Precision in the understanding and treatment of paranoia

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Abstract

Improvements are needed in the effectiveness and accessibility of cognitive behavioural therapy (CBT) for psychosis. One route to improving efficacy is to take a translational approach, focussing on one proposed causal mechanism at a time, and testing specific therapeutic techniques that may help to modify this mechanism. This thesis aims for precision at multiple stages. First, through focussing on a single psychotic experience, paranoia, and a single putative causal mechanism, negative cognition. Second, through testing interventions that target specific aspects of negative cognition in order to reduce paranoia. Third, through conducting studies using a manipulation method to gain precise causal evidence. Finally, using immersive virtual reality (VR) to accurately measure paranoia, train therapeutic techniques in a controlled setting, and, when automated, increase access to evidence-based therapy. Chapter 1 introduces these conceptual and methodological approaches to precision. A systematic review (Chapter 2) found that the manipulation method has to date been infrequently used in psychosis research. Chapters 3, 4, and 5 each report a study that combines the three approaches – specificity, manipulation, and VR. Chapter 3 found that training in compassionate coach imagery, practised in VR social environments, caused significant reductions in paranoia mediated by increases in self-compassion. Chapter 4 found that training in loving kindness meditation, practised in VR, caused significant reductions in paranoia that were mediated by increases in compassion for others. Chapter 5, in contrast, found that altering body posture prior to entering VR had a negligible effect on increasing feelings of power, and no subsequent effect on paranoia. Following this experimental work on modifying negative beliefs, Chapter 6 considered how such beliefs might form in the first place. Using a large epidemiologically representative adolescent sample and a smaller adult sample it was found that parental verbal and physical abuse, over-control, and lack of care were significantly associated with paranoia and negative self and other beliefs. Network analysis did not find that the relationship between parenting and paranoia was mediated by negative self and other beliefs. Finally, given the

limited access to CBT for psychosis, Chapter 7 explored the feasibility of implementing automated VR therapy onto psychiatric inpatient wards. A thematic analysis of qualitative data found that both patients and staff believed VR would be beneficial in this setting, but that certain practical barriers needed to be overcome. Overall, this thesis provides initial evidence of the benefits in taking an early-stage translational approach to treatment development for paranoia, showing that even single therapeutic interventions can bring about large effects, and these techniques can now be tested in clinical populations.

Declaration

The work reported in this thesis was completed between October 2017 and July 2021, supervised by Professor Daniel Freeman and Dr Felicity Waite. The work in this thesis is my own. I declare that the work presented has not been submitted for any other degree, in this or any other university or learning institute.

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Begrudgingly I acknowledge the pandemic. For all the significant challenges and tragedies, I must look for any small positives to be taken. Upon having to suspend all my research in March 2020, I was initially left with little else to do other than to write this thesis. While not what I had planned, this did mean that upon accepting a place on clinical training and realising in early May that despite having spent the last 12 months doing work pretty unrelated to my thesis, I now had to submit within two months, I was at least in good stead to do so without too much panic.

I am also hugely grateful to my funders, Mental Health Research UK, without whom none of this work would have been possible. The National Institute of Health Research, Department of

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Chapter 1

Introduction: conceptual and methodological approaches to precision

"By concentrating on precision, one arrives at technique, but by concentrating on technique one does not arrive at precision."

– Bruno Walter

In many ways, recent decades have seen substantial improvement in the treatment of severe mental health problems such as psychosis. Today there are evidence-based guidelines recommending combinations of psychotropic medication and psychological therapy as first line interventions. On the other hand, when comparing outcomes over time, and between developing and developed countries, it has been argued that many patients today fare only a little better than their counterparts one hundred years ago. What is clear is that there remain significant improvements to be made in the effectiveness of treatments for psychosis, and in the accessibility of psychological interventions.

Effect sizes for first-generation cognitive behavioural therapy (CBT) for psychosis on persecutory delusions – the severe end of the paranoia spectrum and a key positive symptom of psychosis – are small to moderate, typically between 0.3-0.4, (Turner et al., 2020; van der Gaag, Valmaggia & Smit, 2014; Turner, van der Gaag, Karyotaki & Cuijpers, 2014). One recent meta-analysis suggests that when CBT for psychosis is compared to active control treatments, the effects on delusions become non-significant (Turner et al., 2020). Treatment effects for anti-psychotic medication are somewhat higher but sill modest (Leucht et al., 2013), and effective treatment is usually compounded by major side-effects (Haddad & Sharma, 2007; Moncrieff et al., 2009).

The complexity of psychotic experiences and their causal mechanisms creates challenges for research. In this thesis, the response is to simplify, by focussing on single factors and testing them in experimental designs, to allow a degree of certainty about individual causal factors, gaining insights in understanding, even if the picture may not be complete.

Paranoia

"To be alive is to be vulnerable." – Madeleine L'Engle

The first stage to achieving precision has been to focus on understanding and treating one psychotic experience at a time. The advantages of studying individual symptoms rather than psychiatric diagnoses have long been recognised. Such an approach facilitates theoretical understanding by increasing the ease with which mechanistic hypotheses can be formulated and tested, avoids problems of mis-classifying study participants, and ensures important phenomena are not ignored just because they are not central to a diagnosis (Persons, 1986). Relatedly, there have long been concerns over the limited reliability and validity of diagnoses such as schizophrenia (Bentall, Jackson & Pilgrim, 1988) making the individual symptom approach an important one to take.

Moreover, an increasing body of empirical evidence has shown that individual psychotic experiences, such as delusions, hallucinations, and disorganised thinking, load onto relatively independent factors (e.g. Vazquez-Barquero, Lastra, Cuesta Nunez, Herrera Castanedo, & Dunn, 1996; Peralta & Cuesta, 1999; Ronald et al., 2014; Wigman et al., 2011). Different psychotic experiences also have differing levels of genetic and environmental risk (Zavos et al., 2014). For instance, heritability may be higher for paranoia (h^2= 0.52) than for hallucinations (h^2= 0.15). Given these factors, this thesis focuses solely on paranoia.

At the heart of paranoia lies the dual concern that harm is going to occur and that others intend it (Freeman & Garety, 2000). The most severe form of paranoid ideation, persecutory delusions, typically occurs with high levels of anxiety, depression, and disturbed sleep. Half of those with persecutory delusions have levels of psychological wellbeing that fall in the lowest 2% of the population (Freeman, Startup et al, 2014). Persecutory delusions are one end of a continuum. Paranoid thoughts have consistently been shown to exist on a spectrum of severity in the population; many people have a few paranoid thoughts and a few people have many (Bebbington et al., 2013; Elahi, Algorta, Varese, McIntyre & Bentall, (2017); Bird, Evans, Waite, Loe & Freeman, 2018; Freeman et al, 2005; Wong, Freeman & Hughes, 2014). Patients with persecutory delusions typically report high levels of suicidal ideation (Collett et al., 2016; Freeman, Bold et al., 2019), and similarly paranoid ideation in the general population is associated with suicidal thoughts (Freeman et al., 2011). The factor structure of psychotic symptoms is also similar across clinical and non-clinical samples (Shevlin, McElroy, Bentall, Reininghaus & Murphy, 2017).

Theoretical models of persecutory delusions have identified a number of psychological mechanisms as putative causal and maintenance factors in paranoia, thus providing clear mechanisms to be targeted in therapy (Bentall et al., 2001; Freeman et al., 2002; Freeman, 2016). These include negative cognitions about the self and others, reasoning biases, use of safety behaviours, worry, anomalous experiences and sleep dysfunction. Each mechanism is insufficient to cause paranoia on its own, but increases the likelihood that paranoia occurs. A systematic programme of work is required to understand these mechanisms in greater detail, and to identify techniques that help to reduce them. Despite this, CBT trials often do not precisely target or measure change in theoretical factors identified in the models. A systematic review of symptom specific CBT trials identified 12 studies that specifically targeted either delusions or hallucinations, of which few took a focussed approach of targeting causal mechanisms and testing mediation (Lincoln & Peters, 2019).

Negative cognitions about the self and others

"I ain't worth nothing." – Katherine, Devon (paranoidthoughts.com)

One causal mechanism that requires a greater level of precise, experimental investigation, is negative cognition, in particular, beliefs about the self and others. Typically developed in the context of adverse interpersonal experiences (Freeman, 2016), it is hypothesised that negative beliefs about the self, such as seeing the self as worthless, lead to feeling inferior, apart, and vulnerable, and that paranoia builds upon these concerns about vulnerability (Freeman, 2016). Similarly, viewing others as potentially malevolent is hypothesised to increase the likelihood of paranoia, while simultaneously reducing social connections and thus fuelling further feelings of vulnerability (Freeman et al., 2002). While negative beliefs about others have been focused on to a much lesser extent, there are three systematic reviews identifying the high prevalence of negative self-beliefs in individuals with paranoia across the spectrum of severity (Garety & Freeman, 2013; Kesting & Lincoln, 2013; Tiernan, Tracey & Shannon, 2014). Experimental evidence also shows that manipulating self-beliefs has an impact on paranoia (Freeman, Evans et al., 2014; Atherton et al., 2016) suggesting a causal connection between them.

Negative beliefs about the self and others may be particularly important treatment targets. They are associated with suicidal ideation in people with psychosis (Fialko et al., 2006, Collett et al., 2016; Freeman, Bold et al., 2019) and play a role in the maintenance of comorbid social anxiety disorder in psychosis (Aunjitsakul, McGuire, McLeod & Gumley, 2020). When CBT

for psychosis reduces paranoia, negative beliefs about the self and others can remain high (Pot-Kolder et al., 2018). Yet they are also an area that many patients want to be specifically targeted in treatment. Self-esteem has been shown to be a major determinant of patient views of recovery in psychosis (Beck et al., 2012), and in a study of 1,809 patients with psychosis, 71% selected self-confidence as an area they most wanted help with (Freeman, Taylor, Molodynski & Waite, 2019). Additionally, many patients in this study suggested increasing their social connections to other people as an important target for therapy. The only RCT to specifically target self-cognitions in patients with persecutory delusions yielded a small reduction in negative self-beliefs and a moderate reduction in paranoia, though these effects were not statistically significant. There were significant large improvements in wellbeing and positive self-beliefs, however, reflecting the emphasis in the intervention on techniques from positive psychology (Freeman, Pugh et al., 2014). The trial did not try to determine which specific intervention techniques mediated change.

There are many ways negative beliefs about the self and others can be conceptualised. The presence of negative core beliefs and schemas are perhaps most commonly measured. Core beliefs are defined as fundamental, inflexible, absolute, and generalised beliefs (Beck, 2011), negative examples of which might be 'I am worthless' or 'other people are unkind'. Core beliefs tend to be indicative of an underlying schema, which is an enduring internal structure or representation that influences what we believe as well as how we process and organise information. Using measures of current beliefs likely to be indicative of core beliefs and schemas, individuals with both clinical and non-clinical levels of paranoia have been found to hold extremely negative self and other beliefs (Fowler et al., 2006; Mihic, Novovic, Dozios, Bentall & Petrovic, 2019).

Collett et al. (2016) examined multiple alternative ways of conceptualising negative self-cognitions in particular, including self-stigma, self-esteem, social-comparison, and compassion. Two of these areas, compassion and social-comparison, are a particular area of focus in this thesis. Significant inverse correlations have been found between compassion and negative beliefs, as well as evidence of low compassion in patients with schizophrenia (Eicher et al., 2013; Mills et al., 2007). Yet experimental evidence in this area is lacking. Similarly, feelings of social inferiority – a key aspect of social comparison – is an area that warrants further attention. Beliefs about the self as weak and inferior to others predict the occurrence of both clinical and non-clinical levels of paranoia (Freeman et al., 2008; Fowler et al., 2006) yet experimental interventions aiming to modify these beliefs are few in number.

The causal method: manipulation

"[Francis Bacon] taught that not only must we observe nature in the raw, but that we must also 'twist the lion's tail', that is, manipulate our world in order to learn its secrets." – Ian Hacking

Causal explanations are central to our daily interactions, since they allow us to predict, comprehend, and interact with our environment. Testing whether negative beliefs play a causal role in the occurrence of paranoia, rather than being purely an association, is important. If the relationship is purely correlational, then modifying negative beliefs will likely have no impact on paranoia. The idea of conducting experiments that manipulate an aspect of nature in order to better understand cause and effect was embedded into the very first articulations of the scientific method by Francis Bacon in his *Novum Organum Scientiarum* (1620). Shadish, Cook and Campbell (2002) highlight that even as laypersons we often instinctively use manipulation to discover effects: "to see what happens to our blood pressure if we exercise more, to our weight if we diet less, to our behaviour if we read a self-help book" (page 3). The premise of the manipulationist approach to causality is simply that "Y is a cause of Z if we can change Z by manipulating Y" (Pearl, 2009, page 417). The consensus in the philosophy of science is therefore that manipulation is the key approach to be taken, when possible, for testing causal relationships. A causal relationship can be inferred from a correlation, but it is typically impossible to have any certainty about conclusions made in this way. Causal conclusions are based on an accumulation of different types of evidence (Bradford Hill, 1965) or on a triangulation of methods, but the most convincing evidence is provided by manipulationist data. Indeed, Holland (1986) argues that there is 'no causation without manipulation' (page 959).

There are two main methodological routes in clinical psychology to achieving causal evidence. First, there are the traditional short-term randomised controlled experimental studies that manipulate a mechanism (e.g. negative beliefs about the self) and measure the immediate change in a particular outcome (e.g., paranoia). Second, there are interventionist-causal (Kendler & Campbell, 2009) randomised controlled trials that use sustained treatment techniques focused on an individual mechanism to produce change in the primary clinical outcome. Kendler and Campbell (2009, page 881) note how defining causation in terms of "what would happen under interventions" aligns well with the practical interests in mental health research, namely preventing and treating disorders. Three studies in this thesis use the former kind of manipulation method to test the causal role of negative beliefs in paranoia.

