

# CO<sub>2</sub>e (best) avoided? How people experience CO<sub>2</sub>e avoided on the Too Good To Go app

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## Abstract

Carbon Dioxide Equivalent (CO<sub>2</sub>e) avoided is increasingly communicated to individuals through digital media. Too Good To Go – a food waste app – presents users with a personalised CO<sub>2</sub>e avoided figure. Each time they collect food from a supermarket, café or restaurant their number increases. How do users experience CO<sub>2</sub>e avoided on the app? We explore this question through a longitudinal research project with 10 households in Oxfordshire, involving three interviews, five self-report surveys and a 28-day trial of the app. In general, participants did not see the figure as particularly valuable – best demonstrated in how little it influenced their usage of the app. This was largely due to issues of truthfulness. Each time a participant travelled and collected a bag, the CO<sub>2</sub>e avoided data point would increase by a fixed amount. This was at odds with the considerable variation in user experiences. Instead of CO<sub>2</sub>e avoided, participants put forward alternative impact data that was less individualised and more relatable. We use the concept of data experiences, as developed by Hoeyer et al. (2024), to think through the findings. In doing so, we provide empirical support to the utility of the four-part concept and put forward an additional cross-cutting theme of intensity. The paper also highlights how organisations cannot assume that certain metrics will influence peoples’ opinions and behaviours. To have an impact, their audiences’ data experiences need to be properly understood.

## Keywords

Data, experience, media, climate change, app, trust

## Introduction

Carbon Dioxide Equivalent (CO<sub>2</sub>e) avoided is increasingly communicated to individuals. Organisations that facilitate green travel are adding CO<sub>2</sub>e avoided information to their service, for example: Trainline – a travel booking site with 30 million active users per month – presents the user with how much CO<sub>2</sub>e they would save on a specific journey by comparing the emissions of travelling by car and by train; Strava – a fitness app with 125 million registered users – allows people to see how much CO<sub>2</sub>e was avoided by cycling to work instead of driving; and Too Good To Go (TGTG) – an app that allows users to buy nearly-wasted food – provides users a running total of the CO<sub>2</sub>e they’ve avoided by collecting food that would have otherwise gone to waste.

These figures are often assumed to have some impact on users. It is imagined that individuals will better understand how their actions are limiting damage to the environment – and encourage them to continue their climate-friendly behaviours. However, decades of research on information

provision, sustainability and behaviour change caution against such narratives. The information-deficit model, which argues that a lack of information underpins peoples’ unsustainable behaviours, has been widely dismissed as too simplistic (Middlemiss, 2018: 64; Shove, 2010: 1275). This is not to say that information plays no role in sustainable behaviour change – it is just more complex than exposing people to scientific knowledge (Carroll et al., 2014; van Valkengoed et al., 2022). For food behaviours to be changed, for example, peoples’ food practices need to be understood so they can engage with information before, during

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and after food shopping rather than just at the point of purchase (Ran et al., 2022). Much engagement with information is also discursive – it is talked about among peers, allowing people to reflect on their own sustainability-related behaviours (Hobson, 2003; Simcock et al., 2014), and there are often unexpected outcomes from information provision. Smart meters, for example, bring down energy usage but have also been linked to the reinforcement of unsustainable practices (Hargreaves et al., 2010) – spurring exploration of how people engage with home energy data in their everyday lives (Pullinger and Few, 2024).

When thinking about CO<sub>2</sub>e avoided, therefore, we need to reject simplistic narratives around behaviour change and embrace the complexity and open-endedness of how people experience information. This is particularly important for CO<sub>2</sub>e avoided. People may be familiar with CO<sub>2</sub> (Timmons and Lunn, 2022), but not CO<sub>2</sub>e. CO<sub>2</sub>e calculates the seven main greenhouse gasses' global warming potential (GWP) and expresses their warming potential relative to that of CO<sub>2</sub>, which is set at 1. This allows for gasses such as methane – important when understanding emissions from food production – to be included in assessments of impact on the planet. The measure of CO<sub>2</sub>e thus allows for the commensuration of different activities, but to be understood, it requires a high level of carbon literacy and specific technical knowledge.

Even when someone understands CO<sub>2</sub>e avoided, there are ethical arguments concerning the focus on personalised carbon data. All good stories of personalised CO<sub>2</sub>e should recognise the role of British Petroleum (BP) in its creation. Building on the emerging concept of an individuals' 'carbon footprint', the fossil fuel company released the first widely used personalised carbon footprint calculator in 2004 (Kaufman, 2024). The calculator allowed individuals to measure their impact on the planet – argued to be a part of a broader Public Relations campaign to divert responsibility away from fossil fuel companies and towards individuals' actions. Since then, there has been a proliferation of carbon footprint calculators, from government-backed enterprises (e.g., Climate Neutral from the UN) to non-profit entities (e.g., WWF's Footprint) (Mulrow et al., 2019). Two decades on from BP's marketing campaign, it is now normalised for people to think of themselves as personally responsible for climate change, with this figure appearing to be rising (European Commission, 2019).

To understand how people experience CO<sub>2</sub>e avoided, we focus on the CO<sub>2</sub>e avoided data point on the TGTG app.<sup>1</sup> Too Good To Go provides a CO<sub>2</sub>e breakdown for each bag of nearly wasted food collected and a running total for each user. This is a more comprehensive way of communicating CO<sub>2</sub>e avoided than is seen within other apps: Trainline do present a CO<sub>2</sub>e avoided figure to each user, but they do not provide regular users with a running total of how much CO<sub>2</sub>e they have avoided through repeat purchases; whereas Strava's personalised data is not for all journeys but it is

only for specific users who select the 'commute' option when cycling.

To think through how people experience the CO<sub>2</sub>e avoided data point on the app, we use Hoeyer and colleague's (2024) concept of data experiences. How valuable was the CO<sub>2</sub>e avoided data point for users? How truthful was the CO<sub>2</sub>e avoided data point for users? How did users sense the CO<sub>2</sub>e avoided data point? How right – morally, ethically and legally – was the CO<sub>2</sub>e avoided data point for users? These questions are explored through a multi-stage research project with 10 households (12 individuals) in Oxfordshire in the UK. Each household engaged in three interviews, five self-report surveys and a 28-day trial of the TGTG app.

Our findings provide empirical data concerning the way people engage with quantitative information in the context of climate change. It helps us better understand why and how information does not always influence sustainability-related behaviours. At the same time, it attends to the vitally important – yet poorly understood – academic exercise of understanding peoples' experiences of data.

## Data experiences

There are not many over-arching theoretical frameworks for understanding data experiences, however, two stand out as helpful. Burgess and colleagues (2022) position data within cultural studies, arguing for an examination of datafication 'at the ground level' in the 'activities, thoughts and feelings of citizens, consumers and users of technologies'. Mapping out *everyday data cultures* they connect intimate individual data experiences with broader structural conversations concerning agency and publics. Their work is useful but lacks a clear analytical approach to individuals' experiences.

