This is an important area for future research to explore more deeply in order to better understand how we might design resources that are fit for purpose for *all* adolescents.

Secondly, owing to practical and resource constraints, it was beyond the scope of this research to work with adolescents to produce a self-tracking resource. Whilst the proof-of-concept Instagram posts (see Appendix B) are a helpful first step in this process, there is important work still to be done. Researchers should work alongside adolescents towards actually developing resources that capture the diverse needs, motivations, and questions of young people in their self-tracking practices across all forms of individual difference. Increasing attention has been paid to ways in which academics might involve adolescents in the entire research process – all the way from the initial project design to the sharing of key findings (Cooper et al., 2022). Continuing to find new ways to empower adolescents in this way is important for research in this space to evolve. Now, more than ever, it is critical to include young voices in this work.

Throughout this thesis I have emphasised the COVID-19 context in which this study was conducted. The data collection took place in very specific and unusual circumstances of the early stages of the COVID-19 pandemic, and this might limit the transferability of my findings to other times. Furthermore, it is still too early to gauge the long-lasting impact of the pandemic on self-tracking, and this will affect some of the conclusions that can be

drawn from my work in the long term. Nevertheless, this study has also drawn out some of the intricacies of the adolescent experience – beyond the COVID-19 pandemic – and emphasised the importance of resources to support adolescents' construction of empowering data narratives. These key themes are likely to remain important irrespective of the COVID-19 context.

Through this research, I have learned much about the compromises of mixed methods work and the challenge of prioritising data in the face of a large and rich data set. There are many ways that I could have chosen to analyse these data, and indeed I may choose to make other distinct kinds of cuts in papers to come. For this project, I adopted a QUAL + quan approach (see Section 3.3.1 for further details). In doing so, I prioritised the qualitative, interpretative understanding of the social and psychological affordances of digital self-tracking, as seen through my own social interactions with adolescents in interviews and workshops. I decided that this was the best approach to help me comprehend what I had set out to understand in this work. Nonetheless, the quantitative data was an integral aspect of this mixed methods research and provided an important lens on the research questions explored in this thesis. I faced some tension when considering the role of the quantitative data in this work. I wanted to ensure that the time that adolescents spent completing the survey was valued and that the scale of insights offered by these data was seen in this thesis where the survey data were brought into dialogue with data from the interviews and co-design workshops. This balance was hard to strike, and I have grown as a researcher through making these tough decisions.

I also spent considerable time thinking about other kinds of knowledge that might be helpful for gaining a deeper understanding of these complex issues. I was able to find out

much about how adolescents articulate their self-tracking practices, but I did not observe the practices themselves (for reasons explained in Section 3.9 in Chapter 3). Future work might benefit from methods that allow us to better understand *how* different adolescents engage with self-tracking tools and what these differences might mean for the affordances of self-tracking for social and psychological wellbeing. Given the online nature of this study and the limited resources available to ensure that adolescents' wellbeing could be wholly protected, I made the decision not to adopt methods like the go-along method or walkthroughs (e.g., K. M. Jørgensen, 2015; Light et al., 2018) and I was not able to produce these kinds of knowledge. Nonetheless, under the right circumstances, these methods combined with something longitudinal like a diary study (e.g., Rapp & Cena, 2016) could offer a unique perspective on how adolescents live with self-tracking tools and how their entanglements with social and psychological wellbeing reveal themselves.

8.6 What's Next?

8.6.1 … For This Work

The ways in which we translate knowledge matter. Oakes prompts researchers to consider the centrality of knowledge translation in our work and to "effectively communicate research findings and recommendations to various publics in accessible and useful forms" (2017, p. 98). Similarly, Smith et al. encourage researchers to think about creating stories that are "more memorable, more human and more understandable"; that is, narratives that can "open up, rather than close down, different ways of being and possible worlds in a manner that provokes people to think with and not just about research" (2013, p. 2047). When I was considering working with these young communities, I wanted to create a narrative in this research that adolescents could use to "think with and not just about research" (Smith et al., 2013, p. 2047). Therefore, it remained important for me to produce

something from this thesis that young people could have as their own. There was a real hunger from both adolescents and parents for such a resource in this work. There was a question on the consent forms for both adolescents and parents that asked whether they wished to receive a summary of the findings. Of the 163 parents who completed a consent form for their child so that they could take part in the online survey, 126 asked to receive a report summarising the findings of the research. Similarly, of the 605 adolescents over the age of 16 who completed a consent form to take part in the online survey, 423 asked to receive a report summarising the findings. Finally, of the 136 adolescents under the age of 16 who completed a consent form to take part in the online survey, 108 asked to receive a report summarising the findings.

These young people were generous with their time and reflections, and simply sending them a 300-page thesis felt inappropriate. Instead, in Figure 8.4, I have shared the accessible infographic of the findings that I designed to share with the adolescents. One of the great joys in working with adolescents is showing them the value of research and emphasising the importance of their voice. After I stopped recording in interviews and workshops, I always left space for participants to ask me questions. These ranged from *How will you make sure no one knows who I am?* to *When will I get my shopping voucher?* and my personal favourite: *What else can I do to help?*



Figure 8.4. An infographic designed to share the key insights of this research with adolescents.

In my research, I worked with adolescents at an incredibly vulnerable time in their lives, not only in terms of their personal development but also with respect to the global context of the COVID-19 pandemic. During this work, they shared intimate insights and raised great questions. It was therefore important for me to synthesise these in an artefact that is legible in their world and that may lead to new kinds of reflection, both for researchers and for adolescents themselves. Indeed, it is my hope that this output might encourage adolescents to take on the challenge of being researchers – of the self and their worlds. I am determined to be a part of training the next generation of researchers in how to communicate and share findings and how to run a study *with* and not just *on* participants.

By turning this thesis into a more easily digestible output, I learned a lot about this work and those who took part in it. I worked with an illustrator (Weezy Dai) to create vibrant images to accompany key ideas. These illustrations appear in both the thesis and the infographic to ensure coherence between research outputs. The challenge of distilling the findings down not only helped me to crystallise the key arguments of this thesis, but it also provided an opportunity to think about what might matter most to the group at the centre of this work – adolescents. I found writing for a non-academic audience to be a freeing experience and I was able to lean heavily on the words adolescents had chosen to share with me to write a piece that would resonate with them. In doing so, I noticed that the key threads I chose to draw out, although similar to the key arguments of the thesis, were framed in a different way. This led me to revise some of the language in my own thesis to ensure that it remained firmly grounded in adolescents' experiences, using theory as a helpful lens but not making the experience so abstract or lofty that it felt removed from adolescents' words.

Creating this output to send to adolescents has felt like closing a chapter of a book. I perhaps would have had a different sense of closure regarding the data collection had these methods been done in person – if I had wrapped up workshops in a co-located space and closed a physical door. Instead, the online nature of this work meant that it always felt a little 'unfinished'. Ending my final Microsoft Teams call with participants felt anti-climactic, and I wanted to ensure that I shared with them something more final, some artefact that served as proof that their voices had been heard.

Although I had previously thought of this as a dissemination exercise separate to data collection and analysis, when I was reflecting on the value of putting together this infographic, I went back and revised my Methodology and Methods chapter (Chapter 3) to include this process as a distinct stage in the research. Important analytical work was done during this process. Given adolescents' generosity with their time and their personal reflections when collaborating in this project, it was important for them to see that this had been a worthwhile exercise and that their voices had been taken seriously. I hope that this resource empowers them within their communities to share their experiences and underline their own unique contributions to our knowledge of self-tracking.

8.6.2 … For Our Understanding of Adolescents and Technology

I explained in Section 2.1 in Chapter 2 that, when framing this study, I chose to present adolescents as a case of self-tracking users, rather than self-tracking technology as a case of adolescents' engagement with technology. It is nevertheless helpful here to point out what the findings of this work might mean for researchers working to better understand the implications of adolescents' digital technology use and why idiosyncrasies of self-tracking tools make them distinct from other forms of social media.

The concept of adolescents as 'digital natives' (Prensky, 2001), innately adept at engaging with digital technologies, has been widely contested (Helsper & Eynon, 2010; Nash, 2019). However, the idea that adolescents, having grown up alongside digital technologies, are highly skilled technology users across the board persists. Adolescents are not a homogenous population and should not be treated as such. The data in this thesis have demonstrated that whilst many adolescents are critical and capable users of self-tracking technologies, these technologies are not infinitely malleable for them. Adolescents often have a clear understanding of what these technologies can and can't do for them; however, the hard constraints of these technologies can limit their control and creativity. Under these constraints, adolescents face challenges regarding both making useful sense of self-tracked data and using self-tracking technologies. In the co-design workshops, adolescents clearly articulated the many and varying questions that they have about how to situate their data, how self-tracking practices might feed into and out of their social lives, and how they can maintain a firm sense of control over their self-tracking decisions. These challenges demonstrate that adolescents not only have to contend with understanding how to work the technology (i.e., the conditions of perception and dexterity) but also how to integrate the technologies meaningfully into their lives. This belies the concept of a so-called self-tracking digital native.

I want to stress emphatically that this is not to say that adolescents are neither creative nor productive users of digital self-tracking technologies. Indeed, I learned so much about the various ways in which adolescents continually battle against technological and institutional constraints to make these tools work in their contexts. For example, there was one story that stuck with me throughout this work. As it is not specific to health- and fitness-tracking, I have not included it in the empirical findings chapters. However, it is relevant

here. When Jasper (14) was telling me about his experience with location-tracking on the social media app Snapchat, he said that his school does not have an app or another way of tracking when the school bus might be getting close. To fill this gap, Jasper and his friends on the school bus share their locations with one another *"so they know when the bus is getting closer"*. This anecdote demonstrates adolescents' ability to find creative solutions to institutional barriers. Nonetheless, when it comes to self-tracking for health and fitness, adolescents articulated a need for greater support in doing this effectively.

Distinctions between 'online' and 'offline' experiences have permeated much of the literature around adolescents and technology (Lieberman & Schroeder, 2020). In work describing adolescents' engagement with digital technologies, one hypothesis that has circulated widely is the displacement hypothesis (Neuman, 1988). This suggests that time spent online takes away from other, richer 'offline' activities. That is simply not true for self-tracking technology. For example, K. Davis describes how social media allows adolescents to assume "identities that may have little connection to the individuals' offline lives" (2012b, p. 636). However, self-tracking technologies work differently. They are set up to help users gain an intimate understanding of their identity in their so-called 'offline' lives. The technologies are predicated on the tracking of personal health data, often leaving little room for adolescents to hide. Whilst adolescents might use strategies like carefully crafting narratives around their data, curating only select data, or even trying to assume an idealised identity by striving towards new goals in their data, ultimately these all still lead back to their 'offline' lives in some way. As such, self-tracking technologies sit differently in adolescents' social and personal worlds. The affordances of digital self-tracking technologies reveal intractable, physical entanglements between 'online' and 'offline'

experiences for adolescents (e.g., wearables), in ways that look different to other technologies, such as other social media (e.g., Instagram, TikTok).

Researchers thinking through adolescents' engagement with digital technologies more broadly should think carefully about where and how self-tracking technologies might fit into these frameworks. Whilst there are important interconnections between self-tracking technologies and other social media (e.g., Instagram), we should not assume that the mechanisms are always the same. Self-tracking tools defy researchers' attempts to construct and define neat categories of technologies. This remains a key challenge for future work in this space.

8.6.3 … For Self-Tracking Research

This thesis also has implications for broader self-tracking research. Adolescents exist in tightly-wound situational orders that mean that institutions like schools and parents have much more say in their lives, which contrasts with the lives of much more autonomous adults. They are therefore a self-tracking user group that is worthy of consideration in their own right. Whilst many of the findings in this study echo what we have seen with adults, there are some important points of difference that help teach us new things about tracking.

Firstly, this research has clearly demonstrated the centrality of sociality and control in adolescents' varied self-tracking experiences. These themes speak to the very real tension between self-tracking as, simultaneously, a personal and a social act. Adolescents clearly see that this is a challenging space in which to navigate, and they do so gracefully, but often without much support. In this thesis, I have demonstrated how adolescents must manage the friction between these practices of creativity and control. The findings from the co-

design workshops demonstrate the value of an educational resource in opening up these creative opportunities within the bounds of tightly controlled technological and social environments. In their self-tracking experiences, adolescents often leverage imaginative solutions to protect their sense of control over their self-tracking practices. They understand how they might make technologies work for them, but the rigidity in the designs as they exist today refuse adolescents the control and empowerment that are essential for their positive engagement with these technologies.

As adolescents attempt to navigate this balance between creativity and control within strict social orders (i.e., as the affordances of digital self-tracking technologies are conditioned by institutional legitimacy), we can learn more about the challenges of tracking within rigid contextual boundaries, such as workplaces and healthcare systems. Adolescents serve as a case of how we might go forward with understanding the tensions between creativity and control in self-tracking. They are a more extreme case of where we can see these orders of control more clearly; they are subject to the rules of parents, schools, and other institutions. However, adolescents are not the only user group contending with these challenges. Indeed, there are many situations in which users have multiple things in their context that they have to navigate. For example, clinicians trying to work out how to support patients' use of off-the-shelf devices juggle the institutional order of hospitals and the expectations of patients in addition to time and resource constraints. By paying attention to how adolescents are doing this, we can better understand not only the importance of understanding what data mean but also how we might support users in their ability to track within their unique institutional orders.

This research has also emphasised the importance of the continued use of mixed methods work in the area of self-tracking. It is important that we understand *what* adolescents are doing with self-tracking technologies and *why* they are doing it. As highlighted in Chapter 6, there was tension in this study between the quantitative and the qualitative data. Whilst the quantitative data showed no overall significant relationship between adolescents' self-tracking and their psychological wellbeing, the qualitative data told a very different story. Many adolescents shared the profound challenges they had faced when trying to navigate the entanglements of their self-tracking practices and psychological wellbeing. This example points to our need to better understand the mechanisms by which self-tracking might influence adolescents' social relationships and psychological wellbeing.

Researchers must urgently consider more creative ways of measuring engagement with self-tracking technologies. Adolescents spoke of a certain 'threshold' of engagement after which self-tracking can become problematic for psychological wellbeing. Without more sophisticated methods for measuring engagement, gaining a better understanding of this threshold will be challenging. By working to better understand the role of self-tracking practices in adolescents' lives, we will be able to better see the entanglements with their social relationships and psychological wellbeing and points at which more support might be beneficial.

Here, quantitative engagement data are limited for a number of reasons. We know that quantitative methods that are used to capture technology use (e.g., screen time) present challenges (Orben & Przybylski, 2019), such as their inability to capture the types of activities (i.e., time *well* spent) rather than just the quantified time spent (Livingstone & Pothong, 2022; Pitt et al., 2021). Nevertheless, engagement with self-tracking technologies

looks different to that with other screen-based technologies, and observing engagement can be deceptive. An individual might intentionally limit checking their data to once per day because they know it has a profoundly negative effect on their psychological wellbeing. Alternatively, someone might regularly check their tracked step data throughout the day simply out of boredom or curiosity. When adolescents spoke of 'obsession' with self-tracking technologies and data, it did not relate solely to the length of time spent engaging with these technologies but also referred to the meaning attributed to the data in their lives. Capturing this value is challenging. To add additional complexity, in parallel with other research (Clark et al., 2022), many of the adolescents in this study spoke of internalised tracking such that after a certain period of engagement, they no longer relied on digital technologies to give them data and instead had an instinctive understanding of how many calories they had consumed or how many steps they had taken. Future research should consider the many guises of self-tracking and work to capture different types of engagement.

Ultimately, tracking intimate *personal* data within a *social* system is challenging. We can learn important lessons from adolescents about the very real challenges of balancing creativity and control when engaging with digital technologies. These learnings can also be applied to other users and contexts beyond adolescents.

8.7 The Ball's in Our Court

In writing this thesis, I have been struck by a sense of having responsibility to make a change. Gardner and Davis close their book *The App Generation* with the following sentence:

> For ourselves, and for those who come after us as well, we desire a world where all human beings have a chance to create their own answers, indeed, to raise their own questions, and to approach them in ways that are their own. (2013, p. 197)

I join Gardner and Davis in this quest. This work is far from complete, and I am determined not to let this chapter be the conclusion of this story. In the Discussion section above, I have emphasised that collaboration and cooperation are central pieces of the puzzle for adolescents' successful and rewarding engagement with self-tracking technologies. We all have a responsibility to work towards this change, whether we are parents, academics, teachers, designers, adolescents, or media professionals. For instance, the media must work to move away from using overly simplistic 'teens and screens' narratives that patronise adolescents, and academics must think carefully about how they might include adolescents in all aspects of the research design process.

It is clear from adolescents' insights that these self-tracking tools are so much more than step-counters or food-loggers. We have an obligation to this next generation to take them seriously – to not patronise them as technology users but rather to learn from and with them. It has been one of the great honours of my academic career to spend so many hours being taught by these young participants. Being entrusted with their words is not an opportunity I take for granted.

Together, we have taken a step in the right direction, but I want to end this thesis with a call to action. The data laid out in this research have brought adolescent bodies into how we understand the practices of self-tracking. Their participation in this work has clearly demonstrated how we might learn new things about tracking and its entanglements with individual and collective lives. It is now time not just to listen to their data, but to also

listen to their voices. I will remain steadfast in my pursuit of amplifying adolescent stories, and I sincerely hope that others will join me.



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Appendix A: Interview Participant Summary

Participant	Contextual Information (Age, Gender, Ethnicity, Education, Region)	Experience with Self-Tracking?	Summary
Adaline	16 Female White Secondary school South East	No: Never self-tracked	Adaline has very intentionally not self-tracked because she is concerned that she would too easily become obsessed with these data. She saw very clear links between social media use and self-tracking and raised concerns over what she felt to be a very strong relationship between self-tracking and disordered eating behaviours.
Albert	16 Male Mixed Secondary school Eastern	Yes: Previously self-tracked	Albert described starting his self-tracking with a Fitbit that his mother had access to and control over. There were some frustrations with this for Albert and he felt a greater sense of control once he was able to be in charge of his own self-tracking. He stopped tracking because his Fitbit broke and he could not afford to buy a new one. He shared that he would restart tracking if he gained weight.
Aria	18 Female White Secondary school Wales	Yes: Previously self-tracked	Aria previously self-tracked her steps out of curiosity rather than to achieve a goal. She chose to self-track because she wanted something objective so that she couldn't lie to herself about her activity. She found it frustrating that there seemed to be a lot of variation in her step data even on days that she didn't think her activity was very different. During

			lockdown restrictions, Aria thought about restarting her self-tracking; however, she felt that she had almost internalised her tracking and instead walked routes for which she knew the distance and step counts.
Chase	16 Male White Secondary school Eastern	Yes: Currently self-tracks	Chase is a very social self-tracker who shares and compares his activity with between 30 and 50 friends. He has a sense that self-tracking isn't *"trendy"* anymore and is something that people were doing four years ago but don't do now. He prefers to use phone apps to wearables as he finds them more practical. COVID-19 lockdowns gave Chase increased freedom to exercise and track in ways that weren't possible under the constraints of the ordinary school routine.
Damian	13 Male White Secondary school South East	Yes: Previously self-tracked	Damian previously self-tracked using a Fitbit. Initially, this was under the control of his parents on the app, but eventually he progressed to having access to his own account. During the COVID-19 pandemic, he has been motivated to stay physically active and keep exercising. During periods of lockdown, he went on walks with his family. As he wasn't using his Fitbit, his mother tracked their steps during these walks for both of them.
Delilah	13 Female White Secondary school East Midlands	Yes: Previously self-tracked	Delilah started tracking her steps because of COVID-19 and found it gave a bit of peace of mind that she wasn't just doing *"nothing"*. She found the pandemic gave her more time to track but the tracking was never that important to her and was more of a hobby. She found it disappointing when she compared herself to

			marathon runners and athletes on social media as she wished she was performing at their level. She found that her tracking slowly stopped after six months as COVID-19 restrictions lifted and then she got a new phone and never downloaded the app again.
Edward	17 Male White Secondary school Scotland	Yes: Previously self-tracked	Edward started tracking during periods of lockdown as he started walking more. He only used a phone app as using a wearable, like his parents, seemed too much of a commitment and he didn't like how much they talked about it, although he found himself talking about his data when he started tracking. His tracking decreased once he was able to socialise again and he now no longer tracks his steps.
Freddie	<16 but exact age not disclosed* Male Secondary school Region not disclosed	No: Never self-tracked	Freddie has never self-tracked, despite expressing a positive attitude about self-tracking. He is primarily deterred by the cost and the effort involved in tracking. He also shared that he has been quite anxious and has been taking a break from interacting with technology.
Hannah	16 Female White Secondary school South East	Yes: Currently self-tracks	Hannah currently self-tracks. She used to use a Fitbit but found that she was checking this too much when it was readily available on her wrist and so she now prefers to check her steps on her phone. She used to track her calories but has stopped this because she found she was thinking about it a lot and it wasn't useful to her. During COVID-19 lockdowns, she found that she compared herself with others less because she wasn't seeing people at school. This was a positive thing for Hannah as she knows she is

			healthy but these comparisons often made her feel inadequate.
Hari	<16 but exact age not disclosed Male Secondary school Region not disclosed	Yes: Previously self-tracked	Hari previously used Strava and used a phone app to track his physical activity. He started using these tracking technologies during the first lockdown as he was concerned about seeing a decline in his level of fitness. He has stopped this because life has become very busy but he looks forward to returning to tracking when his life settles down a little. Hari has previously engaged in step count and running competitions with his friends and enjoys being on the top of the leader board. Self-tracking has been a very positive experience for Hari and he likes being able to see what he has done and what he needs to do next.
Jasmine	17 Female Asian or Asian British Secondary school South East	Yes: Previously self-tracked	Jasmine started tracking during lockdown using a smartphone app to track her running. She had to do this manually because she didn't like to take her phone with her on runs. Jasmine stopped tracking because it was inaccurate and it became too time consuming. She has thought about getting a wrist-worn wearable but is concerned that it would be too easy to get obsessed with the numbers and that this would detract from lived experience and an intuitive understanding of the body. During COVID-19 lockdowns, her school ran a competition on Strava and this helped students stay connected during lockdown.
Jasper	14 Male	Yes: Currently self-tracks	Jasper is a keen self-tracker with a positive overall experience. He started tracking during lockdown and this was initiated by the

	White Secondary school South West		fitness component of the Duke of Edinburgh Award. Jasper can understand the problems of tracking if people become too obsessed but he hasn't had any issues himself.
Kirsty	15 Female White Secondary school South East	Yes: Currently self-tracks	Whilst Kirsty currently self-tracks, she is grateful she didn't start earlier in life when she feels she may not have been equipped to engage in these practices positively. She has tried a number of different apps but MyFitnessPal is the only one that she has been able to stick with. She likes monitoring her progress and has moved away from setting goals as she got caught in cycle of setting unrealistic expectations of herself. She feels that she wouldn't see progress without tracking and finds she gets a *"sense of security"* from her data. Reflecting on her personality, she thinks it would be easy for her to become fixated on her data and so she is careful with what she does to ensure that this doesn't happen to her. She feels that apps that ask you to pay lose their sense of authenticity and make you feel like they don't actually 'care' about you. Kirsty doesn't share her data because it would be easy to become competitive.
Leroy	>16 but exact age not disclosed Gender not disclosed Ethnicity not disclosed Education not disclosed Region not disclosed	Yes: Currently self-tracks	Leroy currently self-tracks and has particularly enjoyed seeing progress with their weight loss. This achievement has been celebrated with their mother and they describe bragging about this to friends. They have had a generally positive experience with self-tracking and describe a certain intimacy they feel with the self-tracking technology. They share that there is a real sense of

			care and they often feel as if someone is there with them to encourage them to keep persevering.
Logan	15 Male White Home-schooled Scotland	Yes: Currently self-tracks	Logan currently self-tracks and uses these data to help monitor and manage his asthma. He shares his data with friends and his mum. He finds that tracking makes things feel more serious and encourages him to want to do more. During the first lockdown, his physical activity was greatly restricted as he was shielded, as such, his self-tracking decreased but it has picked up again quickly since then.
Luke	16 Male Mixed Secondary school East Midlands	No: Never self-tracked	Luke does not self-track but his family does. He does not track because he feels he is healthy as he is and he doesn't need to change anything about his health or fitness. Luke discussed how social media is not always an appropriate place to share self-tracked data and instead described the value of creating smaller communities in which to share this personal information.
Mikhail	17 Male White Secondary school South East	No: Never self-tracked	Mikhail is quite determined that he has never self-tracked; however, during the course of the interview, he reported using BodyTrax to monitor his body, and manually tracking his weightlifting progress in the gym. He shares that he has never engaged with digital self-tracking apps or wearables as he can't work out how to make the metrics useful to him. He compares his data with friends and his father and recalls sometimes exaggerating his data with certain friends. He finds exercise helps his mental health

			and sometimes tracking has a negative effect when he ascribes too much meaning to what he considers to be arbitrary numbers.
Miriam	17 Female Asian or Asian British Secondary school London	Yes: Currently self-tracks	Miriam uses a menstrual cycle tracking app, Clue, to manage her health. She was diagnosed with polycystic ovary syndrome (PCOS) at the age of 12 and was offered little support from doctors/parents and so felt that she had a responsibility to learn more and to start tracking her health. Miriam has found that tracking has stopped her speculating as much and allows her to plan her life around her PCOS. Miriam finds the tracked data reassuring. She has also tried using calorie/food trackers but found that she did not like this—she set out with the intention of gaining weight but found that through her tracking, she changed her goal and didn't want to gain the weight. She also began to get anxious about eating in social settings where she couldn't weigh her food. Miriam prefers the qualitative nature of tracking with Clue to the quantitative nature of tracking with the calorie app.
Morgan	16 Non-binary White Secondary school North West	No: Never self-tracked	Morgan gave two key reasons why they don't self-track: they are concerned about their privacy and they don't do a lot of physical activity and so they think tracking would be of little value to them. They think that self-tracking is most useful for people who have a deep interest in health and physical activity. COVID-19 has brought about a new awareness of tracking for Morgan (e.g., COVID test results and symptoms). They think about this type of tracking differently as it is

			for a finite period and a clearly-defined purpose.
Natalie	16 Female Black or Black British Secondary school North West	Yes: Currently self-tracks	Natalie currently self-tracks and talks very openly about her lived experience of managing bulimia. She finds that her data are often a bit of a *"safety net"*. During periods when the bulimia was most challenging, she would have multiple apps as she was concerned about the accuracy of the data and she would take an average to ensure that she had the most reliable data possible. Natalie shares her location with her family but not all of her health and fitness data (e.g., sleep data) as she doesn't want to worry her mother. Natalie finds that tracking works well with her mental health, dyslexia, and ADHD; it helps her stay organised and on top of things. In disclosing some of the emotional affordances of tracking she has experienced, she describes feeling devastation and guilt at times over her self-tracked data and is wary of young users self-tracking and managing negative emotions that she wouldn't wish on anyone.
Ophelia	17 Female White Secondary school South East	Yes: Currently self-tracks	Ophelia currently self-tracks; however, she shared quite a negative view of self-tracking, particularly for calories and food-based tracking. COVID-19 has made her a lot more cautious about tracking as she found she became very focused on her data and she has tried to make changes to combat this, such as removing the data from her watch face and replacing it with a photograph.
Quinn	17 Female	Yes: Currently self-tracks	Quinn has been using wearables to self-track her data for a few years. After participating in the

	White Secondary school South West		survey related to this study, she reflected on her tracking practices and realised that they had become unhealthy during lockdown. Instead of focusing on her data so much, she now tries to appreciate the experience rather than just looking at the numbers. During COVID-19, her school introduced tracking competitions to keep students active in the absence of Physical Education classes. Quinn recognised that this could make some students feel quite "*vulnerable"* if they weren't able to keep up with their peers.
Rachael	17 Female White Secondary school North West	Yes: Currently self-tracks	Rachael currently self-tracks and has done so for about 10 months. Rachael described becoming too focused on her data for a few months and felt that she had to change the way she was tracking to ensure she remained in control. Rachael felt that tracking calories and food intake was quite different to physical activity and fitness tracking, and was wary of the former but continued to do the latter. Rachael described having many family members on Fitbit and engaging in weekly competitions with them. She doesn't particularly enjoy this as she often feels that she sits close to the bottom in terms of comparison and would prefer if this feature of Fitbit did not exist.
Rebekah	15 Female White Secondary school West Midlands	Yes: Previously self-tracked	Rebekah described previously self-tracking after having started because of the lockdown. She struggled to remember to use the app and her watch and so only tracked for a short while. She used to share her tracking data with her mother verbally and found that tracking did give her

			motivation to exercise. She feels she now lacks that motivation since stopping tracking. She discussed her friends who have tracked calories or weight and recalled watching the impact this has had on them, particularly around disordered eating behaviours. As a result of seeing this, Rebekah avoided any tracking of weight or calories because she was wary of the negative effects it might have on her. Rebekah believes that self-tracking technologies are marketed as 'healthy' but there is a darker side to them that people aren't acknowledging and this is causing harm. She is keen to see a change in this space and greater acknowledgement of individual differences.
Rosie	14 Female White Secondary school West Midlands	Yes: Currently self-tracks	Rosie has found that her Fitbit and smartphone app self-tracking has had a very positive effect on her psychological wellbeing, particularly during lockdowns. Due to COVID-19, her usual physical activities and sports stopped and so she ran a lot and found this became boring.
Sawyer	16 Male White Secondary school South East	Yes: Currently self-tracks	Sawyer has been tracking his data using a smartphone app for a few years. He only shares his data with others if it's impressive and he tracks out of interest rather than to achieve set goals. He found he tracked more during the COVID-19 pandemic out of boredom, even though he did not feel particularly interested in the data.

Thomas	13 Male White Secondary school South East	Yes: Currently self-tracks	Thomas currently tracks his steps, heart rate, and miles travelled. He is very goal-orientated in his tracking. He enjoys competition with others and shares his data with his family for motivation. His school ran an assembly at the beginning of lockdown to encourage people to self-track as it was important for them to keep moving with COVID-19. He feels that if he doesn't track his exercise, then it does not count, and he will only save and share his data if he deems it to be impressive.
Violet	15 Female White Secondary school South East	Yes: Currently self-tracks	Violet currently self-tracks on Strava and has generally had a very positive experience. She describes herself as very active and she has lots of friends and family who also use Strava. She primarily uses tracking to monitor her progress with running and cycling. She started running and increased her training during the COVID-19 lockdowns. She finds tracking very motivating and struggled to see any negative effects of these practices. She described sitting at the top of the leader board in her friendship group and enjoys seeing what other people are doing. She has found new freedom in her tracking since discovering the *"beacon"* feature on Strava that allows her parents to monitor her activity and check on her safety.

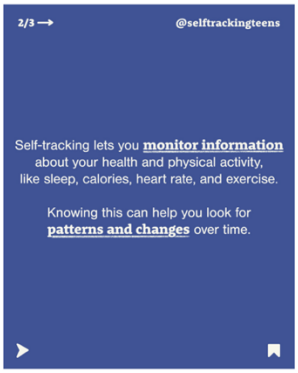
Yash	15 Male White Secondary school South East	Yes: Currently self-tracks	Yash currently tracks using an Apple Watch and has done so for about 18 months after stumbling across this tracking feature. He likes to get a sense of his activity during the day but he is not particularly worried if he doesn't meet his goals. He will check a few times during the day and if he sees he is close to closing his rings, he will then go and walk a longer route home. Yash shares his tracked data with friends if they have a day out in London to show them how many steps they managed to do. He also shares his data on his Apple Watch with a friend and they used to compete to see who could close their rings the fastest.

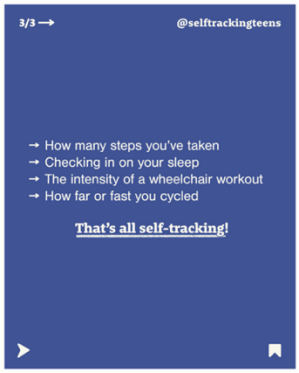
* Note: Some participants chose not to disclose some of their demographic data.

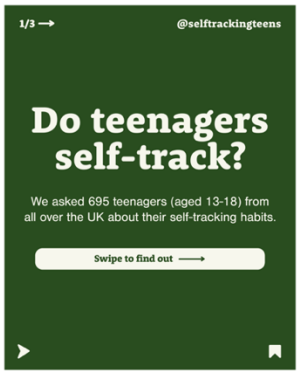
Appendix B: Proof-of-Concept 'How Might You' Self-Tracking Guide for Instagram

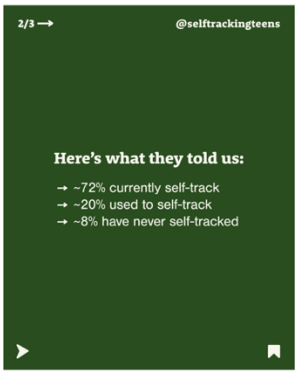
The below images comprise the key output from the co-design workshops; Instagram posts designed alongside the graphic designer involved in this project (Weezy Dai).

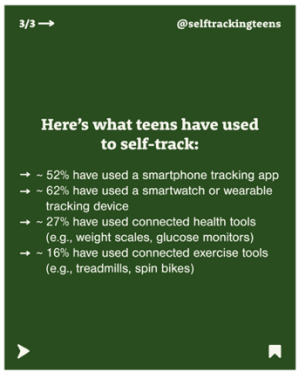


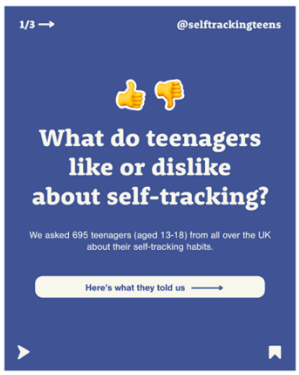












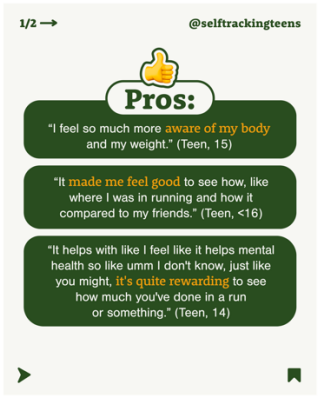





1/3 → @selftrackingteens
When thinking about self-tracking, it's important to remember that there are pros and cons.
Balancing these is important in making sure that tracking is working for you and your life.


2/3 → @selftrackingteens
Pros:
Self-tracking can be wonderful for some people:
→ It can help you to set goals and keep track of your progress
→ It can motivate you to exercise and move your body
→ It can help you monitor a health condition
→ It can feel great to look back at your achievements
→ Exercise can boost your mood and help your mental health


3/3 → @selftrackingteens
Cons:
Self-tracking can be challenging for some people:
→ It can be easy to become obsessed with tracking or feel like you have lost control
→ It can lead to negative mindsets or unrealistic goals around eating and exercising
→ It can feel like a competition and it can be hard not to compare with other people
→ It can be stressful to keep tracking
→ It can be disappointing if you don't see the progress you were hoping to


1/2 → @selftrackingteens
Pros:
"I feel so much more aware of my body and my weight." (Teen, 15)
"It made me feel good to see how, like where I was in running and how it compared to my friends." (Teen, <16)
"It helps with like I feel like it helps mental health so like umm I don't know, just like you might, it's quite rewarding to see how much you've done in a run or something." (Teen, 14)

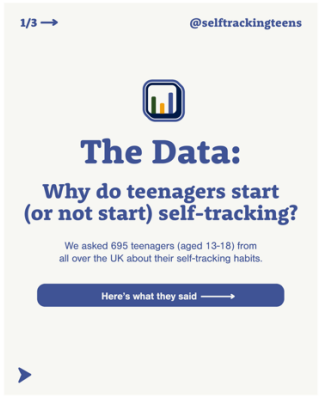

2/2 → @selftrackingteens
Cons:
"I'm also scared like it's just gonna like pull me in and I'm going to get so obsessed with the numbers and everything." (Teen, 17)
"It's very easy to slip into obsessive calorie counting, obsessive calorie burning and things like that umm which is what happened to me [...] it was so unhealthy but you don't really realize it until it's kind of too late and you have to get help for it 'cause you can't do it on your own anymore." (Teen, 17)

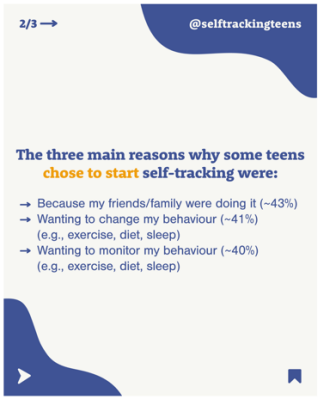

1/2 → @selftrackingteens
What do I do if I feel my tracking is out of control?
swipe →

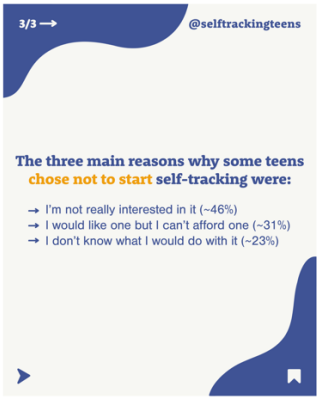

2/2 → @selftrackingteens
If you feel like you need some support in managing your mental health around your tracking, you are not alone.
Talk to someone you trust – your parents, teachers, or a mental health professional.
You will also find some helpful resources at the following charities:
→ YoungMinds (https://youngminds.org.uk)
→ stem4 (https://stem4.org.uk)
→ Mind (https://www.mind.org.uk)

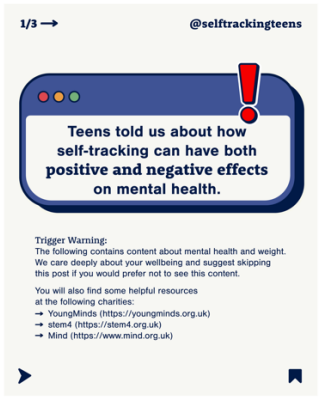

1/2 → @selftrackingteens
REMINDER:
Self-tracking is not for everyone, and there are no rules for how or why you should track.
If it works for you and it's enjoyable, then that's amazing!
If you don't want or need it, that's great too!

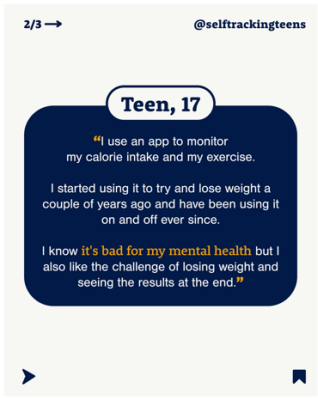

2/2 → @selftrackingteens
Everyone has different reasons for tracking (e.g., curiosity, to monitor a health condition, to improve sports performance, even boredom).
Think carefully about your reasons for tracking.
Is it something that makes you happy?
Is it something that worries you?
If you're not sure, try talking to someone about this to make sure you're tracking for reasons that are positive and healthy for you.