Conclusions from both kinds of study can be further strengthened by the use of mediation analysis (Dunn et al., 2015). This statistical method is described as enabling an answer to the question of how a causal agent X exerts its effect on variable Y (Hayes, 2014). In its simplest form, an effect may be direct from X to Y, or it may be indirect, where X impacts a third variable, the mediator, which then effects Y. Mediation analysis assesses these pathways by comparing the relative associations between the three variables. Taking a targeted, causal-interventionist approach where a specific mechanism is manipulated typically provides the strongest level of evidence that the mechanism manipulated is the most likely explanation of the effect, but mediation analysis provides an additional check on the relationship.

The study of mediation has a long history (e.g. Hyman, 1955; MacCorquodale & Meehl, 1948; Wright, 1934), becoming particularly popular following influential work by Baron and Kenny (1986) who provided a simple four-step approach to performing mediation analysis. While this approach is not without its criticisms (e.g. Hayes, 2014), and while many alternatives have been suggested (e.g. Collins, Graham & Flaherty, 1998), the method of mediation analysis used in this thesis is based on the Baron and Kenny approach given many of its criticisms, such as having low power to detect small effects, are less relevant to targeted, causal-interventionist studies that aim to detect medium to large effects (Shrout & Bolger, 2002).

Of course, taking a causal-interventionist approach and using mediation analysis still does not necessarily enlighten us as to the mechanisms at work in a causal chain. A mediator is an intervening variable that appears to statistically account for the relationship between the independent and dependent variable, but it does not necessarily explain how the change in the outcome came about, i.e. which mechanism(s) are at play (Kazdin, 2007). Mediators are a helpful guide to identifying mechanisms but are not one and the same as mechanisms themselves. Moreover, while less likely in a precisely targeted intervention, there can also be confounds and epiphenomenal associations that induce non-causal associations between variables in a mediation model (Hayes, 2014). There may also be variables playing an important causal role that are not measured or tested within the model. Psychotic experiences are complex phenomena; being precise in research methodology does not change this, but serves to try and better elucidate aspects of this complexity.

Virtual Reality

"It feels very, very real...I couldn't believe how real it actually sort of seemed." – Jonathan, patient with psychosis

Virtual reality (VR) consists of a computer generating an image, a display system presenting sensory information, and a tracker feeding back the user's position and orientation in order to update the image. The potential to use VR in mental health treatment and research has been increasingly recognised over the past 25 years. The development of consumer kit and thus potential for using VR more widely and at scale has only occurred recently (Freeman et al., 2017). The primary reason VR is such a useful tool is because individuals respond emotionally, physiologically, and cognitively in VR as they do in corresponding real-world situations (Morina et al., 2015). VR can therefore help in the assessment, the understanding, and the treatment of many mental health disorders (Freeman et al., 2017).

VR has a particular benefit with regards to assessing paranoia because it can provide a unique way of accurately measuring it. Through entering social situations in virtual reality where virtual characters are programmed to behave neutrally, participants have the potential to form genuine, in the moment, paranoid ideation. Any reported persecution is known to be unfounded, which cannot be guaranteed by other means. Previous literature has shown that objectively neutral VR social scenarios provoke feelings of paranoia in individuals reporting both mild and severe paranoia (e.g. Freeman, Pugh, Vorontsova, Antley & Slater, 2010; Atherton et al., 2016; Freeman, Evans et al., 2014; Pot-Kolder et al., 2018). Paranoia is measured in this way in the three manipulation studies reported in this thesis (Chapters 3-5).

VR also helps with the testing and understanding of causal factors using the manipulation method. Following manipulation of a mechanism through training in a particular technique, individuals can enter VR scenarios and practise using the technique as they would in the real world. Training followed by practise can be repeated a number of times within a single session, with the outcomes of interest also measured repeatedly. A high level of control and precision is achieved because every participant can be exposed to identical scenarios. It can be ensured that participants practise the technique for the same amount of time and under the same conditions. Two of the three manipulation studies (Chapter 3 and Chapter 4) use VR in this way.

VR can also be used to deliver evidence-based cognitive therapy. VR provides the opportunity to enter computerised simulations of the scenarios that patients find anxiety-provoking, while

practising psychological techniques. This enables individuals to practise changing the way they think, react, and behave in such scenarios. Individuals are typically more willing to enter VR simulations of the situations they find anxiety-provoking because they know it is only a simulation. Crucially, however, any learning that occurs in VR transfers to the real world (Morina et al., 2015; Pot-Kolder et al., 2018; Freeman et al., 2017). Thus cognitive therapy can be delivered in VR. For example, individuals can practise imagery exercises, or behavioural experiments where they try doing things that they find too challenging to do in the real world, testing out their beliefs, and learning that they are safer, more confident, and more able than they originally thought. Additionally, VR therapy can be automated (Freeman et al., 2018). A virtual coach can guide users through different virtual scenarios, explaining what to do, suggesting things to try out, and providing encouragement. This may allow for far greater scalability and fidelity in delivery than traditional therapy. Even assuming a therapist thoroughly reads and stays close to a manual when delivering traditional therapy, interpretation and application of the manual still allows for imprecision, a problem that automated VR therapy removes. Automated therapies can often also be delivered to patients by a psychology graduate or peer supporter; they do not always require a highly trained clinical psychologist to be present. If such therapies were implemented into mental health services, far more people would be able to make use of the therapy than traditional one-to-one psychological therapy, for which there are simply not enough psychologists. Although automated VR therapies are beginning to be developed, we know little about the potential feasibility of implementing them at scale into services. This third use of VR is addressed in the final study of this thesis, in a qualitative investigation of the feasibility of having automated VR therapy available to patients staying on psychiatric wards, a setting where delivery of evidence-based therapies is particularly limited.

Aims for the thesis

Taking a more targeted approach in early stages of treatment development may be important for improving outcomes for patients with psychosis. The first aim of this thesis is to assess systematically the current extent of manipulationist causal evidence concerning the occurrence of delusions, and the second to conduct a series of novel manipulation studies, each using a therapeutic technique targeting a certain aspect of negative cognition. The third aim is to then explore inter-personal experiences that may contribute to the development of negative cognition and thus paranoia. Finally, given the potential of automated VR to allow the delivery

of precise, translational, one-to-one psychological therapy, the final chapter aims to gain in-depth qualitative data assessing the feasibility of implementing VR therapy onto inpatient psychiatric wards, where access to psychological therapy can be at its most limited.

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Chapter 2

Manipulationist tests of causation for psychological mechanisms in the occurrence of delusions and hallucinations: A systematic review

This chapter has been adapted from the following paper, attached in Appendix 6.1.
Brown, P., Waite, F., Freeman, D. (2019). 'Twisting the lion's tail': Manipulationist tests of causation for psychological mechanisms in the occurrence of delusions and hallucinations. 68, 25-37.

Abstract

Background: Over the past 20 years the importance of psychological processes in psychosis has gained increasing attention. However, it is key to determine the causal status of these processes in order to inform understanding and identify treatment targets. Studies that directly manipulate a psychological mechanism provide the most robust causal evidence. This review evaluates for the first time the extent of manipulationist causal evidence for the role of specific psychological mechanisms in delusions and hallucinations.

Method: A systematic search identified controlled experiments or targeted interventions that both manipulated a specific psychological mechanism and measured the effect on individual psychotic experiences.

Results: Fifty-two manipulationist studies were found, of which 48 measured paranoia, 12 measured hallucinations, and two measured grandiosity. Thirty-six studies were experiments and 16 were targeted intervention trials. Only 21 used clinical samples. Manipulation of the specified psychological mechanism was demonstrated in 44 cases. Of these, 35 found a subsequent change in a psychotic experience. Negative affect and associated psychological processing in relation to paranoia have been tested the most.

Conclusions: There is a small body of direct causal evidence for the role of psychological mechanisms in psychotic experiences that highlights important novel treatment directions. However, the manipulationist approach has been used too infrequently.

Introduction

The development of cognitive-behavioural therapy approaches for psychosis over the last few decades has provoked an emerging psychological literature examining the causes of psychotic experiences. Delusions (e.g., Bentall et al., 2001; Freeman, 2016) and hallucinations (e.g., Slade, 1976; Morrison, Haddock & Tarrier, 1995) have received the most psychological theorising and investigation, with less attention given to other psychotic experiences such as anhedonia (e.g., Strauss and Gold, 2012) or formal thought disorder (e.g., Goldberg & Weinberger, 2000). In the development of the new generation of psychological therapy for psychosis, The Feeling Safe Programme (Freeman et al., 2016) – a translational treatment for persecutory delusions – has been explicitly developed on the basis of a sustained programme of manipulationist studies. However, to date there has been no systematic assessment of how much of the supporting evidence cited for theoretical ideas comes from causal evidence provided by manipulation studies.

This systematic review therefore set out to examine the manipulationist literature with regard to delusions and hallucinations, and psychological processes. Although the focus of this thesis is on paranoia, hallucinations were included in the review in order to widen its scope and relevance. Like paranoid delusions, hallucinations are also best conceptualised as a quantified trait, existing on a spectrum of severity in the general population (Zavos et al, 2015; Laroi et al, 2021). The aim was to determine the number, quality, and focus of manipulation studies. In particular, which psychotic experiences were assessed, how many studies used clinical versus non-clinical samples, how many were experimental studies versus interventionist-causal studies, and how many included mediation tests. The interest was in causal studies that use a randomised controlled design and a manipulation or treatment intervention targeting a single psychological mechanism.

Method

A search was carried out in Medline, Embase, and PsychInfo for peer reviewed English language papers using the following search terms: (halluc* OR delus* OR paranoi* OR persecut* OR psychotic OR psychosis OR "ideas of reference" OR grandios*) AND (experiment* OR manipulat* OR intervention* OR randomised OR randomized OR randomly) AND (mechanis* OR caus* OR maintenance OR maintaining) AND (emotion* OR cognit* OR social OR psychological*).

Inclusion criteria

Papers were required to have:

1. A manipulation of a specific psychological mechanism.
2. One or more individual psychotic experiences measured at outcome.
3. Random allocation to conditions.

Exclusion criteria

Papers were excluded if they were:

1. Case studies or case series.
2. Non-human studies.
3. Not available as a full text.

This search found 4,820 papers (May 2021). Titles and abstracts were scanned, and then full texts read as required. Citations and references of included papers were also checked. Figure 1 shows a PRISMA diagram summary of the search process.

Quality assessment

The quality of included studies was assessed using a measure of methodological quality developed by Downs and Black (1988). This evaluates quality and risk in four areas: reporting, confounding, bias, and external validity. The measure was adapted to omit the final question that assesses the power of a study, thereby allowing a maximum score of 27. Studies were assigned a grade according to their score: excellent (23-27), good (18-22), fair (13-17) or poor (0-12).

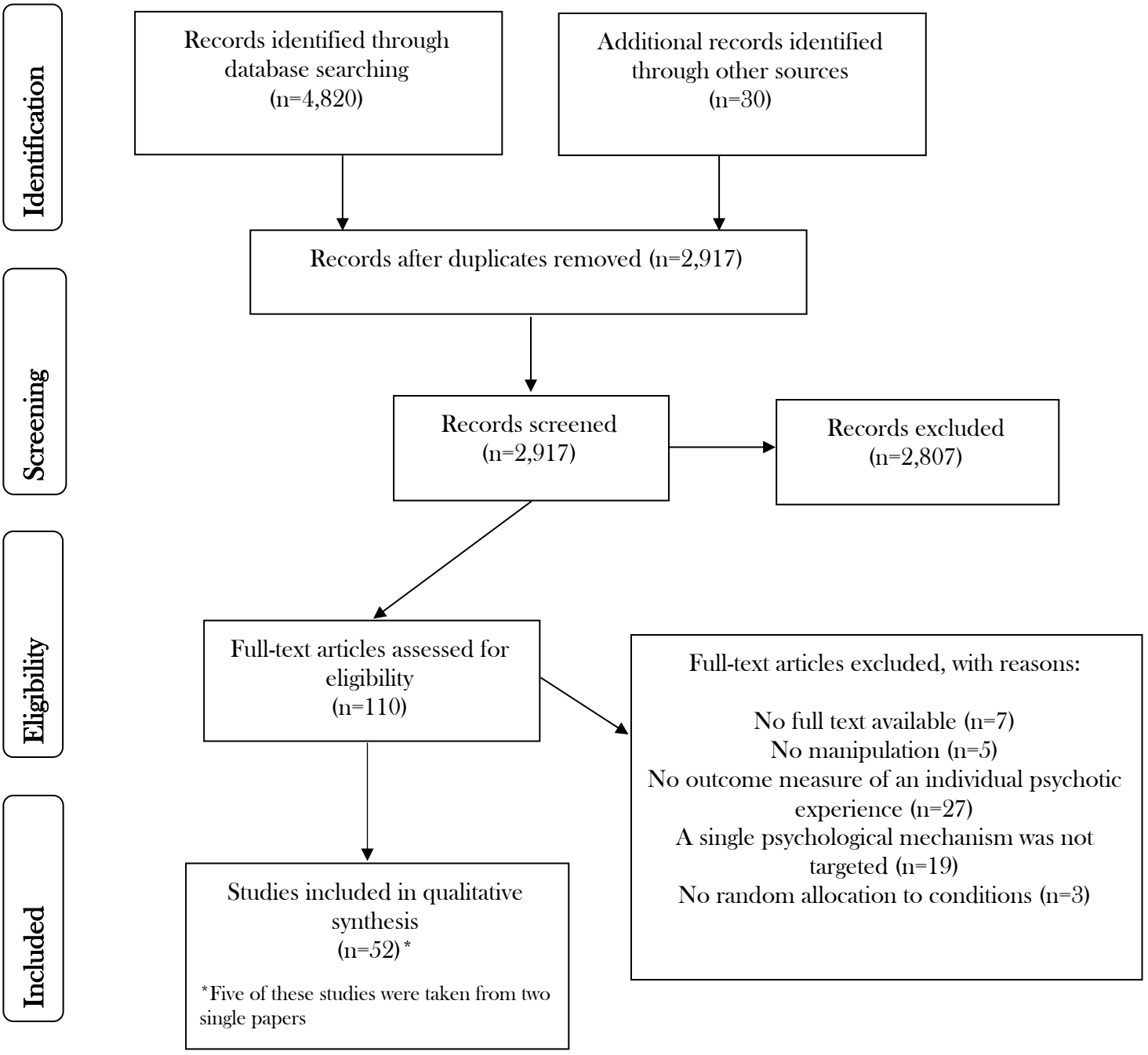

Figure 1. PRISMA diagram of the search process.