This is provided by Hoeyer and colleagues (2024) through their concept of data spaces: 'conditions of being that are enacted when people, computers and organisations use data for manoeuvring hopes, opportunities, risks and challenges – or think that others might be doing so'. They use policy reports and documents about the proposed European Health Data Space – a large-scale health data infrastructure – to map out the nature of data spaces. To analyse data spaces, they outline two dimensions: the *formative* that examines how data spaces come into being through the meeting of labour, users and promises; and the *experiential*, defined as the way data spaces are inhabited. Given the focus of our paper, we use the *experiential* theoretical framework to think through how people experience the CO<sub>2</sub>e avoided data point on the TGTG app.

Hoeyer and colleagues (2024) argue that much of the existing work either focuses on data as knowledge or data as political objects, which misses direct experiences with data. In doing so, academic work can struggle to understand 'how and why some people react to datafied phenomena' (Hoeyer, 2023). To unpick this, they define data experiences

as comprised of four aspects: value – what people experience as valuable (economically, emotionally and socially); truth – what people experience as true (epistemologically); presence – what people sense (phenomenologically); and right – what people experience as right (legal, moral, normative). They are keen to stress that peoples' experiences are often combinations of these four aspects. For example, someone might consider CO<sub>2</sub>e avoided to be *true* but place very little *value* on the figure when engaging with the TGTG app because they don't *feel* that it is *right* to overly individualise the fight against food waste. These combinations change depending on specific individuals and circumstances.

To give a sense of how people might experience CO<sub>2</sub>e avoided, we can turn to the small body of literature on how people engage and experience carbon footprint calculators – and the CO<sub>2</sub>/CO<sub>2</sub>e metrics used in these calculators. To map out this empirical work, we use the four dimensions of data experience. In doing so, we further develop the different elements of Hoeyer and colleague's framework.

### Data experiences of carbon footprint calculators

*Value* can be approached by considering how much the data can influence changes in behaviours. Research is inconclusive as to the effects of carbon footprint calculators on behaviour change (Jack et al., 2024). Some studies have highlighted the effect of calculators on peoples' behaviour, for example, Kok and Barendregt (2021) found that participants made changes to different parts of their lifestyle after using the calculator, ranging from avoiding packaging to decreased meat and dairy consumption. But relying on personalised information from a calculator is considered insufficient to encourage more people to adopt pro-environmental behaviours (Büchs et al., 2018; Dreijerink and Paradies, 2020). Integrated interventions, on the other hand, seem to have more influence, suggesting that individuals may change their behaviour if they use a carbon footprint calculator *and* engage in group discussions (Gram-Hanssen and Christensen, 2012; Sutcliffe et al., 2008).

Beyond the impact of carbon footprint calculators on pro-environmental behaviours, we can consider the impact on individuals' attitudes, social norms and intentions. Kok and Barendregt (2021) outlined how calculators can facilitate conversations with peers and be the catalyst for plans to change in the future – important effects in their own right and building blocks to direct behaviour change. Matching with the work from Luo and colleagues (2023) who show that personalised feedback on carbon emissions can lead to people *intending* to reduce their carbon-related activities. It does seem that footprint calculators can increase awareness (Büchs et al., 2018), but this is mitigated by calculators generally attracting people who already have a modest impact on the planet (relative to other citizens in their country) due to heightened concern about climate change.

The ability for individuals to contextualise data emerges from a meeting of *value* and *truth*. CO<sub>2</sub> and CO<sub>2</sub>e are concepts that individuals can struggle to understand (Dósa and Russ, 2020). This makes it hard to determine the truthfulness of CO<sub>2</sub> and CO<sub>2</sub>e information and makes it difficult to ascribe value to it. To address this, some calculators contextualise the data they present. For example, how many Earths would be needed if everyone had the same consumption pattern as the user (the 'planet representation'). Participants in Kok and Barendregt's (2021) study found this way of communicating CO<sub>2</sub> more comprehensible – in the words of participant 1 'you can tell right away [...] this isn't good, because there is only one Earth'. A similar argument was made by other participants in the study when discussing the amount of land required for their lifestyle (sometimes used to represent carbon footprints): participants called for the hectares of land figure to be converted into square metres or football fields instead.

It seems that contextualisation can de-mystify issues of truth and, in turn, allow people to place more value on the data. Similarly, Lindrup and colleagues (2023) provided participants with different weight totes bags that represented countries' per capita CO<sub>2</sub>e. It allowed participants to understand how countries compared to each other, allowing for people to better contextualise the data. But this contextualisation was only partial. They could not contextualise the impact on the planet of the CO<sub>2</sub>e being presented to them.

The issue of *truth* emerges more explicitly in how personal footprints are calculated. Users of carbon footprint calculators are critical of the level of detail in the survey questions, arguing that there was not enough nuance in how their carbon footprint was calculated (Jack et al., 2024). For example, a participant in Bjorn-Hansen and colleagues (2022) study expressed their discontent, explaining that he shared an electric car with his son, but this 'spreading' of CO<sub>2</sub>e was not captured. Those who were more concerned about the environment would generally be happy to answer more detailed questions concerning their carbon footprint for a more truthful account of their impact (Kok and Barendregt, 2021).

Stepping away from truth and value, we can consider the issue of *presence*. In this paper, we use the term *sense* instead of presence. Sense provides a clearer conceptualisation of the phenomenological question of how some users emotionally interacted with calculators, often in embodied ways (Jack et al., 2024; Kok and Barendregt, 2021). Participants in Kok and Barendregt's (2021) study felt they could never reduce the number of planets to one, and so experienced emotions of hopelessness in their ability to address climate change. Similarly, Jack and colleagues (2024) refer to the role of demotivation and resistance. They outline how one participant felt sad about their carbon footprint: in their view, they were doing a lot already to help the environment – but they were still above average on the

**Table 1.** Data experience applied to CO<sub>2</sub>e avoided data on TGTG.

Data experience (Hoeyer et al., 2024)			
Dimension	Explanation	Research question	How it can apply to TGTG
Valuable	Issues of social, cultural, economic and individually valuable	RQ1. How valuable was the CO <sub>2</sub> e avoided data point for users?	<ul style="list-style-type: none"> <li>Is the data valuable enough to pay attention to?</li> <li>Is the data valuable enough to influence their use of the app?</li> </ul>
True	Epistemological issues (accuracy, credibility, objectivity)	RQ2. How truthful was the CO <sub>2</sub> e avoided data point for users?	<ul style="list-style-type: none"> <li>How do users establish the accuracy of the CO<sub>2</sub>e avoided data?</li> <li>Do users consider the data to be credible?</li> </ul>
Present	Phenomenological issues (emotions and embodied)	RQ3. How did users sense CO <sub>2</sub> e avoided feedback?	<ul style="list-style-type: none"> <li>How does the CO<sub>2</sub>e avoided data make users feel?</li> <li>How is the CO<sub>2</sub>e avoided data embodied?</li> </ul>
Right	Normative issues (moral, ethical, legal)	RQ4. How right was the CO <sub>2</sub> e avoided data point for users?	<ul style="list-style-type: none"> <li>Are there any moral issues concerning the individualised nature of CO<sub>2</sub>e avoided?</li> </ul>

calculator. For others, they continued to live high-carbon lifestyles but had a ‘guilty conscience’ in doing so. These negative feelings of hopelessness, sadness and guilt are important emotional reactions but are not the only ways that people sense data. Data can be embodied when people *sense* the weight of something, as seen in Hedin and colleague's (2024) tote bag study that physicalised emissions.