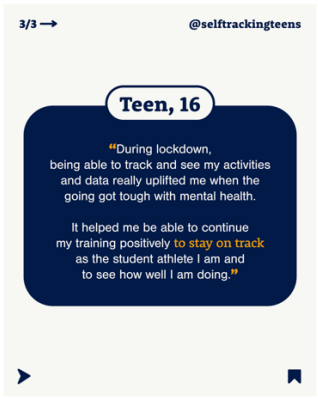

1/3 ⟶
@selftrackingteens
The Data:
Why do teenagers start (or not start) self-tracking?
We asked 695 teenagers (aged 13-18) from all over the UK about their self-tracking habits.
Here's what they said ⟶


2/3 ⟶
@selftrackingteens
The three main reasons why some teens chose to start self-tracking were:
→ Because my friends/family were doing it (~43%)
→ Wanting to change my behaviour (~41%) (e.g., exercise, diet, sleep)
→ Wanting to monitor my behaviour (~40%) (e.g., exercise, diet, sleep)


3/3 ⟶
@selftrackingteens
The three main reasons why some teens chose not to start self-tracking were:
→ I'm not really interested in it (~46%)
→ I would like one but I can't afford one (~31%)
→ I don't know what I would do with it (~23%)


1/3 ⟶
@selftrackingteens
Teens told us about how self-tracking can have both positive and negative effects on mental health.
Trigger Warning:
The following contains content about mental health and weight. We care deeply about your wellbeing and suggest skipping this post if you would prefer not to see this content.
You will also find some helpful resources at the following charities:
→ YoungMinds (https://youngminds.org.uk)
→ stem4 (https://stem4.org.uk)
→ Mind (https://www.mind.org.uk)

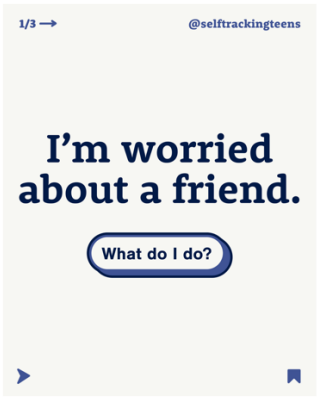

2/3 ⟶
@selftrackingteens
Teen, 17
"I use an app to monitor my calorie intake and my exercise.
I started using it to try and lose weight a couple of years ago and have been using it on and off ever since.
I know it's bad for my mental health but I also like the challenge of losing weight and seeing the results at the end."

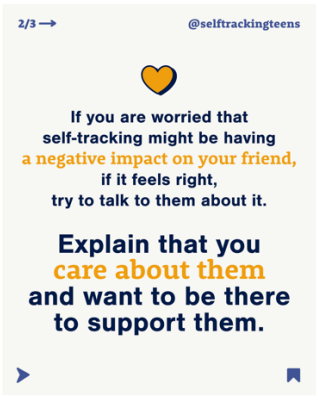

3/3 ⟶
@selftrackingteens
Teen, 16
"During lockdown, being able to track and see my activities and data really uplifted me when the going got tough with mental health.
It helped me be able to continue my training positively to stay on track as the student athlete I am and to see how well I am doing."


1/2 ⟶
@selftrackingteens
REMINDER:
When you are self-tracking, your data isn't everything.
Why not get creative with your tracking? Find a way to add notes to your data. Remind yourself of your achievements – big and small!
The numbers aren't everything.

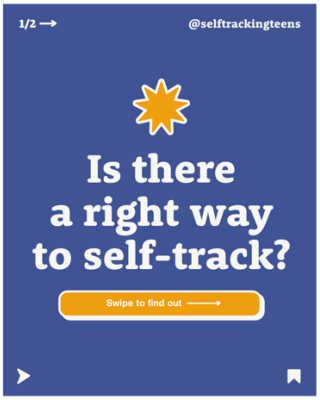

2/2 ⟶
@selftrackingteens
It can be easy to compare your tracking with other people's. This might be helpful for some people but it doesn't have to be a competition if you don't want it to be.
Just because a friend is doing things differently doesn't mean you need to try and do things just like them.
Remember, your tracking is about you; everyone and every body is different.
Enjoy it!


@selftrackingteens
There are lots of great ways to share your self-tracking data with people.
This can be really motivating and can be a great way to connect with friends and family.
But, sharing data isn't for everyone.
There is nothing wrong with keeping your data private and letting others do the same.


1/3 →
@selftrackingteens
I'm worried about a friend.
What do I do?


2/3 →
@selftrackingteens
If you are worried that self-tracking might be having a negative impact on your friend, if it feels right, try to talk to them about it.
Explain that you care about them and want to be there to support them.


3/3 →
@selftrackingteens
Make sure you are also being supported –
friends, teachers, or mental health professionals are great for this.
You will also find some helpful resources at the following charities:
→ YoungMinds (https://youngminds.org.uk)
→ stem4 (https://stem4.org.uk)
→ Mind (https://www.mind.org.uk)


1/2 →
@selftrackingteens
Is there a right way to self-track?
Swipe to find out →


2/2 →
@selftrackingteens
No!
There is no right or wrong way to self-track.
Experiment a bit and see what works for you.
→ What are you interested in finding out more about?
→ Do you want to share with others or keep it to yourself?
You are in control of what your self-tracking looks like and what is right for you.


1/2 →
@selftrackingteens
How can you make tracking work for you?
BE KIND TO YOURSELF
Set boundaries with your self-tracking to make sure you are in control.


2/2 →
@selftrackingteens
Some ideas for healthy self-tracking:
• Don't like seeing the numbers all the time? Personalize your watch face with a photograph or calming image
• Use your tracking to get social – take a walk with family or friends
• Take a break if you need to. Your tracking will be there if you want to come back to it
• Think about personalising your goals so you're only tracking the things that are most important for you


@selftrackingteens
Your voice matters in the future of self-tracking.
Get involved in research, talk to people, share your experiences and ideas.
Together, we can learn how to make self-tracking work for everyone who wants to try it.

Appendix C: Sample Online Survey

Start of Block: About You

Q1.1



© Alessandro Biascioli / Adobe Stock

Q1.2 First, we would love it if you could tell us a bit about yourself.

Q1.3 **How old** are you?

- 13
- 14
- 15
- 16
- 17
- 18

Q1.4 To which **gender** do you most identify?

- ○ Male
- ○ Female
- ○ Non-binary / third gender
- ○ Prefer not to say

Q1.5 How would you describe your **ethnicity**?

- ○ Asian or Asian British
- ○ Black or Black British
- ○ Mixed
- ○ White
- ○ Other _____
- ○ Prefer not to say

Q1.6 Which of these **best describe you**? [Select all that apply]

- ☐ I am a secondary school / college student
- ☐ I am a university student
- ☐ I am an apprentice
- ☐ I have a part-time job
- ☐ I have a full-time job
- ☐ I am not currently employed
- ☐ Other _____

Q1.7

Source: https://www.europarl.europa.eu/unitedkingdom/en/eucitizenscorner/uk_meps.html



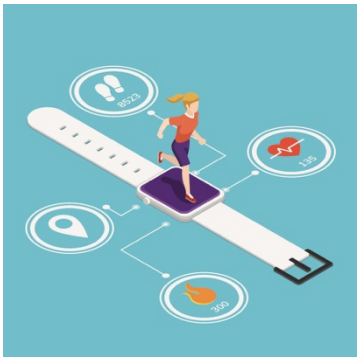
Q1.8 In which **region** of the United Kingdom do you live?

▼ Scotland, Northern Ireland, Wales, North East, North West, Yorkshire and the Humber, West Midlands, East Midlands, South West, South East, Eastern, London

End of Block: About You

Start of Block: Self-Tracking

Q2.1



© Jiw Ingka / Adobe Stock

The following questions are about self-tracking. Self-tracking allows people to monitor, record and analyse information about their health and physical activity, such as sleep, calorie intake, heart rate and exercise. Have you ever looked at your phone to see how many steps you've taken in a day? Have you ever used a fitness tracker to find out how far or how fast you ran? That is self-tracking.

Q2.2 Do you, or have you ever, **used a device or app to track** your health and physical activity?

(e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone).

- ○ **Yes**, I currently use a device/app to track my health and activity data
- ○ **Yes**, I used to use a device/app to track my health and activity data but I don't anymore
- ○ **No**, I have never used a device/app to track my health and activity data

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Or Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.3 **What type of app/device(s)** have you used? [Select all that apply]

☐ Smartphone app (e.g. iPhone Health, My Fitness Pal, Strava, etc.)

☐ Smart watch or wearable device (e.g. Apple Watch, Garmin Watch, Fitbit, WHOOP band, etc.)

☐ Connected health equipment (e.g. weight scales, thermometers, blood pressure monitors, glucose monitors)

☐ Connected exercise equipment (e.g. Peloton, NordicTrack, gym-based equipment)

☐ Other (please name or describe briefly if you can't remember the name)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Or Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.4 **Why did you start** self-tracking your health and physical activity? [Select all that apply]

- [ ] Curiosity
- [ ] Because my friends/family were doing it
- [ ] Because I got a device that did it automatically (e.g. an iPhone)
- [ ] Because someone I follow on social media was doing it (e.g. an influencer, celebrity, sportsperson, etc.)
- [ ] Wanting to manage symptoms or a chronic condition
- [ ] Wanting to change my behaviour (e.g. exercise, diet, sleep)
- [ ] Wanting to monitor my behaviour (e.g. exercise, diet, sleep)
- [ ] Wanting to compare or compete with other people
- [ ] Wanting to learn more about myself
- [ ] Wanting to set goals
- [ ] Wanting to feel connected to other people

☐ Other (please describe)

_____

Display This Question:

If Q2.2 = No, I have never used a device/app to track my health and activity data

Q2.5 Which of the following best describe **why you haven't self-tracked** your health and physical activity? [Select all that apply]

☐ I'm not really interested in it

☐ I don't know what I would do with it

☐ I'm worried about the privacy of my data

☐ I would like one but I can't afford one

☐ I would like one but I am not allowed one

☐ No one else I know does it

☐ Other (please explain)

_____

Display This Question:

If Q2.2 = No, I have never used a device/app to track my health and activity data

Q2.6 **Why might you start** to self-track your health and physical activity?

- [ ] I never would
- [ ] Curiosity
- [ ] Because my friends/family are doing it
- [ ] Wanting to manage symptoms or a chronic condition
- [ ] Wanting to change my behaviour (e.g. exercise, diet, sleep)
- [ ] Wanting to monitor my behaviour (e.g. exercise, tracking, sleep)
- [ ] Wanting to compare or compete with other people
- [ ] Wanting to learn more about myself
- [ ] Wanting to set goals
- [ ] Wanting to feel connected to other people
- [ ] Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Q2.7 **How long have you been self-tracking** your health and physical activity?

- A few days
- A few weeks
- A few months
- A few years

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.8 For **how long did you self-track** your health and physical activity?

- A few days
- A few weeks
- A few months
- A few years

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.9 **Why did you stop** tracking your health and physical activity? [Select all that apply]

- ☐ It wasn't useful to me
- ☐ It didn't track what I was interested in (please explain)

_____

- ☐ Lost interest
- ☐ I did not enjoy tracking my data (please explain)

_____

- ☐ Problems with the device/app (please describe)

_____

- ☐ Unreliable or inaccurate data
- ☐ It was bad for my mental health
- ☐ It was bad for my physical health
- ☐ It was bad for my relationships with other people
- ☐ I didn't like comparing my data with other people
- ☐ I learned what I needed to know

☐ It was boring

☐ Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Q2.10 What do you **like most** about self-tracking your health and physical activity? [Select all that apply]

☐ Comparing my data with others

☐ Competition

☐ Motivation

☐ Learning about my body

☐ Seeing my progress

☐ Feeling connected to other people

☐ Setting goals

☐ It is good for my mental health

☐ It is good for my physical health

☐ Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.11 What did you **like most** about self-tracking your health and physical activity? [Select all that apply]

☐ Comparing my data with others

☐ Competition

☐ Motivation

☐ Learning about my body

☐ Seeing my progress

☐ Feeling connected to other people

☐ Setting goals

☐ It was good for my mental health

☐ It was good for my physical health

☐ Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Q2.12 What do you **like least** about tracking your health and physical activity? [Select all that apply]

☐ It doesn't track what I am interested in (please explain)

_____

☐ Problems with the device/app (please describe)

_____

☐ Unreliable or inaccurate data

☐ It is bad for my mental health

☐ It is bad for my physical health

☐ It is bad for my relationships with other people

☐ I don't like comparing my data with other people

☐ It is boring

☐ Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.13 What did you **like least** about tracking your health and physical activity? [Select all that apply]

- ☐ It didn't track what I was interested in (please explain)

_____

- ☐ Problems with the device/app (please describe)

_____

- ☐ Unreliable or inaccurate data
- ☐ It was bad for my mental health
- ☐ It was bad for my physical health
- ☐ It was bad for my relationships with other people
- ☐ I didn't like comparing my data with other people
- ☐ It was boring
- ☐ Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Q2.14 In general, **how consistent** have you been with your self-tracking?

Where 0 = Not consistent (e.g. I do it once in a while) and 10 = Very consistent (e.g. I do it about everyday)

Not consistent Very consistent

0 1 2 3 4 5 6 7 8 9 10

() 

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.15 In general, **how consistent** were you with your self-tracking?

Where 0 = Not consistent (e.g. I did it once in a while) and 10 = Very consistent (e.g. I did it about everyday)

Not consistent Very consistent

0 1 2 3 4 5 6 7 8 9 10

() 

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Q2.16 **What makes it easy** for you track **consistently**?

- ☐ It is easy to use
- ☐ I enjoy it
- ☐ It teaches me things
- ☐ Other people I know are doing it too
- ☐ It keeps me motivated
- ☐ I like seeing my data
- ☐ It has become part of my routine
- ☐ Nothing makes it easy
- ☐ Other (please explain)

_____

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.17 **What made it easy** for you track **consistently**?

- ☐ It was easy to use
- ☐ I enjoyed it
- ☐ It taught me things
- ☐ Other people I know were doing it too
- ☐ It kept me motivated
- ☐ I liked seeing my data
- ☐ It became part of my routine
- ☐ Nothing made it easy
- ☐ Other (please explain)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Q2.18 **What makes it hard** for you to track **consistently**? [Select all that apply]

- ☐ I forget to charge the device
- ☐ It is uncomfortable to wear
- ☐ I forget to wear it / turn it on
- ☐ I don't like seeing my data
- ☐ Other people don't like that I use it
- ☐ I don't enjoy it
- ☐ I lose interest
- ☐ It is hard to use
- ☐ I don't know what to do with it
- ☐ It's not always accurate
- ☐ Nothing makes it hard
- ☐ Other (please explain)

_____

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.19 **What made it hard** for you to track **consistently**? [Select all that apply]

- [ ] I forgot to charge the device
- [ ] It was uncomfortable to wear
- [ ] I forgot to wear it / turn it on
- [ ] I didn't like seeing my data
- [ ] Other people didn't like that I used it
- [ ] I didn't enjoy it
- [ ] I lost interest
- [ ] It was hard to use
- [ ] I didn't know what to do with it
- [ ] It wasn't always accurate
- [ ] Nothing made it hard

☐ Other (please explain)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Q2.20 Which of the following best describes how you **think about** your health and physical activity **data**? [Select all that apply]

☐ It helps me to achieve my goals

☐ It motivates me

☐ It makes me feel supported

☐ It helps me to connect with other people

☐ It gives me something to do

☐ It teaches me something new

☐ It confirms what I already know

☐ It makes me feel judged

☐ It defines who I am

☐ I don't think about it much

☐ Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.21 Which of the following best describes how you **thought about** your health and physical activity **data**? [Select all that apply]

☐ It helped me to achieve my goals

☐ It motivated me

☐ It made me feel supported

☐ It helped me to connect with other people

☐ It gave me something to do

☐ It taught me something new

☐ It confirmed what I already knew

☐ It made me feel judged

☐ It defined who I was

☐ I didn’t think about it much

☐ Other (please describe)

_____

Display This Question:

If Q2.2 = Yes, I currently use a device/app to track my health and activity data

Or Q2.2 = Yes, I used to use a device/app to track my health and activity data but I don't anymore

Q2.22 Have you **ever shared** your self-tracked health and physical activity data with anyone? (Including posting on social media)

○ Yes

○ No

Display This Question:

If Q2.22 = Yes

Q2.23 **Who** have you shared self-tracked health and physical activity data with? [Select all that apply]

☐ Friends

☐ Parents / carers

☐ Siblings

☐ Other family members

☐ Healthcare professionals (doctors, nurses)

☐ Sports coaches or teachers

☐ On social media (e.g. Facebook, Instagram, TikTok)

☐ Other (please specify)

_____

Q2.24 Have you ever **seen someone else's** self-tracked health and physical activity data shared on social media?

○ Yes

○ No

Display This Question:

If Q2.2 != No, I have never used a device/app to track my health and activity data

Q2.25 When thinking about self-tracking health and physical activity on digital devices/apps, **how important** are these things to you?

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
It is affordable	○	○	○	○	○
It is easy to use	○	○	○	○	○
It is easy to share my data with others	○	○	○	○	○
It is easy to go back and look at my data from past weeks/months/years	○	○	○	○	○
It is easy to connect with others through social features	○	○	○	○	○
My data is private	○	○	○	○	○
My data is accurate	○	○	○	○	○

Display This Question:

If Q2.2 = No, I have never used a device/app to track my health and activity data

Q2.26 If you were to think about self-tracking health and physical activity on digital devices/apps, **how important** would these things be to you?

	Extremely important (21)	Very important (22)	Moderately important (23)	Slightly important (24)	Not at all important (25)
It is affordable	○	○	○	○	○
It is easy to use	○	○	○	○	○
It is easy to share my data with others	○	○	○	○	○
It is easy to compare my data with others'	○	○	○	○	○
It is easy to go back and look at my data from past weeks/months/years	○	○	○	○	○
It is easy to connect with others through social features	○	○	○	○	○
My data is private	○	○	○	○	○
My data is accurate	○	○	○	○	○

Q2.27 Does **anyone you live** with use a device or app to track data about their health and physical activity?

- ○ Yes
- ○ No

End of Block: Self-Tracking

Start of Block: COVID-19

Q3.1 Has the **way you think about self-tracking** health and physical activity changed during the **COVID-19 pandemic**?

- ○ Not at all
- ○ To a small extent
- ○ To some extent
- ○ To a moderate extent
- ○ To a large extent

Q3.2 Can you use this space to briefly **tell us more**?

_____

_____

_____

_____

_____

Q3.3 Which of the following have **influenced the way you think about self-tracking** of health and physical activity during the COVID-19 pandemic? [Select all that apply]

- ☐ Nothing
- ☐ Lockdown restrictions
- ☐ School / university / work closures
- ☐ Working from home
- ☐ Connecting with friends/colleagues
- ☐ Mental health considerations
- ☐ Wanting to monitor physical activity
- ☐ Other _____

End of Block: COVID-19

Start of Block: Physical Activity and School

Display This Question:

If Q1.6 = I am a secondary school / college student

Q4.1 Outside school hours: **How often** do you usually **exercise in your free time** so much that you get out of breath or sweat?

- ○ Never
- ○ Less than once a month
- ○ Once a month
- ○ Once a week
- ○ Two to three times a week
- ○ Four to six times a week
- ○ Every day

Display This Question:

If Q1.6 = I am a secondary school / college student

Q4.2 Outside school hours: How many **hours a week** do you usually **exercise in your free time** so much that you get out of breath or sweat?

- ○ None
- ○ About half an hour
- ○ About one hour
- ○ About two to three hours
- ○ About four to six hours
- ○ About seven hours or more

Display This Question:

If Q1.6 = I am a secondary school / college student

Q4.3 Does your **school/college allow you to use your mobile phone** during school hours?

- ○ Yes
- ○ No

Display This Question:

If Q1.6 = I am a secondary school / college student

Q4.4 Does your **school/college provide, or encourage you to use, devices or apps** that track data about your health and physical activity (e.g. during Physical Education classes)?

- ○ Yes
- ○ No

End of Block: Physical Activity and School

Start of Block: Physical Activity and Work/Home

Display This Question:

If Q1.6 != I am a secondary school / college student

Q5.1 **How often** do you usually **exercise in your free time** so much that you get out of breath or sweat?

- ○ Never
- ○ Less than once a month
- ○ Once a month
- ○ Once a week
- ○ Two to three times a week
- ○ Four to six times a week
- ○ Every day

Display This Question:

If Q1.6 != I am a secondary school / college student

Q5.2 How many **hours a week** do you usually **exercise in your free time** so much that you get out of breath or sweat?

- ○ None
- ○ About half an hour
- ○ About one hour
- ○ About two to three hours
- ○ About four to six hours
- ○ About seven hours or more

End of Block: Physical Activity and Work/Home

Start of Block: Iowa-Netherlands Comparison Orientation Measure (INCOM)

Q6.1 Most people compare themselves from time to time with others. For example, they may compare the way they feel, their opinions, their abilities, and/or their situation with those of other people.

There is nothing particularly 'good' or 'bad' about this type of comparison, and some people do it more than others.

We would like to find out how often you compare yourself with other people. To do that we would like to ask you to indicate how much you agree with each statement below.

	I disagree strongly	I disagree	I neither agree nor disagree	I agree	I agree strongly
I often compare myself with others with respect to what I have accomplished in life.	○	○	○	○	○

If I want to learn more about something, I try to find out what others think about it.	○	○	○	○	○
I always pay a lot of attention to how I do things compared with how others do things.	○	○	○	○	○
I often compare how my loved ones (boy or girlfriend, family members, etc.) are doing with how others are doing.	○	○	○	○	○
I always like to know what others in a similar situation would do.	○	○	○	○	○
I am not the type of person who compares often with others.	○	○	○	○	○
If I want to find out how well I have done something, I compare what I have done with how others have done.	○	○	○	○	○
I often try to find out what others think who face similar	○	○	○	○	○

problems as I face.					
I often like to talk with others about mutual opinions and experiences.	○	○	○	○	○
I never consider my situation in life relative to that of other people.	○	○	○	○	○
I often compare how I am doing socially (e.g., social skills, popularity) with other people.	○	○	○	○	○

End of Block: Iowa-Netherlands Comparison Orientation Measure (INCOM)

Start of Block: Warwick-Edinburgh Mental Wellbeing Scale

Q7.1 Below are some statements about feelings and thoughts. Please select the answer that best describes your experience of each over the last 2 weeks.

	None of the time	Rarely	Some of the time	Often	All of the time
I've been feeling optimistic about the future	○	○	○	○	○
I've been feeling useful	○	○	○	○	○
I've been feeling relaxed	○	○	○	○	○

I've been feeling interested in other people	○	○	○	○	○
I've had energy to spare	○	○	○	○	○
I've been dealing with problems well	○	○	○	○	○
I've been thinking clearly	○	○	○	○	○
I've been feeling good about myself	○	○	○	○	○
I've been feeling close to other people	○	○	○	○	○
I've been feeling confident	○	○	○	○	○
I've been able to make up my own mind about things	○	○	○	○	○
I've been feeling loved	○	○	○	○	○
I've been interested in new things	○	○	○	○	○

I've been feeling cheerful	○	○	○	○	○

Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) © University of Warwick 2006, all rights reserved.

End of Block: Warwick-Edinburgh Mental Wellbeing Scale

Start of Block: Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale

Q8.1 Does your family own a **car, van or truck**?

- ○ No
- ○ Yes, one
- ○ Yes, two or more

Q8.2 Do you have your **own bedroom** for yourself?

- ○ No
- ○ Yes

Q8.3 **How many computers** does your family own (including laptops and tablets, not including games consoles and smartphones)?

- ○ None
- ○ One
- ○ Two
- ○ More than two

Q8.4 **How many bathrooms** (room with a bath/shower or both) are there in your home?

- ○ None
- ○ One
- ○ Two
- ○ More than two

Q8.5 Does your family have a **dishwasher** at home?

- ○ No
- ○ Yes

Q8.6 Before COVID-19, how many times on average did you and your family **go abroad for a holiday** in a year?

- ○ Never
- ○ Once
- ○ Twice
- ○ Three or more times

End of Block: Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale

Start of Block: Future Recruitment/Prize Draw

Q9.1 [Optional] If you are happy to be **contacted about participating in future studies** on this topic, please leave your **email address** below.

Note: You will be compensated with an Amazon voucher for your time if you decide to participate in these future studies.

_____

Q9.2 If you would like to **enter the prize draw** for this study, please leave your **email address** below.

The terms and conditions for this prize draw can be found here.

_____

End of Block: Future Recruitment/Prize Draw

Appendix D: Sample Interview Guides

[Note: Questions excluded from interviews with 13-15 year-olds in order to allow for a shorter interview duration are indicated by greyed out text]

SELF-TRACKING USERS – CURRENT

Introduction

Hi [name], it's so nice to meet you! How are you today?

Thank you so much for agreeing to speak with me today. I'm Jaimie and I'm a researcher at Oxford running this study. Firstly, I want to thank you so much for completing the survey. We really appreciate it.

Before we begin, I want to talk about some important things around confidentiality and safeguarding before we start with the interview. You might have seen those on the information sheet already, but just to make sure that they're clear.

Firstly, I do not expect the interview to be upsetting, but since we are studying the psychological and social impacts of self-tracking, there is a chance you might find talking about this a bit upsetting. So if that happens and you need a moment, please just let me know and we'll pause. You also don't have to share anything you do not want to, and you can stop at any time. In case you feel upset during or after the interview, please let me know and, if needed, I'll make sure that you receive appropriate support.

Secondly, as for confidentiality — as you know, what we discuss today will be kept confidential and only shared with the research team for the purposes of the study. The only case where I would need to break confidentiality is if I was concerned that either you or someone else was in risk of serious or imminent harm and I needed to notify someone to intervene.

Do you want to ask me anything about these? Is everything clear?

I will ask more about this later but, in your survey answers, you said that you currently self-track. Is that right?

To let you know what this interview will involve, we are very interested to hear your whatever you are happy to share about your experience with self-tracking – what you like, what you don't like, what you wish could be different. I will be asking you a series of questions (a lot of which might be similar to the questions you answered on the survey). There are absolutely no right or wrong answers and nothing is too big or too small to mention. I'm not looking for you to say anything in particular or answer in any specific way. I'm interested in what you *honestly* think.

As I mentioned before, if you feel uncomfortable talking about your personal experience, you can of course choose to not answer the question. You can speak hypothetically if that is more comfortable for you. For example, you can say things like "someone might like this or not like that" or "my friends think that this is great".

Okay now that all of that is out of the way, I will start recording now if that's okay with you?

Self-Tracking

1. I know I have used the word self-tracking a few times already. If you were to describe what self-tracking means to you to a friend who didn't know anything about it, what would you say?
2. Have you heard much about self-tracking before you participated in this study?
3. I'm now going to ask a little bit about any experience you have of self-tracking your health and physical activity.
    a. What devices or apps have you used?
    b. What are you interested in tracking? (Steps, running speed, running distance etc.)
    c. How specific would you say you are with your tracking?
    d. How long have you been self-tracking your health and physical activity?
    e. When did you start self-tracking?
    f. Why did you start self-tracking?
    g. Have you ever stopped self-tracking?
        a. Why did you stop self-tracking?
    h. Why do you keep self-tracking?
        a. Is it important to you?
    i. Has how you use it changed since you first started?
    j. What do you like most about it?
    k. What do you like least about it?
    l. Is there anything that has surprised you about it?
    m. Is there anything you would change about it?
    n. Is there anything else you wish it could do?
    o. How trustworthy do you find the device/app?
    p. Can you describe a day wearing your device or using your app?
4. Do any of your friends self-track? Do any of your family self-track?
    a. What do they think about it? What do they say about it?
    b. Do you ever share your data together? What do you talk about? How does this make you feel? How do you share these data (e.g., online, text messages, in person)?
5. Do you ever go back and look at your data?
    a. What do you do with it?
    b. What goes through your head when you look at your data?
    c. How often do you look at your data like that?
6. Have you ever found any differences between what your data told you and what you thought your health and physical activity had been?
    a. What do you think could explain that?
    b. How did that make you feel?
7. Do you feel that self-tracking has taught you anything?
8. What kinds of activities do you like to do?
    a. Is that usually on your own or with other people?
    b. Do these fit well with tracking?

    c. Compared to before you started tracking, do you think self-tracking adds anything or took anything away from the experience of [activity]?
9. Can you imagine what would change for you if you didn't track your health and physical activity anymore?
10. When you are tracking, how concerned are you about the privacy of your data or your data being sold?

Self-Tracking and Wellbeing

11. What benefits have you seen from self-tracking?
12. How has self-tracking made you feel good?
13. What have you found frustrating or disappointing about self-tracking?
14. Has self-tracking ever had any negative effects on you?
15. What do you think it means to have good wellbeing?
16. What do you think it means to be healthy?
17. Do you feel as if health and fitness is a big part of your life?
    a. Are other things more important to you?

COVID-19

18. Has COVID-19 changed anything about your self-tracking?
    a. Could you tell me a bit more about that?
19. Have you been self-tracking more/less/the same during COVID-19?
20. Has COVID-19 changed the way you think about being healthy?

Social Comparisons

21. Have you ever shared your self-tracked data with other people (e.g., teachers/doctors/friends/family)?
22. Can you describe a situation where you might have talked about your self-tracked data with other people (e.g., teachers/doctors/friends/family)?
    a. How did this make you feel?
23. Is there anyone that you wouldn't want to share your self-tracked data with (e.g., teachers/doctors/friends/family)?
24. Why have you (not) chosen to share your self-tracked data with other people?
25. Have you connected with new people/made new friends because of your self-tracking?
26. How much health and fitness content do you see on social media/the Internet generally?
    b. How does that make you feel?
    c. Is it relevant to you?

Self-Tracking in Schools [If Student]

27. Have your teachers ever asked you to use self-tracking at school?
    a. How would you feel if they did?
    b. How do you imagine this could be done?
    c. What might be some of the benefits of this?
    d. And what might be some of the challenges?
28. Does your school let you use your [insert app/device name] during school time?
    e. Are there certain times/places you aren't allowed to use your [insert app/device name] at school?

Anything else?

29. Is there anything else I haven't asked about that you want to tell me about?

Thank you so much for taking part in the interview today – that's all done. I'll stop the recording now.

How are you feeling after the interview? Do you have any questions for me?

SELF-TRACKING USERS – PREVIOUS

Introduction

Hi [name], it's so nice to meet you! How are you today?

Thank you so much for agreeing to speak with me today. I'm Jaimie and I'm a researcher at Oxford running this study. Firstly, I want to thank you so much for completing the survey. We really appreciate it.

Before we begin, I want to talk about some important things around confidentiality and safeguarding before we start with the interview. You might have seen those on the information sheet already, but just to make sure that they're clear.

Firstly, I do not expect the interview to be upsetting, but since we are studying the psychological and social impacts of self-tracking, there is a chance you might find talking about this a bit upsetting. So if that happens and you need a moment, please just let me know and we'll pause. You also don't have to share anything you do not want to, and you can stop at any time. In case you feel upset during or after the interview, please let me know and, if needed, I'll make sure that you receive appropriate support.

Secondly, as for confidentiality — as you know, what we discuss today will be kept confidential and only shared with the research team for the purposes of the study. The only case where I would need to break confidentiality is if I was concerned that either you or someone else was in risk of serious or imminent harm and I needed to notify someone to intervene.

Do you want to ask me anything about these? Is everything clear?

I will ask more about this later but, in your survey answers, you said that you have previously self-tracked. Is that right?

To let you know what this interview will involve, we are very interested to hear your whatever you are happy to share about your experience with self-tracking – what you like, what you don't like, what you wish could be different. I will be asking you a series of questions (a lot of which might be similar to the questions you answered on the survey). There are absolutely no right or wrong answers and nothing is too big or too small to mention. I'm not looking for you to say anything in particular or answer in any specific way. I'm interested in what you *honestly* think.

As I mentioned before, if you feel uncomfortable talking about your personal experience, you can of course choose to not answer the question. You can speak hypothetically if that is more comfortable for you. For example, you can say things like "someone might like this or not like that" or "my friends think that this is great".

Okay now that all of that is out of the way, I will start recording now if that's okay with you?

Self-Tracking

1. I know I have used the word self-tracking a few times already. If you were to describe what self-tracking means to you to a friend who didn't know anything about it, what would you say?
2. Have you heard much about self-tracking before you participated in this study?

3. I'm now going to ask a little bit about any experience you have of self-tracking your health and physical activity.
    a. What devices or apps have you used?
    b. What were you interested in tracking? (Steps, running speed, running distance etc.)
    c. How specific were you with your tracking?
    d. How long did you self-track your health and physical activity?
        a. Was it consistent during that time or more on-and-off?
    e. When did you start self-tracking?
    f. When did you stop self-tracking?
    g. Why did you start self-tracking?
    h. Why did you stop self-tracking?
    i. Did how you used it change from when you first started?
4. What did you liked most about self-tracking?
5. What did you liked least about self-tracking?
6. Is there anything that surprised you about it?
7. Is there anything you would have changed about it?
8. Is there anything else you wished it could do?
9. How trustworthy did you find the device/app?
10. Can you describe what a day looked like when you were wearing your device or using your app?
11. Is there anything that might make you want to restart self-tracking?
12. Do any of your friends self-track? Do any of your family self-track?
    a. What do they think about it? What do they say about it?
    b. Did you ever share your data together? What did you talk about? How did this make you feel? How do you share these data (e.g., online, text messages, in person)?
13. Did you ever go back and look at your data?
    a. What did you do with it?
    b. What went through your head when you looked at your data?
    c. How often did you look at your data like that?
14. Did you ever find any differences between what your data told you and what you thought your health and physical activity had been?
    a. What do you think could have explained that?
    b. How did that make you feel?
15. Do you feel that self-tracking taught you anything?
16. What kinds of activities did you like to do?
    a. Is that usually on your own or with other people?
    b. Did these fit well with tracking?
    c. Compared to before you started tracking, do you think self-tracking added anything or took anything away from the experience?
17. What has changed for you now that you don't track your health and physical activity anymore?
18. When you were tracking, how concerned were you about the privacy of your data or your data being sold?

Self-Tracking and Wellbeing

19. What benefits did you seen from self-tracking?
20. How did self-tracking made you feel good?
21. What did you find frustrating or disappointing about self-tracking?

22. Did self-tracking ever had any negative effects on you?
23. What do you think it means to have good wellbeing?
24. What do you think it means to be healthy?
25. Do you feel as if health and fitness is a big part of your life?
    a. Are other things more important to you?

COVID-19

26. Has COVID-19 changed anything about the way you think about self-tracking?
    a. Could you tell me a bit more about that?
27. [If appropriate] Was your self-tracking more/less/the same during COVID-19?
28. Has COVID-19 changed the way you think about being healthy?

Social Comparisons

29. Did you ever shared your self-tracked data with other people (e.g., teachers/doctors/friends/family)?
30. Can you describe a situation where you might have talked about your self-tracked data with other people (e.g., teachers/doctors/friends/family)?
    a. How did this make you feel?
31. Is there anyone that you wouldn't want to share your self-tracked data with (e.g., teachers/doctors/friends/family)?
32. Why have you (not) chosen to share your self-tracked data with other people?
33. Have you connected with new people/made new friends because of your self-tracking?
34. How much health and fitness content do you see on social media/the Internet generally?
    a. How does that make you feel?
    b. Is it relevant to you?

Self-Tracking in Schools [If Student]

35. Have your teachers ever asked you to use self-tracking at school?
    a. How would you feel if they did?
    b. How do you imagine this could be done?
    c. What might be some of the benefits of this?
    d. And what might be some of the challenges?
36. Did your school let you use your [insert app/device name] during school time?
    a. Are there certain times/places you aren't allowed to use your [insert app/device name] at school?

Anything else?

37. Is there anything else I haven't asked about that you want to tell me about?

Thank you so much for taking part in the interview today – that's all done. I'll stop the recording now.

How are you feeling after the interview? Do you have any questions for me?

SELF-TRACKING NON-USERS

Introduction

Hi [name], it's so nice to meet you! How are you today?

Thank you so much for agreeing to speak with me today. I'm Jaimie and I'm a researcher at Oxford running this study. Firstly, I want to thank you so much for completing the survey. We really appreciate it.

Before we begin, I want to talk about some important things around confidentiality and safeguarding before we start with the interview. You might have seen those on the information sheet already, but just to make sure that they're clear.

Firstly, I do not expect the interview to be upsetting, but since we are studying the psychological and social impacts of self-tracking, there is a chance you might find talking about this a bit upsetting. So if that happens and you need a moment, please just let me know and we'll pause. You also don't have to share anything you do not want to, and you can stop at any time. In case you feel upset during or after the interview, please let me know and, if needed, I'll make sure that you receive appropriate support.

Secondly, as for confidentiality — as you know, what we discuss today will be kept confidential and only shared with the research team for the purposes of the study. The only case where I would need to break confidentiality is if I was concerned that either you or someone else was in risk of serious or imminent harm and I needed to notify someone to intervene.

Do you want to ask me anything about these? Is everything clear?

I will ask more about this later but, in your survey answers, you said that you haven't self-tracked before. Is that right?

To let you know what this interview will involve, we are very interested to hear your whatever you are happy to share about your experiences. I will be asking you a series of questions (a lot of which might be similar to the questions you answered on the survey). There are absolutely no right or wrong answers and nothing is too big or too small to mention. I'm not looking for you to say anything in particular or answer in any specific way. I'm really interested in what you *honestly* think.

As I mentioned before, if you feel uncomfortable talking about your personal experience, you can of course choose to not answer the question. You can speak hypothetically if that is more comfortable for you. For example, you can say things like "someone might like this or not like that" or "my friends think that this is great".

Okay now that all of that is out of the way, I will start recording now if that's okay with you?

Self-Tracking

1. I know I have used the word self-tracking a few times already. If you were to describe what self-tracking means to you to a friend who didn't know what it meant, what would you say?
2. Have you heard much about self-tracking before you participated in this study?
3. Have you ever thought about self-tracking?

4. Why have you decided not to self-track?
5. What do you think would motivate you to self-track? (If anything)
6. Is there anything that worries you about self-tracking?
7. Do any of your friends self-track? Do any of your family self-track?
    a. What do they think about it? What do they say about it?
8. Can you imagine what would change for you if you started tracking your health and physical activity?
9. Do you do any sports or physical activities?
    a. What do you enjoy about them?
    b. Is that usually on your own or with other people?
    c. Is there something that stops you? Do you prefer to do other things instead?

Self-Tracking and Wellbeing

10. What benefits do you think there might be from self-tracking?
11. How might self-tracking make people feel good?
12. What might people find frustrating or disappointing about self-tracking?
13. Do you think that self-tracking can ever have negative effects on people?
14. What do you think it means to have good wellbeing?
15. What do you think it means to be healthy?
16. Do you feel as if health and fitness is a big part of your life?
    a. Are other things more important to you?

COVID-19

17. Has COVID-19 changed anything about the way you think about self-tracking?
    a. Could you tell me a bit more about that?
18. Has COVID-19 changed the way you think about being healthy?

Social Comparisons

19. Why do you think people might choose to share their self-tracked data with other people?
    a. Do you like that idea?
20. Can you see any benefits to sharing data like this?
21. Can you see any problems with sharing data like this?
22. How much health and fitness content do you see on social media/the Internet generally?
    b. How does that make you feel?
    c. Is it relevant to you?

Self-Tracking in Schools

23. Have your teachers ever asked you to use self-tracking at school?
    a. How would you feel if they did?
    b. How do you imagine this could be done?
    c. What might be some of the benefits of this?
    d. And what might be some of the challenges?
24. Does your school let you use students use self-tracking tools during school time?
    e. Are there certain times/places they aren't allowed to use them at school?

Anything else?

25. Is there anything else I haven't asked about that you want to tell me about?

Thank you so much for taking part in the interview today – that's all done. I'll stop the recording now.

How are you feeling after the interview? Do you have any questions for me?

Appendix E: Templates of Co-Design Workshop Activities

The following pages contain the templates for the Miro online whiteboards used in the Series A and Series B workshops.

[THE REMAINDER OF THIS PAGE HAS BEEN LEFT INTENTIONALLY BLANK]

Series A (Exploratory Content Co-Design Workshops):

WELCOME



GROUND RULES:

1. **You are all experts**. Everyone here is an important designer and researcher in this workshop. We are working together to create the best experience for young people if they are self-tracking.
2. **Everyone's opinion is equally important**. We listen to everyone and respect each other's points of view. We can of course disagree with ideas, but we should do this respectfully. We want to hear as many different perspectives as possible.
3. **This isn't a test.** There are no right and wrong answers and no idea is too small or too big to mention.
4. **You can take a break anytime**. You don't need to ask permission to step away for a moment if you need a break. We will also have a break during the workshop so that you can make a cup of tea, go for a walk, cuddle your pets!

WHAT TO EXPECT:

1. We would love for you to **have video and audio on as much as you are comfortable.** We think the best ideas come when we all think together and share our thoughts with others. We will work together in lots of different ways–writing on sticky notes, drawing pictures, commenting or adding emojis, talking and listening to each other.
2. We will have a short introduction task followed by **three main activities**. The workshop will take around **90 minutes** overall.
3. **You don't have to have had any experience with self-tracking to participate.** These workshops are about how you think future young people would like to experience self-tracking apps and devices.
4. **All of your responses on our shared whiteboard will be anonymous**. No one will know who wrote what.
5. These workshops will be **audio and video-recorded** and we will keep everything that we produce together on our shared whiteboard. In any published papers, everything that you write and say will be completely anonymous and you will not be individually named in any work.