Results

A total of 52 manipulationist studies meeting the inclusion criteria were found. Just over half (n=31) used non-clinical samples, and within these non-clinical studies the majority (n=17) used student samples. There were only 21 studies on clinical populations. This gave a total of 6,460 non-clinical participants (2,705 when excluding one large-scale online trial by Freeman et al., (2017)) and 1,912 clinical participants. Thirty-six studies were experiments and 16 were targeted clinical intervention trials. Paranoia was measured at outcome in 48 studies, hallucinatory type experiences in 12 studies, and grandiosity in two studies. A total of 10 studies looked at multiple individual psychotic experiences at outcome. Summaries of the studies can be seen in Tables 1-2.

Studies of psychological mechanisms in non-clinical populations

Attention

The first manipulation studies conducted concerned attentional focus. If attention is frequently threat-focused then this may increase the frequency with which potential threats are identified, which in turn could increase future expectation of threat, and so have an effect on paranoid thoughts (Bentall & Kaney, 1989; Freeman, Garety & Phillips, 2000; Freeman et al., 2002). Two experiments manipulated participants to focus their attention towards a threat and measured paranoia as the outcome, but found contrasting results. Both studies used student samples with no requirement to have paranoid thinking, and were rated as having somewhat poor methodological quality, however, suggesting caution may be required when drawing conclusions from the results.

Locascio and Snyder (1975) randomised 60 undergraduates to selectively attend to threatening or non-threatening stimuli or to no attentional manipulation. They found no significant differences in reported paranoia between the conditions. However, there was no check as to whether the attention manipulation was successful. Conversely, Bodner and Mikulincer (1988), who used a sample of 177 undergraduates, did successfully manipulate attention either to be focused on a threatening agent (the experimenter) or on the self. They found that paranoia increased when attention was focused on the experimenter versus on the self, but only when participants had also been given negative feedback implicating personal failure. This might

suggest that for attentional bias to affect paranoia some sort of negative event or emotion is required. The difference in results between the two studies could also be explained by the bespoke measure of paranoia used by Bodner and Mikulincer (1988), which predominantly assessed ideas of reference rather than ideas of harm.

Three further experiments within the same report examined the effects of self-focussed attention as opposed to threat-focussed attention (Ellett and Chadwick, 2007a, 2007b, 2007c). It has been argued that self-consciousness increases directed attention towards the self, leading to the belief that other people are doing likewise, thus increasing paranoia (Fenigstein and Vanable, 1992). Ellett and Chadwick found in their three studies that paranoia increased in undergraduates following a manipulation to increase self-awareness via use of a camera and failure task. However, the lack of manipulation check means caution is needed with the interpretation of their results.

Self-esteem

As discussed in Chapter 1, paranoia may build upon feelings of vulnerability, arising from low self-esteem and viewing the self as inferior to others (Freeman, 2016). Four non-clinical studies successfully manipulated explicit self-esteem, three of which saw the expected change in paranoia. Only two of these studies used populations selected for reporting paranoid ideation, but the methodological quality across all four studies was mostly strong. Various manipulations of self-esteem were used. Freeman, Evans et al. (2014) reduced the height (as a proxy for social rank and self-esteem) of 60 females reporting paranoid thoughts during an exposure to a social environment in virtual reality. This resulted in lower self-esteem and a greater number of reported paranoid thoughts. The increase in paranoia was fully mediated by the changes in self-esteem. Atherton et al. (2016) used imagery and visualisation tasks to manipulate self-esteem, and Kesting et al. (2013) used exclusion from a virtual ball game, with both also finding significant changes in paranoia at outcome. Conversely, Ascone, Jaya and Lincoln, (2017) did not find a significant effect of manipulating self-esteem on paranoia, despite successfully altering participants' extent of social comparison. This study used a student sample who were not pre-selected for reporting paranoid thoughts, which might explain the absence of change in levels of paranoia.

A further study conversely focussed on implicit, rather than explicit self-esteem. Implicit self-esteem is a process of self-evaluation occurring subconsciously (Farnham et al, 1999) and is therefore measured indirectly through the automatic associations that individuals make between themselves and concepts such as 'good' or 'bad', rather than through questionnaires. Espinosa et al. (2018) modified implicit self-esteem through a positive conditioning task in a sample of 28 students selected for having high levels of paranoia. While the manipulation was successful in increasing implicit self-esteem as measured on an Implicit-Association Test, no effect on paranoia was seen, contrary to their hypothesis. While noting the limitations of the experiment as a small proof-of-concept study only, the findings could suggest that paranoia is not associated with implicit self-esteem in the same way it is associated with explicit self-esteem.

Lastly, one study examined an important aspect of social environment (comments from others) on paranoia, and examined self-esteem as a moderator (Butler et al., 2019). They randomised 97 individuals, predominately university students unselected for levels of paranoia, to receive critical, warm, or neutral comments. Self-esteem increased in those who received warm comments; no changes in the other groups were seen. However, those who received critical comments increased in state paranoia despite the lack of change in self-esteem. All groups were then subjected to social exclusion using a virtual ball game. Following exclusion, those who had received warm comments reported significantly lower levels of self-esteem and higher paranoia. No mediation analyses were included.

Rumination

Two experiments using student samples assessed whether changes in rumination led to changes in paranoia. Rumination may play a role in paranoia by increasing feelings of vulnerability, for example via perseverative appraisal of negative interpersonal experiences (Freeman, 2016; Freeman & Garety, 1999). This appraisal may also have effects by narrowing attention towards negative experiences and increasing anxiety. Martinelli, Cavanagh and Dudley (2013) gave 37 participants a paranoia induction before randomising them to a task encouraging ruminative thinking or to a task encouraging distraction. They found that an increase in ruminative thinking led to the maintenance of paranoid thoughts whereas the distraction task decreased the experience of paranoid thoughts. This study scored highly on methodological rigour, and is supported by a similar experiment by Mckie, Askew and Dudley (2017). However, Mckie et

al.'s (2017) experiment was rated as having a high risk of bias due to a lack of blinding and no adjustment for potential confounders. Moreover, neither study included a mediation analysis.

Negative affect

Eight studies examined negative affect as a putative causal mechanism in paranoia. All but one found an alteration in negative affect led to a change in paranoia and were rated as having good methodological rigour. Six of the studies benefited also from the use of mediation analysis. Lincoln, Peter, Schafer and Moritz (2009) randomised 64 students to either a stress induction (via listening to building site noise) applied during a difficult question task or a control condition. Those in the stress condition experienced an increase in negative emotion and reported significantly more paranoid thoughts than those in the control condition, which was mediated by increased anxiety. This experiment is limited, however, by the use of a student sample not preselected for reporting paranoia, which is also the case for two of the other studies on negative affect (Lincoln, Lange, Burau, Exner & Moritz, 2010; Lincoln, Hohenhaus, & Hartmann, 2013). Freeman, Dunn, Murray et al. (2015) randomised 121 individuals reporting paranoid ideation to either the administration of THC, the active ingredient in cannabis, or a placebo. Those who received THC reported significantly more paranoid thoughts, and this was mediated by changes in anxiety, depression, worry and negative thoughts about the self. This study was rated as having particularly high methodological quality and a low risk of bias.

A fifth study tested the effect of a specific negative emotion, shame, via a brief induction with a large sample of 297 adolescents from the general population reporting elevated psychosis proneness (Hennig, 2019). Compared to a happiness induction, the shame induction significantly increased self-reported feelings of shame, but had no effect on state paranoia. The study was rated as having a high risk of bias, meaning the results may need to be interpreted with caution.

There is also evidence from three studies that loneliness affects paranoia, with two of these studies showing the relationship is mediated by negative affect. Feeling distanced from others and lacking meaningful relations that make one feel valued might plausibly be expected to increase negative affect and thus paranoia (Lamster et al., 2017a). Lamster, Nittel, Rief, Mehl, and Lincoln (2017b) randomised 60 individuals to a high loneliness condition, a low loneliness

condition, or a control group. The inductions successfully altered self-reported feelings of loneliness, and it was found that reducing loneliness significantly reduced paranoia. Increasing loneliness also increased paranoia, although this difference was not statistically significant. Aiming to replicate this finding, Gollwitzer Wilcynska & Jaya (2018a) similarly randomised 222 individuals to a high loneliness condition, a low loneliness condition, or a control group, comparing the effects on paranoia separately for those with high and low baseline levels of paranoia. Those in the high loneliness group experienced a significant increase in loneliness, and subsequent increase in paranoia, mediated by increased negative affect. The effect was only found for those with high baseline paranoia, and not for those with low baseline paranoia, likely due to a floor effect. These findings were further replicated in a second study by Gollitzer and colleagues (2018b), where the addition of an emotional regulation strategy (cognitive reappraisal) to reduce negative affect reduced the impact of loneliness on paranoia.

Finally, one study examined the relationship between negative affect, cognitive load, and the detection of false alarms, a proxy state measure for hallucination proneness (Laloyaux et al, 2019). 174 individuals were randomised to a neutral or negative emotion induction, as well as a high or low cognitive load task (a one versus two N-back task). A significant interaction effect was seen, where those in the negative emotion with high cognitive load condition reported hearing significantly more false alarms (hearing words during white noise that were not really there). The authors conclude the study provides support for a model of auditory hallucinations where such hallucinations arise through an interaction of negative emotions and limited available cognitive resources.

Sleep

Disturbed sleep may contribute to the occurrence of psychotic experiences by increasing negative affect and anomalous perceptions (Reeve, Sheaves & Freeman, 2015; Freeman 2016). Unsurprisingly, sleep deprivation studies have only been carried out in non-clinical samples. It is also one of the few areas to give equal focus to hallucinations as well as to delusions. Three recent randomised controlled studies of sleep deprivation on the general population found that sleep loss increased perceptual distortions such as hallucinations (Reeve et al., 2017; Meyhofer et al., 2017; Petrovsky et al., 2014). Out of these, only Reeve et al. (2017) also found an increase in paranoia. This was the most informative study as a number of psychotic experience outcomes were examined and mediation analyses were included. In a randomised order, 68

participants underwent three nights of restricted sleep and a control condition of three nights of normal sleep. Following sleep restriction, there were signficant increases in both paranoia and hallucinations, but no signficant changes in grandiosity. Mediation analysis revealed that changes in psychotic experiences were mediated by changes in negative affect and related processes. The effect of sleep deprivation on hallucinatory experiences is also supported by Meyhöfer, Kumari, Hill, Petrovsky and Ettinger (2017) and Petrovsky et al. (2014). These studies did not find an increase in paranoia, however. This may have been due to the smaller sample size than in Reeve et al. (2017).

The most convincing causal test is provided by a large interventionist-causal model trial testing the effects of a sleep improvement programme on paranoia and hallucinations (Freeman et al., 2017). 3,755 students with insomnia were randomised to either receive digital cognitive behavioural therapy (CBT) for insomnia or usual care. There was a large improvement in sleep and small improvements in paranoia and hallucinations in those who received the sleep intervention. Mediation analysis showed that improvements in sleep accounted for nearly 60% of the change in paranoia after treatment, with a similar effect found for hallucinations. This indicates that, at least in the specific population of young adults, disrupted sleep plays a contributory causal role in the occurrence of psychotic experiences.

Further psychological mechanisms

A number of further studies on different psychological mechanisms were also found, though these studies were generally rated as having a slightly higher risk of bias than most others included. The experience of internal anomalous experiences, such as unexplained anxious arousal, could be a causal mechanism in paranoia as misinterpretation of these experiences can lead to incorrect conclusions about the external world (e.g., that there is an external threat) (Maher, 1974; Garety et al., 2001; Freeman 2016). Zimbardo, Anderson and Kabat (1981) examined this mechanism, though the study was rated as having a high risk of bias. Twelve students were hypnotised to experience hearing loss and randomised to either being made aware of the cause of this experience or to not being told about the cause, with a further six students included in a control group. All participants then completed an anagram task in a social setting. Being unaware of the cause of the anomalous experience led to participants perceiving themselves as more irritated, hostile and unfriendly than the group who were made

aware of the cause. They also reported greater paranoia and grandiosity than those in the awareness group.

Kaltsi, Bucci and Morrison (2017) aimed to test specifically the causal role of metacognitive beliefs concerning paranoia in 110 university staff and students. They induced either positive or negative beliefs about paranoia i.e., that paranoia is productive in promoting safety vs. it is negative and promotes distress, before exposing participants to social exclusion via a virtual ball game. Frequency of paranoid thoughts increased significantly following exclusion in those who underwent the manipulation to induce positive beliefs. Distress concerning paranoid thoughts decreased in those who had the negative induction. However, the manipulation check showed that only the positive beliefs induction was successful; the negative beliefs induction did not successfully alter metacognitive beliefs, so caution is needed with the interpretation of this result.