The least amount of empirical work centres on what is considered *right*. Some research does refer to issues of responsibility. Some people disagree with calculating an individuals’ carbon footprint because it detracts from structural issues driving climate change (Jack et al., 2024). One participant used this criticism to present an alternative framing of individuals’ relationship to climate change: a handprint, not a footprint, that places emphasis on how individuals can contribute to structural change through signing petitions, voting and joining citizens’ initiatives (Kok and Barendregt, 2021).

We use the empirical work on carbon footprint calculators – set within Hoeyer and colleagues’ data experiences framework – to underpin our examination of the CO<sub>2</sub>e avoided data point on the TGTG app (see Table 1). The four issues form our four research questions, each guided by a set of questions emerging from the literature:

RQ1. How *valuable* was the CO<sub>2</sub>e avoided data point for users?

RQ2. How *truthful* was the CO<sub>2</sub>e avoided data point for users?

RQ3. How did users *sense* the CO<sub>2</sub>e avoided data point?

RQ4. How *right* was the CO<sub>2</sub>e avoided data point for users?

Given the similarities between our empirical focus and carbon footprint calculators, our operationalisation of *true*, *sensed* and *right* match with the literature outlined above. For *valuable*, however, we focus specifically on

users’ attention to the data and usage of the app. TGTG does not use the CO<sub>2</sub>e avoided data point to engender broader changes in peoples’ lifestyles (like carbon footprint calculators do), it is designed to maintain engagement with the app and encourage users to buy the near left-over food bags.

## Methods

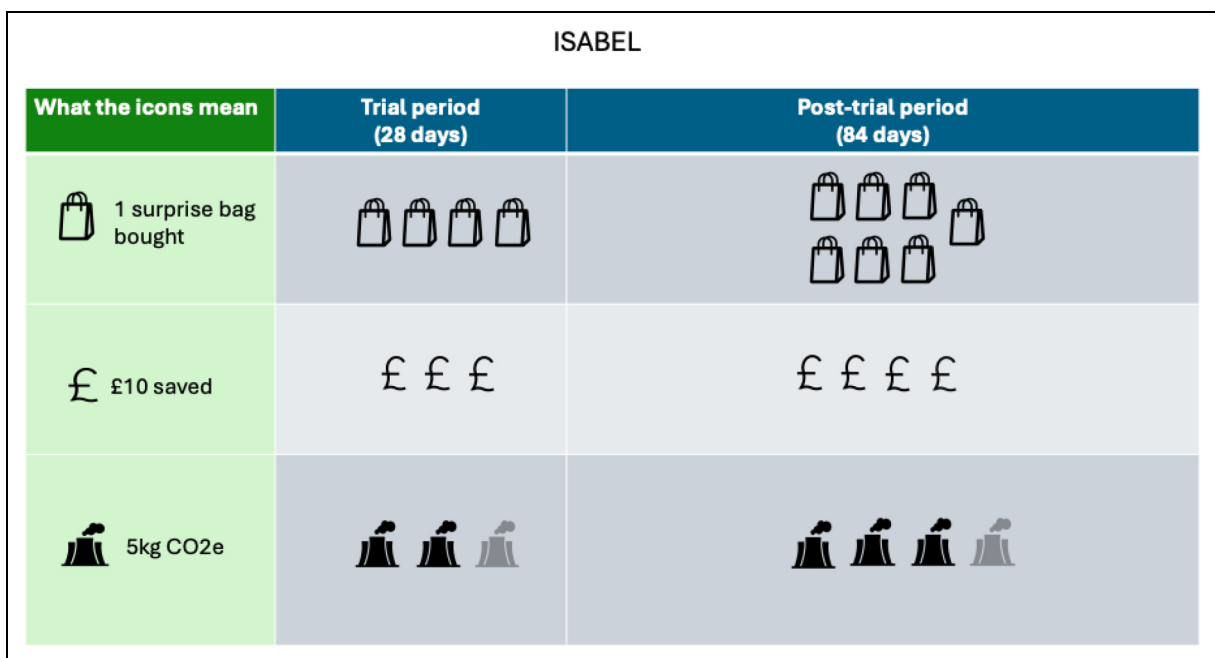
### Research design

To understand how participants experienced the CO<sub>2</sub>e avoided data point on the TGTG app, we developed a multi-stage research design centred around a 28-day trial of the app. Our approach was specifically designed to expose 10 households (comprised of 12 participants) to the CO<sub>2</sub>e avoided data point as they engaged with the TGTG app. Research was conducted from January to June 2024. The stages of the research are outlined in Table 2. This study is testing the concept of data experience before a larger roll-out within an Energy Demand Observation and Laboratory (EDOL) field labs at the University of Oxford.

We conducted three interviews per household (with multi-participant households interviewed together) to understand how they perceived this data: one before the trial of the app, one immediately after the trial and one 12 weeks after the trial had finished. The three interviews per household allowed us to contextualise participants’ data experiences within the broader experience of using the TGTG app and outlined how their experience of the CO<sub>2</sub>e avoided data point changed over time. To aid our discussions of the data, all participants from the 10 households completed self-report data surveys at specific times during the intervention (Table 2). The surveys focused on four data points: time spent on app, bags bought, money saved and CO<sub>2</sub>e saved. The data provided allowed for the researchers to understand participants’ usage and it was used in the second

**Table 2.** Research design organised in three stages: pre-trial, trial and post-trial.

Stage	Method	Details
Pre-trial	Interview 1	<ul style="list-style-type: none"> <li>Baseline questions on knowledge, perceptions and engagement with food waste</li> <li>Familiarisation with the TGTG app and the app tracker software</li> <li>Outlining the design of the research</li> </ul>
Trial	Self-report survey 1	<ul style="list-style-type: none"> <li>Before intense use period started</li> <li>Complete survey for three personalised data (bags bought, money saved and CO<sub>2</sub>e avoided)</li> </ul>
	Intense use period	<ul style="list-style-type: none"> <li>14 days long</li> <li>Users given £35 TGTG vouchers</li> <li>Encouraged to check the app and sent reminders</li> </ul>
	Self-report survey 2	<ul style="list-style-type: none"> <li>At 14 days (halfway through trial period)</li> <li>Complete survey for three personalised data (bags bought, money saved and CO<sub>2</sub>e avoided) and time spent on the TGTG app</li> </ul>
	Unexpected change in personalised data interface for all TGTG users.	<ul style="list-style-type: none"> <li>14 days long</li> <li>Users free to use the app as they want</li> </ul>
	Self-report survey 3	<ul style="list-style-type: none"> <li>Upon completion of the free use period</li> <li>Complete survey for three personalised data (bags bought, money saved and CO<sub>2</sub>e avoided) and time spent on the TGTG app</li> </ul>
Post-trial	Interview 2	<ul style="list-style-type: none"> <li>In the week after the conclusion of the trial period</li> <li>Questions centred on use of the TGTG app, engagement with personalised data and re-asking the baseline questions from Interview 1</li> </ul>
	Self-report survey 4	<ul style="list-style-type: none"> <li>Around 10 weeks after the completion of the trial</li> <li>Complete survey for three personalised data (bags bought, money saved and CO<sub>2</sub>e avoided) and time spent on the TGTG app</li> </ul>
	Self-report survey 5	<ul style="list-style-type: none"> <li>Two weeks after Self-report survey 4</li> <li>Complete survey for three personalised data (bags bought, money saved and CO<sub>2</sub>e avoided) and time spent on the TGTG app</li> </ul>
	Interview 3	<ul style="list-style-type: none"> <li>12 to 14 weeks after the completion of the trial</li> <li>Questions centred on use of the TGTG app over the long-term, engagement with personalised data over the long-term and re-asking the baseline questions from Interview 1</li> </ul>