FIRST ACTIVITY:

Complete this short set of questions here:
https://oii.qualtrics.com/jfe/form/SV_25MzSbJjSESPCnk.

You will have about 10 minutes to complete this.
When you have finished, write "Done" in the chat!

Things you can do on the boards:

- Add stickies
- Add emoijs or comments on other people's stickies
- Draw arrows to show connections between ideas
- Use dots to vote in polls

?

INTRODUCTIONS

In this first activity, we are going to introduce ourselves. We'll take it in turns to share our names and then tell everyone what our favourite place in the UK is. That might be somewhere you've visited on holiday, your favourite local restaurant, or even a nice park you've been to.

Then, we are going to ask for an anonymous vote so you can tell us a bit more about the experience you have with self-tracking (even if that's none at all!)



ENDLESS SUPPLY OF STICKIES



Where is my favourite place in the UK?

Name	Favourite Place
Jaimie	

Name	Favourite Place
Amanda	

ENDLESS SUPPLY OF STICKIES



Self-tracking allows people to monitor, record and analyse information about their health and physical activity, such as sleep, calorie intake, heart rate and exercise.

Have you ever looked at your phone to see how many steps you've taken in a day? Have you ever used a fitness tracker to find out how far or how fast you ran? That is self-tracking.

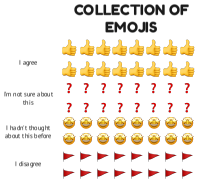
Words that come to mind when you think about self-tracking

Any questions you've ever had about self-tracking



ENDLESS SUPPLY OF STICKIES





ENDLESS SUPPLY OF STICKIES



COLLECTION OF EMOJIS

I agree

I'm not sure about this

I hadn't thought about this before

I disagree

ACTIVITY 1: HOW DO DIFFERENT PEOPLE SELF-TRACK?

Below you will see some vague descriptions of different people. How do you think they would track? What impact would this have on them? You can choose any of the people to answer for (and you can choose more than one). Imagine you are them: how would you answer the questions below?

Why am I tracking?
What makes tracking easy for me?
What makes tracking hard for me?
How does tracking impact my mood?
Who, if anyone, do I talk to about my tracking? (How do I do this?)

COLLECTION OF EMOJIS

I agree

I'm not sure about this

I hadn't thought about this before

I disagree

DOT BANK

ENDLESS SUPPLY OF STICKIES

A keen teenage athlete who plays sports competitively at school

What do I use to track?	
Smartphone app (e.g. Strava)	
Smartwatch or wearable (e.g. Fitbit)	
Connected health tools (e.g. weight scales)	
Connected exercise tools (e.g. Peloton)	
Other (add details as sticky note)	

How often do I track?	
A few times a day	
Once a day	
A few times a week	
Once a week	
Every once in a while (e.g. when I remember to)	
Other (add details as sticky note)	

A teenager who doesn't normally enjoy physical activity but decided to start tracking during lockdown

What do I use to track?	
Smartphone app (e.g. Strava)	
Smartwatch or wearable (e.g. Fitbit)	
Connected health tools (e.g. weight scales)	
Connected exercise tools (e.g. Peloton)	
Other (add details as sticky note)	

How often do I track?	
A few times a day	
Once a day	
A few times a week	
Once a week	
Every once in a while (e.g. when I remember to track)	
Other (add details as sticky note)	

A teenager who is interested in tracking food/calories

What do I use to track?	
Smartphone app (e.g. Strava)	
Smartwatch or wearable (e.g. Fitbit)	
Connected health tools (e.g. weight scales)	
Connected exercise tools (e.g. Peloton)	
Other (add details as sticky note)	

How often do I track?	
A few times a day	
Once a day	
A few times a week	
Once a week	
Every once in a while (e.g. when I remember to track)	
Other (add details as sticky note)	

DOT BANK

ENDLESS SUPPLY OF STICKIES

A teenager who is just curious (e.g. phone was doing it anyway)

What do I use to track?	
Smartphone app (e.g. Strava)	
Smartwatch or wearable (e.g. Fitbit)	
Connected health tools (e.g. weight scales)	
Connected exercise tools (e.g. Peloton)	
Other (add details as sticky note)	

How often do I track?	
A few times a day	
Once a day	
A few times a week	
Once a week	
Every once in a while (e.g. when I remember to track)	
Other (add details as sticky note)	

CREATE YOUR OWN (Who have we missed?)

What do I use to track?	
Smartphone app (e.g. Strava)	
Smartwatch or wearable (e.g. Fitbit)	
Connected health tools (e.g. weight scales)	
Connected exercise tools (e.g. Peloton)	
Other (add details as sticky note)	

How often do I track?	
A few times a day	
Once a day	
A few times a week	
Once a week	
Every once in a while (e.g. when I remember to track)	
Other (add details as sticky note)	

CREATE YOUR OWN (Who have we missed?)

What do I use to track?	
Smartphone app (e.g. Strava)	
Smartwatch or wearable(e.g. Fitbit)	
Connected health tools (e.g. weight scales)	
Connected exercise tools (e.g. Peloton)	
Other (add details as sticky note)	

How often do I track?	
A few times a day	
Once a day	
A few times a week	
Once a week	
Every once in a while (eg. when I remember to track)	
Other (add details as sticky note)	

DOT BANK

ENDLESS SUPPLY OF STICKIES

ACTIVITY 2: WHAT ARE THE IMPORTANT FEATURES AND EFFECTS OF SELF-TRACKING?

Like before, you will see a series of boxes below. We are going to ask about some of the features you like and dislike about self-tracking tools. If you have never tracked before, you can tell us about features that might interest you or what might concern you.

We are then going to talk about some of the effects of self-tracking. Can you think of any links between these features and the effects?

Finally, we will talk about what we think could be done differently with self-tracking tools. If you have never tracked, is there anything you would want to track that can't be tracked at the moment?





Best Things

What are the best features for me? | What features interest me most?

Features

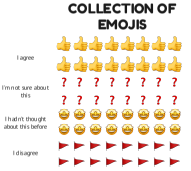
Some examples...



Worst Things

What are the worst features for me? | What features concern me most?





Effects

Can you see any links between the features and the effects?

Social

How does it fit with my social life? | How would it fit into my life?

Feelings

Does it affect how I feel about myself? How does it do that? | How could it change how I feel about myself?



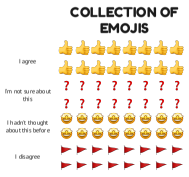






What could be different?

What could it do differently to work better for me? | What would I like to see that isn't currently available?









ACTIVITY 3: HOW CAN WE DESIGN A USER GUIDE FOR TEENS?

In this final task, we are going to think about the information teens are given before they start self-tracking. What's missing? What would you have liked to know? If you haven't tracked before, what do you think it would be useful to learn more about?

This is our chance to bring everything we've done today together. This is about building something for future young people. How can we improve what we have at the moment?

What do I wish I had known?

What would I like to know?

What would I like to tell others?

How do I think this should be presented? What's important to think about?

What would I want schools or parents to know?

Anything else?

COLLECTION OF EMOJIS



ENDLESS SUPPLY OF STICKIES



COLLECTION OF EMOJIS



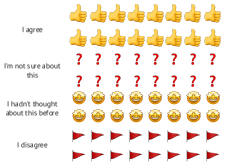
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ENDLESS SUPPLY OF STICKIES



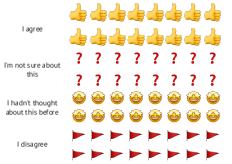
COLLECTION OF EMOJIS



ENDLESS SUPPLY OF STICKIES



COLLECTION OF EMOJIS



Series B (Reflexive Prototype Design Workshops):

COLLECTION OF EMOJIS

I like this

This is great!

I dislike this

I'm not sure about this

ENDLESS SUPPLY OF STICKIES



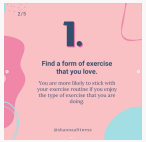
do you currently use IG?

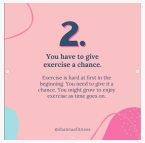
Do you see these guides on your feed?

thoughts on existing guides?

do you have any examples you find particularly good?



























handle / name ideas!

put any ideas about names here!

COLLECTION OF EMOJIS

I like this

👍 👍 👍 👍 👍 👍 👍 👍
👍 👍 👍 👍 👍 👍 👍 👍

This is great!

🤩 🤩 🤩 🤩 🤩 🤩 🤩 🤩
🤩 🤩 🤩 🤩 🤩 🤩 🤩 🤩

I dislike this

👎 👎 👎 👎 👎 👎 👎 👎
👎 👎 👎 👎 👎 👎 👎 👎

I'm not sure about this

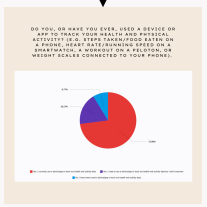
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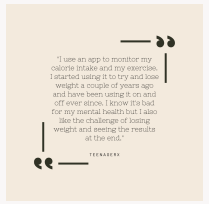
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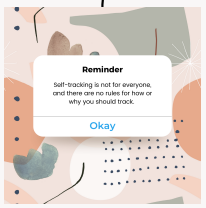






















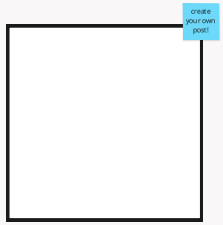












COLLECTION OF EMOJIS

I like this

This is great!

I dislike this

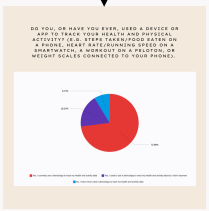
I'm not sure about this

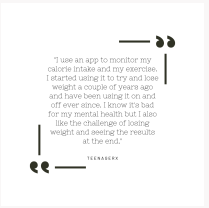
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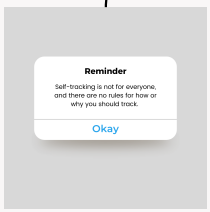










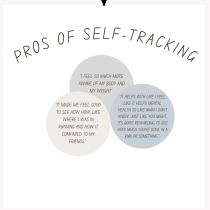












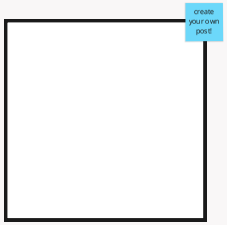












Liked

Disliked



Would have liked to see

Words to describe how you felt during the workshops/focus groups

Appendix F: Sample Information Sheets and Consent Forms

The following pages outline a sample of the information sheets and consent forms for the online survey activity in this project. The forms for the other activities followed this template with additional details relevant to the specifics of each research activity. Participants signed a new consent form for each new activity in which they participated. These documents appear in the following order:

1. Consent form for adolescents aged 16 years or over
2. Information sheet for adolescents aged 16 years or over
3. Consent form for parents of adolescents under the age of 16 years
4. Information sheet for parents of adolescents under the age of 16 years
5. Assent form for adolescents under the age of 16 years
6. Information sheet for adolescents under the age of 16 years

Please note: the CUREC reference number R75812/RE004 listed on these documents was correct at the time that these documents were signed. Following the survey, I sought a number of amendments to the project for subsequent research activities and these approvals were reflected in updated CUREC reference numbers. The updated CUREC reference number (as described in the body of the thesis) is R75812/RE006.

Survey Consent Form for Adolescents Aged 16 Years or Over

Start of Block: Informed Consent

Q1.1

Informed Consent Form (for those aged 16+)
Understanding the Social and Psychological Wellbeing Implications of Adolescents' Digital Self-Tracking Practices
Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee Approval Reference: R75812/RE004

Thank you for considering taking part in this study. Please complete this form after you have read the Information Sheet and/or received an explanation about the research.

If you have any questions arising from the information sheet, please contact project researcher Jaimie Freeman before you decide whether you would to participate (jaimie.freeman@oii.ox.ac.uk).

Page Break

End of Block: Informed Consent

Start of Block: Consent Options

Q2.1 I confirm that I understand that by ticking each box I am consenting to the

respective element of the study. I understand that it will be assumed that unticked

boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element I may be deemed ineligible for the study.

○ I understand (1)

○ I do not understand (2)

Q2.2 Please click on all the statements that apply.

☐ I confirm that I have read and understood the information sheet for this study. I have had the opportunity to consider the information and to ask the researcher questions about my participation. (1)

☐ I understand that participation in this study is entirely voluntary and that I can withdraw at any time without giving a reason and without adverse consequences or penalty. (17)

☐ I understand that this study has been reviewed by, and received ethics clearance through, the University of Oxford Social Sciences and Humanities Interdivisional Research Ethics Committee. (2)

☐ I understand that by participating in the study I will be invited to take part in a short online survey lasting 10-15 minutes. (4)

☐ I understand that confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached. (3)

☐ I understand that members of the project team will have access to the data I provide and that all the data will be stored securely in keeping with the regulations of the University of Oxford. (12)

☐ I understand that the findings of this research will be published and presented in journal articles, University publications, books, conferences, and other dissemination events. (5)

☐ I am happy for aggregate data and verbatim quotes from my survey responses to be included in publication of the study findings. I understand that my name and other identifying details will be anonymised or removed. (6)

☐ I understand how to raise concerns or make a complaint about the study. (7)

☐ I agree to take part in this study. (8)

☐ (optional) I am happy for my contact details to be retained so that the researchers can invite me to participate in follow-up studies to this project. (Note: you will be compensated for your time in future research activities) (11)

☐ (optional) I would like to receive a report by email summarising the findings of this research. (15)

Display This Question:

If Q2.2 != I confirm that I have read and understood the information sheet for this study. I have had the opportunity to consider the information and to ask the researcher questions about my participation.

Or Q2.2 != I understand that this study has been reviewed by, and received ethics clearance through, the University of Oxford Social Sciences and Humanities Interdivisional Research Ethics Committee.

Or Q2.2 != I understand that by participating in the study I will be invited to take part in a short online survey lasting 10-15 minutes.

Or Q2.2 != I understand that confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached.

Or Q2.2 != I understand that members of the project team will have access to the data I provide and that all the data will be stored securely in keeping with the regulations of the University of Oxford.

Or Q2.2 != I understand that the findings of this research will be published and presented in journal articles, University publications, books, conferences, and other dissemination events.

Or Q2.2 != I am happy for aggregate data and verbatim quotes from my survey responses to be included in publication of the study findings. I understand that my name and other identifying details will be anonymised or removed.

Or Q2.2 != I understand how to raise concerns or make a complaint about the study.

Or Q2.2 != I agree to take part in this study.

Q2.3 It seems you have not consented to one or more elements considered essential for taking part in this study. If you think you might have left any boxes unticked by accident, please return to the previous page.

If you have left one ore more boxes unticked because you do not consent to the respective element(s) and want to opt out of this study, that's completely fine. You do not need to consent to anything you do not want to. Just click on the right arrow below to exit the study.

End of Block: Consent Options

Start of Block: Signature

Q3.1 Your full name

_____

Q3.2 Your email address

_____

Q3.3 Please sign here

End of Block: Signature

Oxford Internet Institute
University of Oxford
1 St Giles'
Oxford
OX1 3JS

Professor Gina Neff
gina.neff@oii.ox.ac.uk
Jaimie Lee Freeman [DPhil student]
jaimie.freeman@oii.ox.ac.uk

Understanding the Social and Psychological Wellbeing Implications of Adolescents' Digital Self-Tracking Practices

PARTICIPANT INFORMATION SHEET (For those 16-18 years of age)

Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee reference: R75812/RE004

Why is this research being conducted?

This project is being conducted by researchers at the University of Oxford. We are looking at how teenagers think about and use digital self-tracking tools (e.g., smartwatches, fitness trackers, smartphone apps). This study will help us understand the role of these tools in teenagers' social relationships and psychological wellbeing.

Why have I been invited to take part?

We are inviting you to take part because you are a young person, aged between 13 and 18 years, in the United Kingdom.

Do I have to take part?

No. You can ask questions about the study before deciding whether or not to take part. Your decision to participate is entirely voluntary. You should only consent to take part if you want to and choosing not to take part will not disadvantage you in any way.

Online Survey

If you do agree to take part, you can withdraw at any point during the research activity without penalty and you do not have to give a reason for doing so. As your data is your anonymous responses to the online survey, it won't be possible to withdraw your data after the completion of the survey but you can withdraw participation at any time during the survey.

What will happen to me if I take part in the research?

Online Survey

Participation in this study would involve 10-15 minutes of your time, during which you will complete an online survey. All information collected will be kept strictly confidential. You will not be identifiable in any of the results and all responses will be anonymous. You will have the opportunity to enter a prize draw to win one of three £10 electronic Amazon vouchers.

Are there any potential risks in taking part?

There is no intended direct benefit to you from taking part in the study. There are no reasonably foreseeable discomforts, disadvantages, and risks to you in taking part in this study.

If for any reason the topics addressed cause you any stress or anxiety, we encourage you to speak to someone you know and trust (e.g., a family member, a teacher, a counsellor). You will also find some helpful resources at the following charities:

- YoungMinds (https://youngminds.org.uk)
- stem4 (https://stem4.org.uk)
- Mind (https://www.mind.org.uk)

There are also many confidential sources of support that are available to help. These organisations are truly fantastic and offer support to many young people across the country every day. They offer many different ways for you to get support (phone, text, email, webchat) so you can choose the way that you feel most comfortable. Some of the ways you can speak to someone are:

- Call 116 123 to talk to Samaritans, or email: jo@samaritans.org for a reply within 24 hours
- Text "SHOUT" to 85258 to contact the Shout Crisis Text Line, or text "YM"
- You can also call 0800 1111 to talk to Childline. The number will not appear on your phone bill
- You can contact the Papyrus HOPELINE from 9am — midnight every day of the year (weekends and bank holidays included). Call: 0800 068 4141, Text: 07860039967, Email: pat@papyrus-uk.org

To reduce any potential risks, personal data will be pseudonymised or anonymised.

Are there any benefits in taking part?

There will be no direct or personal benefit to you from taking part in this research.

What happens to the data provided?

The information you provide during the study is the **research data**. Any research data from which you can be identified is known as **personal data**. This includes more sensitive categories of personal data such as racial or ethnic origin or data concerning your wellness practices and wellbeing.

Personal / sensitive data will be stored in an encrypted folder on a personal, password protected computer. These will be backed up on the University of Oxford's Nexus365 OneDrive. Any hardcopies of this data will be kept securely in a lockable cabinet to which only the researcher will have access. This data will be stored for 3 years after publication or public release of the work of the research.

Other research data (including consent forms) will be stored for at least 3 years after publication or public release of the work of the research.

The researcher and supervisors will have access to the research data. Responsible members of the University of Oxford may be given access to data for monitoring and/or audit of the research.

We would like your permission to use direct quotes anonymously or against a pseudonym in any research outputs.

We would like your permission to use anonymised data in future studies, and to share data with other researchers (e.g. in online databases). All personal information that could identify you will be removed or changed before information is shared with other researchers or results are made public.

Will the research be published?

The research may be published in academic publications and presented at conferences. The research will be written up as a student's doctoral thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives to facilitate its use in future research. If so, the thesis will be openly accessible.

The University of Oxford is committed to the dissemination of its research for the benefit of society and the economy and, in support of this commitment, has established an online archive of research materials. This archive includes digital copies of student theses successfully submitted as part of a University of Oxford postgraduate degree programme. Holding the archive online gives easy access for researchers to the full text of freely available theses, thereby increasing the likely impact and use of that research.

Who is organising and funding the research?

The research project is organised by Jaimie Lee Freeman of Oxford University, who is a doctoral student. Jaimie has current Enhanced DBS clearance and has received Safeguarding training delivered by the Oxfordshire Safeguarding Children Board. The research is funded by the Economic and Social Research Council (ESRC).

Who has reviewed this study?

This study has been reviewed by, and received ethics clearance through, the Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee reference: R75812/RE004.

Who do I contact if I have a concern about the study or I wish to complain?

If you have a concern about any aspect of this study, please contact contacting the researcher Jaimie Lee Freeman (jaimie.freeman@oii.ox.ac.uk) or Gina Neff (gina.neff@oii.ox.ac.uk), and we will do our best to answer your query. We will acknowledge your concern within 10 working days and give you an indication of how it will be dealt with. If you remain unhappy or wish to make a formal complaint, please contact the Chair of the Research Ethics Committee at the University of Oxford who will seek to resolve the matter as soon as possible:

Chair, Social Sciences & Humanities Inter-Divisional Research Ethics Committee; Email: ethics@socsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD

Data Protection

The University of Oxford is the data controller with respect to your personal data, and as such will determine how your personal data is used in the study.
The University will process your personal data for the purpose of the research outlined above. Research is a task that is performed in the public interest.
Further information about your rights with respect to your personal data is available from http://www.admin.ox.ac.uk/councilsec/compliance/gdpr/individualrights/.

Further Information and Contact Details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Jaimie Lee Freeman
Oxford Internet Institute
University of Oxford
1 St Giles'
Oxford
OX1 3JS
Email: jaimie.freeman@oii.ox.ac.uk

Thank you for reading this – please ask any questions if you need to.

Survey Consent Form for Parents of Adolescents Under the Age of 16 Years

Start of Block: Informed Consent

Q1.1 Please ask your **PARENT/GUARDIAN** to read the information sheet and fill in the consent form below:

Q1.2

Parent Informed Consent Form
Understanding the Social and Psychological Wellbeing Implications of Adolescents' Digital Self-Tracking Practices
Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee reference: R75812/RE004

Thank you for considering your child's participation in this study. Please complete this form after you have read the Information Sheet and/or received an explanation about the research.

If you have any questions arising from the information sheet, please contact project researcher Jaimie Freeman before you decide whether you would like your child to participate (jaimie.freeman@oii.ox.ac.uk).

End of Block: Informed Consent

Start of Block: Consent Options

Q2.1 I confirm that I understand that by ticking each box I am consenting to the respective element of the study. I understand that it will be assumed that unticked boxes mean that I DO NOT consent to that part of the study. I understand that by not giving consent for any one element my child may be deemed ineligible for the study.

- ○ I understand
- ○ I do not understand

Q2.2 Please click on all the statements that apply.

☐ I confirm that I have read and understood the information sheet for this study. I have had the opportunity to consider the information and to ask the researcher questions about my child's participation.

☐ I understand that participation in this study is entirely voluntary and that my child can withdraw their participation at any time during the research activity without giving a reason and without adverse consequences or penalty.

☐ I understand that this study has been reviewed by, and received ethics clearance through, the University of Oxford Social Sciences and Humanities Interdivisional Research Ethics Committee.

☐ I understand that by my child participating in the study they will be invited to take part in a short online survey lasting 10-15 minutes.

☐ I understand that confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached.

☐ I understand that members of the project team will have access to the data my child provides and that all the data will be stored securely in keeping with the regulations of the University of Oxford.

☐ I understand that the findings of this research will be published and presented in journal articles, University publications, books, conferences, and other dissemination events.

☐ I am happy for aggregate data and verbatim quotes from my child's survey responses to be included in publication of the study findings. I understand that my child's name and other identifying details will be anonymised or removed.

☐ I understand how to raise concerns or make a complaint about the study.

☐ I agree for my child to take part in this study.

☐ (optional) I am happy for my and my child's contact details to be retained so that the researchers can invite my child to participate in follow-up studies to this project. (Note: they will be compensated for their time in future research activities)

☐ (optional) I would like to receive a report by email summarising the findings of this research.

Display This Question:

If Q2.2 != I confirm that I have read and understood the information sheet for this study. I have had the opportunity to consider the information and to ask the researcher questions about my child's participation.

Or Q2.2 != I understand that this study has been reviewed by, and received ethics clearance through, the University of Oxford Social Sciences and Humanities Interdivisional Research Ethics Committee.

Or Q2.2 != I understand that by my child participating in the study they will be invited to take part in a short online survey lasting 10-15 minutes.

Or Q2.2 != I understand that confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached.

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Or Q2.2 != I am happy for aggregate data and verbatim quotes from my child's survey responses to be included in publication of the study findings. I understand that my child's name and other identifying details will be anonymised or removed.

Or Q2.2 != I understand how to raise concerns or make a complaint about the study.

Or Q2.2 != I agree for my child to take part in this study.

Q2.3 It seems you have not consented to one or more elements considered essential for taking part in this study. If you think you might have left any boxes unticked by accident, please return to the previous page.

If you have left one ore more boxes unticked because you do not consent to the respective element(s) and want to opt out of this study, that's completely fine. You do not need to consent to anything you do not want to. Just click on the right arrow below to exit the study.

End of Block: Consent Options

Start of Block: Signature

Q3.1 **Your** full name

_____

_____

_____

_____

_____

Q3.2 **Your child's** full name

_____

_____

_____

_____

_____

Q3.3 **Your** email address (a copy of this completed consent form will be sent to your email address for your reference)

_____

_____

_____

_____

_____

Q3.4 Please sign here

End of Block: Signature

Oxford Internet Institute
University of Oxford
1 St Giles'
Oxford
OX1 3JS

Professor Gina Neff
gina.neff@oii.ox.ac.uk
Jaimie Lee Freeman [DPhil student]
jaimie.freeman@oii.ox.ac.uk

Understanding the Social and Psychological Wellbeing Implications of Adolescents' Digital Self-Tracking Practices

INFORMATION SHEET FOR PARENTS / GUARDIANS

Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee reference: R75812/RE004

As researchers at the University of Oxford, we are running a study investigating how adolescents think about and use digital self-tracking tools (e.g., smartwatches, fitness trackers, smartphone apps). We would like to invite your child to be part of a study. We very much hope you would like your child to take part, but before you decide, it is important that you understand why the study is being done and what it will involve.

What are we trying to find out?

This project is looking at how adolescents think about and use digital self-tracking tools (e.g. smartwatches, fitness trackers, smartphone apps) to record and analyse data about their health and physical activity (e.g. steps taken, distance travelled, calories burned). This study will help us to better understand what the use of these tools might mean for adolescents' social relationships and psychological wellbeing, from the perspective of young people. We hope that these findings will allow us to make recommendations to educators and policymakers as we think collaboratively about how adolescents engage with digital technologies and the implications of this for their social and psychological wellbeing. More information about the project can be obtained by contacting project researcher (jaimie.freeman@oii.ox.ac.uk).

Why has my child been invited to take part?

We are inviting your child to take part because they are a young person, aged between 13 and 18 years, in the United Kingdom.

Does my child have to take part?

No. You can ask questions about the study before deciding whether or not to allow your child to participate. Your decision for your child to participate is entirely voluntary. You should only consent for your child to take part if you want to and choosing for them not to take part will not disadvantage you or them in any way.

Online Survey

If you do agree for your child to take part, you or they can withdraw at any point during the research activity without penalty and you do not have to give a reason for doing so. As your child's data is their anonymous responses to the online survey, it won't be possible to withdraw their data after the completion of the survey but you can withdraw their participation at any time during the survey.

What will happen if my child takes part?

Online Survey

Participation in this study would involve 10-15 minutes of your child's time, during which they will complete an online survey. All information collected from your child will be kept strictly confidential. Your child will not be identifiable in any of the results and all responses will be anonymous. Participants who are involved in the online survey will have the opportunity to enter a prize draw to win one of three £10 electronic Amazon vouchers.

What are the advantages / disadvantages of taking part?

There is no intended direct benefit to your child from taking part in the study. There are no reasonably foreseeable discomforts, disadvantages, and risks to your child in taking part in this study.

What happens to the data provided?

The information you or your child provide during the study is the **research data**. Any research data from which you or your child can be identified, is known as **personal data**. This includes more sensitive categories of personal data such as racial or ethnic origin or data concerning their wellness practices and wellbeing.

Personal / sensitive data will be stored in an encrypted folder on a personal, password protected computer. These will be backed up on the University of Oxford's Nexus365 OneDrive. Any hardcopies of this data will be kept securely in a lockable cabinet to which only the researcher will have access. This data will be stored for 3 years after publication or public release of the work of the research.

Consent forms will be retained by the researchers for 3 years after publication of the work of the research.

Other research data will be stored for 3 years after publication or public release of the work of the research.

The researcher and supervisors will have access to the research data. Responsible members of the University of Oxford may be given access to data for monitoring and/or audit of the research.

We would like your permission to use anonymised data in future studies, and to share data with other researchers (e.g. in online databases). All personal information that could identify your child will be removed or changed before information is shared with other researchers or results are made public.

A summary of our findings will be given to interested families.

Will the research be published?

The research may be published in academic publications and presented at conferences. The research will be written up as a student's doctoral thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives to facilitate its use in future research. If so, the thesis will be openly accessible.

The University of Oxford is committed to the dissemination of its research for the benefit of society and the economy and, in support of this commitment, has established an online archive of research materials. This archive includes digital copies of student theses successfully submitted as part of a University of Oxford postgraduate degree programme. Holding the archive online gives easy access for researchers to the full text of freely available theses, thereby increasing the likely impact and use of that research.

Who is conducting this research?

The research project is organised by Jaimie Lee Freeman of Oxford University, who is a doctoral student. Jaimie has current Enhanced DBS clearance and has received Safeguarding training delivered by the Oxfordshire

Safeguarding Children Board. The research is funded by the Economic and Social Research Council (ESRC). This study has been reviewed by, and received ethics clearance through, the Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee reference: R75812/RE004.

What if there is a problem?

If you have a concern about any aspect of this study, please contact Jaimie Lee Freeman (jaimie.freeman@oii.ox.ac.uk) or Gina Neff (gina.neff@oii.ox.ac.uk), and we will do our best to answer your query. We will acknowledge your concern within 10 working days and give you an indication of how it will be dealt with. If you remain unhappy or wish to make a formal complaint, please contact the Chair of the Oxford Internet Institute Research Ethics Committee at the University of Oxford who will seek to resolve the matter as soon as possible:

Chair, **Social Sciences & Humanities Inter-Divisional Research Ethics Committee**; Email: ethics@socsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD

Data Protection

The University of Oxford is the data controller with respect to your child's personal data and, as such, will determine how your child's personal data is used in the study.

The University will process your child's personal data for the purpose of the research outlined above. Research is a task that we perform in the public interest.

Further information about your rights with respect to your child's personal data is available from https://compliance.web.ox.ac.uk/individual-rights.

What should I do next?

Please fill in the consent form if you would like your child to take part in this study.

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Jaimie Lee Freeman
Oxford Internet Institute
University of Oxford
1 St Giles'
Oxford
OX1 3JS
Email: jaimie.freeman@oii.ox.ac.uk

Survey Assent Form for Adolescents Under the Age of 16 Years

Start of Block: Informed Consent

Q1.1 Now it's time for **your child** to complete an assent form as well if they are interested in participating. After filling in this form, they will automatically be directed to the survey:

Q1.2

Assent Form (for those under 16 years of age)
Understanding the Social and Psychological Wellbeing Implications of Adolescents' Digital Self-Tracking Practices
Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee Approval Reference: R75812/RE004

Thank you for thinking about taking part in this study. Please complete this form after you have read the Information Sheet and spoken to a parent/guardian about this study.

If you have any questions, please speak to a parent/guardian and you can contact project researcher Jaimie Freeman before you decide whether you would like to join in (jaimie.freeman@oii.ox.ac.uk). If you don't want to take part, that's okay! No one will be cross with you.

Page Break

End of Block: Informed Consent

Start of Block: Assent Options

Q2.1 Please answer the questions below:

	Yes (1)	No (2)
Has somebody explained this project to you or have you read the information sheet? (17)	○	○
Do you understand what this project is about? (1)	○	○
Have you asked all the questions you want? (2)	○	○
If you had questions, have they been answered in a way you understand? (4)	○	○
Do you understand it's okay to stop taking part at any time? (3)	○	○
Have you spoken to a parent/guardian about taking part? (19)	○	○
Are you happy to take part? (22)	○	○
(optional) Would you like to be sent a report about the findings of this study? (18)	○	○

Display This Question:

If Q2.1#1 = Do you understand what this project is about? [No]

Or Q2.1#1 = Have you asked all the questions you want? [No]

Or Q2.1#1 = Do you understand it's okay to stop taking part at any time? [No]

Or Q2.1#1 = If you had questions, have they been answered in a way you understand? [No]

Or Q2.1#1 = Has somebody explained this project to you or have you read the information sheet? [No]

Or Q2.1#1 = Have you spoken to a parent/guardian about taking part? [No]

Or Q2.1#1 = Are you happy to take part? [No]

Q2.2 It seems you have not said 'yes' to one or more of the statements considered essential for taking part in this study. If you think you might have left any 'yes' boxes unticked by accident, please return to the previous page.

If you have said 'no' because you do not agree with the sentence and want to leave this study, that's completely fine. You do not need to consent to anything you do not want to. Just click on the right arrow below to exit the study.

End of Block: Assent Options

Start of Block: Signature



Q3.1 Your full name

_____

Q3.2 Your email address

_____

Page Break

Oxford Internet Institute
University of Oxford
1 St Giles'
Oxford
OX1 3JS

Professor Gina Neff
gina.neff@oii.ox.ac.uk
Jaimie Lee Freeman [DPhil student]
jaimie.freeman@oii.ox.ac.uk

Understanding the Social and Psychological Wellbeing Implications of Adolescents' Digital Self-Tracking Practices

PARTICIPANT INFORMATION SHEET (For those 13-15 years of age)

Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee reference: R75812/RE004

We are inviting you to join in a research study. Our names are Jaimie Lee Freeman and Gina Neff and we work at the University of Oxford in the Oxford Internet Institute.

Before you decide if you would like to join in, it's important to understand what the study is about, why we're doing it and what it would involve for you. Please read and think about this leaflet carefully. Please feel free to talk to your family, friends, or the researchers about it if you want.

If anything isn't clear or you have more questions you can ask your parent/guardian to send us an email and we can discuss it with you and your parent/guardian.

Why are we doing this research?

This project is looking at how teenagers think about and use digital self-tracking tools (e.g., smartwatches, fitness trackers, smartphone apps). This study will help us understand how the role of these tools in teenagers' social lives and psychological wellbeing.

Why have I been invited to take part?

We are inviting you to take part because you are a young person, aged between 13 and 18 years, in the United Kingdom.

Do I have to take part?

No - It is up to you. We will ask you to sign a form to say that you agree to take part (an assent form). We will give you a copy of this information sheet and your signed form to keep. You are free to stop taking part at any time during the research without giving a reason, by stopping the survey.

What will happen to me if I take part?

Online Survey

Participation in this study would involve 10-15 minutes of your time during which you will complete an online survey. All information collected from you will be kept strictly confidential. You do not have to answer any questions that you do not want to answer. Your responses are also completely anonymous and you will not be identifiable in any of the results. You will have the opportunity to enter a prize draw to win one of three £10 electronic Amazon vouchers.

What happens to the results of the study?

The information you provide during the study is the **research data**. Any research data from which you can be identified is known as **personal data**. This includes more sensitive categories of personal data such as racial or ethnic origin or data concerning your wellness practices and wellbeing.

Personal / sensitive data will be stored in an encrypted folder on a personal, password protected computer. These will be backed up on the University of Oxford's Nexus365 OneDrive. Any hardcopies of this data will be kept securely in a lockable cabinet to which only the researcher will have access. This data will be stored for 3 years after publication or public release of the work of the research.

Other research data (including consent forms) will be stored for at least 3 years after publication or public release of the work of the research.

The research will be written up as part of a student's work. We also aim to publish our findings in scientific journals, but this may be two to three years from the end of the study.

What are the advantages / disadvantages of taking part?

There is no intended direct benefit to you from taking part in the study. There are no reasonably foreseeable discomforts, disadvantages, and risks to you in taking part in this study.

If for any reason the topics addressed cause you any stress or anxiety, we encourage you to speak to someone you know and trust (e.g., a family member, a teacher, a counsellor). You will also find some helpful resources at the following charities:

- YoungMinds (https://youngminds.org.uk)
- stem4 (https://stem4.org.uk)
- Mind (https://www.mind.org.uk)

There are also many confidential sources of support that are available to help. These organisations are truly fantastic and offer support to many young people across the country every day. They offer many different ways for you to get support (phone, text, email, webchat) so you can choose the way that you feel most comfortable. Some of the ways you can speak to someone are:

- Call 116 123 to talk to Samaritans, or email: jo@samaritans.org for a reply within 24 hours
- Text "SHOUT" to 85258 to contact the Shout Crisis Text Line, or text "YM"

- You can also call 0800 1111 to talk to Childline. The number will not appear on your phone bill
- You can contact the Papyrus HOPELINE from 9am — midnight every day of the year (weekends and bank holidays included). Call: 0800 068 4141, Text: 07860039967, Email: pat@papyrus-uk.org

Will anyone else know I'm doing this?

We will keep your information private. This means we will only tell those who have a need or right to know, such as the research team and your parent/guardian. We will only share information that has your name and address removed.

What if I don't want to take part in the research anymore?

Just tell your parent/guardian and the people carrying out the research that you don't want to take part. You don't have to give a reason and no one will be annoyed with you. It is YOUR choice.

Who is organising and funding the research?

The research project is organised by Jaimie Lee Freeman of Oxford University, who is a doctoral student. Jaimie has current Enhanced DBS clearance and has received Safeguarding training delivered by the Oxfordshire Safeguarding Children Board. The research is funded by the Economic and Social Research Council (ESRC).

Who has reviewed the study?

Before any research involving people can start, it has to be checked by a Research Ethics Committee to make sure that it is OK for the research to go ahead. This study has been approved by the Oxford University Social Sciences and Humanities Interdivisional Research Ethics Committee reference: R75812/RE004.

What if there is a problem or something goes wrong?

Please tell us if you are worried about any part of this study, by contacting the researcher Jaimie Lee Freeman (jaimie.freeman@oii.ox.ac.uk) or Gina Neff (gina.neff@oii.ox.ac.uk). You may also talk to your parent/guardian who will let the researcher know. If you are still unhappy or wish to make a complaint, either you or your parent/guardian can contact the chair of the Research Ethics Committee at the University of Oxford:

Chair, Social Sciences & Humanities Inter-Divisional Research Ethics Committee; Email: ethics@socsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford OX1 2JD

Data Protection

The University of Oxford is the data controller with respect to your personal data and, as such, will determine how your personal data is used in the study.
The University will process your personal data for the purpose of the research outlined above. Research is a task that we perform in the public interest.
Further information about your rights with respect to your personal data is available from https://compliance.web.ox.ac.uk/individual-rights.

Contact details

If you would like to discuss the research with someone beforehand (or if you have questions afterwards), please contact:

Jaimie Lee Freeman
Oxford Internet Institute
University of Oxford
1 St Giles'
Oxford
OX1 3JS
Email: jaimie.freeman@oii.ox.ac.uk

Thank you for reading this – please ask any questions if you need to.

Appendix G: Sample Email Drafts Sent to Parents and Adolescents

Confirmation of Parental Consent

Dear Parent/Guardian,

Please find attached a copy of the completed consent form for your child to participate in the University of Oxford study on "Understanding the Social and Psychological Wellbeing Implications of Adolescents' Digital Self-Tracking Practices".

If you did not give your consent for this research activity or believe you have received this email in error, please contact project researcher Jaimie Freeman (jaimie.freeman@oii.ox.ac.uk).

Best wishes,

Jaimie

Interview/Workshop Recruitment for 13-15-year-olds (Sent to Parent with Participant Cc'd)

Dear Participant,

I am contacting you as you gave consent for your contact details to be retained so that we could contact you about follow-up studies on self-tracking health and fitness.

[Interview] I am writing to invite you to participate in an online interview. This interview will last between 45 minutes and 1 hour. You will be compensated for your time in this workshop with a £10 electronic voucher.

[Workshop] I am writing to invite you to participate in a remote co-design workshop. This workshop will last between 90 minutes and 2 hours. You will be compensated for your time in this workshop with a £15 electronic voucher.

If you would like to participate in this study, please read the information sheet to find out more and complete the parent consent form and participant assent form here: [QUALTRICS LINK].