The effects of attachment style are perhaps difficult to investigate experimentally. Attachment style might be expected to have an effect on psychotic experiences given its importance in the development of affect regulation, self-esteem, and understanding of interpersonal experiences (Sitko et al., 2013; MacBeth et al., 2008). Hutton, Ellett and Berry (2017) randomised 60 students (unselected for levels of paranoia) to experience a secure attachment prime, a positive affect prime or a neutral control condition. All participants then underwent a paranoia induction. Despite expectations that a secure attachment prime might buffer against paranoid thinking following a paranoia induction, no such differences were observed. Whether this is because attachment style does not causally affect paranoia or whether priming feelings of attachment style is not comparable to real attachment style could not be determined. It is also possible that the attachment primes and/or the paranoia induction were unsuccessful. On the other hand, a study by Sood and Newman-Taylor (2020) found that compared to an insecure attachment imagery prime, a secure attachment imagery prime did successfully increase feelings of safety and security and decrease paranoia. Mediation analysis found that the effect was explained by reduced cognitive fusion, a metacognitive process where thoughts become inflexible and dominate behaviour. The authors explain the findings within an attachment framework, where the context of a secure attachment allows greater reflection on one's own and other's mental states, thus reducing the likelihood of cognitive fusion.

Lastly, adaptive reappraisal of anxiety provoking situations has been shown to protect against psychopathology (Aldao, Nolen-Hoeksema & Schweizer, 2010), but has not previously been tested in relation to paranoia. A study by Westermann and colleagues (2014) instructed 86 undergraduates, unselected for paranoia, to respond to anxiety-provoking stimuli with a reappraisal strategy, expressive suppression strategy, or no strategy. Analysis found that state delusional ideation at outcome was not significantly different between those using each strategy. However, while the anxiety induction was successful, there was no check on strategy use, meaning the extent to which each strategy was truly used by participants cannot be determined. Caution may therefore be needed when drawing conclusions from this study.

Studies of psychological mechanisms in clinical populations

Self-esteem

Two clinical intervention studies rated as having high methodological quality and low risk of bias found that increasing self-esteem reduced paranoia. Freeman, Pugh, et al. (2014) successfully increased self-esteem in 30 patients with persecutory delusions and found a moderate reduction in paranoia post-treatment. Lecomte et al. (1999) randomised 95 patients with a diagnosis of schizophrenia to receive either a 12-week empowerment module aimed at increasing self-esteem or treatment as usual (TAU). No increase in self-esteem was seen, although the authors suggest this may have been due to their self-esteem measure looking predominantly at global features of self-worth rather than more specific constructs that might be more relevant for the patient group. On the other hand, scores on both the paranoia and delusion items of the Positive and Negative Symptom Scale (PANSS) significantly decreased in the intervention group, whereas they increased in the TAU group.

Worry and rumination

Three studies with good methodological rigour examined the role of worry in the occurrence of psychotic experiences. A worry induction on 67 patients with persecutory delusions led to an increase in anomalous experiences but not hallucinations (Freeman et al., 2013), and two interventions targeting worry also showed significant effects at outcome (Foster et al., 2010; Freeman, Dunn, Startup et al., 2015). The strongest study randomised 150 patients with persistent persecutory delusions to receive either six sessions of a CBT worry treatment in addition to standard care or standard care alone (Freeman, Dunn, Startup et al., 2015). It was

found that the intervention significantly reduced both worry and persecutory delusions. Moreover, mediation analysis showed that change in worry accounted for 66% of the change in the persecutory delusions.

Negative affect

Four clinical studies investigated the causal relationship between negative affect, predominantly anxiety, and paranoia. An experiment by Freeman, Emsley et al. (2015) was rated as having particularly good methodological quality. They found that upon randomising 59 patients with persecutory delusions to either go outside onto a busy urban street or to stay inside, those in the former condition reported significantly more anxiety and negative thoughts about the self. Paranoid thoughts and voice hearing also significantly increased in this group. The increase in paranoia was mediated by increased anxiety, depression, and negative thoughts about others. Two smaller experiments tested the effects of an anxious mood induction (Cowles & Hogg, 2019) and a social or sensory stress induction (Urbanska, Moritz & Gaweda, 2019) versus neutral control conditions. Both found an increase in paranoia in those randomised to the experimental conditions, though mediation analysis was not performed in either study.

The fourth study concerned the anxiety-related psychological process of safety behaviours. Safety behaviours are actions designed to prevent certain feared catastrophes from occurring (Salkovskis, 1991). Such behaviours prevent individuals from receiving and processing evidence that goes against delusional beliefs, as they believe their feared catastrophe has not happened due to the use of safety behaviours rather than because their belief is inaccurate. Freeman et al. (2016) randomised 30 patients with persecutory delusions to enter a virtual reality social environment and either receive instruction to try to drop their usual safety behaviours or to keep using them. While it was not possible to ascertain the extent to which safety behaviours were fully dropped (although there were expected differences in objective movement in virtual reality), there were large reductions in the conviction with which persecutory delusions were held for the group instructed to reduce the use of safety behaviours.

It might be expected that increasing self-compassion in a clinical sample would reduce paranoia via a reduction in negative affect, as in Lincoln et al.'s (2013) non-clinical experiment. The only experiment to investigate this was by Ascone, Sundag, Schlier and Lincoln (2017b). Fifty-one

patients with paranoid ideation received a negative emotion induction via in-sensu exposure to a recent distressing social situation and were then randomly assigned to a single session intervention using either compassionate imagery or control imagery. Skin conductance levels increased following the negative affect induction, suggesting the negative emotion induction increased physical stress, though no measure of subjective emotional distress was used. The compassionate imagery intervention significantly improved self-reassurance and happiness, but not self-compassion, and there was no change in paranoia at outcome.

Sleep

Only one intervention study targeting the improvement of sleep was found that used a clinical sample. Freeman, Waite et al. (2015) randomised 50 patients with persistent persecutory delusions or hallucinations to receive 12 weeks of CBT for insomnia in addition to standard care, or standard care alone. CBT was found to lead to significant reductions in insomnia as compared to standard care. However, the trial was insufficiently powered to determine with sufficient precision the effects of sleep improvement on hallucinations and delusions, which led to the subsequent OASIS trial in students, reported above (Freeman et al., 2017).

Reasoning biases

Seven interventions, all with strong methodological quality, have successfully manipulated reasoning biases in clinical samples, with five out of the seven finding a resultant change in paranoia. Reasoning biases may distort the appraisal or reappraisal of negative interpersonal events or anomalous experiences, thus increasing paranoia (Garety, Hemsley & Wessley, 1991). Encouraging flexibility in belief formation might plausibly help to reduce the impact of reasoning biases. The largest study was by Garety and colleagues (2021), who randomised 362 patients with persistent paranoia to receive either eight sessions of a digitally supported reasoning intervention plus usual care, or usual care only. There were significant reductions in paranoia immediately post-treatment, as well as significant reductions in delusions at an eight-week follow-up. Improved belief flexibility and reduced worry mediated paranoia change. This large RCT built upon an earlier study, also meeting criteria for this review, with similar results (Garety et al. 2015). This earlier study also looked at the effect of training belief flexibility on hallucinations but found no improvements.

Khazaal et al. (2015) randomised 172 patients with psychosis to either a waitlist control or to an intervention using a card game targeting the ability to general alternative hypotheses. Belief flexibility improved following the intervention, and this group also reported significant decreases in delusion conviction, distress, and preoccupation, which was maintained at a six-month follow up. So et al., (2015) similarly demonstrated in their study of 44 patients with delusions that improved belief flexibility mediated reduced delusional conviction.

Two interventions examined the effects of reasoning training on the jumping to conclusions bias that is often seen in patients with delusions (Dudley et al., 2015). Moritz et al. (2015) randomised 70 patients with schizophrenia to receive six online presentations that taught about cognitive biases or to a waitlist control group. Although the teaching led to improvements in the jumping to conclusion bias, no significant changes in paranoia were seen. Similarly, Ross, Freeman, Dunn and Garety (2011) found that a single session of reasoning training reduced jumping to conclusions, but it did not reduce delusional conviction significantly as compared to an attention control condition.

Beliefs about voices

Two interventionist-causal type trials aimed to change patients' beliefs about the voices that they hear. Both studies had good ratings of methodological quality. Craig et al. (2018) randomised 150 patients to receive AVATAR therapy or supportive counselling for 12 weeks. AVATAR therapy involved patients creating a computer screen avatar of their hallucination, and a therapist helping the person develop and practice a more helpful relationship with the avatar in order to facilitate change in beliefs about the actual voices. AVATAR therapy was successful in reducing patients' perceived omnipotence of voices, and also led to significant improvements in auditory hallucinations immediately post-treatment as compared to the supportive counselling group. Differences between the two randomised groups were not maintained at follow-up.

The COMMAND trial by Birchwood et al. (2014) randomised 197 patients who heard voices that they complied with to either receive treatment as usual or a cognitive behavioural therapy targeting their beliefs about the voices. The intervention reduced compliance with command hallucinations and mediation analysis showed that a reduction in voice omnipotence was the main mediator of change (Birchwood et al., 2017).

Further psychological mechanisms

One intervention was found that examined the effect of trauma-focused treatment on patients with a lifetime psychotic disorder and current PTSD. Trauma may contribute to the occurrence of paranoia in a number of ways, for example leading to negative schemas concerning the self and others (Bentall et al., 2001; Garety et al., 2001). Van den berg et al. (2016) randomised 155 patients to receive eight sessions of trauma focused therapy or to a waitlist control group. PTSD symptoms significantly decreased in the treatment group after eight weeks. Paranoia also decreased significantly after the first session of treatment as compared to the control group. At the end of all eight treatment sessions paranoia was still lower in the treatment group than the waitlist group, though the difference did not reach statistical significance.

Finally, Stinson et al., (2010) argue that certain cognitions may be important for triggering auditory hallucinations. They therefore instructed 30 patients with auditory hallucinations to either focus on their (previously identified) cognitive antecedents to auditory hallucinations, or to focus on neutral cognitions unrelated to their hallucinations while they entered a tube train ride in virtual reality. However, the occurrence of auditory hallucinations in VR was the same for both groups, thus not providing evidence that antecedent cognitions trigger auditory hallucinations.

Table 1. Manipulationist studies assessing non-clinical samples.

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Freeman, Dunn, Murray et al. (2015)	Negative affect	121	Individuals reporting paranoid ideation	VASs, SSPS, PANSS suspiciousness subscale, CAPE, CAPS	THC administration increased paranoia, which was fully mediated by increased negative affect and anomalous experiences	Y	Y	Y	24, excellent
Lincoln et al. (2013)	Negative affect	71	Students	Paranoia checklist	Following a negative mood induction, a compassion focussed task led to fewer paranoid thoughts than a control condition. The effect was mediated by reduced negative emotion	Y	Y	Y	19, good
Gollwitzer, Wilcynska & Jaya (2018a)	Loneliness	222	General population	Brief (5-item) state adapted Paranoia Checklist	Recollecting an experience of companionship reduced paranoia in those with high baseline paranoia. The result was mediated by reduced negative affect	Y	Y	Y	22, good
Gollwitzer, Wilcynska & Jaya (2018b)	Loneliness and cognitive reappraisal	196	General population	Brief (5-item) state adapted Paranoia Checklist	Using a cognitive reappraisal strategy designed to reduce negative affect reduced the effect of loneliness on paranoia	Y	Y	Y	22, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Laloyaux et al. (2019)	Negative affect and cognitive load	174	Students	False alarm detection (measure of hallucination proneness)	Higher cognitive load combined with a negative affect induction led to higher false alarm detection compared to a low cognitive load and neutral affect condition.	Y	Y	N	21, good
Hennig (2019)	Shame	297	Adolescents aged 14-17	Brief (5-item) state version of Paranoia Checklist	A brief shame prime led to no increase in paranoia compared to a brief happiness prime	Y	N	N	14, fair
Lincoln et al. (2010)	Anxiety	90	Students	Paranoia checklist	Induced state anxiety resulted in increased state paranoia, partially mediated by an increased tendency to jump to conclusions	Y	Y	Y	20, good
Lincoln et al. (2009)	Anxiety	64	Undergraduates	Paranoia checklist	A stress induction caused a significant increase in paranoia, partially mediated by increased anxiety	Y	Y	Y	20, good
Martinelli et al. (2013)	Rumination	37	Students	SSPS	Following a paranoia induction, a distraction task significantly decreased paranoia where-as encouraging rumination led to maintained paranoia	Y	Y	N	22, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
McKie et al. (2017)	Rumination	32	Undergraduates	VAS measuring paranoia	Following a paranoia induction, a mindful self-focus task significantly decreased paranoia where-as a ruminative self-focus task maintained paranoia	Y	Y	N	18, good
Atherton et al. (2016)	Self-esteem	26	Males reporting paranoid ideation	SSPS	Compared to a high self-confidence manipulation, a low self-confidence manipulation led to significantly higher levels of paranoia	Y	Y	N	20, good
Ascone, Jaya & Lincoln (2017)	Self-esteem	172	Female students	Paranoia checklist	Giving participants an unfavourable online social profile versus a favourable one had no significant effect on paranoia	Y	N	N*	21, good
Freeman, Evans et al. (2014)	Self-esteem	60	Females reporting paranoid ideation	SSPS	Reducing participants' height in virtual reality led to increased paranoia that was mediated by changes in social comparison	Y	Y	Y	22, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Kesting et al. (2013)	Self-esteem	76	General population	Paranoia checklist	Being excluded from a virtual ball game and receiving negative feedback on a test led to increased paranoia, which was mediated by decreased self-esteem	Y	Y	Y	23, excellent
Espinosa et al. (2018)	Implicit self-esteem	28	Students	Two items adapted from the PIQ	A positive conditioning task increased implicit self-esteem but had no effect on paranoia	Y	N	N	24, excellent
Butler et al. (2019)	Interpersonal stress	97	General population	PDS	Receiving critical comments increased paranoia but had no effect on self-esteem. Receiving warm comments increased self-esteem. Then being excluded from a virtual ball game reduced self-esteem and increased paranoia.	Y	Y	N	19, good
Reeve et al. (2017)	Sleep	68	General population	SPEQ	Sleep loss increased paranoia and hallucinations, but not grandiosity. Changes in psychotic experiences were mediated by changes in negative affect	Y	Y	Y	19, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Meyhöfer et al. (2017)	Sleep	32	General population	PSI	Sleep deprivation induced psychosis-like experiences mimicking hallucinations. No effect on paranoia was seen	Y	Y	N	20, good
Petrovsky et al. (2014)	Sleep	24	General population	PSI	Sleep loss led to increased perceptual distortions, but delusional thinking and paranoia did not increase	Y	Y for hallucinations, N for paranoia	N	20, good
Freeman et al. (2017)	Sleep	3,755	Students with insomnia	GPTS, SPEQ-H	CBT for insomnia reduced paranoia and hallucinations. Insomnia was the mediator of change in both cases	Y	Y	Y	20, good
Locascio and Snyder (1975)	Attention	60	Undergraduates	Bespoke fear/malevolence questionnaire as an index of paranoia	Increasing attention to threat did not increase paranoia	No check	N	N	18, good
Bodner and Mikulincer (1998)	Attention	177	Undergraduates	Bespoke paranoia self-report questionnaire	Increasing attention to threat led to increased paranoia in those who received feedback implicating personal failure as compared to when attention was focussed elsewhere	Y	Y	N	19, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Westermann et al. (2014)	Emotional regulation strategy	86	Undergraduates	VAS measuring state delusional ideation	Using a reappraisal strategy, a suppression strategy or no strategy following an anxiety induction had no significant effect on delusional ideation	No check	N	N	15, fair
Lamster et al. (2017)	Loneliness	60	General population	Paranoia checklist	Reducing loneliness led to a significant reduction in state paranoia, moderated by proneness to psychosis. Inducing loneliness led to increased paranoia though not significantly	Y	Y	N	22, good
Ellett and Chadwick (2007a)	Self-awareness	60	Undergraduates	PS, PDS	Inducing high self-awareness resulted in more paranoid self-cognitions following both a failure and a neutral task as compared to low self-awareness	No check	Y	N	18, good
Ellett and Chadwick (2007b)	Self-awareness	40	Undergraduates	PS, PDS	Inducing high self-awareness resulted in more paranoid self-cognitions following a neutral task as compared to low self-awareness	No check	Y	N	18, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Ellett and Chadwick (2007c)	Self-cognitions	30	Undergraduates	PS, PDS	A negative prime resulted in more paranoid self-cognitions than a positive prime following a failure task completed under a high self-awareness condition	No check	Y	N	18, good
Hutton et al. (2017)	Attachment	60	Students	PDS	A secure attachment prime did not protect against paranoid thinking	No check	N	N	21, good
Sood & Newman-Taylor (2020)	Attachment	117	Adults with high paranoia	Adapted Paranoia Checklist	A secure attachment imagery prime reduced paranoia compared to an insecure attachment prime. The effect was mediated by decreased cognitive fusion	Y	Y	Y	22, good
Zimbardo et al. (1981)	Awareness of anomalous experiences	18	Students susceptible to hypnosis	"A clinically derived" paranoia scale and the paranoia and grandiosity subscales of the MMPI	Those who were hypnotised to experience hearing loss without being aware of this manipulation experienced higher paranoia and grandiosity than those who were aware of the manipulation	Y	Y	N	14, fair