**Figure 1.** Data visualisation of personalised data used in interview 3.

and third home interviews as a prompt. Participants' personal data was converted into a set of infographics that represented the three data points and changes over time (see Figure 1 for an example). The visualisation followed the guidance of Franconeri and colleagues (2021) using icons to represent units, with 5 kg of CO<sub>2</sub>e represented by one power station. When the CO<sub>2</sub>e data point was not a multiple of five, the icon was made more transparent (see Figure 1). During the household interviews, participants were encouraged to discuss the accuracy of the data, how the data connected to their personal experience and the influence of the data on their opinions and behaviours with regards to the app, as well as food waste and climate change more broadly.

### Participants

The research was part of a pre-existing living lab research project conducted by IDODDLE at the University of Oxford. The living lab was developed in 2022 and consists of 47 households who provide insights into real-world conditions in their own homes and are committed to trial, learn, interact and share data on their digitalised daily life. The households have wide ranging characteristics (composition, socio-economic, digital engagement, home type and ownership, location rural/urban). All participants currently part of the living lab were emailed an invitation to take part in our research and sent a screening survey. Of the 25 who responded, we selected 12 individuals from 10 households. The selection was based on four criteria: 18+ years of age; uses a smartphone; no or limited past use of TGTG; lives in or regularly visits Oxford.

Given that TGTG operates through a mobile app and has a minimum age of 18, all participants needed to own a smartphone and be aged 18 years or older. We selected users who had either not used the app before or had purchased a surprise bag on TGTG more than one year ago. This ensured that all users were relatively fresh to the platform, rather than having considerably different current levels of engagement. Finally, we selected those who either lived within 3 miles of Oxford City Centre or travelled into Oxford at least once a week. Given that most food providers on the app were located in the centre of Oxford, this ensured that participants had opportunities to collect food that was on offer. We attempted to achieve a balance of household composition, age and use of a food bank<sup>2</sup> in the last 12 months (see Table 3). All 12 individuals – from the 10 households – who started the project completed the final interview, submitting all five self-report surveys.

### Data analysis of CO<sub>2</sub>e avoided

Our analysis focused on the CO<sub>2</sub>e avoided data point. To analyse how this data was experienced, we analysed each participant's three home interviews and the five self-report survey

data. The predominant focus of our analysis was on the interview data. To do so, we considered three layers of the data:

- *CO<sub>2</sub>e avoided data* – specific discussions about CO<sub>2</sub>e avoided on the app and CO<sub>2</sub>e/CO<sub>2</sub>e avoided more broadly
- *Personalised data* – discussions about their personalised data, focusing on money saved and bags bought;
- *Wider context* – broader conversations about their experience of the app that helped contextualise specific conversations about CO<sub>2</sub>e.

• The self-report data was used as a prompt during these discussions but was also analysed to understand participants' usage of the app over time (particularly important for addressing RQ3 and RQ4).

The presentation of CO<sub>2</sub>e avoided on the app changed in two ways during the trial period. This was unplanned and not part of the research design. First, TGTG shifted from CO<sub>2</sub>e saved to CO<sub>2</sub>e avoided. Second, they changed how the data was presented – showing users the equivalent kilowatt hours (kWh) and how this equated to the number of full smartphone charges, cups of hot coffee and time taking a hot shower. Our analysis does account for users' experience of this change.

All interviews were transcribed and uploaded to QSR NVivo. On this platform, Author 1 conducted the first round of coding (Coding v1). This involved coding the interviews for references to the three layers outlined above: CO<sub>2</sub>e, other personalised data and wider context. Within each of these layers, Author 1 developed a set of codes that linked directly to answering the research questions.

Qualitative coding of interviews can overly compartmentalise different moments of discussions between participants and researchers. The resulting codes can make logical sense yet fail to connect different participants' testimonies in a meaningful, joined up way. When multiple interviews are conducted with one participant over time, this problem is exacerbated. To address this, Author 1 worked with the extracts from the coding document to create the narrative document, which focused on constructing a narrative that formed links between the different testimonies and directly addressed the four research questions. This process involved using all three interviews per participant and accounting for how their experiences changed over time. The self-report survey data was used to contextualise individual participants' usage of the app.

The number of participants' testimonies within each code was not used to determine whether codes should be included or excluded from the narrative. Instead, the narrative clearly indicates a qualitative scale: a single conversation, some participants (less than 50% of the total sample), the majority or most participants (50% or over) and all participants.

Following this, Author 2 critically engaged with the relationship between the coding and narrative. They first evaluated the flow, structure and argumentation of the narrative.

**Table 3.** Participant information.

Participant pseudonym	Household	Type of household	Type of user	Age (years)	Food bank usage in last 12 months	Bags bought
Isabel	a	Multi-person	Downloaded, never purchased	25-45	Yes	10
Alchik	b	Multi-person	Virgin user	65+	No	3
Verity	c	Multi-person	Virgin user	25-45	No	8
Toby	d	Single occupancy	Virgin user	46-65	No	7
May	e	Multi-person, with children	Downloaded, purchased last bag over 1 year ago	25-45	Yes	17
Raymond	e	Multi-person, with children	Virgin user	25-45	Yes	6
Mills	f	Single occupancy	Virgin user	46-65	No	7
Czarina	g	Multi-person, with children	Virgin user	46-65	No	5
Tallulah	h	Multi-person, with children	Downloaded, purchased last bag over 1 year ago	25-45	Yes	4
Gauri	i	Multi-person	Virgin user	25-45	No	6
Chetan	i	Multi-person	Virgin user	25-45	Yes	7
Louise	j	Multi-person	Virgin user	46-65	Yes	4

They then assessed the evidential basis for the narrative using the coding document. In doing so, they created the next version of the coding and narrative. Author 1 and Author 2 repeated this process three times to reach agreement. This process was emergent, interpretive and dialogical. For example, Author 1 and Author 2 would discuss via Teams the relevance of new codes that were previously uncaptured or converse via in-text comments about adding sections to the narrative to improve argumentation.

## Findings

Our findings outline how the CO<sub>2</sub>e avoided data point was not considered particularly valuable to participants (RQ1), highlighted how little it influenced their usage of the app and the lack of meaningful attention they gave the data. This valuation is partly explained by participants' low trust in the data – emerging from the interplay of what is considered true (RQ2) and how the degree of trustworthiness was felt (RQ3). From this distrust, participants outlined how impact data on TGTG could be more valuable (RQ1) and just (RQ4). Some households advocated for a shift away from the individualised CO<sub>2</sub>e avoided data point towards relational impact data that sets individuals within a larger community.