If you have any questions at all about the study or any of the information in the information sheet, please feel free to email me.

Best wishes,

Jaimie

Interview/Workshop Recruitment for 16-18-year-olds

Dear Participant,

I am contacting you as you gave consent for your contact details to be retained so that we could contact you about follow-up studies on self-tracking health and fitness.

[Interview] I am writing to invite you to participate in an online interview. This interview will last between 45 minutes and 1 hour. You will be compensated for your time in this workshop with a £10 electronic voucher.

[Workshop] I am writing to invite you to participate in a remote co-design workshop. This workshop will last between 90 minutes and 2 hours. You will be compensated for your time in this workshop with a £15 electronic voucher.

If you would like to participate in this workshop, please read the information sheet and complete the parent consent form and participant assent form here: [QUALTRICS LINK].

If you have any questions at all about the study or any of the information in the information sheet, please feel free to email me.

Best wishes,

Jaimie

Interview/Workshop Follow Up for 13-18-year-olds Directing to Available Support[22]

Dear Participant,

Thank you for taking part in our [interview/workshop] today.

During our [interview/workshop], I mentioned that I would send through some resources for you to take a look at. It can be really helpful to talk to someone you trust about your feelings and I would encourage you to do so if you feel able. There are many confidential sources of support that are available to help. These organisations are truly fantastic and offer support to many young people across the country every day. They offer many different ways for you to get support (phone, text, email, webchat) so you can choose the way that you feel most comfortable. Some of the ways you can speak to someone are:

- Call 116 123 to talk to Samaritans, or email: jo@samaritans.org for a reply within 24 hours
- Text "SHOUT" to 85258 to contact the Shout Crisis Text Line, or text "YM"
- You can also call 0800 1111 to talk to Childline. The number will not appear on your phone bill
- You can contact the Papyrus HOPELINE from 9am — midnight every day of the year (weekends and bank holidays included). Call: 0800 068 4141, Text: 07860039967, Email: pat@papyrus-uk.org

[22] It is worth noting that it was not necessary to send this email to any participants during the course of this research.

- You can contact the Papyrus HOPELINE from 9am — midnight every day of the year (weekends and bank holidays included). Call: 0800 068 4141, Text: 07860039967, Email: pat@papyrus-uk.org

If you prefer a webchat, these services are available:

- Self Injury Support webchat (for women and girls) is open Tuesday, Wednesday and Thursday from 7pm to 9.30pm
- CALM webchat (for men) is open from 5pm to midnight every day

Please feel free to email me if you have any questions about how to access this support.

Best wishes,

Jaimie

Appendix H: Testing Assumptions of Inferential Statistical Tests

In the following document, I outline the steps taken to ensure that the data met the relevant assumptions for the inferential statistical tests used in this thesis. Each test is identified by its section number and the variables being examined. SPSS output is provided to demonstrate the outcome of related tests.

CHAPTER 4 | Section 4.2: Describing the Sample
Testing the relationship between adolescents' socioeconomic status and their experience of using self-tracking tools

To test the relationship between these two categorical variables, a chi-squared test of independence was used. The assumptions of this test are:

1. The two variables should be measured at an ordinal or nominal level
2. The two variables should consist of two or more categorical, independent groups
3. No more than 80% of the cells should have an expected count less than 5 and no cells should have an observed count less than 5

There were three categorical groups in the socioeconomic status variable (Low SES/Medium SES/High SES). There were also three categorical groups in the experience of using self-tracking tools variable (Current/Previous/Never). As participants were only able to select one option for each of these questions, no participant could be in more than one cell and thus these categories were independent for both variables. All 695 participants were included in this analysis.

Do you, or have you ever, used a device or app to track your health and physical activity? (e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone). * Categorizing SES based on FAS scores Crosstabulation

			Categorizing SES based on FAS scores			
			Low SES	Medium SES	High SES	Total
Do you, or have you ever, used a device or app to track your health and physical activity? (e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone).	Yes, I currently use a device/app to track my health and activity data	Count	230	190	80	500
		Expected Count	228.4	187.3	84.3	500.0
		% within Do you, or have you ever, used a device or app to track your health and physical activity? (e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone).	46.0%	38.0%	16.0%	100.0%
		% within Categorizing SES based on FAS scores	72.6%	73.1%	68.4%	72.0%
		% of Total	33.1%	27.4%	11.5%	72.0%
	Yes, I used to use a device/app to track my health and activity data but I don't anymore	Count	62	54	26	142
		Expected Count	64.9	53.2	23.9	142.0
		% within Do you, or have you ever, used a device or app to track your health and physical activity? (e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone).	43.7%	38.0%	18.3%	100.0%
		% within Categorizing SES based on FAS scores	19.6%	20.8%	22.2%	20.5%
		% of Total	8.9%	7.8%	3.7%	20.5%
	No, I have never used a device/app to track my health and activity data	Count	25	16	11	52
		Expected Count	23.8	19.5	8.8	52.0
		% within Do you, or have you ever, used a device or app to track your health and physical activity? (e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone).	48.1%	30.8%	21.2%	100.0%
		% within Categorizing SES based on FAS scores	7.9%	6.2%	9.4%	7.5%
		% of Total	3.6%	2.3%	1.6%	7.5%
Total		Count	317	260	117	694
		Expected Count	317.0	260.0	117.0	694.0
		% within Do you, or have you ever, used a device or app to track your health and physical activity? (e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone).	45.7%	37.5%	16.9%	100.0%
		% within Categorizing SES based on FAS scores	100.0%	100.0%	100.0%	100.0%
		% of Total	45.7%	37.5%	16.9%	100.0%

From this output, it is clear that none of the cells had an expected count of less than 5 and none of the observed counts were less than 5. Under the parameters described above, each participant was only in one cell and so the assumption of independence was met.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.841[a]	4	.765
Likelihood Ratio	1.838	4	.766
Linear-by-Linear Association	.333	1	.564
N of Valid Cases	694		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.77.

The relationship between these variables was non-significant, $\chi^2(1, N = 694) = 1.841$, $p = <.765$

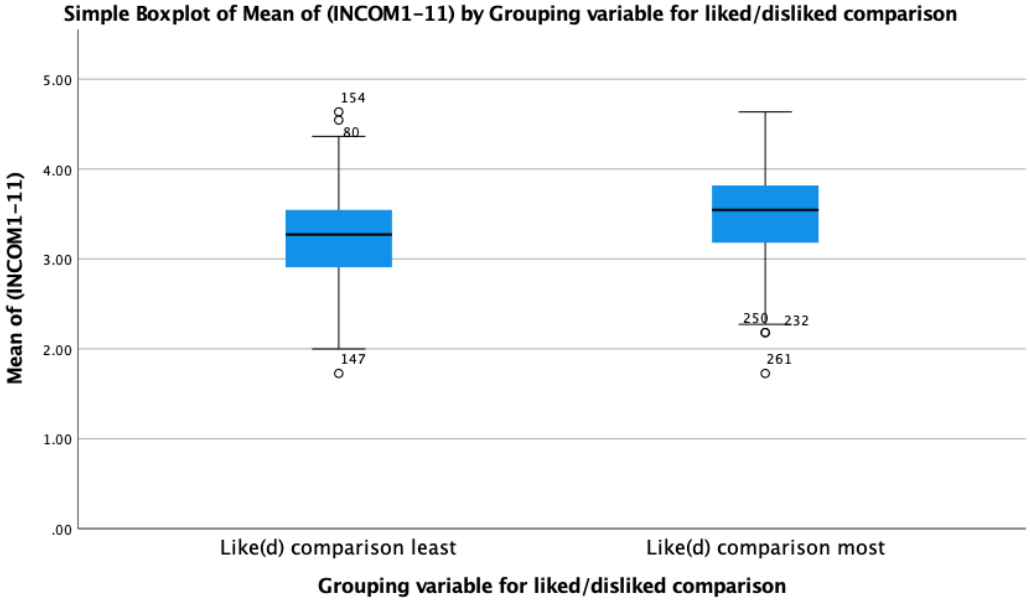
CHAPTER 5 | Section 5.2.2: Walking the Line
Testing the relationship between adolescents' social comparison orientation and liking comparison features of self-tracking the most or least

An independent samples *t*-test was used to test the relationship between adolescents' social comparison orientation and liking comparison features of self-tracking the most or least. The use of this test assumes:

1. The dependent variable is measured on a continuous scale
2. The independent variable should consist of two categorical, independent groups
3. Independence of observations
4. There should be no significant outliers
5. The dependent variable should be approximately normally distributed for each group of the independent variable
6. Homogeneity of variance

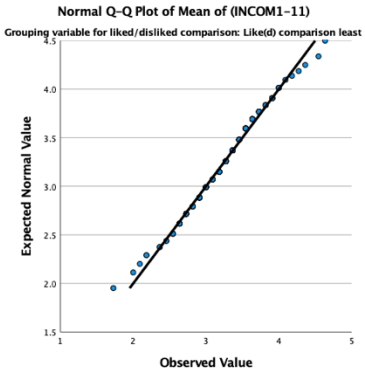
The dependent variable was social comparison orientation (measured by the mean of the Iowa-Netherlands Comparison Orientation Measure). As such, the dependent variable was continuous. There were two categorical groups in the independent variable (liked comparison most and liked comparison least). Any participants who answered that they liked comparison both most *and* least were excluded from this analysis. This left 275 participants in this analysis (108 liked comparison most and 167 liked comparison least). There were no participants in more than one group.

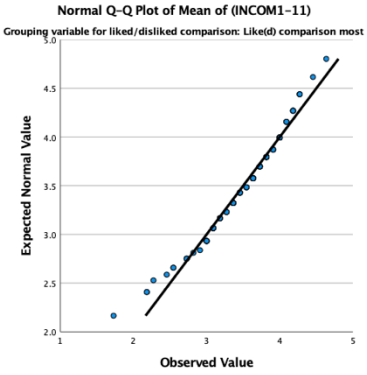
I then explored the data for outliers using a boxplot. A number of outliers were identified (see below).



I went back and analysed the data to clarify whether the outliers had occurred from a data-entry error or participant error. Upon examining the survey results, none of the participants included here had simply answered with extreme values and these appeared to be genuine responses. Given the importance of highlighting adolescent voices in this study, I decided it was inappropriate to remove these outliers. Nevertheless, I also ran the test with the outliers

excluded and the outcome of the two-tailed significance test was the same. This is reported at the end of this section.





Tests of Normality

Grouping variable for liked/disliked comparison		Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Like(d) comparison least	Mean of (INCOM1-11)	.070	165	.049	.990	165	.311
Like(d) comparison most	Mean of (INCOM1-11)	.100	107	.010	.971	107	.020

a. Lilliefors Significance Correction

The Q-Q plots suggested that the dependent variable (mean of INCOM) was approximately normally distributed for both groups, although there was some small deviation. The Shapiro-Wilk test of normality was non-significant for the group that like(d) comparison least but was significant for the group who like(d) comparison most. Given the large sample size (well above n=30) and the fact that the Q-Q indicated that the distributions were close to normal, I considered this acceptable and continued with this test as independent samples *t*-tests are robust to small violations of this assumption. Levene's test for the equality of variances was non-significant, suggesting equal variance between the groups. As such, an independent sample *t*-test was run.

Group Statistics

	Grouping variable for liked/disliked comparison	N	Mean	Std. Deviation	Std. Error Mean
Mean of (INCOM1-11)	Like(d) comparison least	165	3.2253	.47679	.03712
	Like(d) comparison most	107	3.4843	.52280	.05054

Independent Samples Test

		Levene's Test for Equality of Variances F	Sig.	t-test for Equality of Means t	df	Significance One-Sided p	Significance Two-Sided p	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Mean of (INCOM1-11)	Equal variances assumed	1.448	.230	-4.211	270	<.001	<.001	-.25894	.06149	-.37999	-.13789
	Equal variances not assumed			-4.129	211.430	<.001	<.001	-.25894	.06271	-.38255	-.13533

There was a significant difference in the INCOM scores for those who liked these comparison features most (*M*=3.484, *SD*=.523) and those who liked these comparison features least (*M*=3.225, *SD*=.477); *t*(270)=-4.211, *p*=<.001, such that those who liked comparing their data *most* about self-tracking tools scored more highly on social comparison tendencies than those who liked this feature *least.*

Output after removing participants who differed by more than two standard deviations from the mean on the social comparison orientation measure (i.e., removing outliers):

The standard deviations were as follows:

Descriptive Statistics

Grouping variable for liked/disliked comparison		N	Minimum	Maximum	Mean	Std. Deviation
Like(d) comparison least	Mean of (INCOM1-11)	165	1.73	4.64	3.2253	.47679
	Valid N (listwise)	165				
Like(d) comparison most	Mean of (INCOM1-11)	107	1.73	4.64	3.4843	.52280
	Valid N (listwise)	107				

This meant that any participants who INCOM scores fell outside of the ranges of 2.27172 — 4.17888 (Like(d) comparison least) or 2.4387 — 4.5299 (Like(d) comparison most) were removed from this analysis. Overall, 15 outliers were removed through this process and the two-tailed significance test outcome remained the same.

Group Statistics

	Grouping variable for liked/disliked comparison	N	Mean	Std. Deviation	Std. Error Mean
Mean of (INCOM1-11)	Like(d) comparison least	155	3.2258	.38672	.03106
	Like(d) comparison most	102	3.5276	.43945	.04351

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance		Mean	Std. Error	95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Difference	Difference	Lower	Upper
Mean of (INCOM1-11)	Equal variances assumed	2.931	.088	-5.796	255	<.001	<.001	-.30182	.05207	-.40437	-.19928
	Equal variances not assumed			-5.646	196.672	<.001	<.001	-.30182	.05346	-.40725	-.19639

CHAPTER 5 | Section 5.2.2: Walking the Line

Testing the relationship between adolescents' gender and liking comparison features of self-tracking the most or least

To test the relationship between these two categorical variables, a chi-squared test of independence was used. The assumptions of this test are:

1. The two variables should be measured at an ordinal or nominal level
2. The two variables should consist of two or more categorical, independent groups
3. No more than 80% of the cells should have an expected count less than 5 and no cells should have an observed count less than 5

There were two categorical groups in the gender variable (male/female). Participants reporting 'non-binary/third gender' or 'prefer not to say' were excluded from this analysis due to low numbers. There were two categorical groups in the liking comparison features variable (liked comparison most and liked comparison least). Any participants who answered that they liked comparison both most *and* least were excluded from this analysis. This left 265 participants in this analysis.

Removing non-binary/prefer not to say from gender for analysis * Grouping variable for liked/disliked comparison Crosstabulation

			Grouping variable for liked/disliked comparison		
			Like(d) comparison least	Like(d) comparison most	Total
Removing non-binary/prefer not to say from gender for analysis	Male	Count	85	81	166
		Expected Count	99.6	66.4	166.0
		% within Removing non-binary/prefer not to say from gender for analysis	51.2%	48.8%	100.0%
		% within Grouping variable for liked/disliked comparison	53.5%	76.4%	62.6%
		% of Total	32.1%	30.6%	62.6%
	Female	Count	74	25	99
		Expected Count	59.4	39.6	99.0
		% within Removing non-binary/prefer not to say from gender for analysis	74.7%	25.3%	100.0%
		% within Grouping variable for liked/disliked comparison	46.5%	23.6%	37.4%
		% of Total	27.9%	9.4%	37.4%
Total		Count	159	106	265
		Expected Count	159.0	106.0	265.0
		% within Removing non-binary/prefer not to say from gender for analysis	60.0%	40.0%	100.0%
		% within Grouping variable for liked/disliked comparison	100.0%	100.0%	100.0%
		% of Total	60.0%	40.0%	100.0%

From this output, it is clear that none of the cells had an expected count of less than 5 and none of the observed counts were less than 5. Under the parameters described above, each participant was only in one cell and so the assumption of independence was met.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	14.322[a]	1	<.001		
Continuity Correction[b]	13.358	1	<.001		
Likelihood Ratio	14.779	1	<.001		
Fisher's Exact Test				<.001	<.001
Linear-by-Linear Association	14.268	1	<.001		
N of Valid Cases	265				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 39.60.

b. Computed only for a 2x2 table

A chi-squared test of independence was performed to examine the relationship between gender and adolescents' preference for the comparison features of self-tracking tools. The relationship between these variables was significant, $\chi^2(1, N = 265) = 14.322$, $p = <.001$.

CHAPTER 5 | Section 5.4.4: It Runs in the Family

Testing the relationship between whether adolescents had ever used self-tracking tools and whether they had someone in their household who had ever used self-tracking tools

To test the relationship between these two categorical variables, a chi-squared test of independence was used. The assumptions of this test are:

1. The two variables should be measured at an ordinal or nominal level
2. The two variables should consist of two or more categorical, independent groups
3. No more than 80% of the cells should have an expected count less than 5 and no cells should have an observed count less than 5

There were two categorical groups in the household use variable (yes/no). There were also two categorical groups in the self-tracking use variable (ever/never). This variable was produced by combining participants who were currently tracking at the time of the survey and those who had previously self-tracked into the 'ever' group. Those who reported never having used a self-tracking tool were in the 'never' group. As participants were only able to select one option for each of these questions, no participant could be in more than one cell and thus these categories were independent for both variables. All 695 participants were included in this analysis.

Recoding STTUse into two groups: Ever and Never Used STT * Does anyone you live with use a device or app to track data about their health and physical activity? Crosstabulation

			Does anyone you live with use a device or app to track data about their health and physical activity?		
			Yes	No	Total
Recoding STTUse into two groups: Ever and Never Used STT	No	Count	24	28	52
		Expected Count	43.5	8.5	52.0
		% within Recoding STTUse into two groups: Ever and Never Used STT	46.2%	53.8%	100.0%
		% within Does anyone you live with use a device or app to track data about their health and physical activity?	4.1%	24.8%	7.5%
		% of Total	3.5%	4.0%	7.5%
	Current or Previous	Count	558	85	643
		Expected Count	538.5	104.5	643.0
		% within Recoding STTUse into two groups: Ever and Never Used STT	86.8%	13.2%	100.0%
		% within Does anyone you live with use a device or app to track data about their health and physical activity?	95.9%	75.2%	92.5%
		% of Total	80.3%	12.2%	92.5%
Total		Count	582	113	695
		Expected Count	582.0	113.0	695.0
		% within Recoding STTUse into two groups: Ever and Never Used STT	83.7%	16.3%	100.0%
		% within Does anyone you live with use a device or app to track data about their health and physical activity?	100.0%	100.0%	100.0%
		% of Total	83.7%	16.3%	100.0%

From this output, it is clear that none of the cells had an expected count of less than 5 and none of the observed counts were less than 5. Under the parameters described above, each participant was only in one cell and so the assumption of independence was met.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	58.321[a]	1	<.001		
Continuity Correction[b]	55.375	1	<.001		
Likelihood Ratio	43.070	1	<.001		
Fisher's Exact Test				<.001	<.001
Linear-by-Linear Association	58.237	1	<.001		
N of Valid Cases	695				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.45.

b. Computed only for a 2x2 table

A chi-squared test of independence was performed to examine the relationship between having a household member who uses a self-tracking tool and whether adolescents had ever used a self-tracking tool. The relationship between these variables was significant, $\chi^2(1, N = 695) = 58.321$, $p = <.001$.

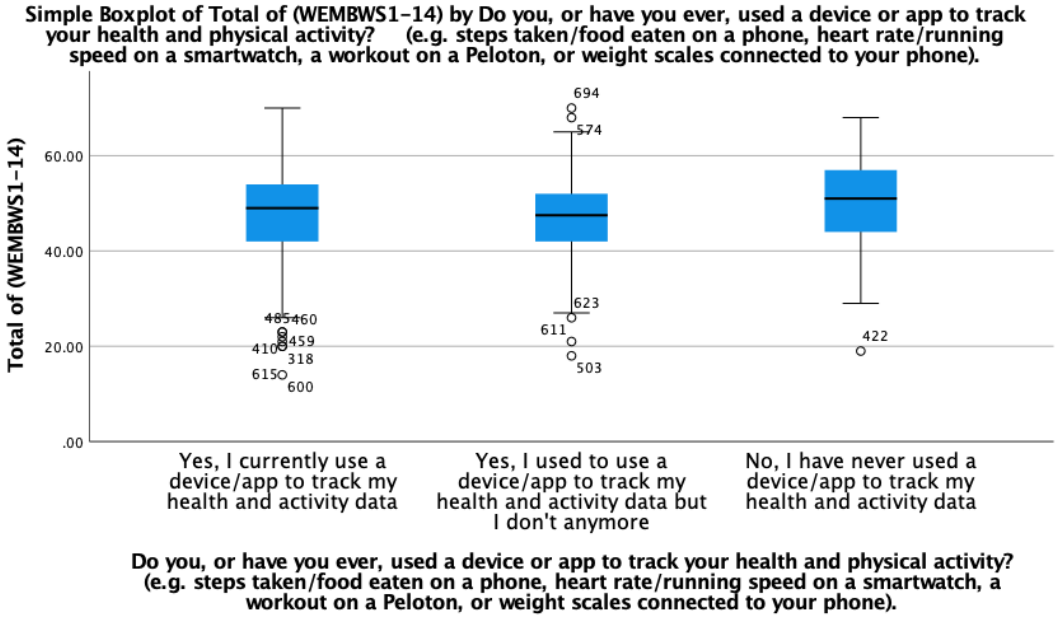
CHAPTER 6 | Section 6.2.3: Widening the Lens
Exploring the relationship between adolescents' experience with self-tracking tools and psychological wellbeing

In order to determine if there were any statistically significant differences in psychological wellbeing according to adolescents' experience with self-tracking tools, a one-way analysis of variance (ANOVA) was used. The assumptions of this test are:

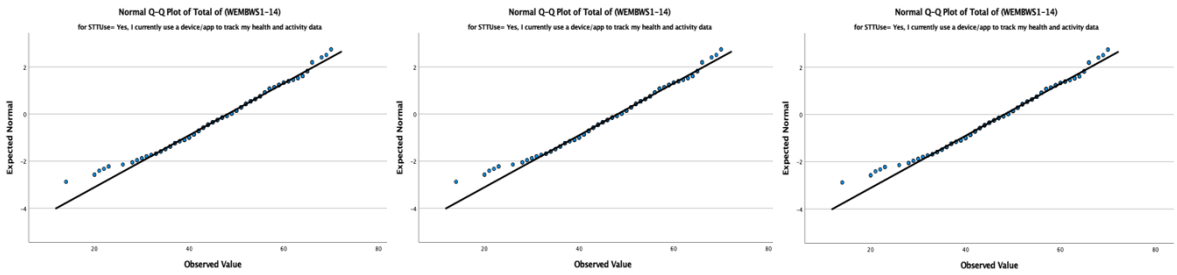
1. The dependent variable should be continuous
2. The independent variable should consist of two or more categorical, independent groups
3. Independence of observations (i.e., no participant should be in more than one group)
4. There should be no significant outliers
5. The dependent variable should be approximately normally distributed for each category of the independent variable
6. Homogeneity of variance

The dependent variable was psychological wellbeing (measured through the total score on the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS)). This is a continuous measure and therefore this assumption was met. The independent variable measured adolescents' experiences with self-tracking tools with three categories (currently use/previously used/never used). Participants were only able to select one option and so this met the assumption of independence.

I then explored the data for outliers using a boxplot. A number of outliers were identified (see below).



I went back and analysed the data to clarify whether the outliers had occurred from a data-entry error or participant error. Upon examining the survey results, none of the participants included here had simply answered with extreme values and these appeared to be genuine responses. Given the importance of highlighting adolescent voices in this study, I decided it was inappropriate to remove these outliers. Nevertheless, I also ran the test with the outliers excluded and the outcome of the two-tailed significance test was the same. This is reported at the end of this section.



Tests of Normality

	Do you, or have you ever, used a device or app to track your health and physical activity? (e.g. steps taken/food eaten on a phone, heart rate/running speed on a smartwatch, a workout on a Peloton, or weight scales connected to your phone).	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Total of (WEMBWS1-14)	Yes, I currently use a device/app to track my health and activity data	.055	496	.001	.989	496	.001
	Yes, I used to use a device/app to track my health and activity data but I don't anymore	.077	138	.043	.982	138	.066
	No, I have never used a device/app to track my health and activity data	.086	52	.200*	.971	52	.231

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Total of (WEMBWS1-14)	Based on Mean	1.180	2	683	.308
	Based on Median	1.038	2	683	.355
	Based on Median and with adjusted df	1.038	2	675.303	.355
	Based on trimmed mean	1.111	2	683	.330

The Q-Q plots suggested that the dependent variable (mean of INCOM) was approximately normally distributed for both groups. The Shapiro-Wilk test of normality was non-significant for the both previous users and those that had never used self-tracking tools but was significant for the group were currently using self-tracking tools. Given the large sample size (well above n=30) and the fact that the Q-Q plots indicated that the distributions were close to normal, I continued with this test as ANOVA tests are robust to small violations of this assumption. Levene's test for the equality of variances was non-significant, suggesting equal variance between the groups. As such, an ANOVA was run.

ANOVA

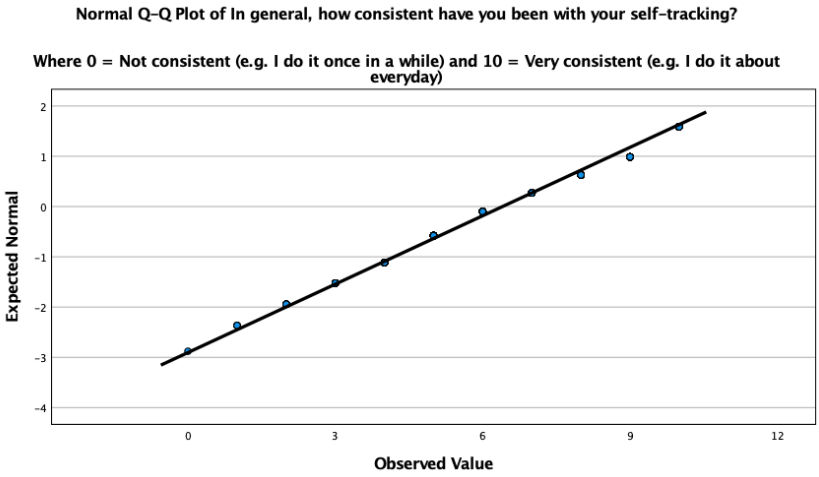
Total of (WEMBWS1-14)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	332.356	2	166.178	1.962	.141
Within Groups	57849.418	683	84.699		
Total	58181.774	685			

A one-way analysis of variance (ANOVA) demonstrated that the overall effect of experience with self-tracking tools on psychological wellbeing was not significant F (2, 683) =1.962 , p = 0.141.

Testing the association between adolescents' self-tracking consistency and psychological wellbeing for adolescents who were currently self-tracking at the time of the survey

A correlation analysis was run to determine the association between adolescents' self-tracking consistency and their psychological wellbeing. As self-reported self-tracking consistency was measured on an ordinal scale from 0 (Not consistent e.g. I do it once in a while) to 10 (Very consistent e.g. I do it about everyday), this was not a continuous variable. Although some argue that such a variable can be treated as a continuous variable in such cases when the variable is not normally distributed. Although the Q-Q plots suggested that the dependent variable (self-tracking consistency) was approximately normally distributed, the Shapiro-Wilk test of normality was highly significant, indicating that the variable was not normally distributed.



Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Current Self-Tracking Consistency	.125	498	<.001	.958	498	<.001

a. Lilliefors Significance Correction

As such, it was not appropriate to use Pearson's product moment correlation to test the relationship between adolescents' psychological wellbeing and consistency of self-tracking. Instead, the non-parametric Spearman's rank-order correlation coefficient was used to test this relationship. The use of this test assumes:

1. The variables are measured on an ordinal, interval, or ratio scale
2. The variables represent paired observations
3. There is a monotonic relationship between the two variables (i.e., the variables move in the same relative direction, but this movement does not necessarily happen at a constant rate)

Both variables were ordinal or continuous (interval); self-tracking consistency was measured as an ordinal variable on a self-reported scale of 0 (not consistent) to 10 (very consistent), whilst psychological wellbeing was measured as a continuous variable by the total score on the WEMWBS. The variables represented paired observation as each participant answered both questions; a single paired observation reflected a participant's score on the WEMWBS and the same participant's self-tracking consistency. Looking at the relationship between the variables (see Figure 6.2), it seems that the relationship was monotonic. Therefore, the assumptions of this test were met, and I was able to move ahead with the analysis.

For adolescents who reported currently self-tracking at the time of the survey, there was a significant positive relationship between consistency of self-tracking and psychological wellbeing such that those who reported tracking consistently reported higher psychological wellbeing, r_s (491) = .281, p = <.001.

Correlations

			Total of (WEMBWS1-14)	Current Self-Tracking Consistency
Spearman's rho	Total of (WEMBWS1-14)	Correlation Coefficient	1.000	.281**
		Sig. (2-tailed)	.	<.001
		N	686	493
	Current Self-Tracking Consistency	Correlation Coefficient	.281**	1.000
		Sig. (2-tailed)	<.001	.
		N	493	498

**. Correlation is significant at the 0.01 level (2-tailed).

For reference, the outputs for Pearson's product moment correlation and Kendall's tau-b are listed below (they are all highly significant).

Correlations

		Total of (WEMBWS1-14)	Current Self-Tracking Consistency
Total of (WEMBWS1-14)	Pearson Correlation	1	.246**
	Sig. (2-tailed)		<.001
	N	686	493
Current Self-Tracking Consistency	Pearson Correlation	.246**	1
	Sig. (2-tailed)	<.001	
	N	493	498

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			Total of (WEMBWS1-14)	Current Self-Tracking Consistency
Kendall's tau_b	Total of (WEMBWS1-14)	Correlation Coefficient	1.000	.203**
		Sig. (2-tailed)	.	<.001
		N	686	493
	Current Self-Tracking Consistency	Correlation Coefficient	.203**	1.000
		Sig. (2-tailed)	<.001	.
		N	493	498

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix I: Relevant Publications

In the following, I provide the accepted manuscript versions of the publications with work relevant to this thesis. The use of these papers in the body of the thesis is described in Section 1.3 in Chapter 1. The papers are presented in the following order:

Freeman, J. L., & Curtis, A. N. (2022). "Ask yourself WHY you want to track yourself": Co-Designing a Self-Tracking Guide with Teenagers. *CHI Conference on Human Factors in Computing Systems Extended Abstracts*, 1–6. https://doi.org/10.1145/3491101.3519650

Freeman, J. L., & Curtis, A. N. (2023). "Putting the Self in Self-Tracking: The Value of a Co-Designed 'How Might You' Self-Tracking Guide for Teenagers. (Accepted as a full paper for the *2023 CHI Conference on Human Factors in Computing Systems*). https://doi.org/10.1145/3544548.3580938

Freeman, J. L., & Neff, G. (2021). The challenge of repurposed technologies for youth: Understanding the unique affordances of digital self-tracking for adolescents. *New Media & Society*, 146144482110402. https://doi.org/10.1177/14614448211040266

DiCosola, B., **Freeman, J. L.**, & Neff, G. (2022). *Connected Fitness During COVID-19: Care, Control, and Social Connection through Digital Self-Tracking Across Three Countries* [Conference paper]. International Communication Association (ICA) Conference, Paris, France.

"Ask yourself WHY you want to track yourself": Co-Designing a Self-Tracking Guide with Teenagers

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ABSTRACT

Teenagers often engage with Personal Informatics tools for health and fitness without support or guidance specific to their individual experiences. There is a lack of research on how putting teens at the center of designing educational resources might empower young users to harness the affordances of self-tracking tools that are of most value to them. To address this gap, we ran five online co-design workshops with 44 teenagers (aged 13-18 years) in the United Kingdom to design a self-tracking guide for teens. We focused on content, presentation of information, and distribution strategy. Our findings highlight the complexity of creating resources which adeptly capture the needs of this diverse user group. To successfully build interactive educational resources appropriate for teens' positive engagement with health-related self-tracking tools, designers and researchers must prioritize teen-centered design with a focus on: (1) teens' core reasons for self-tracking and (2) opportunities for social support and community-building.

CCS CONCEPTS

• **Human-centered computing** → Ubiquitous and mobile computing; Ubiquitous and mobile computing design and evaluation methods; Human computer interaction (HCI); HCI design and evaluation methods; • **Applied computing** → Life and medical sciences; Health informatics.

KEYWORDS

Self-tracking, personal informatics, co-design workshops, youth, education

ACM Reference Format:
Jaimie L Freeman and Amanda N Curtis. 2022. "Ask yourself WHY you want to track yourself": Co-Designing a Self-Tracking Guide with Teenagers. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '22 Extended Abstracts), April 29–May 05, 2022, New Orleans, LA, USA.* ACM, New York, NY, USA, 6 pages. https://doi.org/10.1145/3491101.3519650

1 INTRODUCTION

Personal informatics (PI) systems, such as commercial self-tracking devices and apps, allow users to gather and reflect on personal data, including health data such as daily step counts and calories burned [13]. A recent report in the United Kingdom found that over half of teenagers reported using self-tracking tools, often doing so without a clear understanding of what the data means [23]. This raises urgent questions around how we can develop resources which might best support young users of these PI tools.

The teenage years are a critical developmental period for lifelong health behaviors [10, 16]; however, minimal work has been done to empower teen users to engage with PI tools to track their health and fitness in healthy, personally relevant ways. Teens express uncertainty about how to best harness the affordances of digital technologies for health for their individual circumstances [23], and they often lack the social support and educational resources required to access appropriate health information and feel confident in making informed health decisions [4, 8, 23].

Previous work has recognized that teenagers' engagement with PI tools might look different to adults' [5, 18, 20]. Nevertheless, little has been done to explore how teens might imagine the design of educational resources around these tools differently to fit their purposes. In this late breaking work, we attempt to address this gap by working with teenagers (aged 13-18 years) in online workshops to co-design a reimagined 'user guide' for individuals interested in self-tracking, exploring design considerations for the content, format, and distribution of such a resource.

Teenagers are still missed in much interaction design and product design work [3, 11, 17, 22]. The problem here, as Spiel et al. [25] emphasize, is that rigid, normative design reflects the goals and ideals of designers, rather than the diverse practices of the end users who might engage with these tools. The result is that teenagers often feel frustrated that current PI tools are not designed with their age group in mind [2, 6].

2 RELATED WORK

Recent research in Human-Computer Interaction (HCI) has sought to address the gap in our understanding of teens' self-tracking by engaging with teenagers through innovative extended co-design and participatory design methods to delve into their everyday self-tracking experiences [18, 19]. This work has highlighted how we might think about teenagers' reasons for self-tracking and the effects of their tracking practices differently from adults'. For example, this research emphasizes the importance of affordances of flexibility and self-expression, and the ways in which these practices can foster social connection, learning about the self, and identity development [19]. Further, privacy and curation affordances are key for this population [19] and teenagers are concerned about how their tracking allows them to fit in with accepted social norms, which are often set by adults [18]. More research is needed to explore how additional educational resources designed specifically for this

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population might empower teens to harness the unique affordances of existing PI tools that are of most value to them.

Importantly, despite teens' desire to be included in the design and regulation of digital technologies for health [23], no work critically explores what teens understand about self-tracking and need from educational resources. Co-design methods have previously been used with teenagers to inform the design of educational health resources [14]. As such, the aim of this study was to work alongside teenagers towards designing a teen-centered user guide (i.e., a 'how-to' manual for effectively using PI tools written with and for teens) to be developed for those who might be interested in self-tracking. We chose to use the term 'user guide' in our workshops to reflect that our focus remained firmly on teenagers as core users. We found teens were familiar with the term 'user guide', and this helped them co-design creative solutions in our activities. We oriented away from terms such as 'educational resource' or 'design guide' as we were not engaging with professional designers or educators. Through co-design workshops, we collaborated with teens to uncover topics they felt were most important and relevant to their age group, as well as when and how they felt information about self-tracking should be shared with their peers. In this work, we find that foregrounding individual reasons for self-tracking and opportunities for social support might pave the way for designing teen-centered resources for self-tracking.

3 METHODS

For the purpose of this work, the scope of self-tracking was confined to PI for health and fitness. This paper reports on five online co-design workshops, which formed part of a larger mixed-methods study involving around 800 teenagers (aged 13-18 years) in the United Kingdom to explore their self-tracking practices during the COVID-19 pandemic and beyond. All five workshops were conducted in November 2021.

3.1 Participants

Participants were recruited through a number of channels: those already involved in other research activities in this larger project (i.e., online survey and interviews), social media posts, advertisements distributed by youth organizations, and the researchers' personal networks. Participants were compensated with a £15 online shopping voucher for their participation.

Parental consent and participant assent was obtained online for participants under the age of 16. For those over the age of 16, online participant consent was given. Before any data collection commenced, this study was granted ethics approval by the University of Oxford Central University Research Ethics Committee (CUREC).

Seventy-six teenagers signed up to participate, 44 of whom successfully completed a workshop (13 identified as female, 20 as male, and 11 did not disclose). Of these 44 teenagers, 23 were currently using self-tracking tools, 10 had previously used self-tracking tools, three had never used self-tracking tools, and eight did not disclose their experience of self-tracking.

3.2 Procedure

We ran five 90-minute online workshops with 4-15 participants in each session[1]. The workshops took place using the videoconferencing software *Microsoft Teams* and the online whiteboard platform *Miro*. Participants were able to use the chat, video, and audio functions in *Microsoft Teams* to participate however they were most comfortable.

The workshops consisted of three key activities, besides an introductory activity (familiarizing participants with the online whiteboard functions and each other):

- **Persona exploration**: working with personas (defined by the larger study) to uncover a variety of teenage experiences with PI tools (including reasons for tracking, frequency of engagement, opportunities, challenges)
- **Feature evaluation**: identifying key features of PI tools and their effects to understand pain points and opportunities for improvement (including features of interest, features of concern, and social and emotional effects of PI tools)
- **Designing a teen-centered 'user guide'**: expanding on Activities 1 and 2 to identify key design considerations for a user guide (content it should include, how it should be formatted, and how it should be shared)

In this late breaking work, we focus closely on the third activity focused on designing a teen-centered user guide as this was the culmination of all of the workshop activities. The workshops were video-recorded and transcribed verbatim. Transcripts, *Microsoft Teams* chat histories, and *Miro* boards were analyzed together by two researchers using thematic analysis [1]. Participant quotations and contributions on the boards are reported verbatim (including any spelling or grammatical errors) to retain the authenticity of the teens' voices. Participants are identified by workshop number only (i.e., W2 denotes a participant from Workshop 2).

4 FINDINGS

We have organized our findings into three critical considerations when designing a user guide: (1) key content, (2) information format, and (3) distribution strategy. An example of a Miro board is available in Figure 1.

4.1 What Key Content Would Teenagers Like to Be Included in a Self-Tracking User Guide?

Participants focused on five themes related to key content for a user guide: (1) acknowledging individual experiences, (2) caution around obsessive behaviors, (3) self-tracking as community-building, (4) importance of context in self-tracked data, and (5) balancing privacy and the need for tailored support. All categories were discussed during each workshop.

4.1.1 Why Self-Tracking? Acknowledging Individual Experiences. Teenagers were cognizant of differing self-tracking experiences and acknowledged the importance of discussing these tensions in a user guide. For some, self-tracking was an important part of their

[1]We wanted to ensure we did not compromise participants' anonymity on the whiteboards by having too few participants in each workshop. As such, we decided to oversample for each workshop, thus some workshops had more participants than others. We created 'break out' rooms in *Microsoft Teams* if workshops were too large; however, these were not required.