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Kaltsi, Bucci & Morrison (2017)	Metacognitive beliefs about paranoia	110	University staff and students	Paranoia checklist	Following social exclusion via a virtual ball game, frequency of paranoid thoughts increased in those who received a positive beliefs induction. Distress of paranoid thoughts decreased in those who received a negative belief induction.	Y for positive beliefs group. N for negative beliefs group	Y	N	19, good

Key: VAS = Visual analogue scale; SSPS = Social State Paranoia Scale; PANSS = Positive And Negative Symptoms Scale; CAPE = Community Assessment of Psychic Experiences; CAPS = Cardiff Anomalous Perception Scale; SPEQ = Specific Psychotic Experiences Questionnaire; PSI = Psychotomimetic States Inventory; GPTS = Green Paranoid Thoughts Scale; PIS = Persecution Ideation Scale; PDS = Paranoia and Depression Scale; SPEQ-H = Psychotic Experiences Questionnaire - Hallucinations subscale; PS = Paranoia Scale; PDS = Paranoia and Depression Scale; MMPI = Minnesota Multiphasic Personality Inventory.

*Stated intention to include mediation analysis in the analysis plan but refrained due to lack of effect of the manipulation on the outcome.

Table 2. Manipulationist studies assessing clinical samples.

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Freeman, Emsley et al. (2015)	Negative affect	59	Patients with current delusions	VASs for paranoia and hallucinations, SSPS	Exposure to an urban street scene led to increased paranoia and voice hearing, mediated by increased anxiety (45%), depression (38%) and negative beliefs about others (45%)	Y	Y	Y	22, good
Urbanska, Moritz & Gaweda (2019)	Social and sensory stress	19	Patients with schizophrenia	Paranoia Checklist	Exposure to either social or sensory stress conditions led to increased paranoia compared to a neutral condition	Y	Y	N	22, good
Freeman et al. (2016)	Safety-seeking behaviours	30	Patients with current delusions	VAS measuring persecutory concerns	Encouraging the dropping of safety behaviours led to large reductions in delusional conviction	Y	Y	N	19, good
Freeman et al. (2013)	Worry	67	Patients with persecutory delusions	CAPS, CDS	A worry induction increased a range of anomalous experiences including feelings of unreality, perceptual alterations, and temporal disintegration. There was no effect on hallucinations	Y	N for hallucinations, Y for feelings of unreality	N	20, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Foster et al. (2010)	Worry	24	Patients with persistent persecutory delusions and high levels of worry	PSYRATS delusions subscale, GPTS	A worry intervention led to reduced delusional distress. Indication that it might have also reduced the frequency of paranoid thoughts, but this was not statistically significant	Y	Y	N	21, good
Freeman Dunn, Startup et al. (2015)	Worry	150	Patients with persistent persecutory delusions	PSYRATS delusions subscale	A worry intervention led to a reduction in persecutory delusions. Change in worry accounted for 66% of improvement in delusions	Y	Y	Y	22, good
Cowles & Hogg (2019)	Anxiety	22	Diagnosis of psychosis-spectrum disorder	3-item change sensitive version of the Paranoia Checklist	Using a repeated measures, counterbalanced design, a brief anxiety induction led to increased paranoid ideation compared to a neutral condition	Y	Y	N	19, good
Lecomte et al. (1999)	Self-esteem	95	Diagnosis of schizophrenia	PANSS	A 12-week empowerment module reduced scores on the PANSS delusion and paranoia items. The effect dissipated when treatment stopped	N (maybe due to lack of sensitivity of measure used)	Y	N	21, good
Freeman, Pugh et al. (2014)	Self-esteem	30	Patients with persistent persecutory delusions	GPTS	A brief CBT intervention aimed at reducing negative self-cognitions led to a small but not significant reduction in paranoia	N	N	N	23, excellent

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Freeman, Waite et al. (2015)	Sleep	50	Patients with persistent delusions or hallucinations	PSYRATS	Following CBT for insomnia, confidence intervals for the positive symptom outcomes were wide, suggesting that in some patients delusions and hallucinations were reduced but in some patients they increased	Y	N	N*	21, good
Garety et al. (2015)	Reasoning	101	Patients with current delusions	VASs measuring paranoia and hallucinations	A brief intervention aimed at increasing belief flexibility and reducing jumping to conclusions led to significant improvements in state paranoia. Changes in reasoning mediated changes in paranoia, though this did not reach significance after adjusting for baseline confounders. No significant changes in hallucinations were found	Y	Y	Y	21, good
Garety et al. (2021)	Reasoning	362	Patients with persistent paranoia	GPTS, PSYRATS delusions subscale	8 sessions of a digitally supported reasoning intervention led to reductions in paranoia post-treatment and at follow up, mediated by improved belief flexibility and reduced worry	Y	Y	Y	24, excellent

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Khazaal et al. (2015)	Reasoning	172	Outpatients with persistent psychotic symptoms	PDI	Training in the ability to generate alternative hypotheses led to reduced delusional conviction, distress, and preoccupation, which was maintained at a 6 month follow up	Y	Y	N	22, good
Ross et al. (2011)	Reasoning	34	Patients with current delusions	Question assessing delusional conviction	Reasoning training led to less conviction and more flexibility in delusions for some patients, but the finding was not significant	Y	N	N	22, good
So et al. (2015)	Reasoning	44	Patients with current delusions	PANSS, PSYRATS	Training in reasoning (four modules of standard metacognitive training) led to reduced scores on the PANSS positive and delusions subscales and the PSYRATS delusions and conviction subscales, mediated by improved belief flexibility	Y	Y	Y	24, excellent
Moritz et al. (2015)	Reasoning	70	Patients with schizophrenia	Paranoia checklist	Training in how to reduce 30 common cognitive biases led to a reduction in jumping to conclusions but not paranoia	Y	N	N	19, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Craig et al. (2018)	Beliefs about voices	150	Patients with persistent auditory/verbal hallucinations	PSYRATS-AH	AVATAR therapy led to a significantly greater reduction in PSYRATS-AH total and subscale scores than did supporting counselling. By 24 weeks there were no differences.	Y	Y	N	23, excellent
Birchwood et al. (2014)	Beliefs about voices	197	Patients with persistent command hallucinations	VCS, PANSS	Cognitive therapy to challenge perceived power of voices reduced compliance to voices at 18 month follow up but did not affect delusions or hallucinations	Y	N for delusions/hallucinations but Y for following commands	Y (separate paper**)	20, good
Stinson et al. (2010)	Triggering cognitions	30	Patients with auditory hallucinations	PSYRATS-AH	No difference in severity of hallucinations following instruction to either focus on hallucination-triggering thoughts or on neutral thoughts	N	N	N	20, good
Ascone, Sundag et al. (2017)	Compassion	51	Patients with paranoid ideation	Paranoia checklist	Following an induction of negative affect, a single session compassion focussed imagery intervention had no significant effect on paranoia as compared to a control imagery condition	Y for self-reassurance but N for self-compassion	N	N	22, good

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Van den berg et al. (2016)	Trauma	155	Patients with a lifetime psychotic disorder and current PTSD	GPTS	Paranoia decreased significantly following the first session of trauma focussed therapy. At the end of the 8 sessions paranoia was lower in the treatment group compared to a waitlist group though the difference did not reach significance.	Y	N	N	22, good

Key: VAS = Visual analogue scale; SSPS = Social State Paranoia Scale; CAPS = Cardiff Anomalous Perception Scale; CDS = Cambridge Depersonalisation Scale; PSYRATS = Psychotic Symptom Rating Scale; GPTS = Green Paranoid Thoughts Scale; PANSS = Positive And Negative Symptoms Scale; PDI = Peters Delusion Inventory; PSYRATS-AH = Psychotic Symptom Rating Scale - Auditory Hallucinations subscale; VCS = Voice Compliance Scale.

*Stated intention to include mediation analysis in the analysis plan but refrained due to lack of effect of the manipulation on the outcome.

** Birchwood et al. (2017).

Discussion

In this chapter, the empirical literature was searched with no date restriction for studies manipulating psychological mechanisms potentially involved in psychotic experiences. Only 52 manipulationist studies were found. Just 21 of these studies were with people being seen in clinical services for psychosis. For one of the most severe mental health problems, this is a very small number of causal research studies. Hence, arguably the key point highlighted by the review is the limited number of studies that have directly tested causal roles for psychological processes in psychosis. Interestingly, all but four of the included experiments and interventions were conducted in the last decade, with over two-thirds conducted in the last six years. This perhaps reflects an increasing awareness of the importance of the approach and its neglect hitherto in psychosis research.

Notably, nearly all of the manipulationist studies were on paranoia. This particularly follows an endeavour by Freeman and colleagues to build a more efficacious treatment for persecutory delusions by explicitly using manipulationist studies chosen on the basis of a theoretical model (Freeman et al., 2016). This work conceptualises persecutory delusions as threat beliefs, developed in the context of genetic and environmental risk (Zavos et al., 2014), which, as set out in Chapter 1, are maintained by several psychological processes including anxious avoidance (safety-seeking behaviours), excessive worry, low self-confidence, poor sleep, anomalous experiences, and reasoning biases (Freeman, 2016). The causal mechanisms of maintenance are set out in this theoretical account: safety-seeking behaviours prevent the receipt of disconfirmatory evidence that the person is safe; worry brings implausible ideas to mind, keeps them there, and exacerbates the distress; negative cognition (negative beliefs about the self and others) leads the person to feel inferior and vulnerable to harm from others; subjectively anomalous internal states (e.g. hallucinations) provoke fearful and unusual explanations; disrupted sleep increases anxiety, worry, low self-esteem and the anomalous internal states; and reasoning biases prevent the processing of alternative explanations. From this one theoretical account, numerous different manipulationist tests are identifiable. Each main aspect of the model has been tested in a manipulationist design, and, most notably, typically in a targeted interventionist treatment trial that has directly tested a treatment innovation. Given that the effect sizes for first generation cognitive behavioural therapy are small (Bighelli et al., 2018), the argument is that successfully targeting specific mechanisms (i.e. translational research) has the potential to build better treatments. The interventionist-causal

trials covered in this review have begun to demonstrate this promise. In interventionist-treatment trials there is a valuable combination of causal test and clinical test of specific treatment techniques.