### CO<sub>2</sub>e avoided did not influence app usage

One way to understand the value placed on the CO<sub>2</sub>e avoided data point (RQ1) is to explore how much it influenced participants' behaviour. None of the participants referred to the app changing their broader pro-environmental behaviours. Only one of the participants referred to the CO<sub>2</sub>e avoided data point motivating them to use the app.

I'm not so interested in the number of bags but, I think (...) I'm most interested, it would be the CO<sub>2</sub>e because that would be the reason for doing it. (Mills I2)

In part, this was an emotional experience (RQ3). Mills (I2) explained that when seeing this data, they would 'feel good' about preventing food from going to waste. But within the same conversation, Mills also emphasised that these metrics weren't their priority when using the app (Mills I2). Some participants expressed how knowing the CO<sub>2</sub>e of the bags, while not an influence on their decisions, was a *nice to have* as it served as a 'pat on the back' (Raymond I2).

Like Mills, Czarina (I2) sensed the CO<sub>2</sub>e avoided data point: saying that saving 14 kg in the first two weeks elicited a 'very good feeling' that she was engaging in 'environmentally friendly' behaviour. Czarina's behaviour did change between interviews 2 and 3. The CO<sub>2</sub>e avoided data point was considered more meaningful after the interface change which translated the data into more tangible forms, such as number of full smartphone charges (I3). But for most participants, there was no change concerning the influence of the data on them using the app from interview 2 and interview 3. We can see an example below:

Raymond: I think that something like the CO<sub>2</sub>e, it wouldn't drive me to pick something from a specific place if it was a higher saving. (I2)

Raymond: Yeah, I was going to say, seeing it is the CO<sub>2</sub> emissions. I'll speak for both of us, probably it's not a driver. (I3)

CO<sub>2</sub>e avoided was not considered a reason to use the app for May either. When asked which of the three numbers (bags bought, money saved or CO<sub>2</sub>e avoided) would

motivate them to use the app, she pointed to money saved as being most important

Um, oh, I, it, it [food waste] wasn't important to me. It was more this, the benefit it would have for us financially as a family, if I'm honest, and the savings we would make on purchasing the food for the meals that we used it for. – (May I3)

May purchased the most surprise bags ( $n = 17$ ) out of all the participants in the trial, but the CO<sub>2</sub>e avoided data point was not a driver of this. Why does the CO<sub>2</sub>e avoided data point have such little impact on peoples' behaviour? Some participants expressed not needing CO<sub>2</sub>e-specific figure to know that they were doing something good for the planet by preventing food waste (Mills I2, Gauri & Chetan I2). But the explanation runs deeper than this. We can turn to another aspect of value (RQ1) by considering how CO<sub>2</sub>e avoided on the app was given such little meaningful attention.

### *CO<sub>2</sub>e avoided was not given meaningful attention*

All participants were shown where their CO<sub>2</sub>e avoided data point was in the app during the first interview. Participants were asked to select the 'Me' section (later changed to 'Profile') of the app so they could see the location of the information they needed to self-submit. A typical interaction is outlined below:

I: This is the 'Me' section, and when we send you through the self-report survey, it will basically say, 'okay, can you go on the Too Good To Go app and click on "Me" and then report what it says on here'. (...)

Czarina: And here is the summary of how much I have, how much I spend, and the carbon footprint.

(I1)

Therefore, it is not surprising that all participants stated they were aware of the personalised *CO<sub>2</sub>e avoided data point* on the app. There is a difference, however, between knowing information is on the app and giving the data meaningful attention. Some participants did refer to checking their CO<sub>2</sub>e avoided when they used the app, but this centred on a casual interest in seeing the number change

I: And the CO<sub>2</sub>e saved – did you look at it at any other time than when I asked you to self-report the information?

Gauri: I think I looked at it again, just when I was using the app (...) but not because the number means anything to me. (...) I kind of was just interested in seeing it change.

(I2)

For some participants, however, this data was not part of their experience of using the app at all. Returning to May, who amassed the most CO<sub>2</sub>e avoided (49 kg) of all the participants

[In a two-person interview, asking the second person about their experience with the TGTG app]

I: How about you, May? [Did you look at the CO<sub>2</sub>e saved any other time?]

May: If I'm honest (laughs), I have no thoughts on it [CO<sub>2</sub>e avoided].

I: Well, it just wasn't an important aspect of-?

May: No.

(I2)

Given that the study design involved participants needing to check and report this data, we would expect our participants to give more attention to their personalised data than the average user of the TGTG app. The lack of attention indicated that it held very little meaning. This was reflective of a broader pattern. Participants generally ignored the 'Me' section, where the personalised data was presented.

Only when I was probably first on the app to seeing what was there. Seeing where this information was, and then the next time when you asked me to report it (...) so it's not something I would refer to a lot. (Mills I3)

The 'Me' section is one of four tabs at the bottom of the app, alongside 'Discover', 'Browse' and 'Favourites'. The three latter tabs allow users to search for surprise bags. The 'Me' section is siloed from the experience of searching and securing surprise bags on the app, as Isabel explains below

I never looked [at the 'Me' Section] until like apart from the points where you asked me to, I didn't look at the Profile bit because all I was interested in is it's on a separate bit to the bit of like 'What, what have you got going for me?' (Isabel I2)

The design of the app meant people were unlikely to engage with the personalised data. When participants did engage with the data due to the research design, they were sceptical of how it was calculated.

### *CO<sub>2</sub>e avoided was confusing, untrustworthy and opaque*

Despite low levels of attention to CO<sub>2</sub>e, participants did discuss the data during both interviews 2 and 3. Their experience of CO<sub>2</sub>e avoided was confusing, untrustworthy and opaque – combining issues of truth (RQ2) and sensing

(RQ3). In part, this explains why the data was not considered particularly valuable (RQ1).

*Confusion and cynicism.* Some participants outlined how they felt confused when it came to CO<sub>2</sub>e avoided (RQ3). When Raymond (I3) referred to the CO<sub>2</sub>e figure, he referred to ‘CO<sub>2</sub> emissions’ rather than ‘CO<sub>2</sub> equivalent’. Whereas Toby initially thought ‘that’s my CO<sub>2</sub>’ (I1).

This can be linked to a lack of explanation on the TGTG app about how the figure was calculated.

You look at the number and go, well, really, can it be that? I’m not too sure. If there’s anything that at least allows me to sort of understand, okay, this is how we’ve estimated it and in the degree of confidence that there’s some rationality behind it, then maybe yeah but even then I’d find it a bit challenging because there’s so many variables involved, you can’t just easily put a number and go ‘I’ve picked this up’. (Chetan I3)

During the same interview, Gauri explained that ‘every time I saw like how many carbon whatever I was saving, I was like, that’s bullshit (laughs). I just don’t believe the calculations for it’ (I3). Participant’s cynicism and confusion were often rooted in disbelief of the veracity of the CO<sub>2</sub>e figures, based on disconnect between their experience of picking up a TGTG bag and the CO<sub>2</sub>e avoided data point.