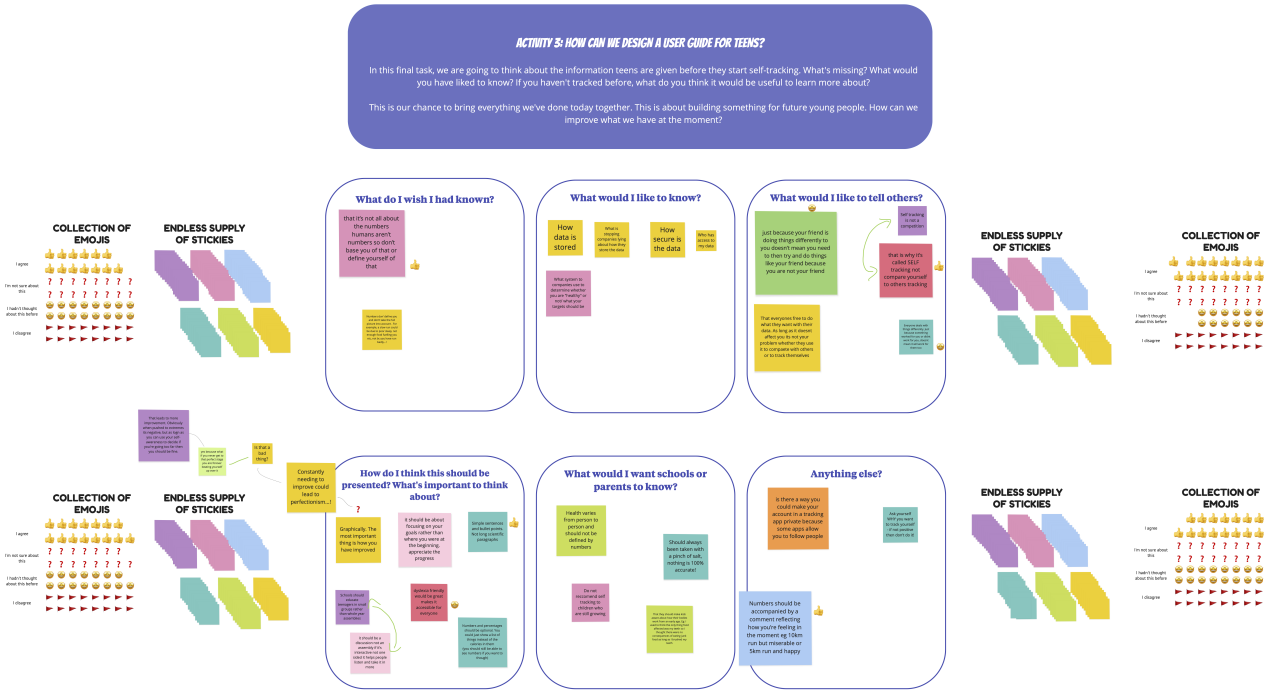


Figure 1: A screenshot of Activity 3 on the Miro board from Workshop 4, demonstrating participants' use of sticky notes, emojis, and arrows to connect ideas. This was supplemented by verbal discussion and comments using the 'Chat' function.

routine and self-care; others felt the use of PI tools was, or could be, detrimental to their psychological wellbeing. Critically, participants addressed the importance of different reasons for self-tracking in understanding individual experiences: *"Ask yourself WHY you want to track yourself - if not positive then don't do it!"* (W4).

For example, this question of *"WHY"* was prominent when discussing calorie tracking. Some participants highlighted the benefits of calorie tracking for specific individuals, such as for teenage athletes, whilst others were staunchly against the practice: *"if someone asked me if they should start tracking calories my answer would be a big resounding NO"* (W2). Despite differences of opinion, participants were clear they wanted the user guide to encourage nuanced, *"not judgmental"* (W2) conversations about this. As one participant stated, *"Tracking is for everyone and also not for everyone. It's helpful for people who can bear listening or knowing about their health status"* (W3). Participants wanted the user guide to be unafraid to address these tensions.

Participants agreed it is not only teenagers who needed to be better educated. They argued that a user guide must expand this non-judgmental space to include parents and schools as well. The participants articulated that teenagers, educators, and parents need to be aware of individual reasons for engaging in self-tracking and the nuanced experiences, both positive and negative, that come alongside those.

4.1.2 How to Self-Track? Caution Around Obsessive Behaviors. Participants repeatedly used cautionary language when describing self-tracking, including phrases such as *"be careful"* (W5). The teens acknowledged the benefits of self-tracking, but many were concerned about it being a slippery slope: *"it is so easy to become obsessed with"* (W5). Some participants wanted to warn others about the dangers of tracking beyond a certain threshold of use: *"dont get too drawn in"* (W1) and *"keep an eye out for obsessive tracking"* (W5).

For some, the dangers of obsession were related to the reasons for using PI tools: *"i think that self tracking can be good for competition with peers, as in fitness goals and prepping for competitive sport, however it can definitely effect you negatively if you become obsessed with your aims, especially if they're unhealthy obsessions/habits"* (W5). Some also referenced the role of following social media influencers in prompting obsessive tracking behaviors.

Short of defining when too much is too much, participants agreed that each individual should determine their own balance: *"Obviosuly when pushed to extremes its negative, but as logn as you can use your self-awareness to decide if you're going too far then you should be fine"* (W4). Some stressed that community can be important for countering obsessive habits: *"track with friends and family who will support you when you are doing well, but also inform you when you are doing too much and becoming unhealthy, physically or mentally"* (W1). The teens felt the user guide must discuss the dangers of obsessive tracking and provide resources for identifying and addressing such habits, such as fostering supportive communities.

4.1.3 Sharing the Tracking Experience? Self-Tracking as Community-Building. Teens agreed that community-building is important for healthy self-tracking practices and suggested that the user guide could promote this community orientation. For some, the idea of community involved competitions. Others simply imagined a space for conversation, support, and care: *"The community shouldn't just be competitive.it should be a community where you can relate easily with other people in the community"* (W3).

To facilitate healthy communities, participants discussed moderators and the absence of leaderboards. Moderators—whether third parties, older students, or peers—were contentious, with no consensus reached. Participants broadly agreed that leaderboards were more detrimental than helpful and were wary of the promotion of this in a user guide: *"Teens liek to comapre, please don't piush that agenda because it can harm mental health"* (W2).

The teens often disagreed on the role of competition in healthy self-tracking practices. Nonetheless, most participants felt the role of competition should be determined by one's reasons for tracking. Some held a firm stance that everyday self-tracking should only be an individual activity without competition or comparison: *"That is why it's called SELF tracking not compare yourself to others tracking"* (W4). On the other hand, participants acknowledged that, for teenagers tracking for clearly-defined reasons, such as athletes, competition can play an important role in their practices: *"i think that self tracking can be good for competition with peers, as in fitness goals and prepping for competitive sport"* (W5). The teens were keen for a user guide to offer guidance on both individual and healthy community self-tracking practices.

4.1.4 What Does it Mean? Importance of Context in Self-Tracked Data. Many teenagers expressed that numbers are not everything and they emphasized the importance of recognizing the context of self-tracked data. Participants believed quantitative data from self-tracking is not the only measure of wellbeing: *"Numbers don' define you and don't take the full picture into account"* (W4). This was one reason that some teens gave for moving away from competition and leaderboard-style data, as it often lacked this important context.

Participants felt the user guide should switch the framing from monitoring numbers alone to more dynamic goal setting which considers other measures of health and wellbeing. They wanted the guide to remind teens *"that it's not all about the numbers humans aren't numbers so don't base you of that or define yourself of that"* (W4). Participants wanted others to be aware of how quantitative data is often limited and inaccurate. When describing self-tracked data, one participant said it *"Should always been taken with a pinch of salt, nothing is 100% accurate*!" (W4).

Participants focused on the holistic context of their data, rather than the numbers themselves: *"my weight and fitness level is the least interesting thing about me"* (W5). As such, they wanted the user guide to think beyond quantification and instead to offer guidance on how teens might explore more deeply the context of their self-tracked data. One participant described self-tracking goal setting by shifting their language use: *"if you don't hit a goal, it does not mean that you're a disappointment or you should give up, it means you have room to grow and become better"* (W5). Just as participants intentionally used cautionary language around self-tracking practices, they also wanted the user guide to purposefully use *"gentle"* (W5) language when considering wider contexts.

4.1.5 Who's There? Balancing Privacy and the Need for Tailored Support. Participants wanted the user guide to address the role of third-party actors. The teens were critical of how their personal data was kept private, both by technology companies and within their social groups. There was widespread concern regarding the storage and security of their personal data. Participants wanted the user guide to answer questions such as: *"how is data stored"* (W4), *"is our data used for studies, do our devises save our data"* (W5), and *"how secure is the data"* (W4). Further, participants believed that their privacy should be respected and they sought guidance on how to keep their tracking private from peers and family if desired: *"i would love people to respect my privacy"* (W2).

Whilst the teens were wary of others accessing their private data, they wanted to be directed to information about third-party support. For example, many emphasized how the user guide must include resources for mental health support. Participants drew on their knowledge of other digital tools to make these suggestions: *"meetwo also has this section where you could reach out to third parties for support which is also nice"* (W2). These resources are not only for teenagers; participants emphasized the importance of improving parents' understanding of the complex relationship between self-tracking and mental health, such as anxiety and body-image issues. As a participant in Workshop 1 warned, *"be careful who your buying them for because if it is a particularly anxious child then its best just to give them direct advice about excersise."*.

4.2 How Do Teenagers Think Information Should Be Presented in a Self-Tracking User Guide?

Participants wanted the user guide to be simple, with straightforward sentences or bullet points and *"gentle"* (W5), *"peaceful"* (W4) language. The teens wanted to leverage language to positively reframe the goals of self-tracking away from a focus on inadequacy: *"it should be presented as a way to improve how already amazing you are"* (W5). Further, they argued that it was important the user guide should employ cautionary language. As one participant suggested, *"it should viewed as a inovative product with a few cautions like anything from caffeine to perscription drugs"* (W1).

Participants disagreed on visual presentation of data and wanted the user guide to inform them about different ways of tracking their data. Often preference for the presentation of data and information depended on participants' ideas around possible reasons for self-tracking. Some felt graphical representations of quantitative data were most useful, whereas others wanted an explanation of qualitative tracking options to be included in the user guide. As discussed in *3.1.4*, the teens focused on the context of self-tracked data and some expressed that the guide should emphasize how quantitative data is insufficient in capturing this context: *"Numbers should be accompanied by a comment reflecting how you're feeling in the moment eg 10km run but miserable or 5km run and happy"* (W4).

4.3 Where Would Teenagers Choose for a Self-Tracking User Guide to Be Distributed?

Participants were divided over the distribution methods of the user guide. Some participants had strong opinions on the best ways to share this information, while others believed the communication

strategy was less important than ensuring the information is available. As one participant said, *"there are different ways of passing the information it could be with a video or poster or whatever it doesn't means it just about the information being passed"* (W1).

Some teens believed schools were the ideal places to present this information, though in small, interactive discussions, rather than large assemblies. Whether these discussions should be compulsory or not was controversial. One participant explained possible unintended effects of schools discussing this topic: *"I think school can be great for spreading awareness for these things BUT since we normally associate schools with our normal school subjects then learning about tracking may imply that it is also an obligatory subject and students may feel pressured to partake in it"* (W2). Discussing this topic in schools was seen as potentially encouraging self-tracking, which some teens were wary of: *"honestly i would say schools and parents shouldn't encourage tracking at all"* (W5). Conversely, some believed that whilst engaging in self-tracking practices should be optional, education around PI systems should be obligatory: *"i think it needs to be talking about full stop I know in my experience I have never had a conversation with someone about tracking"* (W4).

Most participants agreed that external experts should discuss self-tracking, not teachers: *"I think it should be an expert that comes into schools to talk about it. I wouldn't feel comfortable with a teacher commenting on how I ate/exercised"* (W4). Further, many felt teachers were not well-educated on the subject. As such, our teens proposed that having an informed expert would provide students with a safe environment to discuss the complex topics in the user guide.

Many felt social media was another helpful place for sharing the user guide, as it was accessible and comfortable for teenagers to use. Teens also appreciated how social media afforded anonymity in accessing this information. Social media was where many come across self-tracking for the first time, and as such, they felt it would likely have a large reach: *"I think also on social media, because that's probably where most people pick up ideas about self tracking"* (W5).

5 DISCUSSION

This study aimed to explore what teens would look for in the design of a user guide for those interested in self-tracking. Teenagers' use of self-tracking tools is widespread [23] and they are often skilled at using such tools [18]; however, our participants still felt ill-informed about many aspects of PI. Previous work demonstrates the great variability in teenagers' self-tracking practices [5] and our findings highlight the challenge of designing a teen-centered resource to capture the needs of such a diverse user group. We see contradictions in teenagers' design priorities and our participants identified these intricacies as well. To try to resolve these tensions would do a disservice to the complexity of the teen experience. Instead, we found that many of the participants' considerations in designing a user guide centered around two key questions, highlighting both the individual *and* social nature of self-tracking practices:

- Why am I self-tracking?
- What support systems and communities are in place around my self-tracking?

5.1 Core Reasons for Self-Tracking

Central to our teens' discussions was the recognition that different people might vary in their approaches to PI for health. Whilst they see positive opportunities for self-tracking, teenagers also share concerns that self-tracking can be stressful or can promote unhealthy competition [5, 23]. The risk teenagers see is that beyond a certain threshold of frequency of use, or importance of data in one's life, one might become obsessed with self-tracking. Teenagers' concerns with crossing this threshold echo the potential risks of self-tracking previously studied, such as disordered eating behaviors [7, 12]. Although there seems to be little agreement on where this threshold falls—and indeed teenagers acknowledge that the threshold might differ according to specific contexts—there is agreement that such a threshold does exist and crossing it could be detrimental to teens' mental and physical health. In response, teenagers emphasize that a user guide should encourage individuals to be reflective about their reasons for tracking.

Teenagers express a desire to move to a new, more supportive language around self-tracking. This differs from the motivational or behavior change language often associated with self-tracking tools and associated resources designed for adults [13, 15]. Teens resist features such as leaderboards and negative feedback around failing to reach goals. Instead, they are eager to see a more holistic approach embedded in educational resources, as well as being commonplace in support systems and communities built around self-tracking. Future research should consider working with teens to explore how to effectively introduce this new language into new or existing PI systems and educational resources.

5.2 Opportunities for Social Support and Community-Building

The themes in our data emphasize that teenagers see the broader data ecosystem beyond the user and the PI tool. This includes intimate social relationships (such as friends and family), as well as third-party actors (such as corporate entities and mental health services). Teenagers highlight that *choice* is central both to their self-tracking practices and to the support and communities built around them. Privacy is paramount and teens seek guidance on how to maintain their autonomy in decisions around self-tracking and sharing data with others. This parallels previous HCI work with both teen [19] and novice users [21].

The social affordances of PI tools are important not only for competition and comparison, but also for connection with others [9, 24]. Teenagers are keen to highlight what they might expect from positive communities of care and are enthusiastic about resources around self-tracking tools that might enable healthy competition, and foster support and information-sharing between teens. Future work should examine opportunities to include mental health support in self-tracking educational resources, building out caring communities beyond teenagers' intimate social networks.

Teenagers stress the importance of balancing care and guidance with their freedom of choice in their self-tracking practices and education. We suggest that schools can offer important opportunities for building communities and support around self-tracking (e.g., by starting self-tracking after school clubs); however, thought should be given to separating this from curriculum-based teaching to emphasize teens' autonomy in choosing whether and how to self-track. Suggestions to achieve this include bringing in external experts to talk about health-related tracking, and moving

away from assembly-style lectures towards small group, interactive activities.

6 CONCLUSION AND FUTURE WORK

There remain important directions for future work in this area. Although our recruitment strategy aimed to include current users, previous users, and non-users of self-tracking tools, non-users were underrepresented in our sample. Future research should explore the needs of non-users and how educational resources might look different for this group.

Ultimately, this late-breaking work takes an important first step in understanding how we might design teen-centered resources to support PI practices. Drawing on teens' insights, we suggest an interactive user guide with multiple pathways might be best suited for teenagers to capture their diverse needs and uses. This guide might be available in accessible formats on social media, written in simple language, and contain video content. The user guide could be signposted through schools and scaffolded with interactive discussions with external self-tracking experts to help foster healthy communities. Our data demonstrates the challenge of embracing complexity in teens' self-tracking practices and suggests that keeping individual reasons for self-tracking and opportunities for social support at the center will enable researchers and designers to build resources appropriate for teens' positive use of PI tools for health and fitness.

ACKNOWLEDGMENTS

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Putting the Self in Self-Tracking: The Value of a Co-Designed 'How Might You' Self-Tracking Guide for Teenagers

A 'How Might You' Self-Tracking Guide for Teenagers

ANONYMOUS AUTHOR(S)

Although teenagers engage with Personal Informatics tools to track their health and fitness, many do so without adequate guidance, and they express concerns regarding the potential for these practices to bring harm. Further research is needed to understand how we might leverage resources beyond these tools to support young self-trackers. We worked with 44 teenagers (aged 13-18 years) in the United Kingdom in two series of online workshops to co-design a reimagined 'how might you' guide to promote lifelong, healthy behaviors with self-tracking tools. Our findings emphasize the importance of flexible resources that can support teens' self-tracking practices. For example, guidance on asking critical questions can be particularly valuable in the preparation and reflection stages of self-tracking. To better design teens' interactions with health technologies, particularly Personal Informatics tools, we must think critically about how we design the broader information ecosystems within which these tools reside.

CCS CONCEPTS **Human-centered computing ~ Ubiquitous and mobile computing ~ Ubiquitous and mobile computing design and evaluation methods** • Human-centered computing ~ Human computer interaction (HCI) ~ HCI design and evaluation methods • Applied computing ~ Life and medical sciences ~ Health informatics

Additional Keywords and Phrases: Self-tracking, personal informatics, co-design workshops, youth, education

ACM Reference Format:

First Author's Name, Initials, and Last Name, Second Author's Name, Initials, and Last Name, and Third Author's Name, Initials, and Last Name. 2018. The Title of the Paper: ACM Conference Proceedings Manuscript Submission Template: This is the subtitle of the paper, this document both explains and embodies the submission format for authors using Word. In Woodstock '18: ACM Symposium on Neural Gaze Detection, June 03–05, 2018, Woodstock, NY. ACM, New York, NY, USA, 10 pages. NOTE: This block will be automatically generated when manuscripts are processed after acceptance.

1 INTRODUCTION

Personal Informatics (PI) systems, such as commercial self-tracking devices and apps, allow users to gather and reflect on personal data. For example, these tools can track health data such as daily step counts and calories burned [42]. This is commonly referred to as 'self-tracking'[1]. The proliferation of these tools has been accelerated by the COVID-19 pandemic and, according to the United Kingdom (UK) mobile network EE (2020) [11], tracking apps such as *MapMyRun* and *Strava* saw two- and three-fold increases in data usage respectively during the first UK lockdown (a legally-enforced Stay at Home order) compared with pre-lockdown usage figures in February 2020.

We know that teenagers are an important user group for these tools [9,18,72]. In 2020, an academic report in the UK found that over half of teenagers reported using self-tracking tools, often doing so without a clear understanding of what their self-tracked data means [61]. As young people grow up with these technologies, we as a Human-Computer Interaction (HCI) community are faced with important questions around how we can work *alongside* teens to develop resources which might best support young users of these PI tools.

The teenage years are a critical developmental period for life-long health behaviors [35,53]; however, more work is needed to empower teen users to engage with PI tools to track their health and fitness in ways most relevant to them, their personal motivations, and their needs. Previous work has recognized that teenagers' engagement with PI tools might look different to adults' [18,57,59]. Yet, studies of teenagers' use of self-tracking tools are still relatively limited outside of intervention settings, where researchers prescribe the uses and intended outcomes of PI tools [45,57]. These interventions often deny users autonomy in deciding their own self-tracking practices [64], and many teens express uncertainty about how to best harness the affordances of digital health technologies for their individual circumstances [61]. We need a better understanding of how teens might re-imagine the design of educational resources around these tools to fit their purposes and to identify new opportunities and interactions that such a resource might foster. Now, more than ever, it is critical to involve young people in this research.

In this study, we attempted to address this gap by working with teenagers (aged 13-18 years) in two series of online workshops to co-design a reimagined resource to promote lifelong, healthy behaviors with self-tracking tools. We started by understanding the different experiences teens have when engaging with PI tools as teens reflected on their own PI experiences and those of their friends, family, and classmates. We then explored the types of information they wished they knew more about and how to design a guide that could provide these resources. Finally, drawing teens' recommendations together, we worked alongside our young collaborators to co-design a series of posts intended to be a 'how might you' guide for teenagers interested in self-tracking. We then collaborated with a graphic designer to produce an example of what such a resource could look like on *Instagram*.

The contributions of this work are: (1) designing remote co-design workshops with teenagers to gather insights on their needs and questions around interacting with PI tools, (2) identifying design opportunities for educational resources to support self-tracking practices, and (3) demonstrating the value of flexible resources to support teens' decision making in all stages of their self-tracking journeys. We argue that to better design teens' interactions with health technologies, particularly PI tools, we must think critically about how we design the broader information ecosystems within which these tools reside.

[1] The terms 'personal informatics' and 'self-tracking' are often used interchangeably in the HCI literature. Our teenage collaborators were more familiar with 'self-tracking' so both terms can be considered equivalent in this paper; however, we only used the phrase 'self-tracking' in the workshops with our collaborators.

1.1 Related Work

PI has been the focus of considerable work in the field of HCI. The related work in this section touches on: the conceptual foundations of PI, teens' engagement with PI tools, and educational resources around teenagers' engagement with PI tools. We also describe previous efforts to engage teens in co-design work around PI tools.

1.1.1 Conceptual Foundations of Personal Informatics

The Quantified Self community and their interest in generating "self-knowledge through numbers" is often associated with PI [26,34,42,67,73,74]. The demographic of the Quantified Self movement has been historically most represented by white males aged 20-40 [38] and, although some work has been done to extend the Quantified Self practices to youth populations [39], to date this has been limited. Recent work has emphasized the need to look beyond these highly engaged users within the Quantified Self movement and instead consider the needs and experiences of everyday self-trackers and the benefits and challenges they may find when engaging with PI tools [10,12].

PI tools are predicated on models of behavior change; empowering users to become more self-aware and take control of their health behaviors [42]. For example, studies have demonstrated that self-tracking tools are beneficial for increasing motivation, self-efficacy, and levels of physical activity [7,8,47]. Nevertheless, behavior models have been criticized for assuming that the collection of data is sufficient to enable data interpretation and action [50], particularly for teenagers who sometimes struggle to know *what* questions to ask of their data and how to interpret the data they collect [18]. To better understand different journeys through self-tracking and some of the barriers to users finding value in self-tracking, some HCI researchers have proposed models of self-tracking to illuminate the different stages of these practices. For example, in the earliest and one of the most commonly used frameworks of self-tracking, Li et al. outline a stage-based model with five iterative stages: *preparation*, *collection*, *integration*, *reflection*, and *action* [42]. Expanding on this model and acknowledging the pervasiveness of self-tracking, Epstein et al.'s model of lived informatics captures the ways in which self-tracking is embedded within the fabric of other practices of everyday life beyond goal-orientation motivations [12,64]. This framework divides *preparation* into *deciding* and *selection*, and suggests two additional stages of *lapsing* and *resuming* self-tracking [12]. Each of these frameworks highlight the challenges that diverse sets of users face when integrating self-tracking tools into their everyday lives and provides a lens through which to consider how individuals might need to be supported throughout their self-tracking journey.

1.1.2 Understanding Teenagers' Use of Personal Informatics Tools

Much work has been concerned with the health behaviors of teenagers as it is during this developmental period that we see the onset of various mental and physical health challenges [30,32,33,36]. Technological interventions have been used to address some of these issues, with a specific focus on self-tracking technologies [25,66]. Beyond managing long-term health conditions, some have celebrated these tools as 'the solution' to improving teenagers' engagement in physical activity and teaching them about 'healthy' behaviors [5,9,19,22,52] and they have been used in schools to foster engagement with Health and Physical Education [6,49,52].

Whilst digital self-tracking tools might encourage increased levels of physical activity [62], when taken too far they can also encourage more harmful behaviors such as disordered eating and obsessive exercise [24,41]. Previous work has demonstrated that some teens face challenges as they try to make these technologies work for their individual contexts [18,31,59]. For example, there are additional complexities for teenagers who are often tracking in tightly structured contexts, such as schools and families where concerns around privacy and surveillance are central [31].

Within these structures, teens are often thrust into an awareness of self-tracking through social media, friends, and family [19,54]. Without adequate support—particularly around the *preparation* (deciding and selection) and *reflection* stages described in Section 1.1.1—it can be difficult for teens to gain maximal value from PI tools. For example, previous work with young people aged 16-18 in the UK demonstrates that whilst teenagers appreciate being able to strive for goals, instantaneously review data, and compete with others, they struggle to understand how to engage with or interpret their data, often even forgetting to use their PI tools [61]. Recent work has called for additional education around these stages to support teens' positive engagement with PI tools [55].

1.1.3 Teenagers and The Importance of Dialogic Personal Informatics Education

Adolescence is a pivotal moment for health education as it is here that young people learn behaviors that they carry with them into adulthood [46,68]. They often lack the social and educational support required to feel confident in making informed health decisions [15,28,61]. Technology increasingly sits at the heart of much health-related education as teens change their health behaviors in response to online content [20].

There is an urgent need to move away from a traditionally patronizing and didactic education paradigm around health-related technologies, which can be frustrating for young people and potentially hinder them from getting the best out of technology [16,23]. Instead, we should consider how flexible education interventions might support young people's interactions without technology curtailing their opportunities [43,71]. Although teenagers have repeatedly been shown to be critical and sophisticated users of PI tools [57], little work has been done to understand how we might scaffold their self-tracking experience with additional educational resources to encourage positive and fulfilling engagement with PI tools in a way that meets their needs and expectations. Here we are presented with a chance to think about how stakeholders might better collaborate to scaffold the self-tracking experience for young people. The importance of dialogic exchange, such as through co-design workshops, is an important step [63].

1.1.4 Co-Design in Personal Informatics Research with Teens

Importantly, we know teens have a desire to be included in the design and regulation of digital technologies for health [61] – it is here that co-design workshops can offer a real opportunity to engage teenagers in a democratic process and ensure their voice is heard and valued. Previous work has clearly demonstrated that teenagers are still underserved in much interaction design and product design research [14,40,56,60]. The problem here, as Spiel et al. [70] emphasize, is that rigid, normative design reflects the goals and ideals of designers, rather than the diverse practices of the end users who might engage with these tools. Many PI tools are designed with adults in mind [65,72] and whilst some are happy to use 'adult' tools when supported in the right way [54], this can be frustrating for others [4,20].

In the field of HCI, important work has sought to understand teens' everyday self-tracking practices through innovative extended co-design and participatory design methods where teens were encouraged to engage with PI tools as part of the study [17,57,58]. This work has highlighted what self-tracking looks like for teens, how we might think about their reasons for self-tracking, and how the effects of their tracking practices differ from adults'. For example, this research emphasizes the importance of affordances of flexibility and self-expression and the ways in which these practices can foster social connection, learning about the self, and identity development [58]. Further, privacy and curation affordances are key for teenagers [58]; they are concerned about how their tracking allows them to fit in with accepted social norms, which are often set by adults [57]. This work highlights the complexity and nuance in the teenage tracking experience; however, our findings demonstrate that more research is needed to explore ways to inform and empower teens to feel comfortable exploring how self-tracking might be incorporated into their routines.

Co-design methods have also previously been used with teenagers to inform the design of educational health resources [48]. This offers a useful way in for researchers to explore the unique affordances of existing PI tools that are of most value to teens and better understand how to enable young people to think critically about the role of self-tracking within their broader information ecosystems. As such, the aim of this study was to work alongside teenagers towards designing a teen-centered educational resource.

Building on these important foundations, in this paper we describe our process of uncovering and recognizing teens' voices in a design space where they are too often overlooked. We sought to break down assumptions of what self-tracking *should* look like, and instead created open, flexible spaces for creativity and imagination. Drawing on previous work [57,58], we wanted to consider how young people's self-tracking practices could be scaffolded with resources beyond the PI tools themselves. This teaches us as an HCI community how we might open up new opportunities for teens to engage with PI tools and support them across different stages of self-tracking, particularly *preparation* and *reflection*. Through these co-design workshops, we collaborated with teens to co-create a resource that could support positive tracking experiences for young people.

2 METHODS

In line with previous work [21], in this study the scope of self-tracking was confined to PI for health and fitness. We conducted five 90-minute online exploratory content co-design workshops (Series A) and two 60-minute follow-up online reflexive prototype design workshops (Series B). These workshops formed part of a larger mixed-methods study involving around 800 teenagers (aged 13-18 years) in the United Kingdom to explore their self-tracking practices and the entanglements with their social and psychological wellbeing (see Figure 1 for an overview of this larger project). Series A workshops were conducted in November 2021 and Series B workshops were conducted in March 2022.

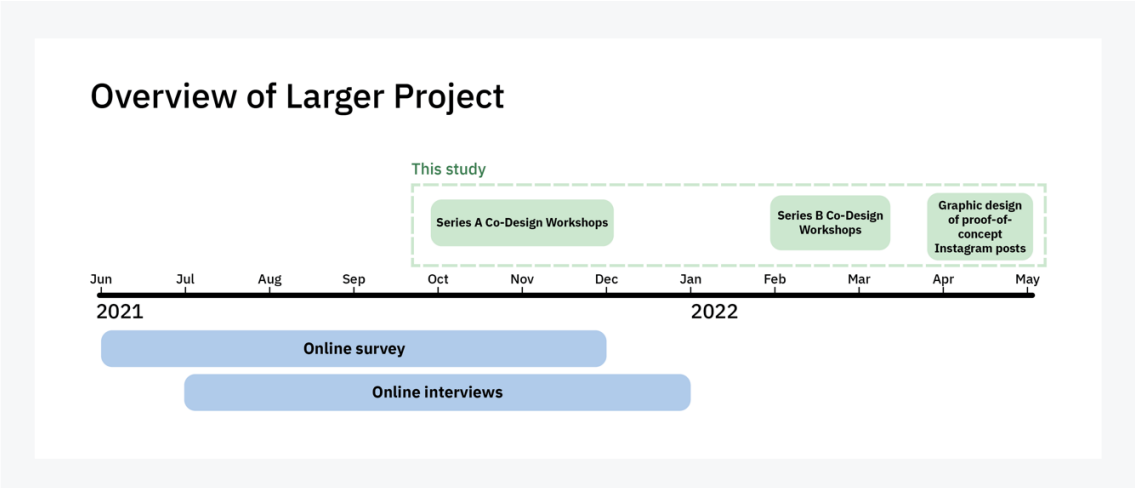


Figure 1. Overview of larger research project and where this paper sits

2.1 Participants

Participants were recruited through a number of channels: the participant pool in the larger study, social media posts, advertisements distributed by youth organizations, and the researchers' personal networks. Participants were compensated with an online shopping voucher for their participation in each workshop.

Seventy-six teenagers signed up to participate in the Series A workshops, 44 of whom successfully completed a workshop (13 identified as female, 20 as male, and 11 did not disclose). Of these 44 teenagers, 23 were currently using self-tracking tools, 10 had previously used self-tracking tools, three had never used self-tracking tools, and eight did not disclose their self-tracking experience.

Eight teenagers signed up for a Series B follow-up workshop and three successfully returned to take part in a workshop (two identified as female and one as male). Two were currently using and one had previously used self-tracking tools.

This work was underpinned by the idea that we were researching *with* teens rather than *on* them, and as such valued them as equal partners in the research process [44]. In this spirit, from here, we refer to our participants as workshop "collaborators" to emphasize the participatory, reciprocal—rather than extractive—relationship we aimed to develop with teens through these workshops.

Our workshop collaborators were informed they would be participating in workshops where they might "design a self-tracking tool and information for teens". The definition of self-tracking provided to teens as part of this study was as follows: "Self-tracking allows people to monitor, record and analyze information about their health and physical activity, such as sleep, calorie intake, heart rate and exercise. Have you ever looked at your phone to see how many steps you've taken in a day? Have you ever used a fitness tracker to find out how far or how fast you ran? That is self-tracking."

2.2 Study Design

To better scaffold educational resources for teens interested in self-tracking, we broke this project into two series of co-design workshops: exploratory content co-design workshops (Series A), focusing on how teens engage with self-tracking and where they could benefit from further support, and reflexive prototype co-design workshops (Series B), centered

around creating tangible prototypes and guidelines for an *Instagram*-based educational guide. The full process for this study is illustrated in Figure 2.

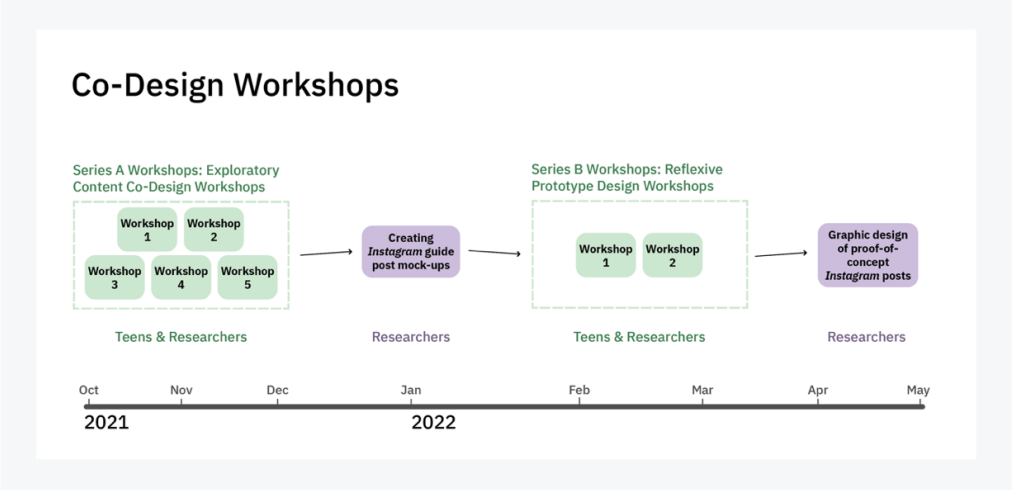


Figure 2. Overview of methods for this paper. We began with Series A workshops, ideated mock-ups for the *Instagram* posts, ran Series B workshops, and then designed final proof-of-concept *Instagram* posts.

2.2.1 Series A Workshops (Exploratory Content Co-Design Workshops).

The purpose of the first series of workshops was to understand how teens perceive self-tracking tools, what features they like and dislike, what effects self-tracking has on their lives, and what resources and information would they like to have to better support their self-tracking. During the activities in these workshops, we asked them to work together to reflect on both their experiences and how they believe others experience self-tracking. We ran five 90-minute online workshops (W1-5) with 4-15 collaborators in each session.2 The workshops took place using the videoconferencing software *Microsoft Teams* and the online whiteboard platform *Miro*. Teens were able to use the chat, video, and audio functions in *Microsoft Teams* to participate in whichever way they were most comfortable.

The workshops consisted of three key activities, drawing on previous co-design work with teens using personas to help foster empathy and agency [27,51] and sticky note activities to prompt reflection [29]:

1. **Persona Exploration:** working with personas (defined by the larger study) to uncover a variety of teenage experiences with PI tools (including reasons for tracking, frequency of engagement, opportunities, challenges).
2. **Feature Reflection:** identifying key features of PI tools and their effects to understand pain points and opportunities for improvement (including features of interest, features of concern, and social and emotional effects of PI tools).

[2] We wanted to ensure we did not compromise collaborators' anonymity on the whiteboards by having too few teens in each workshop. As such, we decided to oversample for each workshop, thus some workshops had more teens than others. We created 'break out' rooms in *Microsoft Teams* if workshops were too large; however, these were not required.

3. **Designing a Teen-Centered 'User Guide'**[3]: expanding on Activities 1 and 2 to identify key design considerations for a user guide (content it should include, how it should be formatted, and how it should be shared).

Following each of these activities, we opened up space for critical discussion and reflection on the contributions to draw out any points of tension or agreement amongst the teens. In doing this, we were careful to foster an environment of respectful curiosity and reflection.

It is important to note that our workshop collaborators raised the need for more information and resources around self-tracking before we began Activity 3 (Designing a Teen-Centered 'User Guide'). For example, in Activity 2 (Feature Reflection), our collaborators considered prompts such as "What could it [PI tool] do differently to work better for me?" and "What would I like to see [in PI tools] that isn't currently available?". Despite the fact that this activity was intended to center on PI *tools*, the teens instead asked for links to different informational support, such as clearer information about their data and clarity on how people from different situations might have different self-tracking options. Here, in line with previous work [54], teens shared that they did not necessarily need different tools, but instead wanted more information in order to be more critically aware of how to make existing tools work for them. This helped validate our decision to design Activity 3 with a focus on determining what information, and what format, might be best suited to meeting teens' needs.

2.2.2 Series B Workshops (Reflexive Prototype Design Workshops).

Through meetings between two researchers (BLINDED FOR PEER REVIEW) following the Series A workshops, we took on board the contributions of our collaborators and redeveloped the notion of a 'user guide' to instead focus on a 'how might you' guide. During this stage, the researchers generated content for initial mock-ups of a 'how might you' self-tracking guide for teenagers and used the graphic design tool *Canva* to build a series of *Instagram* posts to give teens a starting point for their reflections. These sample posts were grounded in the insights that teens had offered during the Series A workshops.

First, our collaborators reflected on their current experience on social media: the types of posts with which they liked to interact, and any existing *Instagram* guides they knew of and liked or disliked. We then shared the mock-up *Instagram* posts with teens and thought together about the content, design, tone, and distribution considerations for such a resource. Once again, our workshop collaborators were positioned as co-designers and experts in their own needs and experiences.

Our collaborators were repeatedly reminded that the ideas were not finalized, and we intentionally left these posts under-developed to encourage them to share how they would change the content or design without feeling as though they were criticizing a finished product. We encouraged our collaborators to share how they thought these posts may fit with their existing social media feeds, what topics they felt were most important for the 'how might you' guide to cover, and how they felt it could best to capture the attention of young people. An example of how we and the teens collaborated on Miro is seen in Figure 3.

[3] We chose to use the term 'user guide' in our workshops to reflect that our focus remained firmly on teenagers as core users. We found teens were familiar with the term 'user guide', and this helped them co-design creative solutions in our activities. We oriented away from terms such as 'educational resource' or 'design guide' as we were not engaging with professional designers or educators.

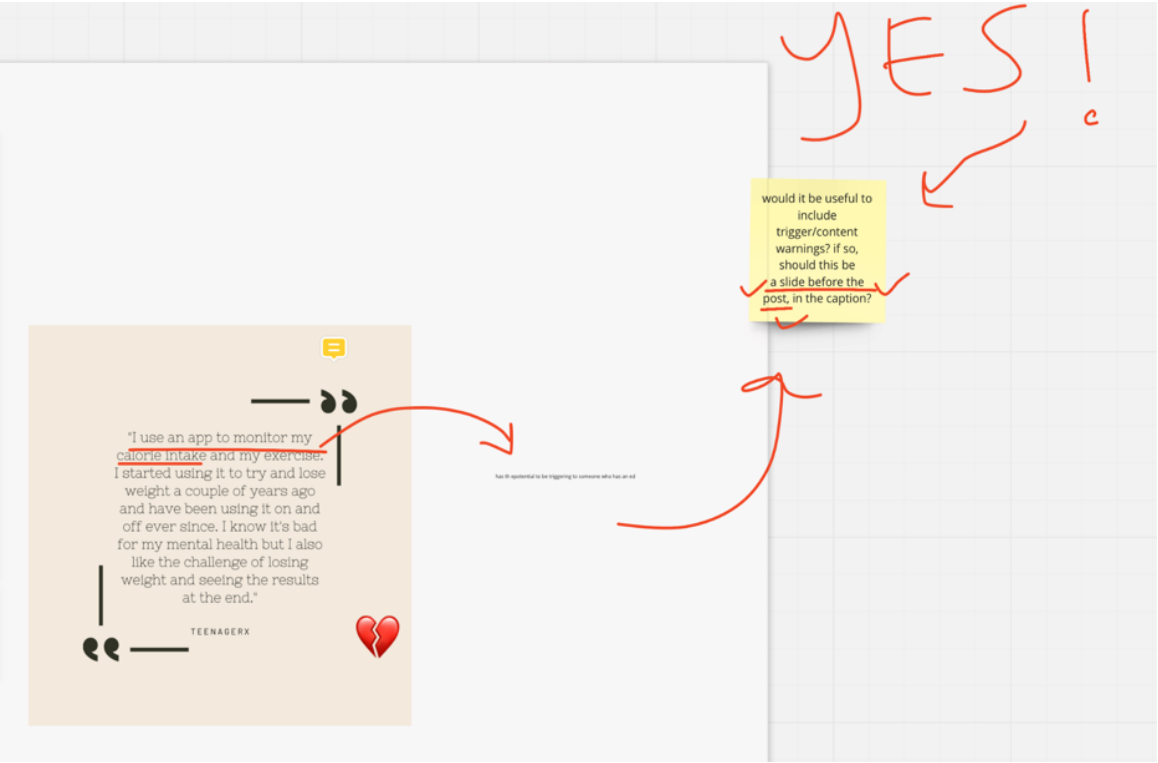


Figure 3. A dialogue between researchers and collaborators on the Miro board in Workshop 7. A researcher poses a question on a sticky note in response to a collaborator's written text comment and collaborators respond by drawing on the Miro board. The small collaborator comment reads: *"has th epotential to be triggering to someone who has an ed"*.