Other than the literature on sleep - which itself still requires further work in clinical samples - only two intervention studies tried to reduce hallucinations via targeting key psychological mechanisms (appraisals) (Birchwood et al., 2014; Craig et al., 2018). These appraisal-focussed hallucination trials have shown clinical benefits. No interventions have specifically targeted grandiosity. The file-drawer problem might contribute to the lack of experimental manipulation studies, but this is far less likely to be the case with clinical interventions, given that the pre-registration of clinical trials now decreases the likelihood of such publication bias. More significant, therefore, is likely to be the time and difficulty involved in conducting such clinical intervention studies.

It is important to recognise that there are no single causes of psychotic experiences. As set out in Chapter 1, most causes are likely to be an 'inus condition' – an *insufficient* but *non-redundant* part of an *unnecessary* but *sufficient* condition' (Mackie, 1974). Each causal factor only increases the probability of a particular psychotic experience occurring. A consequence of this is that the causal role of a mechanism can be difficult to detect without using a large sample size. Given this caveat, it is interesting that replicated findings are nonetheless seen in several areas, namely self-esteem, worry, negative affect, belief flexibility, and sleep, all in relation to paranoia.

It seems that when the psychological processes contained in psychological models of psychosis have been successfully manipulated then effects on psychotic experiences are seen. This is encouraging for the development of interventions. However, the findings in this review also perhaps indicate that research has been focused only on mechanisms in which there is a good deal of confidence in the relationship. As the field matures, we may see novel mechanisms being successfully manipulated that are not found to have any effects on psychotic experiences, as would be expected in any well researched area.

Although in most cases methodological quality was strong, with risk of bias therefore being low, the included literature did have a number of limitations. Fewer than half of the included studies

used mediation analysis, thus limiting to a degree the strength of causal inferences that are made. Moreover, six of the studies did not include a manipulation check. In cases where no effect on a psychotic experience was then found, it is unclear whether this was because the manipulation was unsuccessful or because the mechanism had no causal relationship to the outcome. Additionally, although the majority of samples included more than 50 participants, few included more than 100. Over half (17) of the non-clinical studies used student samples, making conclusions from these studies somewhat limited in their generalisability. Replications across different samples and with greater statistical power are needed, with a stronger focus on examining moderators and mediators of relationships.

Limitations

There are number of limitations of the review. First, it cannot be guaranteed that the search strategy identified every study that would meet the inclusion criteria. While three different databases were searched, any study not including one word from each search string would not have been identified. Scanning of citations and reference lists of included studies would have reduced the likelihood of this problem, but a number of studies may still not have been found. Second, the file-drawer problem means there may be unpublished studies that would have met criteria for inclusion in this review but that have been missed. Third, this review was limited to the positive symptoms of psychosis, specifically delusions and hallucinations. Negative symptoms of psychosis, such as anhedonia, were not examined. Finally, the Downs and Black (1988) scale of methodological quality has its limitations. The value of totalling a score for each study based on a wide variety of methodological questions, and giving it a rating based on this score, is somewhat questionable. Some aspects of method are more important than others, yet this method assigns equal weight to every aspect. Moreover, some of the questions within this tool are more appropriate for cohort studies than randomised controlled designs. However, no existing tool that focuses on the study design included in this review was found. Most tools are either solely for observational studies or for clinical trials.

Conclusion

As Shadish, Cook and Campbell (2002, page xv) state: "the rewards associated with being correct in identifying causal relationships can be high, and the costs of misidentification can be tremendous." Conducting manipulation experiments and therapeutic interventions serves an

important theoretical and clinical purpose. The results of the studies included in this chapter indicate that these methods have the potential to be informative but have been insufficiently applied to the psychological understanding of psychosis. The following three chapters therefore present three studies to add to those identified in this review.

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Chapter 3

A virtual reality clinical-experimental test of a self-compassion treatment technique to reduce paranoia

This chapter has been adapted from the follow paper, attached in Appendix 6.2.

Brown, P., Waite, F., Rovira, A., Nickless, A., Freeman, D. (2020). Virtual reality clinical-experimental tests of compassion treatment techniques to reduce paranoia. Scientific Reports, 10(1), 1-9.

Abstract

Background: In a theoretical model it is hypothesised that paranoia builds upon feelings of vulnerability associated with negative self-beliefs. One method of reducing such negative ideas about the self might be to increase self-compassion. This chapter aims to test whether creating a compassionate coach, an imagery technique aimed at enhancing self-compassion, can reduce paranoia via increasing self-compassion.

Method: A randomised controlled experimental design, with embedded tests for mediation, was used. One hundred individuals from the general population reporting current paranoid ideation were randomised to develop an image of a compassionate coach or a neutral image. Individuals then repeatedly entered neutral virtual reality social environments. Changes in self-compassion and paranoia were assessed.

Results: By the end of testing, individuals who created a compassionate coach experienced a significant increase in self-compassion (group difference (95% C.I.) = 2.12 (1.57; 2.67), p = <0.0001, Cohen's d = 1.3) and a significant decrease in paranoia (group difference (95% C.I.) = -1.73 (-2.48; -0.98), p = <0.0001, Cohen's d = 0.8) in comparison to the control group. Mediation analysis indicated that changes in self-compassion accounted for 57% of the change in paranoia.

Conclusions: Low self-compassion may be a contributory causal factor in the occurrence of paranoia. Using compassionate coach imagery may be a beneficial technique to help reduce paranoia. Tests in clinical populations are indicated.

Introduction

The focus of this chapter is on the hypothesis that negative beliefs about the self lead to feeling inferior, apart, and vulnerable, and that paranoia builds upon such concerns (Freeman, 2016). Self-compassion is highly inversely correlated with negative beliefs about the self (Collett et al., 2016) and so training in self-compassion may be one way to help to reduce these negative beliefs, and thus paranoia. As identified in Chapter 2, self-compassion has not successfully been manipulated in a sample selected for paranoia.

The whole spectrum of paranoid experiences shares an underlying aetiology, supported by evidence of a consistent heritability between mild and severe paranoia (Zavos et al., 2014). Persecutory delusions build upon common emotional concerns (Freeman et al., 2005). It is therefore possible to learn about clinical extremes by studying individuals with lower levels of severity. In this chapter the effects of increasing self-compassion in individuals from the general population scoring highly for current paranoid ideation are tested.

Neff (2003) defines self-compassion as the awareness of our own suffering, combined with the ability to be kind to ourselves and understand our suffering as part of our common humanity. In addition, Gilbert (2010a) states that an important part of self-compassion is a motivation to alleviate our suffering. In a theoretical model of the compassionate mind, Gilbert (2009, 2010a) proposes that there are three distinct systems that regulate emotion: the soothing system (manages distress and helps us bond with others), the drive system (motivates us to achieve our goals), and the threat system (detects threats and raises anxiety in order to help protect us from these threats). It has been suggested that psychosis is developed and maintained by a lack of activity in the soothing system, and over-activation of the threat system, likely arising in the context of stressful or traumatic life experiences and an insecure attachment style during childhood (Gumley, Braehler, Laithwaite, MacBeth & Gilbert, 2010). If this is the case, there needs to be a focus on helping patients to develop their soothing systems, to ensure that individuals not only feel an absence of threat, but also the presence of safety, two distinct concepts (Gilbert, 2005, 2009).

Compassion focussed therapy (CFT) was developed out of Gilbert's (2010a) compassionate mind model as a transdiagnostic approach involving a range of exercises – collectively termed compassionate mind training, (CMT) – that aim to activate the soothing system (Gilbert 2009, 2010b). CFT has been found to be clinically beneficial for many mental health problems (Beaumont & Hollins Martin, 2015; Leaviss & Uttley, 2015) and proposed for use with patients

with psychosis (Ascone, Sundag, Schlier & Lincoln, 2017). There is evidence to suggest that self-compassion exercises in particular might be helpful, given evidence that levels of self-compassion correlate with the severity of psychotic experiences, as well as paranoia specifically. For example, Eicher et al. (2013) found that greater self-compassion was associated with lower positive and negative symptom scores in 76 patients with schizophrenia. In 21 patients with current persecutory delusions, Collett et al. (2016) found that self-compassion scores were considerably lower than in non-clinical controls. Similarly, Mills et al. (2017) showed in 131 students that paranoid ideation negatively correlates with self-kindness and the ability to self-reassure. A qualitative study (Waite, Knight & Less, 2015) of recovery in psychosis also provides support for the importance of self-compassion, with one patient stating: 'When things are going less well that's really symptomatic of the fact that you haven't really been being very kind to yourself'. Therefore, it seems plausible that training in self-compassion could be one way of helping to reduce paranoia by helping individuals develop their soothing systems, moderating their negative self-beliefs and feelings of threat. Both a recent review (Hickey et al., 2017) and meta-analysis (Kirby et al., 2017) support further research into compassion-based interventions.

One way to train self-compassion is through generating a compassionate coach image. The coach, often referred to in the literature as a 'perfect nurturer', provides strength, kindness, and warmth in order to help individuals feel better able to cope with everyday challenges. The aim is to harness the experience of being nurtured by your coach, gradually internalising it. It is both an experiential and cognitive exercise. A compassionate coach can have any identity, for example, a human, an animal, or something natural, but it must embody all the qualities of compassion, including strength, warmth, wisdom and kindness, and should encourage the individual to be kind towards them-self.

In the first experimental test of a self-compassion intervention to reduce paranoia, Lincoln et al. (2012) induced negative emotion by in-sensu exposure in 71 students (not selected for having paranoia) and randomised them to either generate a compassionate coach image or a neutral image of a chair. It was found that generating a compassionate coach image reduced paranoia scores in comparison to using neutral imagery (Cohen's $d = 0.59$). Ascone et al. (2017) conducted a similar compassion-focussed intervention following induction of a negative affective state in 51 patients with psychosis. However, while the manipulation did increase happiness and self-reassurance, it failed to increase levels of self-compassion (or decrease paranoia).

This study built upon the work of Lincoln and colleagues in three ways. First, individuals from the general population reporting significant current paranoia were recruited, so that an analogue population for clinical disorder was tested. Second, immersive virtual reality (VR) was used to present the participants with neutral social situations, so that there would be opportunity to potentially form paranoid ideation. This also ensured that genuine paranoid thinking was being assessed, which cannot be guaranteed by other means. Third, participants repeatedly entered different VR social experiences, which enabled repeated measurement of the key variables and thus temporal tests within the mediation analysis.

The hypotheses were that compared to the control group who generated a neutral image, individuals with paranoia who generated a compassionate coach would show an increase in self-compassion and a decrease in paranoid ideation in VR. Further, it was hypothesised that any decrease in paranoia experienced by the individuals using the compassionate coach would be mediated by increased self-compassion. The focus was at the clinical level of causal explanation: testing the effect of the clinical technique on the main hypothesised mechanism (self-compassion) and outcome (paranoia). The study did not set out to establish further detail in the causal chain (e.g. how alterations in self-compassion may affect other psychological processes).

Method

Participants

Participants were primarily recruited via social media and radio advertisements in Oxfordshire, UK. 740 participants were screened using questionnaires administered through Qualtrics. Exclusion criteria were: aged under 18 years; history of severe mental illness; photo-sensitive epilepsy; or self-identifying as having any significant visual, auditory, or mobility impairment. One-hundred individuals reporting six or more paranoid thoughts in the last month (a total score of 22 or above on the Green Paranoid Thoughts Scale Part B (GPTS-B; Green et al., 2008) took part. This cut off score captures the upper quartile of paranoia scores in the general population (Freeman, Evans & Lister, 2012; Freeman, Lister & Evans, 2014).

Design

The design was between-groups with each participant tested within a single one-hour session. Participants completed baseline measures and were then randomised to the compassion or control condition. Randomisation was carried out using an online generator by an independent researcher. There were four stages of imagery development and four periods in VR social environments. Two different VR scenarios were used (a tube train and a lift), each experienced twice. Figure 1 shows the experimental procedure. The study received ethical approval from the University of Oxford Central University Ethics Committee (CUREC).

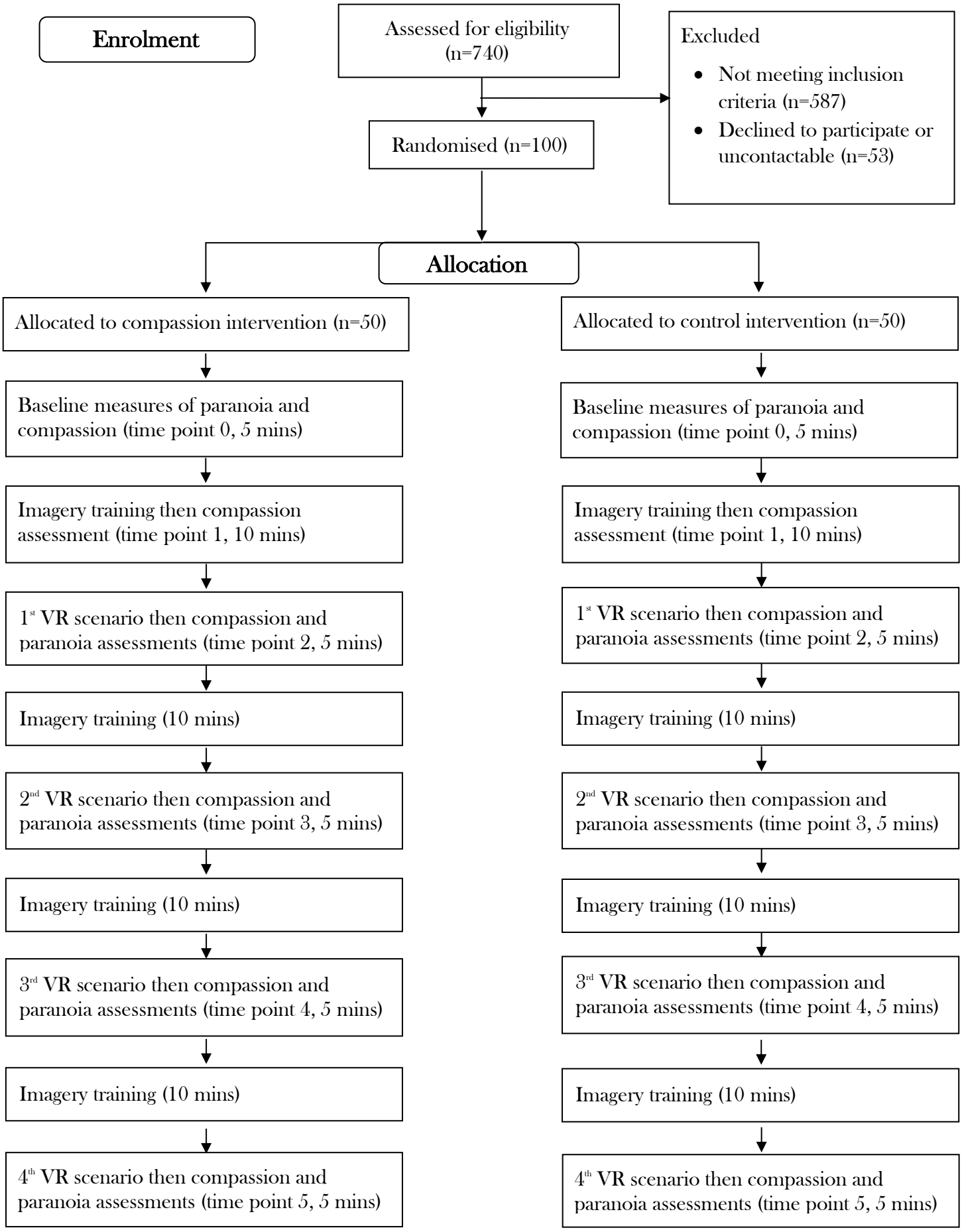

Figure 1. Experimental Procedure.