*Disconnect between the content of the bags and data.* Some participants accepted that CO<sub>2</sub>e would be avoided by stopping food from going to landfill and producing methane (Isabel I2; Chetan I2 & I3). But most participants were keen to challenge the assumptions that were made to calculate the CO<sub>2</sub>e figure. TGTG failed to account for the variation in the *contents* of surprise bags (Mills I3). Even the same business would provide very different food. Below Verity outlines how this occurs at a bakery

The CO<sub>2</sub> part I think is very ballpark to the point it’s not useful. Because they don’t know really what I’ve been given. You know, if I go to a bakery and they give me free items and one day, let’s say they’re three doughnuts, like just plain sugar glaze ring doughnuts and then the next time I go, there are three half baguettes that have got like seven types of meats and cheeses in them. One of them has a very different carbon footprint than the other. But do they [TGTG] know? (Verity I3)

This variation was linked to the practice of the particular food provider in selecting food for the surprise bag. Isabel describes:

Certainly, in Coop [a supermarket], they just go around, like, bunging things in a bag, so they’re clearly not logging it to say these are the things. And I don’t know enough about what happens when bread decomposes and how carbon-intensive bread is, because there’s a lot of like bakery bread. (Isabel I3)

Isabel experienced seeing the TGTG bag being made. It did not match her expectations, hence creating distrust on how the CO<sub>2</sub>e avoided data point was calculated. The TGTG model works on food providers having a large degree of flexibility when it comes to the content of the surprise bags. While such a process works well to monetise food that would go to waste, participants expected more monitoring of the bag contents to create an accurate calculation of the CO<sub>2</sub>e avoided. As Gauri aptly puts it, ‘if it’s a surprise bag, how do they even know what I picked up?’ (I2). It is not possible for the user to provide this information on the app, as Mills outlines:

I haven’t listed all the things that I’ve got from my surprise bag that time. It’s very much a finger in the air (i.e., guessing based on very limited information). (Mills I3)

Hence, there was a clear expectation that the CO<sub>2</sub>e avoided data point would be linked to the specific contents of each surprise bag. When they perceived that there was no apparent link, they seemed to trust the data less.

The CO<sub>2</sub>e avoided figure is also related to the actions of the person picking up the food. As Gauri emphasises, ‘you don’t actually know what happens once people pick it up’ (I3). To collect a surprise bag, a user must travel to the food provider. As outlined by some participants, the app does not collect information about transport. Toby discussed in both the second and third interviews:

I did think a couple of times, when looking at the CO<sub>2</sub>. Yeah, but if, if I had driven to pick up this stuff, then your CO<sub>2</sub> calculation ain’t the global picture, is it? ‘Cause you’re saying I’ve saved CO<sub>2</sub>, I don’t know... I don’t know how they calculate it. But certainly if I’ve driven, I’ve burnt some CO<sub>2</sub>. (Toby I2)

I can get the logic of it; I just don’t get that I have saved 19 kilos. Where? How? What? What were they assuming? that I drove there? I don’t know. I really don’t know how they get that. (Toby I3)

The CO<sub>2</sub>e savings made by preventing food from going to landfill may be offset by driving to collect the bag itself. As Mills (I3) explained, ‘I’m in theory, I’m saving all this CO<sub>2</sub> on the thing, but I’m just starting up my diesel car and driving to ALDI’.

*Filling in the gaps of how the CO<sub>2</sub>e avoided data point is calculated.* In the absence of information, participants developed their own understanding of the CO<sub>2</sub>e metric. One participant assumed the figure was based on miles travelled by the food (Raymond I2). Louise outlined their interpretation that the embedded CO<sub>2</sub>e in the food (from its production, transportation and storage) moves from the hospitality sector to the domestic setting in more detail

I think that's more marketing, that data, what the icons mean, rather than they've made me go 'oh, look, I'm saving CO2' because actually, that's CO2 would have been...I know it's saving stuff from landfill or from incineration or composting, but it's moving CO2, it's not getting rid of it. If you see what I mean? (Louise I2)

Louise's interpretation reflects a high level of carbon literacy – tied to her professional background in 'waste planning' (I1). But due to a lack of information within the app about CO2e saved, it is still an *interpretation*. We can observe a similar process for Chetan (I1), who discussed the CO2e avoided data point with some confidence but – in lieu of the app providing it – were aware that they did not have access to enough information to make an informed interpretation. This highlights the need to communicate the method of calculating CO2e saved, otherwise users will use their varying levels of carbon literacy to make interpretations.

Contextualisation was key. Participants would place CO2e avoided within their existing experience of interacting with concepts of embedded carbon, CO2 and CO2e. Some participants talked about food in the first interviews: Isabel (I1) had visited a café where they 'guesstimated the carbon footprint of the food'; Gauri (I1) discussed how they were signed up to Oddbox – a vegetable delivery service – partly due to 'an analysis of the most carbon neutral' vegetable box.

But other contextualisation was not food related. Louise (I3) refers to the impact of investments within pension schemes on climate change – and how changing from one scheme to another can have a significant effect on an individuals' carbon footprint. Referring to another context, Verity referred to comparing the CO2e figures on TGTG to a self-tracking app, Strava:

I use Strava for my cycling (...). If you log something as a commute rather than a like a workout, it gives you a CO2e figure as well. So, I know that like I think it's 1.4, 1.5 kilos for each trip to work, and again for back from work. And this is just X to X basically when I cycle in, I think compared to a private vehicle sort of expected emissions. So, I know what my commute, it's sort of there and back is like 3 kilos a day that I save by cycling rather than driving. So, I think that's where my benchmark is on the figures. (Verity I2)

But other participants explained how they had not come across *CO2e avoided* in their day-to-day life (Toby, I2), which meant they struggled to contextualise the data they came across. As Mills (I3) outlined, 'I don't know what 5 kg of CO2e looks like, you know, what harm it would create or how many car journeys is it?'

By chance, the way the data was presented to the user was changed part way through the trial period. The original user interface provided users with a single CO2e avoided

figure in kilograms (kgs). The new user interface presented the user with three types of data: CO2e avoided in kg, energy saved in kWh, and the equivalent actions that would use the energy saved (full smartphone charges, cups of hot coffee and time taking a hot shower). Participants outlined how they liked the new user interface and how it did go some way to improving their understanding of CO2e, but the change had little impact on how much meaning or trust they gave the CO2e avoided data point on the app. Both the extracts below are from interviews that occurred after the interface change.

'I guess it doesn't mean very much. I know [that] with the update of the app, they've kind of changed it, so it's now like... "it's this many miles"' (Isabel I2)

'Well, under the CO2e one, it sort of rotates between giving [the data] in different ways to understand: "[oh yeah], that was interesting". I mean, I still don't feel like I'm personally responsible for that [CO2e avoided], but that was interesting to see [the CO2e avoided data point] in a format that was more relevant to me (...), in a more easy to understand way, really, for people like me (laughs)'. (Tallulah I3)

The new user interface allows users to convert the impact of collecting a surprise bag into everyday activities. But there are other ways that data can be contextualised, as discussed by Louise. She recognised that the app was trying to reinforce good behaviours, but criticised the lack of reference points for the user to comprehend the impact of activities.

The average family does, however, many tonnes of carbon a year and this food is only a small part of it. (Louise I3)

As she outlines above, a family's activities will produce tonnes of carbon a year. When one surprise bag saves 2.7 kg of CO2e, the scale is not properly contextualised alongside other activities.