As with the Series A workshops, Series B workshops took place using *Microsoft Teams* and *Miro* and our workshop collaborators were able to use the functionalities of the tools however they were most comfortable.

All collaborators in the Series B workshops had also taken part in a Series A workshop. Our mock-up designs were based entirely on the content we created together in the Series A workshops. Following this design activity, we worked with a graphic designer to create the final proof-of-concept designs. These are not mirrors of these initial designs; rather, they are evolved versions based on the designs our workshop collaborators co-created in Series B. Where the teens in our second workshop series resisted the designs presented to them, or felt the direction was not helpful, we worked with them to evolve the designs to better meet their needs and expectations. Given more resources, we would have involved the teens throughout the entire process; however, it was necessary for two researchers to build some basic designs to give our collaborators a springboard for the Series B workshops. This hybrid model, moving between creations and insights from teens, to analysis and synthesis from researchers, allowed us to still ensure their voices were heard and incorporated throughout every stage this study.

2.2.3 Data Analysis.

The workshops were video-recorded and transcribed verbatim. Contributions from teens on the Miro board were anonymous and this is where the majority of teens' participation took place. As such, we chose to analyze all of the data

together as it was not possible to separate teens by gender or age. Transcripts, *Microsoft Teams* chat histories, and *Miro* boards were analyzed together by two researchers (BLINDED FOR PEER REVIEW) using thematic analysis [3]. This approach involved six recursive stages: (1) familiarization with the data, (2) coding, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) writing up [3]. The researchers anonymized and combined the teens' contributions from all sources into one joint *Miro* board, with stickies tagged with the workshop date. A hybrid approach of inductive and deductive coding was used [13]. The visual capabilities of the Miro board allowed the researchers to cluster contributions in themes, draw links between and within the themes, and any discrepancies were discussed until consensus was reached. Quotations and contributions on the boards are reported with any spelling or grammatical errors to retain the authenticity of the teens' voice; we did not want to speak for the teens nor erase their own words. Collaborators are identified by workshop number only (i.e., W2 denotes a collaborator from Workshop 2).

2.3 Ethical Considerations

Given the age of our workshop collaborators, we paid great attention to the ethical considerations in running this study, following guidance from previous work in this area [1,37]. Working with young people was not a responsibility we took lightly. Parental consent and participant assent was obtained online for those under the age of 16. For those over the age of 16, online participant consent was given. Before any data collection commenced, this study was granted ethics approval by [BLINDED FOR PEER REVIEW].

3 FINDINGS

Here we describe how teens articulate a need for educational resources and support around their self-tracking practices. First, we draw out the experiences that teens believe can be opened up by self-tracking practices. Next, we explore how teens make sense of the tools and resources at their disposal: how do motivations and uses vary across users, and how do design features encourage or discourage different interactions? Finally, we describe the co-design process with teens to produce an educational resource for young people interested in self-tracking. Drawing together insights from our young workshop collaborators, we highlight teens' perspectives on a proof-of-concept 'how might you' guide.

3.1 Who are we co-designing for?: What different experiences do teenagers believe are afforded by self-tracking practices?

In this section, we explore how different teens experience self-tracking. Before the workshops began, teens shared some questions and words they associate with self-tracking. This helped establish the tone of the workshops and drew out their existing understandings and associations of PI. In the first design stage, we worked with through a persona exploration activity to uncover the variety of teens' experiences with self-tracking tools. For some, they drew on their own life experiences to describe how a certain persona (such as a teenage athlete) engages with PI tools. Others might have reflected on how they see their friends and peers track. This exercise was critical for allowing us to think about the nuanced experiences different teens have with PI tools and resources in their lives.

3.1.1 What can go wrong? Teens' negative self-tracking experiences.

There was a decidedly negative tone towards PI from the outset of many of the workshops. Most commonly, teens associated words such as *"gloomy"* (W4) and *"stressful"* (W5) with self-tracking. Many of these negative associations centered around potential mental health implications of self-tracking. They felt that self-tracking could be *"addictive"* (W5), possibly resulting in teens becoming *"paranoid"* (W4). Some shared personal stories of these *"obsessive and*

damaging" (W5) experiences: *"I used to track my food/calories and it led to developing some bad habits for example, weighing ALL of my food. Literally down to a single grain of rice"* (W2).

Teens were particularly concerned that self-tracking *"can lead to eating disorders especially without medical advice"* (W5). This led to personal disclosures of disordered eating associated with self-tracking, accompanied by stories of the toll unconstrained self-tracking can take on teens' social lives: *"When i was tracking my calories it really badly impacted my social life. I was so scared to go out to eat with friends […] just seeing a fork would worry me"* (W2).

Teens were wary that self-tracking could encourage harmful comparison and competition between peers or within sports teams as young people worked to *"achieve their 'ideal body'"* (W2). They saw worrying links between such comparisons, lowered self-esteem, and teens' mental health: *"Comparison can be detrimental to a teen's mental health and can make them feel bad about themselves if they aren't doing as much as others"* (W2). Teens feared that these experiences could make people *"more self concious"* (W1), *"feel guilty"* (W5), or *"feel disappointed in yourself"* (W5). Some young people shared their own experiences of the way self-tracking *"magnifies my insecurities"* (W1) and *"often makes you feel like you could always be doing better and you're never good enough"* (W5). These conversations were persistent throughout the workshops and teens were keen for us to understand the gravity of the situation they saw before them.

Teens also spoke of the ways being online shapes relationships with self-tracking, with many fearing that young self-trackers might *"end up comparing themself to social media"* (W5) and felt that the online space currently lacked guidance on how to navigate these challenges. Our collaborators could clearly see how self-tracking data sat within a broader information ecosystem that could inform their understandings of their body and health. Social media was described as a driver that could lead young people to self-track, even if they felt they didn't want to: *"tracking for aesthetic is usually not done because you want to change it's usually because of social media influence"* (W4). Further, our teens reflected: *"It can be bad for their mental health if they are aiming to mirror a certain body type that they may have come across online. I think that this is really common for teens given the amount of social media exposure we get."* (W2).

3.1.2 What works well? Teens' positive self-tracking experiences.

Conversely, many teens also saw how these practices could be *"Helpful"* (W5) for *"Keeping fit"* (W5), *"monitoring"* (W5), and staying *"Organized"* (W4). Many of these positive experiences centered on the promotion of physical health, in contrast to the more negative experiences which centered on the potential mental health implications of self-tracking.

Our collaborators appreciated the cognitive affordances of self-tracking of increased self-awareness and identity as *"self tracking helps realise our strengths and weaknesses"* (W5) and *"could help someone understand their body and how it response to exercise or food etc."* (W1). For some, self-tracking was a way for teens to feel "*a sense of control"* (W4) over their bodies. This awareness was critical especially during such a transitional phase in their lives—*"the best thing about it is being able to know what my body is about"* (W2) —and during periods of social distancing during the COVID-19 pandemic as it *"helps seek progress in a difficult and monotonous time"* (W5). These benefits of self-knowledge applied to physical activity and fitness, but also to teens' health more generally. In our workshops, this manifested in perceived improved agency in healthcare situations, more self-aware goal setting and progression tracking, and increased understandings of the relationship between their actions and their health.

Teens were quick to discuss the ways in which self-tracking could be beneficial in monitoring progress and fostering motivation. They felt a great sense of achievement and self-efficacy when they saw they were *"achieving their goals"* (W1). Particularly for teens engaging in competitive sports, they saw that self-tracking could offer physical health benefits as it *"helps them keep fit and can improve easily"* (W4). For them, the ease with which self-tracking tools integrated into their lives was important: *"It almost becomes part of a routine"* (W2).

For teens who thought about using self-tracking to monitor health conditions, they saw how it could enhance communication between doctors and patients, allowing more continuous monitoring. Indeed, they imagined that *"Some can self track instead of unneeded doctors appointments"* (W5). One collaborator shared her personal story of monitoring a chronic health condition using PI. This was seen by many to be a positive self-tracking experience as it afforded young people greater agency in their own healthcare.

Closely tied with increased self-awareness were positive social and emotional affordances of these practices. Teens drew out the relational experiences opened up by *"sharing data"* (W5) with others. They designed a persona of a teen who engages in competitive sports who *"Probably shares data with coach and teammates"* (W4). Similarly, teens saw how competition with friends and family could create communities and motivation to continue to track; it *"could be a positive thing to get moving with your friends outside"* (W4) and could foster a community of like-minded others *"who also care for exercise or tracking"* (W1). Here, self-tracking connected teens and encouraged co-located activities: *"my friends and I go on walks together to achieve daily goals"* (W5).

Nevertheless, in line with what we described in Section 3.1.1, teens were clear that there was a difference between *"healthy and friendly competition"* (W1) and unhealthy competition. They felt that healthy competition experiences were possible with the right community and support. Many spoke of how tracking allows them to *"Feel proud at my progress"* (W5) and they felt that *"if i am more healthy i tend to have more fun"* (W2).

3.1.3 What are we assuming? Teens questioning the self-tracking experience.

Many teens expressed ambivalence or skepticism about the value of self-tracking, recognizing that it *"Can be both useful and harmful"* (W4) and sharing concerns that it can be *"glorified by the media"* (W4). Teens' open questions about self-tracking centered around two key themes: (1) questioning the assumption that self-tracking is 'good': *"is it actually beneficial?"* (W5), and (2) determining if self-tracking is appropriate: *"why are we still using self tracking devices if we know that they are harmful. Especially in this generation"* (W4).

This hesitance demonstrates that teens recognized the fine line between positive and negative experiences with self-tracking: *"the pedometer gives me a feeling of pride or self doubt"* (W1). This was particularly the case for social experiences and comparisons, and they acknowledged that *"where there is motivation and inspiration there is also the problem of people feeling worried that they are not keeping up with "normal" people"* (W1). There was no one approach to self-tracking for young people and teens were eager to learn from resources that might help them critically question assumptions about if and how they should be engaging with these tools. Our workshop collaborators highlighted for us the ways self-tracking may be both beneficial and detrimental, and how easy this can shift for each person. As such, they stressed that any resources for self-tracking must be flexible enough to address this complexity.

3.2 What are we co-designing with?: How do teenagers make sense of the self-tracking tools at their disposal?

Teens discussed a variety of use contexts for self-tracking and could clearly see how the affordances of these tools might vary across individuals and motivations for tracking. Combining our persona exploration exercise (Activity 1) with one thinking through different features and effects (Activity 2), we were able to collaborate to piece together this complex puzzle.

3.2.1 Rigidity of design doesn't make sense for teens.

Our collaborators did not subscribe to a rigid approach to self-tracking, and they felt that the design of many self-tracking tools was not flexible enough for their purposes. They were frustrated by *"Not having features that work for me"* (W1) and instead wanted to *"have more options for different situations"* (W1). They wanted alternative presentations of data, such as graphs, because often, the quantitative data presented was not aligned with their individual needs: "*the numbers and words can be confusing to understand"* (W4).

The prescriptive approach of common self-tracking tools (e.g., wearables, apps) was also challenging for teens as *"they often tell you how you should feel about yourself i.e. whether you have exercised enough"* (W5). They felt that the feedback from these tools was often filled with *"critizism"* (W4) and could even be *"Manipulateive"* (W4). Our collaborators were wary of *"apps like myfitnesspal telling you you've eaten too much or haven't burnt enough calories"* (W5) without taking their individual context into account. The language and uncertainty surrounding self-tracking tools often led teenagers to feel as if they were being dehumanized: *"Makes me feel like a lab rat as I do not know how the data is stored"* (W4). In this way, teens felt that they were being told what to do rather than supported by self-tracking tools. This presented an opportunity for teens to think about how educational resources might help them navigate the more rigid designs of PI tools and creatively engage with them in ways that made sense for their needs.

3.2.2 Lack of age-appropriate support makes self-tracking challenging.

Some teens suggested that stricter age limits and better education on self-tracking were critical: *"maybe some of these apps like MyFitnesspal should have an age limit or like something that would mean that people understand what they are doing if they go onto the app"* (W4). This spoke to a concern that teens' experiences differed from those of adults, and as such, without additional scaffolding, the use of off-the-shelf PI tools could present challenges for young people. Importantly, teens emphasized age as an important consideration in the tracking experience and questioned whether appropriate support was available for young people who were interested in tracking: *"Is it right that children are getting self tracking devices from such a young age? (Eg fitbits)"* (W4).

For example, teens repeatedly raised the prevalence of social comparisons at this formative lifestage. In the absence of adequate age-appropriate support and resources to think critically about personal data and understand relevant comparisons, teens saw how positive aspects of self-tracking could become negative for young people: *"It can be positive if the comparison can motivate someone to continue with their own self tracking journey but it also runs the risk of trying to replicate someone else's data which would be inaccurate"* (W2). This emphasized the need for new, targeted educational opportunities for young people around self-tracking that spoke to the prevalent concerns of teens.

3.3 What are we co-designing?: What educational opportunities do teens imagine are possible and effective?

Drawing on the insights above, we worked together with our workshop collaborators to design a teen-specific educational experience to support their self-tracking practices. While Activities 1 and 2 of the Series A workshops centered around experiences with PI tools and their features, the teens expressed uncertainty and a strong desire for more information around self-tracking. When describing how PI could be improved, they asked questions rather than positing new features to be integrated into existing tools. This demonstrated the acute need to reimagine the support and resources around self-tracking tools for teenagers. Specifically, they highlighted that this was often the difference between 'good' and 'bad' self-tracking experiences. They felt that self-tracking experiences with proper support and education, and healthy boundaries, found it more fulfilling and useful. This is where the 'how might you' guide came in as teenagers recognized that some *"may ned someone else to assist in tracking"* (W5), particularly if they were tracking to help them handle a physical or

mental health condition. This validated our decision to focus Activity 3 on information needs rather than co-designing new tools.

As teens discussed different features and effects of self-tracking tools, they focused on broad themes and practices, rather than highlighting aspects that would be unique to one type of person or experience. This was a promising insight suggesting that, if done thoughtfully, a single, adaptable educational resource might be leveraged for teens rather than needing to create individual, personalized guides. So, together we grappled with the challenge of designing resources and experiences that were broad enough to encompass different perspectives but also personal enough to not be superficial, providing instead beneficial insights for this population. Here, we focused on two key considerations: content and distribution of such a resource.

3.3.1 What key content would teens like to be included in a self-tracking guide?

Teens were clear they wanted the user guide to encourage nuanced, *"not judgmental"* (W2) conversations which acknowledged individual motivations for tracking: *"Ask yourself WHY you want to track yourself - if not positive then don't do it!"* (W4). As one collaborator stated, *"Tracking is for everyone and also not for everyone. It's helpful for people who can bear listening or knowing about their health status"* (W3). Our collaborators wanted the educational resource to be unafraid to address these tensions. Teens argued that such a guide must expand this non-judgmental space to include parents and schools as teenagers, educators, and parents need to be aware of individual reasons for engaging in self-tracking and the nuanced experiences, both positive and negative, that come alongside those.

The teens acknowledged the benefits of self-tracking, but many were concerned about it being a slippery slope: *"it is so easy to become obsessed with"* (W5). Our collaborators repeatedly used cautionary language when describing self-tracking, including phrases such as *"be careful"* (W5). Short of defining when too much is too much, our collaborators agreed that individuals should determine their own balance*: "Obviosuly when pushed to extremes its negative, but as logn as you can use your self-awareness to decide if you're going too far then you should be fine"* (W4). The teens felt the guide should discuss the dangers of obsessive tracking and provide resources for identifying and addressing such habits.

Teenagers agreed that community-building is important for healthy self-tracking practices and suggested that the guide could thoughtfully promote this community orientation. Our collaborators often disagreed on the role of competition in healthy self-tracking practices, as discussed above in Section 3.1.2. Nonetheless, most felt the role of competition should be determined by one's reasons for tracking. The teens were keen for an educational resource to offer guidance on both individual and healthy community self-tracking practices.

Many teens emphasized the importance of recognizing the context of self-tracked data; our collaborators felt the guide should switch the framing from monitoring numbers alone to more dynamic goal setting which considers other measures of health and wellbeing: *"Numbers don' define you and don't take the full picture into account"* (W4). Teens focused on the holistic context of their data, rather than the numbers themselves: *"my weight and fitness level is the least interesting thing about me"* (W5). They wanted the guide to encourage teens *"if you don't reach a goal, remind you that that is okay"* (W5). They felt that the guide should think beyond quantification, instead offering guidance on how teens might explore more deeply the context of their self-tracked data.

Finally, our collaborators wanted the guide to address the role of third-party actors. They wanted it to answer questions such as: *"how is data stored"* (W4), *"is our data used for studies, do our devises save our data"* (W5), and *"how secure is the data"* (W4). Further, some of our collaborators sought guidance on how to keep their tracking private from peers and family if desired: *"i would love people to respect my privacy"* (W2). However, they also wanted to be directed to information about third-party support; for example, many emphasized how the guide must include resources for mental

health support. These resources were not only seen as important for young people; they emphasized the importance of improving parents' understanding of the complex relationship between self-tracking and mental health, such as anxiety and body-image issues.

3.3.2 Where would teens choose for a self-tracking user guide to be distributed?

Our collaborators were divided over the distribution methods of the guide; yet ultimately, they just needed this information to become available to them. As one teen said, *"there are different ways of passing the information it could be with a video or poster or whatever it doesn't means it just about the information being passed"* (W1). Our collaborators wanted the guide to be simple, with straightforward sentences or bullet points and *"gentle"* (W5), *"peaceful"* (W4) language. They wanted information to be *"very clear and straight forward to read"* (W1). The teens wanted to leverage language to positively reframe the goals of self-tracking away from a focus on inadequacy: *"it should be presented as a way to improve how already amazing you are"* (W5).

Some teens believed schools were useful places to present this information, though in small, interactive discussions, rather than large assemblies. Whether these discussions should be compulsory or not was controversial. Discussing this topic in schools was seen as potentially too encouraging of self-tracking: *"honestly i would say schools and parents shouldn't encourage tracking at all"* (W5). Conversely, some believed that whilst engaging in self-tracking practices should be optional, education around PI systems should be obligatory: *"i think it needs to be talking about full stop I know in my experience I have never had a conversation with someone about tracking"* (W4). Most collaborators agreed that external experts should discuss self-tracking, not teachers: "*I think it should be an expert that comes into schools to talk about it. I wouldn't feel comfortable with a teacher commenting on how I ate/exercised"* (W4). As such, our collaborators proposed that having an informed expert would provide students with a safe environment to discuss the complex topics in the user guide.

Many felt social media was another helpful place for sharing the user guide, as it was accessible and comfortable for teenagers to use and had the potential to reach a large number of young people. Teens also appreciated how social media afforded anonymity in accessing this information. Social media was where many had come across self-tracking for the first time (often with content they considered to be harmful such as content that encouraged disordered eating or obsessive exercise), and as such, they felt it would likely have a large reach: *"I think also on social media, because that's probably where most people pick up ideas about self tracking"* (W5). It was seen as important to meet teens where they currently are. For these reasons, we decided to base our mock-up designs for Series B workshops around examples of other social media-based guides.

3.4 Why are we co-designing?: What do teenagers make of a co-created 'how might you' self-tracking guide?

Following teens' recommendations to consider social media as an important space for distributing additional, supportive resources around self-tracking, two researchers (BLINDED FOR PEER REVIEW) went away to deliberate on how to action these recommendations and design a series of *Instagram* posts that would be appropriate for young people. In what follows, we describe our process of collaborating with teens to co-create such a guide (see Figure 4 for examples of the mock-up posts).

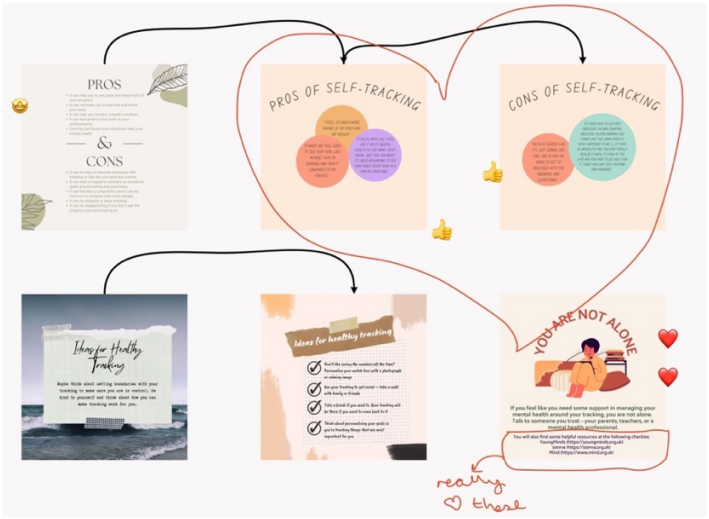


Figure 4. Teens emphasized the types of posts they found to be most useful and information in Workshop 7 (Series B). We prioritized these posts in our proof-of-concept designs.

In particular, something we as researchers had to take pause and think about was whether an educational guide like we were aiming to co-design with teens was even appropriate. As we highlighted in Section 3.1.3, many teens questioned the assumption that self-tracking is in fact good or healthy and were wary of young people their age being encouraged to track. As such, based on the collaborative design process in the Series A workshops, we thought carefully about the tone of the guide and moved away from a practical 'how to' guide for self-tracking, and instead focused more on a technology-neutral and practiced-focused 'how might you' guide. In doing so, we acknowledged that there are open questions around the value of self-tracking for individuals and aimed to equip young people with the skills and knowledge to question any broad stroke assumptions. We understood that it was imperative that this guide captured different use contexts and experiences, whilst providing tools to support young people as a group in making their own assessments about healthy practices and balances. It was important that this was done without dictating a 'right' or 'wrong' way to engage in self-tracking.

3.4.1 Who are you speaking to? Balancing wide audience reach with personalization needs.

Teens acknowledged the complexity of social media as a means of distributing information to diverse audiences whilst simultaneously making the content feel personally relevant: *"I do like the idea of reaching a more personal level"* (W7) but *"if you don't know the person, it's kind of hard to make a connection with your audience"* (W6). Drawing on the different teenage personas we had discussed in the Series A workshops, we worked together with teens to think through how we might address this challenge and ensure that the guide would reach a broad audience without feeling out of place in their feeds: *"its important to acknowledge that different people have different needs and its important to make the posts accessible to everyone ?"* (W7).

One of our collaborators reframed this challenge and encouraged us to target posts at specific groups to avoid a one-size-fits-all approach: *"I think having certain… certain groups of of posts for different types of people will be quite good […] you don't have to create one post that aims at everyone but tries to talk to them individually. But actually talking to them all individually"* (W6). To facilitate this, teens felt that it might be useful to signpost in the image captions that not every post would be applicable to everyone: *"I don't think you should say this post is not for you. I think you should say*

this post might have some useful information in it if you want to read it, you can, but there are other posts that might suit you better" (W6).

Teens clearly saw how design decisions could also reveal the intended audience of posts and were critical of how this might impact young people's willingness to engage with this content. For example, in Workshop 7, one teenager shared: *"you often see these types of like formats and um colours and images on sort of health blogs and stuff like that […] it's a very targeted audience"*. They were keen that the visuals of the posts were leveraged to signal the content but also strategically designed to ensure certain audiences were not excluded from this resource: *"i think being 'non specific' in your posts could be good. eg. for a post on tracking fitness maybe avoid having images of a fitbit or something because it can alienate some people who may not have access to certain resources"* (W7). Further, they wanted to see themselves reflected in the posts, and shared, *"if you include little avatars/characters on posts then i think making them diverse and representative of a range of demographics would be good"* (W7). Our collaborators stressed that design can be used to achieve this delicate balance between addressing young people as a group but also acknowledging individual differences in self-tracking experiences.

3.4.2 Who is speaking to me? Establishing a relatable authorial voice.

Teens were focused on the tone of content and were eager to see something that was not *"patronizing"* (W7) which emphasized their autonomy: *"It's not really telling you what to do, it's just telling you what you can do"* (W6), which were important themes also touched upon in the Series A workshops. Our co-created 'how might you' content was considered to be a good model of this. Our collaborators liked posts that did not underestimate their intelligence and instead highlighted the choices teens have in *why* and *how* they might self-track: *"I don't really like being told what to do, but umm I do… I do have common sense. And so like, yeah, I do, like read... If I'm trying to do something new. I do read on it. I do my research and stuff like that"* (W7).

When it came to testimonials and *"more personal stories"* (W7), teens were eager to hear from *"someone famous or like someone around… close to my like age, definitely someone who's not an adult though, definitely"* (W6). Teens wanted a relatable voice that didn't feel like a teacher or a parent: *"if it's an adult, you've just feel like it's your like like it's your parents telling me to do the same thing over and over again and you start to zone out more and more"* (W6). However, testimonials from people close to their age were controversial as this *"can be a very slippery slope with regards to leading teens to compare themselves with someone theyve never met"* (W7).

Akin to previous work [16], when engaging with health content online, teens were wary of commercial voices and instead were keen to hear from other authoritative, expert voices. Our collaborators felt that the use of testimonials was *"most effective when they're personal. too often testimonials are about selling some kind of product and quite generic"* (W7). For example, *"a qualified umm dietitian or doctor or someone like that that umm you can sort of rely on […] there's like a lot of lies and a lot of fake advertisement that goes through. Umm so having something that's backed up medically umm does help a bit"* (W7). They felt this would help them to determine the trustworthiness of the information in the guide as they navigated the often-overwhelming quantity of other health information available online.

3.4.3 Say what? Finding the right message.

Teens felt that it was important for the guide to present *"non biased information"* (W7) as *"swaying towards one way or another could impact people's choice in deciding to self track or not"* (W7). High quality content was central to teens' decisions around whether to engage with a guide like this: *"I think the content and the quality of the content is one of the most important things, and that would make me follow it"* (W6).

Despite the prevalence of negative self-tracking experiences in the Series A workshops, when it came to designing an educational guide, teens felt that overly negative content could be read as patronizing or could compromise teens' autonomy to choose if or how they engaged with PI tools: *"When you wanna start doing something for your own benefit, you don't wanna be bombarded with like all the things or the negative things that could happen to you"* (W7). They felt that this removed teens' ability to weigh up risks and benefits in their own mind: *"I feel like people aren't stupid, they do know their limits, and so it's not everyone that will end up having eating disorders or obsessions and stuff like that"* (W7). Such content could be viewed as *"demoralizing"* (W7) or *"an attack to what I'm doing"* (W7) and instead teens wanted the guide to offer a balanced perspective addressing both the pros and cons of self-tracking.

For any content that related to potentially sensitive topics such as mental health, weight, or calories, teens were keen to see trigger warnings or other signifiers that vulnerable young people might choose to move past the post without engaging. Our collaborators were particularly fond of including a slide in every post to remind young people of where they can go for help and wanted this to be carefully designed to ensure maximum engagement from teens when needed as they felt this would be *"helpful for people that do need it to have that constant reminder and then people who don't will gloss over it because they don't need it"* (W7).

3.4.4 What does it look like? Designing for teen trackers.

Reflecting on the sample posts we created for the Series B workshops, teens felt that these were consistent with the other content they engaged with on social media and would not feel out of place on their feeds: *"i think all of these are very 'Instagrammy' and the type of content that i look at on ig [Instagram]"* (W7). A few shared that they were feeling uninspired by the content they were seeing on their existing feeds and were excited by the prospect of a visually-appealing guide to break up the monotony: *"that would be enough to like draw me in, cause a lot of the Instagram pages nowadays aren't like very interesting. So umm I think that would be enough to draw me in to watch and read what it's got to say"* (W6).

Eye-catching visual designs and images were key for teenagers as they shared *"when im looking through insatgram i dont usually read, i tend to gravitate towards the pictures and vedios"* (W7). The teens were drawn to color schemes that were bold and unexpected but appeared gender-neutral: *"I think you've completely nailed it… like in this one it's uhh like it's like I didn't think of it being like these two colours, but they fit so perfectly together"* (W6).

Drawing these considerations together, teens felt that a 'how might you' *Instagram* guide had the power to be impactful for young people and the information could stay with them as they went about their daily routines. They saw real value in a skillfully-designed resource to address a real education gap and felt confident that, with a sensitive and age-appropriate approach, it could have powerful effects on teens' engagement with PI tools.

4 DISCUSSION

In this study we worked alongside teenagers to co-design resources which may support young people in their individual self-tracking journeys. Our collaborators were highly reflexive and cautious about the negative experiences of self-tracking for young users; however, they also saw the value in self-tracking with the required level of support and under the right conditions, validating our decision to focus on co-creating an 'how might you' guide.

Our data celebrates the messiness of teens' self-tracking experiences and clearly highlights the challenges of creating educational resources around technology that are relevant to such a diverse user group. While re-designing tools to address the varied experiences of teens—such as more age-appropriate considerations and space for more nuanced interpretations

of data—will be crucial, there is much worked needed to support teens through all stages of their PI practices. These different stages should be scaffolded with educational resources, particularly when teens are making important health decisions in response to their understandings of these tools [21]. Here, we suggest that developing more educational resources will help young people, particularly when it comes to the *reflection* and *preparation* stages [12,42], enabling them to make more considered, nuanced decisions about what PI habits are best for them.

4.1.1 A balancing act: Acknowledging the complexities of health and wellbeing.

One of the most apparent findings from the workshops is that teens have no single, agreed upon definition of 'healthy' self-tracking. Instead, teens are wary of a trepidatious line between being highly engaged users and 'obsessive' tracking, speaking to the broader theme: teens are deftly navigating various balances between healthy (but not obsessive), educational (but not patronizing), and flexible (but not structureless) self-tracking practices and want the autonomy to decide on the most appropriate balance for them. Healthy self-tracking habits could include achieving realistic fitness goals, whereas unhealthy behaviors could be identified by undue focus on physical appearance or strict calorie counting. Teens identify different ways self-tracking can influence mental health, from building a supportive social network, to becoming happier through being healthier, to becoming fixated on numbers and lowering self-esteem. These nuances can be difficult to articulate, but teens are well aware that there is no prescriptive approach to 'good' self-tracking or 'healthy' behaviors. As a group that is often underrepresented, they desired resources dedicated to helping them work through these unique complexities of balance, health, and wellness as young people.

Likewise, our workshop collaborators were very clear when we discussed the notion of the 'how might you' guide that they wanted a balance between positives and negatives. In initial conversations in the Series A workshops, much of the discourse skewed towards a negative view of self-tracking, with critical reflections on the role of self-tracking habits in different people's lives. However, when teens engaged with the mock-up designs of an *Instagram* resource in the Series B workshops, they were keen to see a more balanced perspective (the evolution of this shift throughout the co-design process can be seen in Figure 5). Teens are all-too aware of these potential harms, but they currently lack educational resources to help them discern what 'healthy' and 'unhealthy' can look like for them, and how the complexities of this balance may translate into self-tracking behaviors. Particularly when engaging with PI-related content on social media, our teens noted a distinct absence of this critical discourse online. Whilst teenagers do not want an educational resource telling them what

is right and wrong, they advocate for a balanced presentation of information and experiences which preserves their autonomy and personal judgment.

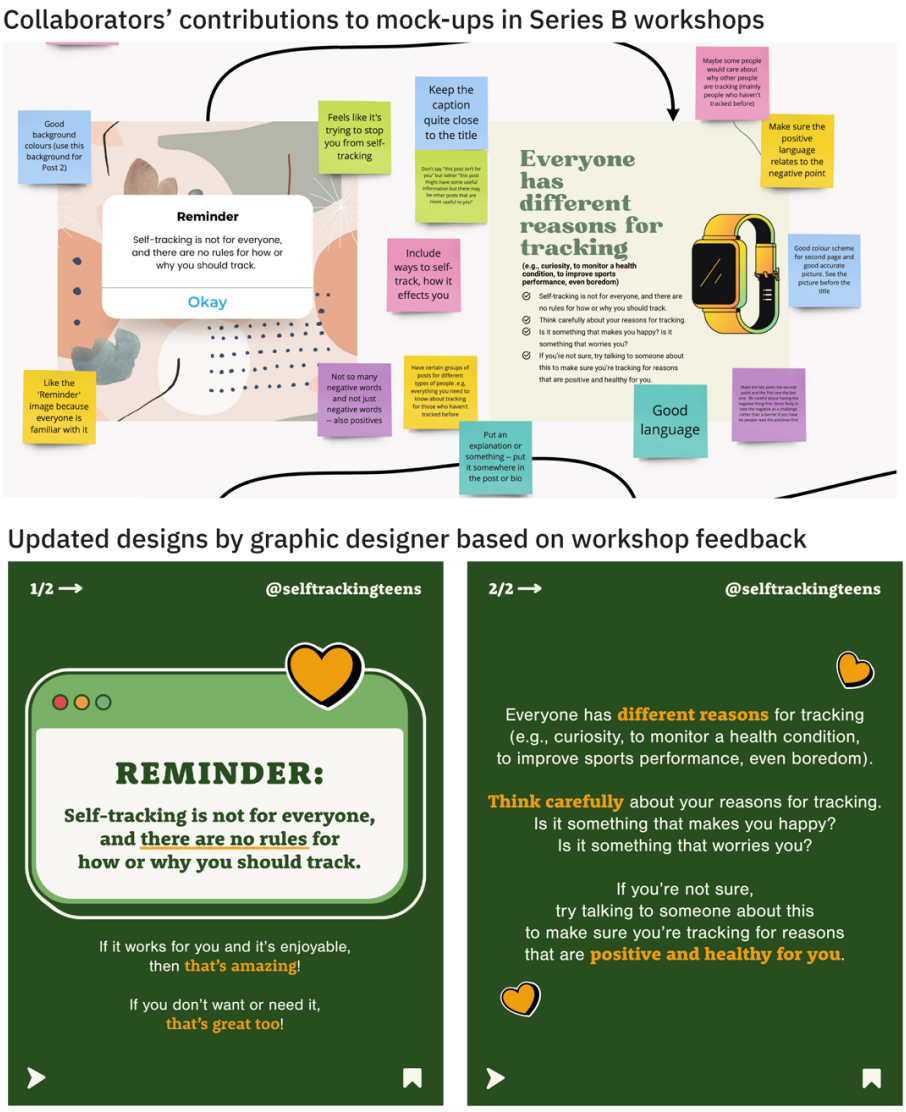


Figure 5. Evolution of changes from initial mock-ups in the Series B workshops to the final posts created by our graphic designer

4.1.2 Putting the personal in personal informatics.

The concept of the 'self' sat at the core of this project and although there is an important social component of many teens' self-tracking behaviors, they still largely view self-tracking as a highly personal habit. As such, they want resources which

similarly value individual experiences. This can be seen in their approaches to resource content, testimonials, and empowering other voices. Our workshop collaborators initially expressed their thoughts on self-tracking through personas in Series A. By considering the nuances of self-tracking in the form of varied personas, whether that was self-reflection or placing themselves in the proverbial shoes of someone else, we were able to construct complex dialogues around what self-tracking is and how it manifests for different people. Self-tracking is truly about the self, it is unique for each person, and teens resisted any cookie-cutter model of how to self-track.

The rigidity of today's tools [70] makes such personalized practices difficult, if at all possible, for young people to achieve. As such, teens see real potential in a guide which opens up avenues to be creative and playful. Despite the narrow conceptions of health often encouraged by PI tools [9], teens do not want to be fed ideas of normalized health, such as quantified metrics which lack context and personalization (i.e., achieving 10,000 steps a day). As such, the co-designed guide prioritizes these notions of personalization and individual experiences through a balance of professional resources and peer testimonials; providing critical education to help teens understand how to "move away from asking what is normal toward 'what is normal for me?'" [50]. These more personal touches create a sense of intimate conversation, providing suggestions and resources for how one *might* think about something, in opposition to firm 'how to' guides intended to serve and instruct everyone.

Moreover, in line with previous work [16,20], our study demonstrates that social media spaces such as *Instagram* are valuable as resource sites for education on health technologies. These more 'informal' platforms afford a space for young people to engage in (often difficult) conversations. Teens are resistant to the idea of being lectured and seek a relatable, empathetic voice. They want education around self-tracking to find them in *their* space (e.g., in schools or on *Instagram*), and they want to see people who look and sound like them working through these challenges. By creating resources in an environment that teens are comfortable with and feel creative in, we can help cultivate a sense of feeling heard and included in conversations around self-tracking.

These workshops teach us that, in order to design resources around technical practices for populations for whom these tools are not explicitly designed, it is critical to think about how to balance a variety of perspectives, positives and negatives, and to promote an awareness of unique, personal experiences. Interacting with technologies is not just engaging with the tools themselves, but rather broader interactions in our information ecosystems. Schools, organizations, and other spaces can also leverage these points of balance and celebrating individual differences. This goes far beyond designing an *Instagram* guide, and even resources for young people, and speaks to the ever more varied technological use contexts of populations across the globe.

4.1.3 Resources, not just re-tooling.

For populations who might be overlooked in design, part of the purpose of an educational resource can be providing information to critically assess assumptions and arguments to inform their interactions with technology. For this research, this included questions such as: Does self-tracking work for everyone? Do I have to self-track to be healthy? Should teenagers self-track? Teens express a strong desire for spaces that foster *conversations*—not instructions—acknowledging the complexities of health and balance and allowing space for personal experiences rather than generalizations. Teens highlight that these conversations and support can be the difference between positive and negative experiences with self-tracking. As highly inquisitive and reflexive thinkers, our collaborators had many questions around the role of self-tracking in their lives. The 'how might you' guide may not necessarily have answers for all those questions, but it would help provide teens with resources they could look to in order to answer those questions for themselves, and help them ask new

ones. While PI tools may provide teens with data about themselves, creating resources which promote nuanced discussions and encourage question asking will empower teens to make PI decisions that work best for them.

Previous work has emphasized the centrality of *reflection* in data practices [54,55,69] and the teens in this study posed many questions that influenced their reflection on self-tracking data. This is why a 'how might you' guide is so valuable for this group, as it affords us an opportunity to consider individual differences and move beyond a prescriptive 'how to' approach to self-tracking. Instead, a 'how might you' guide can meet teens at whichever stage of self-tracking they are at, from *preparation* all the way through to *lapsing* and *resuming* tracking [12,42]. As teens might move through these stages fluidly, in different orders and at different times, a readily-available 'how might you' guide offers important flexibility for teens navigating the complexities of their interactions with PI tools.

To take a first step, taking direct action on the work done in our Series B workshops, we worked with a graphic designer to create a series of 15 proof-of-concept *Instagram* posts bringing together the insights from all seven of the workshops. An example of these posts is available in Figure 5. Two researchers curated a list of the key insights offered by our collaborators and shared this with the designer to ensure that the teen voice was reflected in every stage of the design process. Working through the challenges alongside teens, we saw just how reflective young people are about their technology habits and needs. This led us to engaging, dynamic, and fruitful discussions and a useful output that encapsulates the core insights from these workshops.