Imagery interventions

Participants were trained in creating an ideal compassionate coach unique to them. The term compassionate coach, rather than perfect nurturer, was chosen, as it was felt that this term was more accessible and relatable. The use of a compassionate coach imagery intervention seemed particularly appropriate for this experiment because although the study would only be examining the short-term effects of training the technique, participants would be entering virtual reality environments four consecutive times. This gave participants the opportunity to build on their image so that it would become gradually stronger and more accessible. A script was devised combining elements from a number of existing scripts (Gilbert & Procter, 2006; Kolts, 2012; Lee, 2005; Welford, 2012) that aimed to make the task more accessible and easier to achieve. Participants were guided by the candidate (PB) throughout in how to create their image. The image was developed in four stages. First, participants created their coach and focussed on their qualities, before bringing to mind a difficult situation from their life, and practising having their coach help them to cope with it. For instance, it was explained:

"Spend some time with your compassionate coach; they are there just for you, to comfort you and soothe you in any time of distress. They have your best interests at heart. They are someone who cares about you and strengthens your confidence, who makes you feel like you can face all of life's challenges...With your coach there, you are not alone. You have someone with you, alongside you, and able to help you face this situation."

Each latter stage allowed for greater detail and other (e.g., sensory) aspects of the coach to be developed. In between each of the four stages participants entered a VR social situation, during which they practised being self-compassionate with support from their coach.

The control condition was identical except the image generated was entirely neutral: a weather forecaster, and participants were not instructed to think about their image during the VR scenarios. The two imagery tasks were designed to be as similar as possible, apart from the affect associated with the images. The conditions were similar in length, required a similar level of creativity and communication with the researcher, and both included encouragement to focus on breathing in order to help participants relax. The key difference between the interventions was the affect of the images created. The compassionate coach was intended to be warm and supportive, whereas the weather forecaster was neutral and provided only a weather commentary. Scripts from the imagery interventions can be viewed in Appendices 1.5 and 1.6.

Assessments

Paranoia

At baseline participants completed the Green et al. Paranoid Thoughts Scale - Part B (GPTS-B; Green et al., 2008). This is a 16-item scale assessing ideas of persecution such as 'I was convinced there was a conspiracy against me' and 'I was sure someone wanted to hurt me' on a 1-5 scale (1 = not at all, 5 = totally). Scores can range from 16-80; higher scores reflect greater paranoia. The scale is well validated for use in both clinical and non-clinical samples (Statham, Emerson & Rowse, 2019) and has strong concurrent validity with paranoia severity as assessed by clinical interviews and by controlled virtual reality tests (Freeman, Antley et al., 2014; Freeman, Pugh, Vorontsova, Antley & Slater, 2010). Using item response theory analysis with over 10,000 individuals, the GPTS-B has been shown to demonstrate high reliability (a >0.95) across both mild and severe ends of the paranoia spectrum (Freeman et al., 2019). Test-retest reliability has also been shown to be good, with an intra-class correlation coefficient of 0.81 (Green et al., 2008).

Two visual analogue scales were averaged to form a state measure of paranoia used for analysis. They were: 'Please mark on the line below how vulnerable you felt during the virtual reality scenario' and 'Please mark on the line below how much you felt under threat during the virtual reality scenario'. The scale ranged from 'Not at all' to 'Extremely'. These were completed after being in each VR environment. Cronbach's alpha measure of internal consistency for the scale was 0.83. Visual analogue scales were chosen due to their sensitivity to change. Paranoia as measured on such scales has been correlated with both GPTS scores and interviewer assessment of paranoia (Freeman, Antley et al., 2014).

Self-compassion

Two visual analogue scales were also averaged to form a state measure of self-compassion for analysis. These were: 'Please mark on the line below how kind you are feeling towards yourself right now' and 'Please mark on the line below how compassionate you are being towards yourself right now'. As with the paranoia measures these ranged from 'Not at all' to 'Extremely'. Cronbach's alpha measure of internal consistency for the scale was 0.85.

The VR system

The VR setup included a tracking system that allowed participants to move freely in an area of approximately 3x3m. The tracking system provides the position and orientation of the participant several times per second so that the computer can adjust the images to their perspective in real time. Participants wore a consumer VR head-mounted display (HMD), an HTC Vive PRO, with a resolution of 1440x1600 pixels per eye and a field of view of 110 degrees. It was powered by a computer with an Intel i7 CPU, an Nvidia GeForce GTX1080 graphics card, and Windows 10 operating system. The HMD also includes an integrated audio system.

VR scenarios

Two scenarios of approximately three minutes were used: an underground tube train ride and a lift (Figure 2). These scenarios were based on those used in Freeman et al. (2016), upgraded to have more natural lighting in the environment. In addition, the number of virtual characters present in the scenarios was adjusted. In the tube scenario participants began on a station platform, before entering the tube carriage when it arrived. There was a total of either 12-13 people on the carriage, with three people in the central area where the participant was during the first exposure and four people in the second. There was a real pole co-located with the virtual pole in the middle of the area next to the doors of the car. The presence of the pole not only increased the plausibility of the scenario by allowing participants to touch what they could see, but also ensured participants remained in the middle of the scene. A journey commenced that took participants to the next station where they could get off the train. The audio was recorded in the real London tube and included the announcer speaking, the doors closing, and the noise of the train travelling through the tunnel.

In the lift scenario the participants entered a lift with three or four avatars in it, again for the first and second exposures respectively. Participants entered the lift, the doors closed, and they stayed in the lift as it ascended 27 floors before descending again to the ground floor where they could get off. There was background music playing and the participants could see a display on each side of the doors showing the current floor. Throughout the journey, the characters performed subtle actions on top of their scripted animations, such as coughing discreetly or looking at the displays, to increase the realism of the scene. The presence of an additional

avatar in each second exposure was designed to increase the intensity of the social situation and prevent participants re-entering an identical scenario. Figure two shows the two environments.

Figure 2. VR scenarios.

Analysis

The target sample size was 100 individuals randomised equally between the experimental (CC image) and control (neutral image) group. The aim was to be able to detect moderate to large effect sizes. To detect an effect size of 0.6 using two-tailed t-tests and 80% power, a sample size of 45 per group would be required. The use of mixed effects models would also allow greater statistical power and therefore detection of somewhat smaller effect sizes.

A linear mixed effects regression model for each continuous outcome was used in order to account for the repeated measures at the four different time points. This addressed hypotheses one and two i.e. whether a relationship exists between condition (compassion or control) and self-compassion, and between condition (compassion or control) and paranoia. Standardised effect sizes were calculated with Cohen's d, dividing the treatment effect by the shared standard deviation at baseline.

To test the mediation hypothesis two models were tested. Firstly, determining the extent of mediation of paranoia at the final time point, by self-compassion and self-kindness also at the final time point, as this is when the compassion intervention was complete and thus at its strongest. Secondly, as a check on the direction of the relationship, a reversed mediation test was also conducted, putting paranoia at the final time point as the mediator and self-compassion at the final time point as the outcome. Due to the concern of conducting cross sectional mediation models, the extent of mediation of paranoia at the final time-point, by self-compassion and self-kindness at the mid time point, was also determined, when half of the compassion intervention had been completed. This was able to assess mediation across time.

The approach used was similar to that of Baron and Kenny (1986) but used a linear mixed effects model at each step. Two separate linear mixed effects models showed that the intervention was correlated with the outcome, and with the mediator. A third model then used the outcome as the response and both the intervention and mediator as covariates. Extracting the parameters as per Baron and Kenny enabled the total, direct, and indirect effects to be obtained and also the percentage mediation. Baseline measures of the outcome and mediator were included as covariates in all models. This approach was chosen, as in Freeman et al. (2017), as opposed to the method of using an instrumental variable approach with two-stage least squares, because the latter methodology has not been updated to include repeated measurements from the same participants. Since there were up to four repeated measurements per participant per outcome, it was important to take advantage of all this information by using linear mixed effects models. Although randomisation ensures that the estimate of the intervention effect on the mediator and on the total intervention effect on the outcome are not affected by unaccounted confounders, the effect of the mediator on the outcome (path b) may still be affected by confounding (Whittle, Mansell, Jellema & Van der Windt, 2017). This was accounted for by including baseline levels of the mediator and outcome in each of the linear

mixed effects models. R version 3.4.2 was used for the statistical analysis. The R code used for analysis can be viewed in Appendix 1.7.

Results

Participants were predominantly males (n=63), in their late twenties, and working full or part time. The mean age of participants was 29 (range 18-55 years). The mean GPTS-B scores of 35 and 33 out of 80 in the compassion and control groups respectively indicated a much higher level of paranoia than in most analogue samples (e.g. 24.2 in Atherton et al., 2016; 25.6 Freeman, Evans et al., 2014) and are over the cut off used for inclusion in some clinical trials for persecutory delusions (e.g. 29 in Garety et al., 2017). Scores of 35 and 33 fall at the upper end of 'elevated' paranoia and lower end of 'moderately severe' paranoia as categorized in a recent large-scale validation of the GPTS, based on data from over 10,000 individuals (Freeman et al., 2019). Table 1 presents a summary of participant demographic and baseline characteristics. There were no missing data.

Table 1. Baseline and demographic characteristics.

	Compassion (n=50)	Control (n=50)
Age (years), mean (SD)	28.7 (8.6)	29.4 (9.6)
Men/woman, *n/n*	33/17	30/20
Ethnicity, *n*		
White British/Irish	34	35
Non-White British/Irish	16	15
Employment status, *n*		
Unemployed	3	2
Full/Part-time employed	30	36
Student	17	12
Retired	0	0
GPTS Part B score at baseline, mean (SD)	35.4 (11.2)	32.6 (10.0)
Self-compassion score at baseline, mean (SD)	6.5 (1.8)	7.0 (1.5)

Hypothesis 1: Effect of condition on self-compassion

Figure 3 shows the mean scores and effect sizes for the two outcomes at each time point. The compassion group showed significantly higher levels of self-compassion at all follow-up time points relative to the control group. For the final outcome the group difference was 2.12, 95% C.I.=1.57;2.67, p=<0.0001, d=1.4.

Hypothesis 2: Effect of condition on paranoia

The compassion group showed significantly lower levels of paranoia relative to the control group for both the mid and final time points. For the final outcome the group difference was -1.73, 95% C.I.=-2.48;-0.98, p=<0.0001, d=0.8.