### *Making impact data more influential*

From the analysis above, we can see that inclusion of CO2e avoided in the TGTG app is was not considered valuable enough to influence usage of the app or be given meaningful attention and – given the perceived inaccuracies and lack of transparency – not particularly trustworthy as a piece of knowledge. Emerging from these discussions, however, were imagined alternatives to CO2e avoided. Through these testimonies, participants highlighted how impact data could be more valuable (RQ1) and just (RQ4) by shifting away from individualised CO2e avoided.

*Is CO2e the right measure?.* Some of the participants stressed how they couldn't sense CO2e in an embodied way (RQ3). Czarina (I2) referred to CO2e as 'intangible and, you know, in our daily lives we are not aware of this

part at all', whereas money saved or surprised bags bought are more 'tangible'. During both the second and third interview, Alchik explained

To tell you the truth, it does not mean a lot. I know we're talking about greenhouse gasses and things like that. But in terms of my personal experience, it means really nothing. It's a theoretical concept, it's not a living part of my experience. (Alchik I2)

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I: What are your feelings when you see that number?

Alchik: It's just a number, I'm afraid. Just a number. I don't have feelings, so you know it's a-, an abstract number. (...) you know, it's not as if its making a tangible impact on my body or my health. (Alchik I3)

CO<sub>2</sub>e is a measure of GWP, relative to CO<sub>2</sub>. Whilst the impact of CO<sub>2</sub>e is tangible, namely in how people experience extreme weather conditions, the measure itself is not immediately relatable. Gauri and Chetan called for a change in how impact was presented to the user. They argued that the size of food wasted items should be used, using 'bins of food' as a measure (Gauri I3). Using this measure would allow individuals to conceptualise just how much food had been saved. The change in measure was combined with a re-thinking about how the individual fits within a broader set of users.

*Disconnect between the user and TGTG.* For some participants, there was a recurrent tension between the impact of an individual user of the app and the impact that TGTG has in terms of food savings as a whole. Two participants felt that they were not really saving food from being wasted because of the high demand for TGTG bags – and therefore were not saving CO<sub>2</sub>e.

It feels like these are surprise bags that probably will be claimed by someone and therefore it doesn't necessarily feel like, I, you know, I've actually really saved anything. (Isabel I2)

And also, had I not managed to get that surprise bag, someone else would have snapped it up, so I doubt that sushi would ever be wasted. It's almost like you're in luck, it's your lucky day if you've managed to bag one, and that's what they call it 'You've bagged a surprise bag', but yeah, you know, it almost doesn't feel like that's about food waste. That's about getting a bargain. (Tallulah I2)

So, it's either me or someone else, but it will be, it's sort of, is good for the environment anyway. It just might be someone else doing it (...) maybe they're telling you this information

because some people will feel good that they're responsible for that and not think any more about it. (Tallulah I3)

Due to the high competition users faced in securing bags, individuals could be fairly certain that someone else would buy a surprise bag if they did not. Therefore, users lacked agency in how they saved CO<sub>2</sub>e. This disconnect between an individuals' experience and the work of TGTG as a whole was also outlined during a conversation between Gauri and Chetan about displacement of food

Chetan: And in the second scenario, they say, 'enable surplus food to be safe for going to waste, thereby avoiding new food production'. Mhmm OK.

Gauri: (Laughs)

Chetan: What is that? Avoiding new food production. That is a... It's already been produced. It's already being produced. What do you mean avoiding?

(I2)

The CO<sub>2</sub>e numbers seemed so disconnected from the TGTG app users that Gauri (I2) discussed how the CO<sub>2</sub>e avoided data point might not even be made for them, that the numbers seemed inflated to appeal to investors.

### *From individual to collective action*

Building on Gauri and Chetan's conversation above, in theory, people using TGTG would reduce their demand from their regular food providers – having a knock-on effect for the production of food. For example, if 1000 users of TGTG bought three less items per week from the same supermarket, the supermarket would order less food and thereby reduce need for supply. But to the individual user, who is making a choice between purchasing a surprise bag or using something from their cupboard, a reduction in supply is not immediately apparent. Whether TGTG is reducing food production or not, the user does not experience food provision in this way.

To address this tension, Chetan and Gauri (I3) argued that the app should move away from being 'hyper-individualised', placing the individual within a community.

Gauri: So, like you might have taken one action but actually in total these number of actions have happened and so that figure of like how many bins of food collectively have been saved in your area, or in your postcode is, that would be because it feels like you're like adding to additional efforts that other people have. That might motivate more of a kind of collective effort and I think might go beyond the slightly individualistic kind of reward that the app seems to add to it

(...)

Chetan: Yeah, that's a good idea actually. Yeah, if they can show that in terms of our postcode, for example (...) if it's possible to have like an OX4 postcode level information on like how people are using the app, and how much food we've collectively saved, that would be quite powerful potentially, actually. I'd want to also tell people I know in the neighbourhood about the app, as well as a result saying 'we're doing this', you know.

(13)

As Gauri outlines, this is being done elsewhere. She refers to Oatly, who consistently refer to the consumer as 'one person who's contributing to a larger set of people who are taking action' (13). In doing so, TGTG can present the user with an intelligible measure of impact, a scale to the impact that feels substantial and positions the user as part of a collective action on food waste. Such a proposition chimes with the sentiment of participants who emphasised the need for structural change:

Because I think fundamentally the problem isn't with the consumers. I think it's with the whole food system. I've been pleased to see things initiatives like Wonky veg in the supermarkets. But a lot of these things require system change, not individual change. Yes, it's good that consumers can see things and put pressure on because they understand a bit more, but I think we need system change. (Louise I3)

I mean, it's difficult to enforce, but there should be no reason why any food that is edible should ever be thrown away. And if it's not edible, you shouldn't have ever let it get to the point it's inedible, and whether that's relationships with charities who can do a lot of the sort of grunt work on collecting and distribution and whatever. But yeah, it should be, whether it's, I don't know, penalties or higher taxes, I don't know how you do it in terms of a mechanism or regulatory environment. (Verity I1)

Moving away from the individualised CO<sub>2</sub>e avoided data point and towards more accessible impact data communicated at different levels from the individual to the collective may mean users personalised data is given more attention, understood better and more influential.

## Conclusion

Overall, the point of the CO<sub>2</sub>e avoided data point on the TGTG app is unclear. Based on our participants' experiences, the data is generally not meaningful, not trustworthy, not informative and does not influence behaviour. We can unpack this experience by returning to Hoeyer and colleague's (2024) framework and connecting the specific findings to the work on carbon footprint calculators. To do so, we have outlined the four aspects of data experience

below, how they intersect and interact, and two potential cross-cutting themes.

*Value.* The data was not considered particularly valuable by participants, best highlighted in how little it influenced their usage of the TGTG app. The personalised CO<sub>2</sub>e avoided figure *is* designed to drive engagement with the app. For our participants, however, this was not achieved. In part, this was because participants could not contextualise the data within their existing activities. Research outlines that people generally struggle to rank the impact of different individual activities in terms of carbon emissions (Kretschmer, 2024), which means better contextualisation of the CO<sub>2</sub>e avoided figure is needed. The current TGTG approach of converting CO<sub>2</sub>e avoided into familiar daily activities is potentially misleading. Users are presented with a large number of cups of hot coffee or full smartphone charges, but this hides the relatively small impact of collecting a surprise bag on an individuals' annual CO<sub>2</sub>e footprint.