We are not advocating against redesigning tools, but rather are promoting a more holistic information ecosystem to be available for teens to support their interactions with health technologies. These findings show there can be great impact in offering age-appropriate, effective resources to better support practices for these populations. In many cases, the technologies we have are acceptable for young people [54], but what is lacking is the means to educate people on how to make these tools work *for them*. We saw from our collaborators that there are difficult balances that need to be struck when deciding if and how to incorporating self-tracking into one's regular routines. Determining this balance is deeply personal, and requires an individual, tailored approach. We saw in our findings from the Series A workshops that many teens find current tools to be too rigid to work for their purposes. This is what makes resources uniquely valuable, as they are more flexible in content, presentation, and distribution, allowing for more diversity in the types of information, experiences, and use cases shared. Resources are an important step forward, but they should not be designed without first listening to and hearing the people we are seeking to design for.

4.1.4 Limitations.

We saw a high collaborator attrition rate between our Series A and Series B workshops and this limits the generalizability of the findings from the Series B workshops. There are a number of reasons for this, such as lower incentive rate (Series B were shorter, and therefore the compensation was less). Furthermore, there was an increase in cases of both the flu and the Omicron variant of COVID-19 at the time of the Series B workshops, and many collaborators were unable to attend for health-related reasons.

Recruiting through social media allowed us to engage with teenagers where they often come across self-tracking content, but it also posed a variety of challenges. As we prioritized anonymity, it was hard to verify the ages of collaborators and, to promote inclusivity, anonymity, and comfort for teens, we allowed them to participate with their cameras off if they wished. Nevertheless, these online workshops allowed us greater geographic reach and the ability to bring together different voices, without collaborators bearing the cost of travel [37].

We began this project with a self-awareness that we lacked the means to create brand new self-tracking tools. Limited by budget, resources, and means, we prioritized compensating our workshop collaborators for their time and drawing out

informational needs of young people. This limited our potential to co-design new self-tracking tools, but instead we uncovered something new: the value of 'how might you' guides.

We know that social media is an important space for health information to reach teens [16,20]. The proof-of-concept *Instagram* guide we designed goes some way to show the possibilities here; however, we would be remiss not mention the ways in which the affordances of this platform shaped the guide. For example, we focused on image and text-light based content and were constrained to standard image sizes for the platform. Future research might consider other format opportunities for the guide and what new educational opportunities these might bring.

5 CONCLUSION

By working alongside teens, we gained invaluable insights into their experiences with current self-tracking tools, the impacts these have on their mental and physical health, and importantly, the types of educational resources they would like to engage with to better support their engagement with PI tools. Teens walk a delicate line between dependence and independence [2], which is reflected in their ideas about self-tracking tools and resources. Our collaborators spoke of the increasing prevalence of PI tools in conversations around personal health and wellbeing. As such, they wanted more *information* that could support them at various stages of their self-tracking journeys (particularly around *preparation* and reflection). Teens want to learn more about personal and personalized informatics practices. They sought to understand how to make informed decisions for themselves and to better integrate PI tools into their lives as they continue to develop their interaction patterns with technology.

Importantly, teens showed us that simply re-designing tools is not enough. Rather, they saw the value of educational resources that accompany self-tracking tools to be a flexible space for nuanced conversations, which should be scaffolded alongside PI tools to cultivate broader health informational ecosystems. A 'how might you' guide rejects normative and rigid conceptualizations of health in-built into many PI tools, instead encouraging teens to ask questions relevant for them, and their user experience with such tools. When designing future educational resources around PI tools we suggest embracing the messiness of self-tracking and teen experiences, while ensure the tone and content remain supportive, and non-patronizing. Particularly, teens require support at all stages of self-tracking practices. We found that educational resources, such as this 'how might you guide', are particularly helpful at the *reflection* and *participation* stages but more work is required to determine how best to implement support across all stages of teens' self-tracking journeys.

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The challenge of repurposed technologies for youth: Understanding the unique affordances of digital self-tracking for adolescents

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Abstract

Adults' digital self-tracking practices are relatively well studied, but these pre-existing models of digital self-tracking do not fit for how adolescents use these technologies. We apply the mechanisms-and-conditions framework of affordance theory to examine adolescents' imagined affordances of self-tracking apps and devices. Based on qualitative data from an online survey of 16- to 18-year-olds in the United Kingdom, we find the following three key themes in how adolescents imagine the affordances of digital self-tracking: (1) the variability of use across adolescents and with adults, (2) the role of the social control of data in school settings, and (3) the salience of social comparisons among their peers. Using these findings, we show how social and institutional configurations come to matter for technological affordances. By examining adolescents' imagined affordances for self-tracking, we suggest self-tracking research move away from a "one size fits all approach" and begin to highlight the differences in practices from adults and across adolescents.

Keywords

Adolescent, affordances, digital technologies, school, self-tracking, self-tracking in everyday life, social comparison, survey

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Introduction

Digital technology is ubiquitous in adolescents' networked lives, shaping their experiences of social interactions, self-identity, group memberships, games-playing, and skill-learning (Davies and Eynon, 2013). As highly engaged technology-users, adolescents are often early adopters of new technologies (Rideout et al., 2010). However, regarding digital self-tracking tools—such as Fitbit, Apple Watch, and digital sports and fitness watches and devices or smartphone apps—the scholarly literature and technology marketing alike try to fit adolescents' patterns of use into adult molds. Exploring how adolescents imagine, negotiate, and use self-tracking technologies may help researchers better understand technology practices and behaviors at this developmental life stage and expand our knowledge about digital self-tracking in general.

Our aim in this article is to unsettle the idea of adolescents as "mini-adults" and suggest that the models for self-tracking based on adult practices do not fit for adolescents. Digital self-tracking tools are designed to allow individuals to monitor, control, and analyze personal data, including health and wellness data (Ridgers et al., 2018), and many are designed with adults in mind (Schaefer et al., 2016; Wartella et al., 2016). These same tools, we find, afford adolescents quite different uses.

Adolescence is an important life stage because of "rapid physical and cognitive changes, expanding social relationships, and additional rights and responsibilities" (Zimmer-Gembeck and Collins, 2003: 175), and it is when lifelong health-related knowledge and behavior patterns are established (Kumar et al., 2015; Patton et al., 2016). It is also a time when agency functions differently due to the constraints of school. Young people spend over 7800 hours of their lives in school (YoungMinds, 2017), constrained by the particular norms, structures, and routines of schooling. Digital self-tracking practices are now moving "into areas beyond personal choice" (Gorm and Shklovski, 2019: 2508) for many people, but the stakes are particularly high for adolescents within the institution of formal education.

As we will see below, the current self-tracking scholarship has serious limits in explaining adolescents' practices with these technologies. We look at how adolescents approach self-tracking tools. Do they show elements of the same kind of "soft resistance" that some adult users show (Nafus and Sherman, 2014)? Are adolescents using these devices to reformulate or reimagine their identities through the data or are they rejecting quantification? We use the concept of "imagined affordances" (Nagy and Neff, 2015) to understand how adolescents might be afforded different things from the same material tools that adults use. Drawing on a survey of 16- to18-year-olds, we show that adolescents' imagined affordances for self-tracking in school-based Health and Physical Education offerings are shaped by the outsized importance of social comparisons for their life stage, how schools highly circumscribe their roles and agencies, and their wide variety of experiences and practices with self-tracking. Our findings about adolescent self-tracking suggest that other digital scholars should both take care with their assumptions about adolescents' abilities to reconfigure digital technologies and reexamine the roles that social institutions play in shaping people's engagements with new technologies.

Adolescents as self-trackers

Adolescents use digital self-tracking tools, despite the fact that these tools are neither designed for them, nor fit their needs. A recent survey in the United Kingdom found that 52% of adolescents use digital self-tracking tools (Rich et al., 2020). Adolescents value the content, personalized information, and social features of apps and wearables (Goodyear et al., 2019a). Adolescents' use of these tools is often within highly institutionalized contexts. Schools increasingly use digital self-tracking tools to help educate young people about the benefits of physical activity (Casey et al., 2017; Gard, 2014; Lupton, 2016; Williamson, 2015) and interventions for increasing physical activity aimed at young people often use these devices (e.g. Drehlich et al., 2020; Tymms et al., 2016).

There are many reasons for caution. The same motivational "nudges" (Thaler and Sunstein, 2009) encoded into digital self-tracking tools designed for adults may not work for adolescents and may even be harmful. After using self-tracking tools, adolescents report increased feelings of competition, guilt, and internal pressure (Kerner and Goodyear, 2017). They are also skeptical of the educational value of self-tracking, experience negative feelings about themselves after using them, and are left with narrow conceptions of health and fitness through peer-surveillance, self-surveillance, and normative physical activity standards (Depper and Howe, 2017; Goodyear et al., 2019b; Kerner and Goodyear, 2017). Lupton (2021) found that relatively few studies have been conducted on young people's use of wearable tools for health and fitness and most of the work to date has centered on intervention-based studies. For example, a recent UK-based study found 16- to 18-year-olds appreciated instantaneously reviewing their data, competing against others, and reaching for goals, but they struggled with how to engage their data, found data interpretation hard, and often forgot to use the device (Rich et al., 2020).

We are eager to make it clear from the outset that this does not mean that adolescents are incapable of sophisticated self-tracking practices, nor that the risks of adolescents' self-tracking data work are insurmountable. Quite the contrary, adolescents' unique skills and expertise in navigating both new technologies and the social and institutional contexts in which they live mean that the imagined affordances of these tools look different to those imagined by adults. As such, it is important to consider these imagined affordances to help us recognize the opportunities that may exist for adolescents' positive use and enjoyment of these tools.

Thinking through affordances

New approaches to affordances show how social and institutional positionality come to matter for technological affordances. It is this lens we adopt to analyze our qualitative survey responses in this study. Davis and Chouinard (2016) define affordances as "the range of functions and constraints that an object provides for, and places upon, structurally situated subjects" (p. 1). Thinking through affordances allows us to see for whom technologies may prompt and dissuade and under what circumstances (Davis and Chouinard, 2016). This approach can highlight the "politics and values in technical systems" and lay "the groundwork for intentional (re)design" (Davis, 2020: 20).

We apply "imagined affordances" (Nagy and Neff, 2015) to show how "expectations for technology that are not fully realized in conscious, rational knowledge but are nonetheless concretized or materialized in socio-technical systems" (Nagy and Neff, 2015: 1). By using this framework, we ask explicitly how adolescents articulate their expectations and beliefs about self-tracking tools, rather than focus solely on what users *do* with these tools. "Imagined affordances" arise between the experiences of the users, designers, and materiality of the digital tools (Nagy and Neff, 2015). Using imagined affordances in this way allows scholars to look beyond the design and material features of digital self-tracking tools to contemplate how adolescents engage with the often complex social and psychological aspects of them. Our approach suggests that scholars should study the difference between the affordances of self-tracking tools for adolescents and the assumptions of the designers of those tools based on an idealized adult user.

Of course, affordances are not fixed. Technological tools afford uses and actions along a "porous continuum" (Davis, 2020: 22) of interrelated *mechanisms*: request, demand, encourage, discourage, refuse, and allow. These mechanisms are *conditioned* by perception, dexterity, and cultural and institutional legitimacy (Davis, 2020; Davis and Chouinard, 2016). This means how technologies afford is based in part a subject's socialized awareness of and ability to use available features within user's social contexts. Both awareness and ability are shaped by "cultural and institutional legitimacy": "[t]he push and pull of an artifact rests partially on the structural position of the subject with whom it relates" (Davis and Chouinard, 2016: 6).

Schools dominate the institutional legitimacy of adolescence, shaping and constraining young people's practices with digital technologies in key ways. In schools, "contested affordances" between teachers and students show the importance of power and resistance in affordances (Dinsmore, 2019). Adolescents often engage in creative use of technology, for example, by finding workarounds to institutional restrictions on technology, such as using virtual private networks (VPNs) to bypass schools' firewalls (Dinsmore, 2019). However, the broader cultural logics of an institution—in Dinsmore's case and ours, the school—can shape the affordances of technological tools. Thus, user agency comes to matter differently in different institutional contexts based on cultural and institutional legitimacy.

How does the adolescent context shape affordances for digital self-tracking tools?

Our aim here is not to compare adults' and adolescents' self-tracking practices. Previous literature has documented how complex and nuanced adults' self-tracking practices can be, varying considerably within and across individuals and groups (e.g. Chung et al., 2017; Gorm and Shklovski, 2016; Nafus and Sherman, 2014). Instead, we show how thinking through the social context for adolescent practices might shape different affordances for digital self-tracking tools from those afforded adult users. Specifically, we look at the following three challenges that adolescents contend with: institutional constraints, a rapidly changing bodily laboratory, and social pressures.

Institutional constraints

While off-the-shelf self-tracking tools are often marketed for data-driven behavior modification, working for this purpose depends on people's ability to make changes based on their access to and negotiations around their data (Neff and Nafus, 2016). For instance, Apple describes the prompting actions of the Apple Watch as "A tap on the wrist. A kick in the butt" (Apple, 2020), a reminder for users to engage periodically in health-promoting behaviors. Consumers of these products are often positioned as projects to be shaped (Schüll, 2016). Such activity and behavior modification may not be the appropriate frameworks for understanding adolescents' digital self-tracking practices.

Behavioral "nudges," such as reminders to "stand" or "move," will not work if one's schedule is outside one's control, as several have found for adults in the workplace (e.g. Saukko and Weedon, 2020). These agency constraints may be even more apparent for adolescents who may not be in the position to negotiate or reconfigure the boundaries of so-called appropriate digital behavior both within and outside of the classroom (Potapov et al., 2021), where digital self-tracking tools may be banned from certain spaces.

While models of use of self-tracking tools based on adult practices are messy, varied, and complex, they still may not be realistic for adolescents. The practices afforded by these tools for adolescents might differ from the affordances imagined by the designers of these products, or indeed the practices afforded for individuals in other contexts. Self-tracking tools are "everywear," so ubiquitous that they infiltrate everyday spaces (Gilmore, 2016). This is likely not the case in adolescents' more highly circumscribed digital media use. Similarly, for models of sense-making that happen around self-tracking tools and data, adolescents' positions within nested sets of institutional relationships come to matter. Such data in adult models of self-tracking "define from a distance but assess us with incredible intimacy" (Cheney- Lippold, 2018: 144). How adolescents come to understand the self in relation to others is particularly important for thinking about the implications of their technology use (boyd, 2014).

A rapidly changing bodily laboratory

Adolescents also may differ in their perception and dexterity in using self-tracking tools for self-optimization or experimentation. Within the "laboratory of the self," the self-tracker becomes an experimenting "everyday scientist," discovering more about the self as they co-evolve with these technologies (Kristensen and Ruckenstein, 2018), and engage in self-tracking as a process of self-optimization (Ruckenstein and Pantzar, 2017; Sharon and Zandbergen, 2017). Self-trackers are urged to interpret data, and ask and answer questions, such as, "What do I want to find out?" "How can I answer that question?" "What does this mean?" The problem is that many tools, "sold through appeals to 'empowerment', do not actually help people figure out which questions they should be asking, much less how to ask the next question, test ideas, or make discoveries" (Neff and Nafus, 2016: 11). Adolescents juggle this, too, but in a time of marked biological, social, and emotional growth (Archibald et al., 2003). Adolescents' tracked bodies are neither child nor adult and are rapidly changing. Thus, adolescents may struggle to make

sense of and act on their own data in expected ways, especially when the baselines and standards for measures of steps, heart rate, and calories are based on adult bodies.

Nor should we assume that how adolescents take action mirrors adults. For example, notions of governmentality and control, like Lupton (2013) and others suggest, are challenged by how adolescents imagine different affordances to suit their own purposes within their own contexts.

Social pressures

One possible lens through which to consider adolescents' social relationships is Festinger's (1954) Social Comparison Theory. Social Comparison Theory suggests that individuals possess an innate drive for accurate self-evaluation. However, in contrast to Festinger's (1954) emphasis on self-evaluation as the purpose of social comparisons, subsequent research has suggested that individuals might engage in biased social comparisons for the purposes of self-improvement or self-enhancement (Wood, 1989). Social Comparison Theory has been recently applied to social media (e.g. De Vries and Kühne, 2015; Yang et al., 2018) and digital self-tracking tools (Zhu et al., 2017).

Social relationships and peer comparisons play a powerful role in adolescents' identity development (Ragelienė, 2016). As adolescents struggle with how others perceive them, these processes take on even greater complexity when considering the comparison of intimate self-tracked biomedical data allowed or encouraged by digital self-tracking tools. Scholars know that social comparisons with friends play an important role in adolescents' body image dissatisfaction (Ho et al., 2016) and this can have harmful consequences for adolescents' health and wellbeing outcomes (e.g. Neumark-Sztainer et al., 2006). Conversely, such comparisons are also important for motivation and helping young people to navigate their social worlds (Goodyear and Armour, 2019). Consequently, this context of peer comparison in adolescence points to important areas for research concerned with the unique affordances of technological tools for this population.

There are significant limitations to scholars' current models of self-tracking for explaining the complexities of adolescent self-tracking. This leads us to the following two questions: (1) how do social institutions and relationships enable or constrain how and when adolescents create, access, and control data about themselves and others? (2) how do adolescents imagine, make sense of, and negotiate self-tracking practices within their institutional boundaries?

Method

In this mixed-methods study, we used an online, school-based questionnaire with both closed and open-ended questions. We focus here primarily on the qualitative data.

Participants and procedure

Before any schools were approached and any data were collected, ethical approval was obtained from the Faculty of Education, University of Cambridge. Our sample was students aged 16–18 in the United Kingdom, drawn from two schools in Greater London

and the South East of England. School A is a selective independent day school in South-West London. School B is a selective independent day and boarding school in Surrey. Students at both schools were predominately White British and came from professional family backgrounds.

The survey contained both closed questions for quantitative analysis and open-ended questions for qualitative analysis. Examples of the closed questions in the survey included demographics questions (age, gender), self-reported number of days engaged in physical activity, and the use of digital self-tracking tools. The open-ended questions in this survey included "What do you think people can learn from self-tracked health and physical activity data?" "Can you explain some [benefits/problems] you can see in the use of devices or apps that track data about health and physical activity being used as part of Physical Education classes in schools?" "Do you have any other comments on the use of digital devices and apps to track health and physical activity data?" The quantitative data collected were concerned with the use of digital self-tracking tools. The qualitative data primarily focused on *imagined* use, beliefs, and expectations of these tools within the context of Health and Physical Education, in line with our use of the lens of "imagined affordances" (Nagy and Neff, 2015). The quantitative results will be touched on briefly; however, the insights offered by the qualitative data will be the focus of this article.

All qualitative data were coded following Braun and Clarke's (2006) Thematic Analysis framework. This approach drew out adolescents' insights and perspectives on the affordances of digital self-tracking tools in the school institution. Students' responses were coded phrase-wise. This means if a student referenced more than one theme within their answer, each phrase was allocated to the relevant code. Students' responses are presented verbatim below to retain participants' voices in data reporting. The three key themes that emerged in how adolescents imagine the affordances of digital self-tracking tools were as follows: (1) the variability of use across adolescents and with adults (One size fits . . . Some), (2) the role of the social control of data in school settings (Who is in control?), and (3) the salience of social comparisons between peers (Social comparisons: the good, the bad, and the ugly).

Results

Demographics

The link to the online survey was distributed by the school and as such we do not have the number of students who did not participate. In School A, 159 students commenced the questionnaire; 38 of these did not reach the final debrief page and were removed from the analysis. Thirty-two students from School B commenced the questionnaire; seven of these did not click through to the end and thus their data were removed. We include 166 participants' responses in our study. Participant demographics are available in Table 1.

Table 1. Participant demographics.

		Total sample	School A	School B
Number of Participants (*N*)		166	141	25
Gender (%)	Male	54	54	56
	Female	44	44	44
	Other	1	1	0
	Prefer not to say	1	1	0
Age (Mean [SD])		17.05 (.67)	17.13 (.69)	16.60 (.50)

SD: standard deviation.

The use of self-tracking tools

Almost half (46%) of the students had never used self-tracking tools, 54% of students were either current users (27%) or had previously used digital self-tracking tools but had stopped (27%).

Of the students with experience using digital self-tracking tools, 52 had used a self-tracking app and 65 students had used a self-tracking device. The most popular apps were *Apple Health* (16), *My Fitness Pal* (13), and *Strava* (6). The most popular devices were *Fitbit* devices (18), *Apple Watch* (9), and *Garmin* devices (6).

In total, 94.6% of the students surveyed said that their school does not currently provide or encourage them to use digital self-tracking tools as part of their Physical Education.

One size fits . . . Some

The adolescents we surveyed showed that they understood that the same tools can offer different, even contradictory, affordances in the school context. On one hand, some adolescents perceived that self-tracking devices might encourage health-promoting behaviors, but that the tools are flexible in their use. They "Can help with ur calorie intake compared to amount of calories burnt" (Male, 17 years, Year 12, School B) or can "Help you to improve and be healthier" (Female, 17 years, Year 13, School A). Adolescents also articulated a keen awareness of the fragility of their own and their peers' psychological wellbeing with regard to these data. For example, one observed, "I've seen people with eating disorders obsess over tracking this data" (Female, 18 years, Year 13, School A), and another, "Health tracking apps can instigate false ideals such as weight loss which is especially damaging to pupils mental health" (Female, 17 years, Year 12, School B). Echoing Morris' (2018) argument that built into these tools is the often wrong and sometimes dangerous assumption that "all users need to be pushed into exercising more" (p. 41), those in our survey recognized that being "nudged" to exercise more is sometimes problematic.

Given that this was a school-based study, and that we asked them to imagine how these tools will be used within schools, adolescents also described a pressure to perform to a certain standard in their data. One participant shared that self-tracking practices

"Could introduce unnecessary pressure to achieve certain stats or goals when it's not necessary" (Male, 17 years, Year 12, School A). They were aware that this "pressure" could have negative impacts, as "People could become obsessed with the data and develop unhealthy obsessive habits" (Female, 18 years, Year 13, School A). Adolescents shared concerns that the requests of these tools "Can cause unhealthy obsession—calory [sic] counting etc . . ." (Female, 17 years, Year 12, School A). Adolescents saw how healthy requests from self-tracking tools could turn into "unhealthy" habits: "People can become addicted to their apps/devices" (Male, 17 years, Year 12, School A) or that "People may become too reliant on the numbers" (Male, 17 years, Year 13, School A).

Adolescents also identified possible educational, playful, and personalization affordances encouraged or allowed by these tools. For some, the use of these tools was seen to offer value because it "actually gives data to work on instead of playing games" (Male, 17 years, Year 13, School A) or "Engages the students more" (Male, 17 years, Year 13, School A) than traditional Health and Physical Education classes.

In fact, some imagined that engaging with these tools might provide "Relief from stress" (Female, 17 years, Year 12, School A) and might be "fun" (Male, 17 years, Year 12, School A). Adolescents saw that the tools encouraged them to access and analyze personalized data; allowing the collection of data that is "tailored to you" (Female, 17 years, Year 13, School A). From adolescents' diverging narratives of the opportunities and challenges offered by digital self-tracking tools, we can begin to see how a "one size fits all" approach to the design and implementation of these tools may be inappropriate.

Who is in control?

We asked adolescents to elaborate on the challenges of digital self-tracking, and they clearly saw how the powerful intersection between the institution and their data could bring them harm, particularly in terms of who has control of the data, its provision, and its distribution. Nearly half (46%) of the adolescents we surveyed did not believe that digital self-tracking tools should be used as part of their school's Health and Physical Education classes.

Some adolescents were keen for these tools to be introduced into Health and Physical Education; however, 12 adolescents (32%) stated that use in these settings must be voluntary, not compulsory; it "Should be encouraged but not compulsory as not everyone would want to" (Male, 16 years, Year 12, School A). Adolescents' concern over imposed tracking parallels Sharon and Zandbergen's (2017) work with ethnographic work with members of the Quantified Self community where one of their participants noted, "tracking your weight yourself and having a doctor put you on a scale are not the same" (p. 1702). As such, adolescents distinguished between institutionally imposed self-tracking practices outside of their control and "voluntary," individually directed use, where adolescents maintained some level of agency over their participation.

Adolescents understood that, in the context of the school, the same data perform different functions depending on who has control. They felt that the institutional use of digital self-tracking tools could serve different educational purposes for staff and students with distinct perceptions and dexterities. On one hand, these tools could be involved in "Teaching children what benefits a fitness tracker can provide and how to use them"

(Female, 18 years, Year 13, School A). On the other hand, adolescents articulated that the institutional use of digital self-tracking tools in Health and Physical Education "allows for teachers to cater education to an extent" (Male, 17 years, Year 12, School A). Supporting this, another adolescent shared, "It can measure the effectiveness of the lesson in terms of how much students gain from it" (Female, 17 years, Year 12, School A).

Some adolescents expressed how the infiltration of self-tracking practices into the context of Health and Physical Education classes changed the space from one of enjoyment, or a break from the "routine" of formal classes, to yet another space where they felt a quantified pressure to perform: "Use technology slightly goes against being 'unplugged' and outside" (Male, 18 years, Year 13, School A) and "Over complicates PE, as people generally use it to unwind and have fun" (Male, 17 years, Year 12, School A). Therefore, adolescents were aware of the different affordances and opportunities offered by these tools to those in different structural positions of power and control, whether over their data or over their time.

Sanders (2017) describes digital self-tracking tools as an "institutionally unbound element" (p. 44) of a public health surveillant assemblage. It is interesting here that, while these tools might be "unbound," adolescents certainly are not. Adolescents in our study articulated a clear difference between imaginings of individual and institutional uses of self-tracking tools, showing how there is a shift in affordances when the setting, social circumstances, or mechanisms of control change. Thus, there appears to be some blurring of the boundary between "school" and "out-of-school" self-tracking practices. For example, adolescents shared that "They are for independent exercise rather than a group" (Female, 17 years, Year 12, School A) and are "not necessarily relevant to school sport more recreational" (Female, 16 years, Year 12, School B). Nonetheless, not all adolescents were concerned by the permeability of the borders between school and out-of-school spaces, and some saw this as a valuable opportunity: "It could get people more used to them and how they work, so that they could use the app or devices effectively outside of school" (Male, 17 years, Year 12, School A). Here, we see the institutional use of self-tracking tools breaking out of the borders of the school to spaces outside of the institution where adolescents might have more control and the mechanisms of affordance might look very different.

Social comparisons: the good, the bad, and the ugly

boyd (2014) explains that "[t]eens continue to occupy an awkward position between childhood and adulthood, dependence and independence. They are struggling to carve out an identity that is not defined solely by family ties" (p. 17). The body and its data are critical for understanding one's identity and there is a performative aspect to using and owning digital self-tracking tools that can play into this concept of identity formation (Lupton, 2016). One of our respondents said that these tools could be used to help adolescents "understand their bodies and how they work" (Female, 17 years, Year 12, School A). However, the social nature of self-tracking data was also particularly clear. One participant discussed the processes by which "Students may compare themselves to other friends" (Female, 16 years, Year 12, School B). These social comparisons serve an important role as a psychological mechanism that influences individuals' judgments,

behavior, and experiences (Corcoran et al., 2011). These comparisons may be particularly important during the adolescent period as this is a critical time for identity formation (boyd, 2014; Erikson, 1968).

Existing work on social comparisons on social media has paid great attention to associations between upward social comparisons and reduced psychological wellbeing (Fardouly et al., 2017; Ho et al., 2016; Reer et al., 2019). This observation parallels our findings where adolescents linked comparisons of self-tracked data to negative impacts on the user. For instance, one adolescent explained, "I feel the pupil with the lowest data will feel bad about themselves" (Male, 18 years, Year 13, School A). Another adolescent was concerned about the impact of upward social comparisons, suggesting that they "could cause mental health problems (e.g. they share their data with a friends who's results show them to be a lot fitter . . . this may damage them mentally from a younger age)" (Female, 16 years, Year 12, School A).

Adolescents in our study, however, considered both the risks and benefits of the encouragement of social comparisons through digital self-tracking tools. Self-tracking can encourage healthy competition that motivates adolescents, but for some, like those with eating disorders or already low self-esteem, the same technology may request obsessive behavior, or an antagonistic relationship with peers. Adolescents articulated some concept of a "threshold" of social comparisons, such that, with the right amount, there were motivational effects of "healthy competition" (Female, 18 years, Year 13, School A). For example, one adolescent reported, "You can use the data available as a form of competition between pupils, and this will help the more competitive pupils work harder to beat their friends" (Male, 18 years, Year 13, School A). However, if the balance was tipped, this competition could become more worrisome, with adolescents sharing concerns about "People comparing heart rates and steps taken too much" (Female, 17 years, Year 12, School A) and fearing that "Students may get too competitive about it" (Male, 16 years, Year 12, School A). Adolescents were concerned about the institutional space in which self-tracking might take place, sharing that the use of these tools "Potentially makes it into a more competitive environment if everyone of looking at them" (Female, 17 years, Year 13, School A).

The on- and offline implications of these social comparisons were real to our respondents. Self-tracked data have the potential to infiltrate peer conversations and relationships (Lomborg et al., 2018), encouraging processes of both upward and downward social comparisons. As such, adolescents imagined that self-tracking practices could contribute to "self-esteem issues or bullying" (Female, 17 years, Year 12, School A). Lupton (2016) argues that, within self-tracking, bodies that cannot be contained or controlled are objects of "pity" while those that are lean and fit are "portrayed and regarded as morally just" (p. 51). Nevertheless, the division here is not just based on the perceived quality of one's data but also between those who are excluded from these practices of self-tracking. Adolescents were aware that the high "buy in" cost of many digital self-tracking tools could create ingroup or outgroup divisions between those that have the dexterity and financial means to participate and those who cannot as "Not everyone can afford it" (Male, 17 years, Year 12, School A). Thus, the social comparison processes encouraged by self-tracking tools might allow for the sorting of bodies into categories such as "good", "bad", or even "ugly". At a time where concerns surrounding body

image and identity are paramount, these comparison processes might be of great importance to the ways in which the self is presented to and appraised by peers in this social institutional context.

What is interesting here is that none of the adolescents in our study imagined a situation where their data were *not* shared with teachers (and in some cases, peers). To some extent, adolescents assumed data-sharing as part of having self-tracking tools in schools. As adults, we might imagine the privacy practices differently, but these adolescents did not imagine any such alternative. Adolescents expressed concerns that by engaging in these data-sharing practices, "it becomes a competition instead of a personal thing" (Female, 17 years, Year 12, School A). Morris (2018) argues that "even though we typically have little control over the distribution of our personal data, sharing within our relationships and communities is something we can thoughtfully determine" (p. 37). However, the cultural logics within educational settings may refuse adolescents the opportunity to control their sharing practices or even to figure out how they would negotiate for control. Our respondents were also much more concerned about the consequences of peer-surveillance than they were by possible top-down surveillance from their teachers, showing that gamification rampant for practices in adult models of self-tracking might be deeply problematic for adolescents. If adolescents lose control of the data that they share and the data that they keep private from their teachers and peers, this could have profound implications for the communicative and narrative affordances of adolescents' self-tracking practices.

Discussion

Looking critically at adolescents' self-tracking practices shows important theoretical and empirical work that scholars have to do. Through the lens of the mechanisms and conditions framework of affordances (Davis, 2020; Davis and Chouinard, 2016), we focused on how the affordances of digital self-tracking tools come to matter for adolescents. We see the complexities, challenges, and opportunities when young people try to incorporate extremely personal practices into the social institution of education. Gilmore (2016) highlights the importance of acknowledging how digital self-tracking tools are embedded in everyday life, arguing that research should consider the institutional, political, and cultural forces at work in shaping engagement with these tools. By foregrounding adolescents' experience here, we offer insight into the complexity and nuances in the individual, social, and institutional implications of these tools that are increasingly ubiquitous in young people's lives.

In line with Rich et al. (2020), we found that playful and creative opportunities for the use of these tools exist alongside adolescents' concerns that the use of these tools could be stressful or too competitive. Adopting an affordance approach allows us to theorize how different groups of users imagine and negotiate technologies differently and helps us capture the complexity of adolescents' perspectives into narratives of self-tracking.

To be fair, there has been much written about young people, technologies, and power. What remains particularly interesting to us is adolescents' "imagined affordances" (Nagy and Neff, 2015) of self-tracking: their expectations, fears, and uses of these tools. While over half of our respondents reported firsthand experience with self-tracking tools,

almost all of them reported that their school did not provide them or encourage their use for Health and Physical education. Thus, while they were in a good position to imagine this institutional use from their own experience, our respondents could not report what school-based use might look like in practice. Instead, our survey allowed them to build their own vision of self-tracking from their own perspectives and experiences. These adolescent imaginings of digital self-tracking differ considerably from adults' and they point to important considerations when thinking about the unique affordances of self-tracking tools for adolescents.

We suggest that other scholars of technology take on board the following three key considerations when examining how adolescents use digital technologies that were designed for adults: boundedness, embracing variation, and the complex social world of adolescents.

Boundedness

Adolescents spend a tremendous amount of their time in a school space bound by institutional rules, regulations, and rituals, with deep implications for their control and agency with technological affordances. In our case, adolescent self-trackers may not be free to move, making the affordances of these tools different in different spaces and depending on the context of the individual user, their structural position, and the cultural logics governing their social spaces. Adolescents also perceived stark and dark differences between individual and institution-directed digital tracking practices. They were wary of the use of digital self-tracking in schools. They articulated concerns schools might give data undue control over a range of behaviors and activities. And as a group, they stressed the importance of voluntary use and consideration of individuals, and groups, where these tools might offer varying affordances.

Embracing variation

The mechanisms and conditions framework of affordances "centralizes variability, otherness, and difference" (Davis, 2020: 124). Adolescents' digital self-tracking practices vary from adults,' and there are also differences across adolescents. Much like the variation seen in adolescents' approaches to online health tools (e.g. Freeman et al., 2020), the heterogeneity in adolescents' imagined affordances in our study was apparent. Our respondents suggested affordances of self-tracking that were both intensely personal and social. Thus, a "one size fits all" approach does not fit adolescents' self-tracking practices and in fact does a disservice to adolescents' creative capacity, individual experiences, behaviors, and knowledge.

Asking, or allowing, adolescents to track a constantly changing body is both a challenge and an opportunity with very real implications for the stories adolescents might tell about themselves and their data. A better understanding of how self-tracking practices might feed into, or out of, such identity-forming and -affirming processes should be a priority for design, policy, and education. Technology designers could embrace variation across the users of their products and to think creatively about how to design the most appropriate tools for different users, with particular attention paid to adolescent users.

The complex social world of adolescents

Self-tracking practices are inherently social. That means adolescents try to understand what their data means within their social context. Our participants framed their concerns about surveillance in relational terms—they were unsettled by the possibility of social comparison and what this might mean for their status within their peer groups. While scholars question the "highly normative and normalizing ideals of what 'fitter' and 'happier' mean" (Sharon and Zandbergen, 2017: 1698), how adolescents understand their own bodies in relation to their peers calls into question some of the fundamental principles of gamification and social comparison hard-wired into digital self-tracking tools. Our findings caution against the use of self-tracking tools in school settings without critical education on making sense of one's own data. Educators could, perhaps, help adolescents work through the challenge of how to "move away from asking what is normal toward 'what is normal for me?'" (Neff and Nafus, 2016: 43).

Conclusion

Adolescents' own understandings of digital self-tracking practices shape how they might come to use these technologies. They also show us how social and institutional configurations come to matter for technological affordances. Adolescents in our study saw the affordances of digital self-tracking as flexible and shifting across different users and contexts, rather than intrinsic to any particular device. Examining the affordances that adolescents imagine for self-tracking, we begin to see how designers could create tools that are appropriate for how—and where—adolescents might use them.

One limitation of our study is the student composition in the two schools involved. Owing to our constraints on access to young people, the students who participated in our study were relatively homogeneous in their socioeconomic and demographic background. Future research could highlight the adolescent voice further and in more diverse contexts. Focus groups or semi-structured interviews might be important to gain a deeper understanding of the nuances and commonalities in how digital tools work in practice for adolescents.

Adolescence is an important time when body image considerations, social pressures, psychological wellbeing, and concerns about identity become particularly salient. The need for critical analyses of adolescents' digital self-tracking practices is pressing. Adult models for self-tracking simply will not work for understanding how adolescents might use, modify, or resist these tools. Adolescents themselves are uniquely equipped to offer insights into their own imaginings, and the oftentimes complex and even contradictory behaviors, about the technologies they use. We think that this presents an exciting opportunity for future researchers to engage with and learn from young people's expertise and experience. By listening to the adolescent voice, we hope our findings might help lay the groundwork for educators, psychologists, and policymakers to think through the design of digital self-tracking tools for adolescents, and the serious implications of their use. We hope that our findings will help scholars critically approach adolescent self-tracking and extend research on how the mechanisms and conditions of affordances come to matter in the relationship between technologies and their users.

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Connected Fitness During COVID-19: Care, Control, and Social Connection through Digital Self-Tracking Across Three Countries

Author Note
To Come

Abstract

Digital self-tracking has been researched as part of exercise motivation, but researchers do not understand if people self-track for social connection and how this influences their mental health and wellbeing. We surveyed 1,631 adults in Australia, the United Kingdom, and the United States about their use of self-tracking tools before and during COVID-19 and conducted 19 follow-up interviews with self-trackers (6 in Australia, 10 in the UK, and 3 in the US). Our survey data revealed strong positive correlations between social connectedness and mental health and wellbeing and strong positive correlations between consistent self-tracking and social connectedness. We find self-trackers engage in thoughtful social data sharing practices and people's needs for control, care, and connection in self-tracking deserve more attention from researchers and designers. Shifting the focus from fitness goals to these broader needs will help self-tracking technologies of the future be more meaningful for people's lives.

Keywords: self-tracking, tracking devices, wearables, social connection, data sharing, mental health, wellbeing, COVID-19, control, care, technology design

Connected Fitness During COVID-19: Care, Control, and Social Connection through Digital Self-Tracking Across Three Countries

Connected fitness—which we define as online and digital fitness tools, wearables, apps, and communities—offers people novel ways to measure and track their physical activity and health, especially during the COVID-19 crisis. Much of the research on connected fitness has rightly focused on positive health behavior change and exercise motivation (see among many examples, recent work by Kim et al., 2021). Our paper takes an alternative approach, examining the social affordances of connected fitness tools and asking how connected fitness data might influence the maintenance and formation of social connections, how people may express care for the self and others through such data, and how people exert control over uncertain situations with connected fitness data. We wanted to know how and why people share this data and what might have changed with the global challenges of COVID-19 lockdowns and restrictions. In this paper we explore the social affordances of self-tracking and how these might be supporting improved mental health and wellbeing.

Previous survey research has shown that, at least for Americans, the social features of fitness tracking apps are among the features that they report as least important to them (Zimmer et al 2020). We also know that activity tracking and their perceived health outcomes are among the most important reasons people cite for starting and continuing to use smartwatch devices (Kang & Jung, 2020; Gupta et al., 2020). Using self-tracking devices has some relationship to users' ability to be able to be absorbed in them, including connecting to others, but these relationships of social connectedness to other users are paradoxically unclear (Oh & Kang, 2021). COVID-19 presented an interesting opportunity to explore social connection mediated through mobile and digital technology when people were physically (and "socially") distant. We wondered whether self-tracking data was used to improve social connectedness during social isolation around the world. This time also saw declining levels of physical activity (Tison et al.,

2020), and people looked to connected fitness to help them achieve their fitness goals. For mobile communication scholars, might such a study serve as an opportunity to assess whether practices with these data for social connectedness and mental wellbeing are changing, and if so, how?

Literature Review

Self-Tracking and Social Connectedness

During COVID-19 restrictions, online fitness communities convened using social media, digital tracking tools, and apps, providing an alternative to closed gyms and community centers. People used digital trackers on wearable and mobile devices to track their exercise, and sales of home fitness equipment, including those with connected fitness capabilities, increased dramatically (Mintel, 2021). With restrictions, people shifted from consuming services to goods, and in the luxury market, this meant connected fitness devices. Sales of Peloton cycles, a connected exercise bike that allows for online coaching and group rides, doubled over 2020, according to JP Morgan estimates. Other types of online classes and coaching proliferated while COVID-19 restrictions were in place. Mobile and digital tools provided opportunities for people to maintain engagement with existing communities through sharing data. Groups of athletes, including the elite squads at many universities, relied on “team” sports settings through apps like Strava to continue working out alone, yet together. Couch-to-5K and virtual marathons connected casual and serious runners. According to 2020 data released from mobile network EE, the use of self-tracking tools increased significantly during the first UK lockdown: the use of the fitness tracking app Strava tripled and the use of MapMyRun doubled.

Beyond elite and luxury users, we wanted to see if and how people expanded their social connections to new communities or developed new ways to connect to existing communities through the affordances of mobile and digital connected fitness. Self-Determination Theory (Deci & Ryan, 1985) posits that relatedness is centrally important to human motivation and new research looks at the relationship between mobile application use and the drive for

relatedness (Schneider et al., 2021). Research suggests that, at least for some users and in some contexts, having social relatedness as the default increases the likelihood that users will share in-app information with others (Joeckel & Dogruel, 2020) and that users of fitness trackers are more likely to use them more frequently if the tracker makes them feel connected to other users (Zhou et al., 2021).

Such interventions have potentially significant impact. At-home fitness solutions provide an opportunity to intervene in mental wellbeing while encouraging people to maintain cardiovascular health and mitigate the effects of COVID-19 (Dwyer et al., 2020), and mobile connected fitness tools, apps and wearables provide ways to support people's health and wellness goals. Social isolation from national restrictions, restrictions on household mixing, and social distancing guidelines can be harmful for both physical and mental health, intensifying the experience of COVID-19 trauma (Jetten et al., 2020).

Self-Tracking and Mental Health & Wellbeing

The COVID-19 mental health pandemic has been labelled as 'the next pandemic' (Parrish, 2020), with a profound impact on individuals' psychological wellbeing. According to the UK Office of National Statistics (ONS, 2020), 19.2% of UK adults were likely to be experiencing some form of depression during COVID-19 (June 2020); a number that is almost double that of 9.7% before the pandemic (July 2019 to March 2020). Nonetheless, social connectedness and the feeling of belonging to a group can improve mental and physical health (Haslam et al., 2018). What we don't know is what, if any, role connected fitness plays in social connectedness.

Purpose of the Present Study

We know that communities shape how people understand their self-tracking data (Neff & Nafus, 2016). This study focuses on how that data may be, in turn, shaping our communities by mapping the roles that mobile and digital self-tracking data play in maintaining psychological and social wellbeing and social connectedness during COVID-19 restrictions and beyond. Existing research on self-tracking technologies covers motivation on individual levels. However,

there is a research gap on more diverse communities across demographics and to gauge community effects of self-tracking and connected fitness (Spiel et al. 2018). We predict that at-home fitness can also be used to facilitate social connectedness during and after this pandemic. While other studies have reported that social features of fitness apps are a drawback of using the apps (Zimmer et al. 2020), we may see that social motivations for connected fitness may be even more important in some vulnerable or marginalized communities. We also know that there are cross-cultural differences in the appreciation of smartphone privacy features (Dogruel & Joeckel, 2019) and that the experience of COVID-19 lockdowns and restrictions varied widely across countries. The possible positive impacts that social affordances of connected fitness technology may present to some subpopulations might be overshadowed by these differences. Studying the social connectedness of connected fitness might help designers of fitness apps create more appropriate and human-centric designs for diverse user populations.

Our work extends state-of-the art research by looking at community effects of the use of connected fitness tools. This goal of our project is to answer how online fitness communities facilitate social connectedness during COVID-19, and we address the following research questions:

RQ1: How are adults in Australia, the United Kingdom, and the United States (AU, UK, US) using connected fitness technologies and communities to maintain or build social connections?

RQ2: Are there measurable psychological benefits from social connections formed through connected fitness?

RQ3: How do people experience connected fitness?

Methods

Sample

In June 2021 we recruited 1,635 adults aged 18 and over across Australia, the United Kingdom, and the United States (AU, UK, US) using Prolific.co to complete a 10-minute survey about health and fitness habits and preferences. We had an initial wave of 1,200 adults and a

secondary wave of 435 older adults, 58 and over. Four participants either did not give consent or were under the age of 18 and were excluded. Our final sample of 1,631 participants was well balanced: 25% aged 18-24, 26% aged 25-34, 16% aged 35-44, 13% aged 45-54, 14% aged 55-64%, 6% 65-74, and less than 1% were 74 or above. Participants were paid a £3 GBP (or local equivalent) incentive through the Prolific.co platform. All adults (aged 18 and over) were eligible to complete the survey, regardless of their previous experience with using digital self-tracking tools and no pre-screeners were used to get a broad sample of adults, largely mirroring adult populations in each country.

From participants who completed the survey and indicated that they were willing to be contacted further, we sampled people who were currently self-tracking to take part in a 40-minute online, semi-structured interview. Participants received £10 GBP (or local equivalent). At the time of writing, interview recruitment is ongoing and we aim to interview 90 participants in all. This paper presents data from the 19 interviews completed to date; 6 in Australia, 10 in the UK, and 3 in the US.

Ethics approval was obtained from the [BLINDED] before any data collection commenced.

Mixed Method Design

This paper leveraged a mixed-method design of quantitative survey data and qualitative interviews. The primary purpose of our survey was to better understand how adults across AU, the UK, and the US used self-tracking devices and apps during the pandemic, to measure participants' engagement with online and offline communities through sharing or discussing their activities and data, and to explore how sharing and tracking practices may contribute to an improved sense of mental health and wellbeing. Building on key themes and findings from our survey, we conducted and analyzed interviews to understand how people use these self-tracking tools to facilitate social connection, care, and control.

Instrument. We built our survey in Qualtrics and distributed it using Prolific.co. The survey included general demographic questions and asked participants questions about COVID-19 and its impact on their lifestyle, as well as their use of wearables and mobile apps for tracking health and fitness activities. We asked participants to rate their consistency and duration of self-tracking and to select what makes consistent tracking easier. Tracking consistency was measured via self-report on our survey using a sliding scale. Additional questions tapped into motivations for self-tracking, health and fitness goals, and the activities people engaged in before and during the pandemic. We also asked whether people shared self-tracking data with others, and if so, how. We then asked participants a series of questions on their feelings about sharing or comparing their data with others. Finally, we included the short 7-item Warwick–Edinburgh Mental Wellbeing Scale (Tennant et al., 2007) a 15-item revised Social Connectedness Scale (Lee et al., 2001; Lee et al., 2008) to help us understand the relationships among self-tracking, social connectedness and mental health and wellbeing.

Interviews. We conducted semi-structured online interviews, allowing us to probe when participants revealed information related to our key research questions. The initial portion of our interview schedule focused on getting acquainted with the participant and providing them with context on the study and gaining their consent to start, record, and transcribe the interview. The interview core consisted of the following four sets of questions, each designed to take around 8-10 minutes of interview time:

1. COVID-19 and health and fitness habits and practices
2. Self-tracking, sharing, and social connectedness
3. Impact of health and fitness self-tracking on mental health and wellbeing
4. Meaning of self-tracked health and fitness data.

Data Analysis

Quantitative Data Analysis. We analyzed our survey data to provide statistical evidence of linkages between self-tracking, social connectedness, and mental health and

wellbeing. We exported data from Qualtrics and imported them into a statistical software package. We then created three models.

We first assessed what factors might significantly contribute to mental health and wellbeing scores. We established a model with the key dependent variable being the mental health and wellbeing score and a variety of possible predictor variables including age group, location (AU vs. UK vs. US), social connectedness, tracking consistency, pandemic impact on lifestyle, and the interaction between age group and pandemic impact on lifestyle. A standard least squares analysis of variance (ANOVA) was run on this model.

After confirming social connectedness was strongly and positively correlated with mental health and wellbeing scores, we created a secondary model with the key dependent variable being the social connectedness score and possible predictor variables. These variables included age group, location, pandemic impact on lifestyle, and level of self-tracking consistency. A standard least squares ANOVA was run on this secondary model as well.

After confirming that self-tracking consistency was strongly and positively correlated to social connectedness, we created a tertiary model with tracking consistency as the key dependent variable. The predictor variables in this tertiary model included age group, method of self-tracking (smartphone app, wearable, connected health equipment, connected exercise equipment), length of self-tracking history (from a few weeks to a few years), and whether or not participants had shared self-tracking data with others. Again, standard least squares ANOVA was run on the model. Our collective findings will be discussed in the results section.

Qualitative Data Analysis. For the interview data, we used thematic analysis (Miles and Huberman, 1994) through in-process notes and meetings among the research team. We had weekly meetings during the interview data collection period to discuss highlights and voice significant findings. We converged on the themes of control, care, and connection, given the importance of these themes in our quantitative data and in the emergence of these themes in interviews. We then systematically and holistically read interview transcripts for themes of care,

control and connection. From these themes, we created documents with quotes from each of our participants along these themes. We present a qualitative data display table (Table 1) for the interview participants. We use pseudonyms below.

Results

Self-tracking was common across our survey with 44% currently using a digital self-tracking tool, 31% having previously used one, and only 25% having never used one. Most commonly, self-trackers were engaging with smartphone apps (82%) or wearables (53%), such as smartwatches or Fitbit devices. The survey data seems to indicate that the social circles that participants built during COVID-19 were not limited to a given connected fitness app or device ecosystem; many users reported that they talk about their connected fitness activities and data with friends and family through in-person conversations (68%) or through other text messaging platforms like WhatsApp or iMessage (36%), both of which are distinct from their connected fitness tools. As expected, the pandemic seemed to have an impact on the type of fitness activities individuals took part in. Before the pandemic, the most popular fitness activities were individual outdoor activities (like walking or running alone) (67%) or individual indoor activities outside of the home (like weightlifting or using cardio equipment at the gym) (43%). During the pandemic, individual outdoor activities remained popular, but home workouts became the second most common activity people reported (60%).

Mental Health & Well-Being Model

The overall model on mental health and wellbeing was found to be highly significant, F (17, 1174) = 50.43, $p < .0001$, $R^2 = 0.4258$. Age was significantly correlated to mental health and wellbeing scores (MHWB), F (6, 1174) = 5.19, $p < .0001$, such that younger age groups (18-24, 25-34) had significantly lower average MHWB scores compared to older adults (35-54, 55+). Location was significantly correlated with MHWB, F (2, 1174) = 10.00, $p < .0001$. UK participants had significantly lower MHWB than people in Australia and the United States. It is worth noting that our survey was completed before many restrictions were removed across the

UK in July and August 2021. Social connectedness was also significantly and positively correlated with MHWB, F (1, 1174) = 664.01*, $p < .0001$*. This suggests that higher levels of social connectedness are associated with improved mental health and wellbeing. The relationships between tracking consistency and the interaction between age and pandemic impact on lifestyle and MHWB were also significant at $p = .0126$ and $p = .0195$, respectively. The correlation between tracking consistency and MHWB was positive, indicating higher levels of self-tracking were associated with higher MHWB scores. As such, our statistical analysis uncovered various significant predictors for MHWB, but it was the very strong, positive correlation between social connectedness and MHWB scores that we felt needed further exploration and explanation given our research aims. This strong correlation prompted us to explore what role self-tracking may play in facilitating a greater sense of social connectedness, building upon the direct link that self-tracking consistency seems to have with improved MHWB. To do so, we looked at factors that might significantly contribute to social connectedness.

Social Connectedness Model

The overall model on social connectedness was found to be highly significant, F (10, 1181) = 4.33, $p < .0001$, $R^2 = 0.0357$. Two of the four independent variables achieved significance. Age group was significantly correlated to social connectedness, F (6, 1181) = 2.77, p =.0111, such that youngest participants aged 18-24 (M = 3.77) and 25-34 (M = 3.78) and the oldest participants aged 75+ (M = 3.77) had lowest levels of social connectedness, on average, while those aged 55-64 (M = 4.07) and 65-74 (M = 4.28) had higher average levels of social connectedness. Most notable was the positive correlation between self-tracking consistency and social connectedness, F (1, 1181) = 18.06, $p < .0001$, indicating that higher levels of self-tracking consistency are associated with higher levels of social connectedness. These findings indicate that more engaged self-trackers benefit from higher levels of social connectedness, which, in turn, may be associated with an improved sense of MHWB. But what drives tracking consistency?

Tracking Consistency Model

The overall model on tracking consistency was found to be highly significant, F (14, 1214) = 22.60, $p < .0001$, $R^2 = 0.2088$. All of our predictor variables proved to be meaningful in some way. Age group was found to be highly significant, F (6, 1214) = 5.98, $p < .0001$, such that tracking consistency increases with age up until 74. Young adults aged 18-24 had the lowest average level of tracking consistency ($M = 4.89$) while those 65-74 had the highest average level of tracking consistency ($M = 7.02$). As we expected, sharing of self-tracking data was strongly and positively correlated with tracking consistency, F (1, 1214) = 56.30, $p <.0001$. People who share self-tracking data with others report higher average levels of tracking consistency ($M = 6.32$), compared to people who do not share this data with others ($M = 4.88$). How long a participant has been self-tracking also proved to be highly significant, F (3, 1214) = 31.07, $p < .0001$, with new self-trackers reporting lowest average levels of tracking consistency ($M = 3.97$) and the most experienced self-trackers who have been engaged in the practice for years reporting highest average levels of tracking consistency ($M = 6.69$), indicating that on-going engagement over longer periods may drive increased engagement in self-tracking practices. Only one of four self-tracking methods was shown to be significantly related to tracking consistency in our data set -- tracking using a smartwatch or wearable, F (1, 1214) = 15.93, $p < .0001$, with individuals who reported they have self-tracked using a smartwatch or wearable having significantly higher average tracking consistency scores ($M = 6.22$) than those who have not ($M = 5.09$), perhaps driven by the “always on” and “always tracking” nature of wearable tracking devices as compared to more episodic use that may be associated with other means of self-tracking such as through a phone or other health or fitness equipment (Spiel et al. 2018).

All in all, the survey data seems to illuminate strong relationships between self-tracking, social connectedness, and mental health and wellbeing. While our survey data indicates that more regular and consistent self-tracking is related to higher levels of social connectedness,

and sharing this data with others is meaningfully related to self-tracking consistency and engagement, our qualitative in-depth interviews proved critical in helping us to uncover what other social affordances of self-tracking may be contributing to a greater sense of social connectedness and, in turn, improved mental health and wellbeing amongst a focused but broad set of users from our survey.

To better understand the experience of connected fitness, from our interview data we drew out the role of the social affordances of digital self-tracking tools. In particular, we focused on the key themes of: connection, care, and control. These speak to important—but not always conscious—concerns for the diverse group of users we spoke to when sharing self-tracked data with others.

Connection

Participants were usually thoughtful and purposeful in their practices of data sharing. Few of our participants described using the social affordances and communities built into self-tracking tools; this was reflected in our survey results with less than 17% of our survey participants indicating they shared their self-tracking data directly via their app or device. Most people, though, reported sharing information with others in creative ways that worked for their context, demonstrating how expansive these sharing practices are. Many did not see these practices as ‘sharing’ data and if they did not share via the self-tracking tool, they would often tell us they do not share their data. It was only when we probed further that we uncovered these alternative ways of sharing: “I don't share, but I talk about it. I do talk about it” (Kimberly UK).

Brian (AU) described setting up a family “Fitbit like community or family group feature” that they don’t use “very often [but] during lunch times it would be like, ‘Oh, you know I need to get more steps, I'm going to head out for lunch’ and then you know you sort of announce it to the family and then you head out.” Similarly, Francesca (UK) described verbally sharing and comparing data with her friends, “When I meet up with friends, a lot of them have got Fitbits and […] we do talk about, ‘Oh well, how many steps did you do yesterday?’”

For some, sharing verbally reflected personal preference or spontaneous conversations. For others, technical limitations sometimes required that people talked about, rather than digitally share, their data. For example, when friends or family members used connected fitness devices in different ecosystems: “she didn't get a Fitbit, so we couldn't connect. She got [...] a “fake” one on Amazon, that she called a Fitbit but it wasn't a Fitbit so we weren't able to” (Kimberly UK). Others found workarounds by moving their data to other social media platforms, where their data was more likely to find an audience, “I mean, almost everybody I know is probably not on Strava, so I wouldn't have been able to connect with them [...] So I think that's probably my main reason for starting that Instagram page” (Kyle UK).

Lomborg and Frandsen (2016) describe self-tracking as communication. Indeed, for our participants, the data functioned in various ways as connectors or communicative tools in different social contexts. Participants clearly articulated certain boundaries and data-sharing etiquette and were uneasy when these were breached. Brian (AU) described a tracking competition in the workplace during COVID-19 and some of the uncomfortable interactions that took place around this data, where the people like himself who were junior to the managers, “can't really punch up [...] but you know they can sort of punch down.”

Social media was a space where users were aware of the social contract around the sharing of self-tracked data. Whilst they were often keen to share big achievements with “absolutely everybody [...] on Facebook” (Denise UK), they were wary that doing so could jeopardize their existing connections with others if they were seen to be “trying to brag” (Daisy UK) or saying, “Look at me, I'm doing all this exercise” (Leah UK). As such, participants often described their own behavior and caution around sharing as a reflection of their response to others’ sharing of self-tracked data: “I think for me, the reason I don't like sharing on social media in particular is umm I find it boring when other people share it, so I don't want to be like that person that's always [...] talking about their workout on Facebook or whatever all the time” (Elizabeth AU).

What these sharing practices had in common was the emphasis on forming or strengthening connections with others. This pattern is validated by our survey data with sharing being positively correlated with tracking consistency which is positively correlated with social connectedness. People used self-tracking leaderboards and data fitness groups to connect across many different kinds of relationships, connecting long-distance friends, mothers and daughters, married couples, and colleagues. For example, during the pandemic, Kimberly (UK) described connecting with friends from graduate school who lived overseas: “I have friends in the States and they did the Fitbit groups, so it was who could get the most steps in a week and I found that like the competitive streak and then some of them would just be like how you doing that much in a week, but very motivating.” In a similar way, Tracy (US) used connected fitness tools as a form of social media to stay in touch with friends around the world:

> There was a great connection [...]. when you're overseas and all your friends are sort of scattered, the normal, everyday [...] maintenance of friendships is quite [...] a challenge [...] There was interaction over them as a result. Shared discussions. Shared experience. A little bit of intimacy. [...] It was yet another way in addition to Facebook and Skype at the time.

In a more intimate sharing network, Charlotte (US) described sharing and competing with her daughter on Fitbit while she was living overseas, “I think for me it was a great connector with my child for a long time”. As such, the shared experience of exercise and tracking often connected those who were physically distant, as well as those who lived in the same household, especially during periods of lockdown and stay-at-home orders: “Yes, so my wife and I were doing this program called ‘28 by Sam Wood’ [...] it's good because we can do it as partners” (David AU). Some described how these connections were some of the most important features of the tool and kept them engaged in self-tracking. When her daughter stopped tracking Charlotte (US) said, “It became a little bit less emotionally important to me [...] It was really important to do something in conjunction with her.”

We learned that self-tracked data functioned as much more than a personal record of health for many people, instead it was a tool through which to find common interests with others, build on existing relationships, start new ones, and even rekindle ones that were lost in ways that offered a common language and foundation for expressing care and connection.

Care

In line with Kristensen et al.'s (2021) recent work on relational affordances in self-tracking, we found that people demonstrated care for the self and for others in how they share data. Our survey data shows amongst those who share their connected fitness data, 78% share with friends, 72% share with family and 24% share with co-workers; our qualitative interviews showed us that sharing with close others was often motivated by care. For some people, this care became tightly linked to healthcare in general, and care during the COVID-19 crisis in particular. For example, Charlotte (US) described sharing Fitbit data with her daughter who was recovering from an eating disorder. Here, acts of data sharing strengthened the parent-child bond and provided a language for Charlotte to support her daughter:

> When she got competitive with me about it, I thought that's a beautiful thing [...] she wanted me to do that with her. So that became like, OK, this is something we can do together and I will do it. I think in some ways it brought us closer [...] I always let her think she won, which was great [...] I think it made her feel important and it made her feel like she had my approval. Which she had anyway, she just never understood that she had [it].

The users we spoke to demonstrated care in how, what, and with whom they chose to share data. Sometimes, this was care for the self. Some participants shared their data as a way to keep motivated through competition with others, or even simply as a way of keeping a daily record of their activities. For example, while completing a charity activity challenge, Sandra (AU) shared her data on Facebook "not so much for other people, more for me to just have a record".

On the other hand, some people who did not view themselves as typical ‘fit’ self-tracking users felt shame over their data. They kept data private to protect themselves from negative responses from others: “I don't really like the idea of uploading something like that or social media, just 'cause it feels sort of either possibly setting yourself up for judgments, like from people who are more sort of fit or whatever” (Daisy UK). Participants were aware that by sharing their data with others, they were setting themselves up for comparisons that were not always positive: “I don't share my info 'cause I feel like I'm not very good at it. I wouldn't compete” (Jeremy US). Users described feeling “embarrassed” (David AU) about their data, saying they would only consider sharing achievements they felt to be significant or impressive to others.

These acts of self-care sometimes fed into their tool choice, and some avoided apps and devices with built-in social features: “I've quite specifically not done that. I did download Strava for a bit and then I saw it who on my contacts was on there and I thought well I know they’re all good runners [...] and I thought well I'm doing Couch to 5K, I don't really want them to see how long it takes me to run 5K to be honest and so I thought, well I won’t use Strava, I’ll use an app that is less social-oriented” (Grace UK). For some, these decisions were temporary and they looked to a future where they might feel comfortable sharing their data with others. “I'm quite a private person,” Rachel (AU) told us, “So yeah, [...] I don't feel like I'm engaged in [...] a community sense.” However, Rachel could imagine joining groups and communities “when I feel more confident in myself.”

Nonetheless, these decisions around sharing were not always made out of care for the self alone. Our participants also articulated an awareness of and concern for others’ responses to their shared data. They were wary of causing harm to others by discussing self-tracked data: “if I had a boss, for instance, who you know wasn't a fan of fitness or a friend who wasn't [...] I would probably actively avoid it just because you know, for for some people it can be sort of [...] not upsetting but you know a bit annoying to hear if if they're not into walking, but you are and

then you know it's kind of like you're casting shade on them" (Brian AU). Again, this reflected a consensus of etiquette around data sharing that was common amongst users in our study.

Sometimes, our participants even described lying about their data, or selectively sharing data, in order to demonstrate care for others. Sometimes this was to perform continued engagement with connected fitness, for example Charlotte (US) described: "sometimes I would fake that I was doing it to make her happy. There were a few times where I would just like shake my hand back and forth so she would think that I had done more because I knew that was important to her." For others, this was to ensure their high levels of physical activity were not intimidating or demotivating to those around them:

> I mean, I'm trying to encourage [my] new boyfriend [...] he wants to think about going to a gym at some point. So I'm gently saying, 'Well, why don't we do some walking?' I don't tell him quite how much I do because I think that'll make him feel like the mountain's too big to climb so I limit what I talk to him about steps-wise [...] I want to encourage and get him to take small steps. (Francesca UK)

For many, sharing data became a way "to encourage others to be healthier" (Lily UK). This data was a motivational tool to encourage loved ones, colleagues, and others in their networks and sharing data was often used as a way to open up conversations about concern for others' health and wellbeing. 56% of our survey participants indicated they shared their self-tracking data with others and this was most often with friends, family and co-workers. This was reflected further in our interviews. Lily (UK), for example, used her Fitbit to encourage her daughter to stay active, but also found it useful in opening up conversations and healthy competition over physical activity with co-workers. John (UK) described his data sharing with his wife, who had been encouraging him to walk more, as a competition: "I never beat her! Yes, we do, and tells me she's done 40,000 steps to my 5,000. Absolutely! [...] We do share. She loves telling me. [...] She encourages me in her own way." Participants expressed frustration when

other family members or friends were reluctant to join them in their self-tracking practices. For example, Denise (UK) shared:

> I mean my son won't get into it. Umm My daughter-in-law would like to [...] I think it's a brilliant thing and I think as a family we should all do it and we should share what we've done. Because my son keeps saying, 'I need to do more exercise, I need to run'. And I'm like, 'OK, well get a tracker because that encourages you'.

As such, the thoughtful sharing of data connected people and helped people demonstrate care towards the self and others. This care came in many forms, and was sometimes best demonstrated by *not* sharing data, or 'tinkering' with their shared data (Kristensen et al., 2021). However, to share care effectively users required control over when, how, and with whom they shared this personal information.

Control

When asked what influenced tracking behavior most during the pandemic, survey respondents' most common response was lockdown restrictions, followed by monitoring physical activity, indicating the restrictions of place and movement increased a desire to track to ensure participants were still in control of their health and wellbeing. During a global pandemic where very little felt under individuals' control, participants described how they sought control through their self-tracking data: "I cannot control the world, but I can change myself accordingly" (Nathan AU). For some, this was seeking to control a body that was unpredictable due to disability or ill-health, be it mobility, autoimmune conditions, or anxiety. For example, Nancy (UK), described the uncertainty of her body due to age and various disabilities. She sought to find control through recording her data in a spreadsheet dating back to 2013:

> I have data back to 2013 [...] Now I have a Fitbit, which is obviously connected, but [...] I've worn a pedometer for years, because I'm very aware that because of disability it would be very easy for me to collapse into a heap and not do anything. Obviously, now it's easier because the computer does it for me, but even then I transfer it [the data] to a

> spreadsheet. I can see what I've done whenever [...] Because I feel that no matter what, even if I change my technology in years to come, I will still want to look back at that information. I'm very conscientious about it. I do it every day [...] That is important information to me. I'm approaching 70. I want to be as fit as I can for as long as I can given my disabilities, so I can see that I'm actually doing more than I was five years ago.

Exerting control over her data bolstered Nancy's sense of self-esteem and psychological wellbeing: "Actually, I can see that I'm taking care of myself, looking after myself, valuing myself and that I'm actually getting better than I was, so [...] I think it does help my mood." Similarly, John (UK) shared that his tracking gave him "a wee bit of personal pride". In terms of our survey respondents, the most commonly reported reasons for deciding to self-track were motivation, achieving goals, and having 'something to do', all showing ways that people use self-tracking for types of control.

Rather than sharing widely, many participants described carefully creating smaller communities in which to share and talk about their data (e.g., families, friends, and groups of known others, such as co-workers or exercise partners). While slightly more than half our survey participants (56%) indicated they shared their data with others, we learned through our interviews that many people who initially indicated that they don't share changed their view of social sharing when prodded, indicating this true scale of self-tracked data sharing is likely higher, given the desire to use this data to control and mold important social relationships. This sense of control over communities for sharing emerged as important in the interviews: "I'm not keen on just like a random person like the kind of wider community of people that I don't know like that doesn't really appeal to me" (Elizabeth AU). Often, these smaller communities were chosen for their knowledge or shared interest in health and fitness. For example, Daisy (UK) described sharing her workout data with friends that she considered "gym people" to get their opinion on "whether it's good or not."

Others described maintaining control of their data sharing by not disclosing it to anyone; 44% of our survey respondents reported not sharing their data. Nancy (UK) was “accountable to me and me only” and “not bothered about sharing with anybody else.” This decision to maintain privacy was often made because comparisons with others were inappropriate. Nancy (UK) said that, “If I were trying to compete against other people I would be depressed because I'm never going to be that good.” On the other hand, she “can only compete against past me to prepare for future me and I think the tracking matters for that. If I were competing against buddies, as Fitbit calls them, … nobody would have quite the disabilities that I've got and I would either use it as an excuse or I would just give up so the tracking is important for me.”

For those with goals specific to their circumstances, the sharing of data within the social affordances of self-tracking tools often lacked context. For example, Grace (UK) was concerned how her ‘Couch to 5K’ running ability would compare to friends on Strava who had run ultramarathons. Similarly, Nancy did not feel that 3,000 steps was a ‘worthy’ goal for other people. However, these goals were important and meaningful to each individual. Sharing data with others, in the form digital tools currently offer, did not fit their purposes. Instead, they maintained privacy over their data.

As such, people’s autonomy to choose—and maintain control over—how and when to share their fitness data was important. In our diverse sample of users, we found a sense that connected fitness tools were not designed with them in mind and they lacked information about how to use these tools in a way that was met their needs:

> You know everything about Fitbit and that sort of exercise tends to talk about people who are training, who are quite fit anyway. But I'm at the other end of the spectrum, if you like. I'm a bit of an old crock but I don't want to be any more of a crock than I am at the moment, so I keep going. (Nancy UK)

> I think if people could be made aware, particularly in this sort of 60/70/80s age bracket and I'm sorry if I'm sounding terribly ageist [...] it's quite easy. All you do is just put it on, press a button and you can see how much, how much you've walked today. (John UK)

Overall, people found creative ways to maintain control over the sharing of their connected fitness data. When asked how they share this data, 68% indicated they shared through in-person conversations, 40% shared directly via their app or device, and then directly through the app/device, and 36% shared using text messaging or some sort of messaging app. In fact, two out of three of the most common sharing methods were ad-hoc and outside the app/device, and there was often a sense that the technology could do more to afford flexibility for control. For example, Tracy (US) joked with us, indicating others like her might share more "If they could have some Fitbit apps [...] 'for the introvert'." Participants stressed the importance of having control over both the collecting and sharing of this personal data. Without this control, opportunities for connection and care were lost.

General Discussion

Digital self-tracking tools offer people important ways to stay connected, demonstrate care, and exert control during a time of global uncertainty and distance. To do these things effectively with self-tracking tools and data, people often employed creative practices and imagined new ways of sharing data beyond the bounds of the technology. In line with Kristensen et al. (2021), we found that this sociality of connected fitness data can afford care for both the self and others. Key to these demonstrations of care are connection with others through data, and control of how data are shared.

Our data show strong positive correlations between consistent self-tracking and increased social connectedness across all three countries, suggesting people in connected fitness communities experience higher levels of social connectedness (RQ1). While the data seem to show a meaningful link between connected fitness and social connectedness, data also show self-tracking consistency and social connectedness have a measurable impact on mental

health and wellbeing (RQ2). Consistent self-tracking was positively correlated with mental health and wellbeing directly, as was social connectedness.

We began this study wondering how social support might emerge with and through self-tracking data and how people experience connected fitness (RQ3). We were surprised by the survey finding that a large proportion, 44%, of our sample, reported not sharing these data. However, in the interviews, we heard that very few of our respondents *didn't* share their self-tracking data. The difference is in the digital and social affordances of the apps and tools. Practices of sharing are important as part of control, care, and connection. From Self-Determination Theory, we can see how relatedness is central to motivation (Deci & Ryan, 1985). However, for devices that are often designed to "work" through social affordances and gamification of motivation, our findings suggest that relatedness is more complex in terms of people's practices with their data.

Both our survey and interview data suggest that self-tracking has an impact on mental health and wellbeing. Our findings suggest that the mechanisms for this impact on mental health and wellbeing are likely through the social affordances of sharing, broadly construed as communicative moments or digital features. Of course, our study design cannot differentiate between the impact of exercise *per se* and people's relational connections in sharing the data from that exercise. That said, there are powerful ways that people communicate with and through self-tracking data and these communicative uses of self-tracking data should be taken into account in the design of the mobile apps and wearables. For researchers, our findings mean that features and social affordances should not be the sole way that we frame what people "do" with their data. The relational practices that people have with their self-tracking data may not be captured through survey or device data, as we discovered. Instead, we found that many of our participants dismissed the idea of sharing at first, thinking of sharing as being a part of the pre-made social features and affordances of the tools. Their practices, however, show a rich social tapestry of how they experience connection, care, and control. As Kimberly (UK) said

about her experience which could be applied to many of our participants' experiences with self-tracking data during COVID, "I don't share [my data], but I talk about it."

Our study included a mixed-methods design that incorporated both quantitative survey data and in-depth qualitative interviews with users to add richness to patterns and trends observed in our survey data. Still, our study is not without limitations. First, while we originally sought to gather representative population samples from Australia, the UK, and the US through Prolific.co, this could not be supported across all three countries at the time of our survey, and as such our survey sample does have a larger proportion of young users than the general population in these three countries: 25% of our survey participants are 18-24 even though they represent only 20% of the overall population. This can be expected when using a digital panel. We compensated with a second wave of recruitment of older adults. Second, by limiting our study to these three countries, we have placed a strong focus on the Global North and Western cultures, and we must be careful not to overgeneralize about how these practices might extend globally. Third, our survey tapped into a broad adult population across three countries that included both users and non-users of self-tracking tools, but our interviews only focused on users. We lack insights into the barriers that prevent people from engaging with connected fitness. We tried to address this by including new and intermittent users of self-tracking tools in our interviews.

Across both our survey and interview data, the comparisons across Australia, the UK, and the US were not as strong as we had anticipated. Instead, we saw more convergence across the three countries. This may have been a function of our sample (all of whom were drawn from Prolific.co) rather than reflecting true underlying similarity in COVID-19 experiences across countries. Future research would do well to explore these comparisons further, as well as to expand the countries of comparison beyond the Global North.

Conclusion

Our study suggests moving away from a highly individualized notion of digital self-directed tracking and individually-targeted benefits to a more expansive and social definition of connected fitness and wellness tracking. Our findings show how sharing and talking about data may help increase people's sense of their connection to others. Our approach to self-tracking data calls for researchers to reimagine the people's practices with these types of data and to expand the view on their social affordances.

Design of these tools has suggested that people "compete" with numbers in a gamified model of behavior change. However, we find that many people want to share their successes with others, even when they show care for themselves and others where the numbers might be interpreted outside their individual contexts. What if, for example, Nancy could share that she had completed her exercise goal for the day, without feeling like her 3,000 steps a day were inadequate on leaderboards with friends? Or if Francesca could do the same with her new boyfriend, without making him feel like he wasn't walking enough?

The importance of looking at connected fitness helps remind us of a key reason why we research digital communication technologies: they represent powerful ways to share and connect with others. Digital self-tracking data, we find here, are no different. We hope other researchers join us in studying how people are making sense of mobile connections in their everyday lives and how these data come to make sense for their everyday experience. This may help technology designers and researchers better understand people's authentic connections with others through their devices and their data.

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Table 1. Interview Participant Summary.

Pseudonym	Country and Region	Age	Employment	Connected Fitness Tools Used and Length of Time Using	Summary
Brian	AU Victoria	18-24	Employed full time	Smart watch or wearable device; Connected health equipment A few months	Brian is not particularly motivated or interested in self-tracked data. Brian shares Fitbit data with his family and partner (both on the app and through other means) and describes workplace tracking competitions during COVID-19.
Charlotte	US	55-64	Employed full time	Smart watch or wearable device A few years	Charlotte is an avid, long-time tracker who is careful not to put too much emphasis on the meaning of self-tracked data. Charlotte uses data to connect with friends but also used Fitbit to connect with her daughter overseas and support her eating disorder recovery journey.
Denise	UK West Midlands	65-74	Employed part time	Smart watch or wearable device A few years	Denise is a long-time tracker who focuses on monitoring how much she walks. Denise wishes she had a wearable 20-30 years ago. Denise has been worried about her and her family's health and fitness during the pandemic and wishes her family would lean into self-tracking like she has, both as a way to connect but also to improve their collective health and wellbeing.
Daisy Note: Link survey response not available	UK				Daisy has tried a variety of different tracking tools and is reluctant to share personal health information widely. Instead, she selects knowledgeable friends to create networks of support and expertise around her self-tracked data.
Rachel	AU New South Wales	18-24	Employed full time	Smartphone app A few weeks	Rachel does not classify herself as a 'sporty' person (and did not turn her camera on for the interview). Rachel is reluctant to share data with others as she is self-conscious but finds motivation from looking at other people's data shared on social media.

David	AU New South Wales	25-34	Employed full time	Smartphone app A few years	Davis is slowly becoming more engaged with self-tracking through his phone. David turned to tracking his running in the pandemic and is now more engaged than ever. He is considering purchasing a wearable to allow him to continue easily tracking other field sport activities once life gets back to “normal”.
Elizabeth	AU New South Wales	25-34	Employed full time	Smart watch or wearable device A few years	Elizabeth received a second hand Fitbit from a co-worker but didn’t really get engaged with self-tracking until her doctor told her that her diabetes was worsening. From there, she decided to get a more robust wearable and make tracking more routine.. She has found that tracking has given her an increased sense of body positivity because she often was a tough judge of herself but her tracker often reminds her that she is doing well.
Francesca	UK North West	55-64	Employed part time	Smartphone app A few years	Francesca is an avid tracker who uses data to manage long-term health conditions and she uses this data to open up conversations with medical professionals. Francesca also uses her self-tracked data to connect with friends and find social support. She is reluctant to share data with her new boyfriend as this may be demotivating and unachievable for him.
Grace	UK East Midlands	25-34	Employed full time	Smartphone app A few years	Grace is an intermittent self-tracker who is very intentional in not sharing personal health data with others. Grace is very specific about the types of data she wants to track and has grappled with the technological affordances of self-tracking apps and has struggled to find an app that really works for her and her needs.
John	UK Scotland	55-64	Employed full time	Smartphone app A few years	John started self-tracking to lose weight and increase his walking with the assistance of wife. John also uses this data to open up conversations with medical professionals. John does not share health information widely but he frequently discusses it with his wife (who often beats his step count!).
Jeremy	US California	25-34	Employed full time	Smartphone app	Jeremy is a keen self-tracker who uses a variety of tools to manage health conditions and track fitness activities.

				A few months	Jeremy does not share data with others but uses others' self-tracked data for motivation.
Kyle	UK South West	18-24	Student	Smartphone app; Smart watch or wearable device; Connected health equipment A few years	Perhaps our strongest model for the "typical self-tracker," Kyle got into running and self-tracking at the same time and will only run if he can track his data and see his performance. Kyle wants to constantly improve and set new goals for himself, and his self-tracking data helps him do this. He is now a confident and habitual runner, but used to share modified versions of his run data through social media as a way to get motivated and build running into his routine.
Kimberly	UK London	45-54	Employed part time	Smartphone app; Smart watch or wearable device A few years	This busy mom likes to stay active to feel good and doesn't see this changing anytime soon. Kimberly has used both a smartphone app and wearable to track various activities from walking to online exercise through YouTube and uses her self-tracking data to better understand her holistic health and stay motivated. ound self-tracking data so useful that she is worried she may become "obsessed" so she tries to check her data just a few times a day. She liked engaging in social competitions with other Fitbit friends but as her friends got new devices and she kept her Fitbit, she found that she can't do this anymore.
Lily	UK London	45-54	Employed full time	Smart watch or wearable device A few years	Lily is a keen self-tracker who enjoys motivating others to track their steps. She has experienced technical difficulties in setting up community networks on Fitbit so instead verbally shares data with others (e.g., colleagues and daughter) to encourage others and find social connection at home and in the workplace.
Leah	UK South West	18-24	Student	Smartphone app A few years	This university student is happy that she's naturally lean but is aware that she is not very physically active. She has tracked her steps on her phone but struggles to get really engaged in self-tracking as she finds it hard to get started alone. She would be more likely to get active and track if she had a solution that would help her get started.

Nancy	UK East Midlands	65-74	Retired	Smart watch or wearable; Connected health equipment A few years	Nancy is a keen self-tracker who has kept a detailed spreadsheet of her step count and a diary of her weight over many years. Nancy does not share this data with others as its purpose is a private source of pride to demonstrate her persistence in maintaining activity despite age and numerous disabilities. Her tracking is very important to her and is a part of her daily routine.
Nathan	AU Victoria	25-34	Employed part time; Student	Smartphone app A few years	Nathan is a university student who uses various tracking apps to monitor health and fitness and to connect with others at his University's gym. Nathan enjoys competing with other people and seeing himself at the top of leaderboards. He also looks through communities on his fitness apps to search for potential romantic partners.
Sandra	AU New South Wales	45-54	Employed full time	Smartphone app; Smart watch or wearable device; Connected health equipment A few years	Sandra is a relatively keen self-tracker who has previously shared health and fitness data on social media in order to keep a record for herself. Aside from this, Sandra has not found much occasion to talk about her data with other people.
Tracy	US New York	45-54	Unemployed - looking for work	Smart watch or wearable device A few years	Tracy is a long-time user that describes tracking to better understand herself. While she has generally avoided sharing her walking data given her introverted nature, she has a group of friends that all share their fitness data and she has found it really engaging as a way to stay connected and have something to talk about, given these friends live all over the world.