It should be recognised here that our approach to value involved a narrower behavioural focus than existing research on carbon footprint calculators. The CO<sub>2</sub>e avoided data point on TGTG was designed to encourage continued engagement with the app and purchase of surprise bags. Carbon footprint calculators, on the other hand, present users with their CO<sub>2</sub>e at a moment in time and encourage broader pro-environmental behaviour changes.

*Truth.* The value given to the data was influenced by experiences of truth. A lack of transparency about how the CO<sub>2</sub>e avoided figure was calculated meant participants were often left confused and were thereby critical about the accuracy of the data – rejecting it as a valuable piece of knowledge. Confusion and criticism were articulated during the interviews as participants described gaps in understanding of the CO<sub>2</sub>e avoided figure in relation to their experience: participants would see their CO<sub>2</sub>e avoided figure increase by a fixed amount each time (2.7 kg) but experienced high levels of variation in the contents of their surprise bags and factored in how they travelled to pick it up, which led them to deduce that the figure was inexact. An inability to account for such nuances has been documented in carbon footprint calculator research (Biørn-Hansen et al., 2022; Jack et al., 2024), with the work of Hedin and colleagues (2024) outlining how the public will focus on the type of food and its transportation when estimating the embedded CO<sub>2</sub>e.

*Sensing.* In previous work on carbon footprint calculators, sensing has focused on negative emotional reactions (Jack et al., 2024; Kok and Barendregt, 2021). In our analysis, sensing was both an emotional and embodied experience that was intertwined with questions of truth. In response to the certainty in which TGTG presented the CO<sub>2</sub>e avoided data point, participants' felt confused about how the data was produced and described an inability to sense CO<sub>2</sub>e avoided in an embodied way. Even attempting to contextualise the figure led to struggles to make the CO<sub>2</sub>e avoided data point relatable

– chiming with previous research on carbon footprint calculators (Kok and Barendregt, 2021). There were some references to positive emotions by participants, notably feeling good about seeing how much CO<sub>2</sub>e they had saved, but these feelings were not particularly widespread and did not seem to influence how much they used the app.

*Right.* Only presenting users with their individualised CO<sub>2</sub>e avoided was seen by participants as hiding the structural nature of climate change, also chiming with previous work on carbon footprint calculators (Jack et al., 2024; Kok and Barendregt, 2021). Understanding food waste through the lens of the individual consumer ignores the way individual consumption is set within local, national and international structures, including how food production and distribution, systemically impact the carbon footprint of the food, as expressed by participants.

Trust is a potential cross-cutting theme identified by Hoeyer and colleagues (2024). Distrust of the CO<sub>2</sub>e avoided data point cuts across issues of truth, sensing and value in our study. Participants reacted with frustration and disbelief at the tension between the certainty of the personalised data presented to them and the variation in their experiences of actually collecting, consuming and wasting surprise bags. This sits in direct opposition to those arguing that numbers have a near magical hold over individuals (Eriksson, 2012) and aligns with existing research pointing to the complex nature of how trust with data is formed (Lawson et al., 2024).

Our findings go beyond affirming the value of Hoeyer and colleague's theoretical framework, it actively develops the concept of data experiences in three ways. First, the *site of quantification must be understood*. There is a clear difference between health data experiences and climate change data experiences. Health has the potential to be known through personal (non-data-specific) experience, such as the embodied symptoms of an illness, *and* through data, such as the engagement with numerical representations of health risks and benefits. Climate change, on the other hand, cannot be known solely through personal (non-data-specific) experience. As Edwards (2013: 4) tells us 'not even the most cosmopolitan traveller could perceive a global average temperature change of about +0.75c'. Yes, collecting, eating and wasting food is tangible but the CO<sub>2</sub>e avoided data point linked to this process is only known through quantification. The way a topic is experienced – through data and not through data – must be understood.

Second, the *medium and provenance* of the data experience must be acknowledged as being just one part of the overall user experience of using the app (Hassenzahl and Tractinsky, 2006). When we consider mobile apps – the medium for this study – the role of gamification must be also understood. Relying on the unexpectedness of surprise bags, adopting ideas of scarcity to create a sense of reward when securing a bag or by providing quantified incentives (amount of money saved, amount of CO<sub>2</sub>e saved) can

increase initial use, as seen by some participant testimonies regarding the 'surprise' of getting a bag, but do not support long-term behaviour change (Boncu et al., 2023; de Salas et al., 2022). Application of such game mechanics within mobile apps may at least initially mask low levels of engagement with the data and the topic of food waste.


Added to this, we focused on a profit-making entity communicating data via an app. Participants were generally aware that TGTG was motivated by profit – and that the app would often have food listed that could have gone to not-for-profit organisations, such as food banks. Receiving the CO<sub>2</sub>e avoided data point in this way will be a different data experience than being presented with the same information on a poster at a local, not-for-profit, community food pantry. How does the motivation of an organisation at the heart of a data experience influence all four issues? How does the medium of accessing data, whether through an app, a website or printed information, change the data experience? Scholars must pay attention to this.

Third, and finally, we can see how data experiences and *information-related behaviour change* research intersect. We highlighted how the CO<sub>2</sub>e avoided data point had little influence on peoples' usage of the app. Existing work within behaviour change does point to the emotive power of information, how data is discussed by individuals with their peers, and how quantitative information is embodied within daily practices (Hargreaves et al., 2010; Hobson, 2003; Middlemiss, 2018; Shove, 2010; Simcock et al., 2014). But this work lacks an over-arching theoretical framework to bring these different elements together. In the case of CO<sub>2</sub>e avoided on the TGTG app, the lack of influence on behaviour can be explained by working with data experience. Participants did not pay much attention to the information. When they did engage with it, an interplay of truth and sensing resulted in low levels of trust in the data – combining with a distinct rejection of the individualised premise of CO<sub>2</sub>e avoided. The power of data experiences is to provide this holistic approach that can be used in different quantitative contexts. Whilst here data experiences help explain why CO<sub>2</sub>e avoided largely failed as a behaviour change intervention, in other cases, such as home energy data (Pullinger and Few, 2024), it could help explain why they succeed.



Taken together, our application of Hoeyer and colleagues' framework offers an empirically grounded demonstration of how data is experienced. Whether a Critical Data Studies scholar or an academic focused on behaviour change techniques, utilising this framework is eye-opening. We know that data struggles to change behaviours. Data experiences can explain why.

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### Ethics

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### Data available

The data for this study can be made available upon reasonable request. Consent to publish was obtained within the manuscript text.

### Supplemental material

Supplemental material for this article is available online.

### Notes

1. We use the term ‘CO<sub>2</sub>e avoided data point’ to refer to the specific number (or data point) presented to the user of the TGTG app. This specific data point emerges from all the data held by TGTG, including data about users (e.g. how many bags they have purchased) and the environmental impact of engaging with the app (e.g. the total CO<sub>2</sub>e avoided by TGTG in a specific country).
2. We used a broad definition of a food bank to include any place that stocks food provisions – often donated by organisations – that people can collect for free or a small fee. In Oxford, these were called food banks, food pantries and food larders.

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