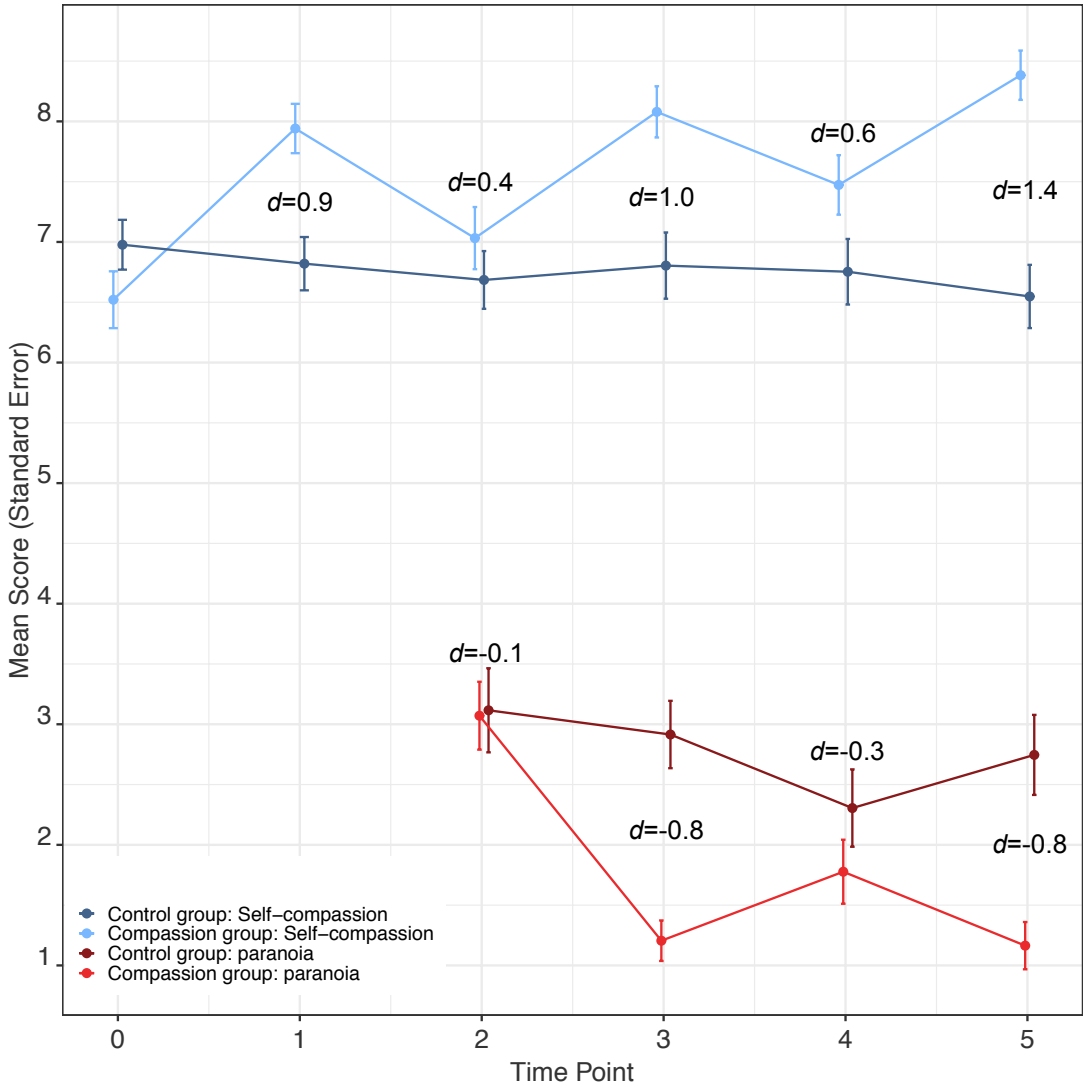

Figure 3. Scores and effect sizes for primary compassion and paranoia outcomes.

Hypothesis 3: Mediation

Table 2 shows the results from the mediation analysis. Change in self-compassion at the mid and final outcomes explained 36% and 57% respectively of the treatment effect on paranoia at the final outcome. In comparison, mediation analyses in the opposite direction indicated that changes in paranoia at the final time point explained only 24% of the change in self-compassion at the final time point.

Table 2. Total, direct, and indirect effect estimates from the mediation analysis.

	Mid time point as mediator	Final time point as mediator
Total effect (CI, *P*-value)	-1.81 (-2.56; -1.07), <0.000	-1.81 (-2.56;-1.07), <0.000
Direct effect (CI), *P*-value	-1.17 (-1.95; -1.40), 0.003	-0.80 (-1.59;0.00), 0.050
Indirect effect (CI, *P*-value)	-0.65 (-1.08; -0.22), 0.001	-1.04 (-1.52; -0.56), <0.000
Percentage mediation	35.84	57.43

Discussion

This chapter draws on the hypothesis that paranoia directly builds upon negative ideas about the self (Freeman, 2016). The aim was to build self-compassion in order to lessen feelings of vulnerability arising from negative self-beliefs. This is the first known randomised controlled experimental test of a self-compassion intervention technique in individuals selected for reporting current paranoid ideation. As set out in Chapter 1, the interventionist-causal approach (Kendler & Campbell, 2009) allows for inferences to be made concerning both treatment development and causal mechanisms.

The first necessary stage in such an approach is for the treatment technique to alter level of self-compassion, which was achieved. Large effect size increases were found at all time points in those randomised to receive the compassionate imagery intervention compared to those who received the control intervention. This demonstrates that even a very brief self-compassion intervention, when practised in VR social environments, is effective in increasing self-kindness and compassion in the short-term. This result suggests there is potential for compassionate coach imagery to be tested as a clinical technique. Anecdotally, participants generally reported finding it surprisingly easy to create their compassionate coach and found it useful to practise using their coach in VR social environments. Many participants based their coach on someone they knew, others used an animal, a tree, or an inanimate shape of a particular colour, and one individual used a perfected version of themselves.

The success of the manipulation meant that effects on paranoia could be determined. Those participants who received the self-compassion intervention showed a large reduction in paranoia. Because of the manipulationist design of the study (i.e. it was level of compassion that was targeted and altered) the inference is that low self-compassion is likely to be a contributory causal factor in the occurrence of paranoid thoughts. The mediation analysis supports this interpretation, particularly given that change in self-compassion at the midpoint explained nearly 40% of change in paranoia at the final outcome and increased self-compassion accounted for almost 60% of the reduction in paranoia at the end of the intervention. Reverse mediation tests suggested that a reduction in paranoia also accounted for some of the increase in self-compassion (24%), which is unsurprising given it is likely the two mechanisms are highly correlated and somewhat reciprocal in relationship.

It is interesting that the effects were most evident at both the middle and final time points, with smaller effects seen after the first and third VR scenarios. This is likely due to the middle and

final time points being the most intense VR scenarios where there was an additional avatar present in the scene. This added intensity perhaps increased the level of paranoia of the control group, but not that of the compassionate group, who could employ the compassionate coach imagery, which would have been established to a greater degree after the previous practising.

Limitations

There are a number of limitations to the study. First, although both mild and severe paranoia are part of a single continuum (Freeman et al., 2005), the use of a non-clinical sample means the results may not fully generalise to those experiencing more severe levels of paranoia. Potential fears of compassion may first need to be investigated within clinical samples (Martins et al., 2017). Each stage of imagery training would likely need to be extended to become its own session, with a gap of perhaps a week in between stages in order to allow consolidation of each training stage and further practice in daily life. Moreover, including a stage of practice where the coach helps to identify and re-frame self-critical thoughts and beliefs, rather than just focussing on promoting positive thoughts and beliefs, may be important for achieving long-term cognitive change in those with more severe paranoia.

Second, the participants were self-selecting in responding to adverts and other invitations to take part, which will have affected the representativeness of the sample. Recruitment was primarily achieved through social media advertisements in Oxfordshire, and participants had to be able and willing to travel to the in-person testing session. Third, there was no blinding in terms of the intervention that participants were receiving, although participants themselves were blind to the study hypotheses and the outcomes were self-report. Linked to this, the outcome measures used words that were included in the manipulation itself, i.e. self-compassion and kindness. Hearing those words, combined with the lack of blinding, might mean it is unsurprising that increased identification with those words was seen in the manipulation check, either due to priming or due to demand characteristics. On the other hand, the study tested the technique in the way that it would be administered in clinical practice: teaching the patient about a particular concept, practising a technique to modify it, and then asking if the patient feels an improvement in it or not. Where this limitation may imply caution, is with regards to the inferring a causal role of self-compassion in the development and maintenance of paranoia. Fourth, the compassionate coach is only one technique for increasing self-compassion. There may be other techniques not tested in this study, such as chair work or compassionate letter

writing, that are better. Fifth, only the short-term effects of the manipulation were examined, and it is unknown whether there were any lasting benefits. Given the briefness of the intervention long-term effects would not necessarily be expected, so this will be an important avenue for future research. The results certainly show support for the testing of the compassionate coach technique in patients with severe paranoia, with investigation into longer-lasting effects and consideration on how to embed the techniques into day-to-day life.

Finally, and perhaps most significantly, the study explored only one level of causal explanation: that the technique affected self-compassion and that this impacted levels of paranoia. The aim was not to test the potential cascade of effects within this causal chain (for example, by assessing other mechanisms or altering the control condition). It is always possible to further disentangle causal pathways and discover, for example, precisely how, i.e., by what mechanism, self-compassion may have effects on paranoia (for example, via reduced anxiety, increased positive affect, or distraction). Similarly, compassionate coach imagery could be seen as primarily an exercise in receiving compassion, rather than in self-compassion, because although the coach is self-generated, it is separate to the self. However, this was not measured. Given the lack of prior research in this area, the aim of this study was just to be able to determine if there would be an effect of a self-compassion intervention on paranoia, without dismantling at this early stage, the exact pathway of the effect. The findings from this study therefore open up a number of avenues for future research to discover greater knowledge about the causal chain.

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Chapter 4

A virtual reality clinical-experimental test of increasing compassion for others to reduce paranoia

This chapter has been adapted from the follow paper, attached in Appendix 6.2.
Brown, P., Waite, F., Rovira, A., Nickless, A., Freeman, D. (2020). Virtual reality clinical-experimental tests of compassion treatment techniques to reduce paranoia. Scientific Reports, 10(1), 1-9.

Abstract

Background: In a theoretical model it is hypothesised that negative beliefs about others contribute to paranoia. Training in compassion for others may be one method of reducing such negative beliefs, helping individuals to learn to see others as a source of safety rather than threat. This chapter aims to test whether practising loving kindness meditation, an imagery technique designed to develop an affective state of kindness and compassion to all people, can reduce paranoia via increasing compassion for others.

Method: The identical design and method were employed as in Chapter 3, with a new sample of 100 individuals reporting current paranoia. Individuals were randomised to receive training in LKM or a neutral, control, imagery exercise, and repeatedly entered neutral virtual reality social environments.

Results: In comparison to the control group, the LKM group reported significantly increased levels of compassion for others by the end of testing (group difference=3.26, C.I.=2.72;3.80, p=<0.0001, d=1.7), and decreased paranoia (group difference=-1.70, C.I.=-2.50;-0.89, p=<0.0001, d=0.8). Mediation analysis indicated that change in compassion for others explained 67% of the change in paranoia.

Conclusions: Low compassion for others may be a contributory causal factor in the occurrence of paranoia and using loving kindness mediation may be a beneficial technique to help reduce paranoia. Tests in clinical populations are indicated.

Introduction

The focus of Chapter 3 was the contribution of negative self-beliefs to paranoia, and how to target these through compassionate imagery. However, paranoia is also hypothesised to build upon negative beliefs about other people (Freeman et al., 2002). Beliefs that others are inherently hostile and dangerous, and feeling dissimilar and apart from others, may contribute to the feelings of vulnerability and thus paranoia. Fowler et al. (2006) found that negative evaluations of others, as well as of the self, are associated with clinical and non-clinical levels of paranoia. Despite this, negative beliefs about others have never been targeted experimentally in individuals with paranoia.

Compassion techniques may be helpful for targeting these beliefs about others, as was found for the self, because the soothing system is also responsible for helping us bond with others. Part of developing compassion for others is gaining a sense of common humanity, that is, an understanding that all people are a product of their genes and environments and tend to act in ways that make them happy (Jazaieri et al., 2013). Being compassionate to others also requires being flexible in one's interpretation of a situation, and not judging a person from their actions without first considering contextual factors, such as that person's own suffering. Considering these factors allows us to become less fearful and judgemental of other people's actions. Thus, compassion could help individuals consider non-threatening interpretations of others' actions (Braehler et al., 2013). This would help to reduce the rigidity of beliefs that other people are inherently hostile and dangerous, thereby reducing paranoia and enabling the view of others as a source of safety, rather than threat.

There has been a recent movement called 'compassion for voices' which is based on a similar premise to help those who hear distressing voices (Cultural Institute at King's, 2015; Heriot-Maitland, McCarthy-Jones, Longden & Gilbert, 2019). The aim is to help individuals to understand their voices and the purpose they serve, interacting compassionately with them, rather than just responding with fear. This helps individuals feel more in control and allows the recognition that at times the underlying aim of their voices might be protective, rather than threatening. An analogous approach of increasing compassion for others in individuals with paranoia may therefore be helpful.

One way to increase compassion for other people may be through loving kindness meditation (LKM). Hoffman, Grossman, and Hinton (2011) state that LKM 'aims to develop an affective state of unconditional kindness to all people'. Changing one's affective state towards others may

aid cognitive changes, such as an increased flexibility in the interpretation of other peoples' actions and the creation of alternative schemas, such as that other people are not inherently different to us, but similar to us; other people are not inherently hostile, but loving. There is evidence supporting that LKM can cause a change in affect towards others. Hutcherson et al., (2008) randomised 93 participants from the general population to a brief LKM training or to a neutral imagery condition, finding that those trained in LKM increased in their explicit and implicit positivity towards neutral strangers, relative to a control imagery condition. LKM also resulted in individuals showing greater positive affect towards neutral strangers.

There are few studies testing the use of LKM clinically. Some evidence suggests its effectiveness for chronic pain, PTSD, and depression, though studies are mostly uncontrolled (Graser & Strangier, 2018). In the only known study of LKM in the context of psychosis, Johnson et al. (2011) found that LKM training resulted in increased positive emotions and decreased negative symptoms in 18 patients with schizophrenia. However, this study was also uncontrolled, and no measures of compassion or positive symptoms were included. There are no known studies of LKM for paranoia.

This study therefore tests the impact of LKM using the same protocol as chapter three but using LKM training instead of compassionate coach training. The hypotheses were of the same format: those trained in LKM would show an increase in compassion for others, and decreased paranoia ideation in VR, as compared to the control group. Any decrease in paranoia experienced by the experimental group would be mediated by increased compassion for others.

Method

Figure 1 shows the experimental procedure. The design, recruitment and screening procedure, measures of paranoia, and VR set up were deliberately designed to be identical to Chapter 3. There were also several differences, however. Firstly, the outcome measure of compassion for others used novel wording that had not been discussed in the compassion intervention, to help overcome the limitation of potential priming or demand characteristics. Secondly, a measure of positive affect was included, so it could be ascertained whether affect is also a mediator of change in paranoia. Finally, at the end of the study, participants in the compassion group were asked to describe how they found the compassion training so that some brief qualitative feedback could be gained. The study received ethical approval from the University of Oxford Central University Ethics Committee (CUREC).

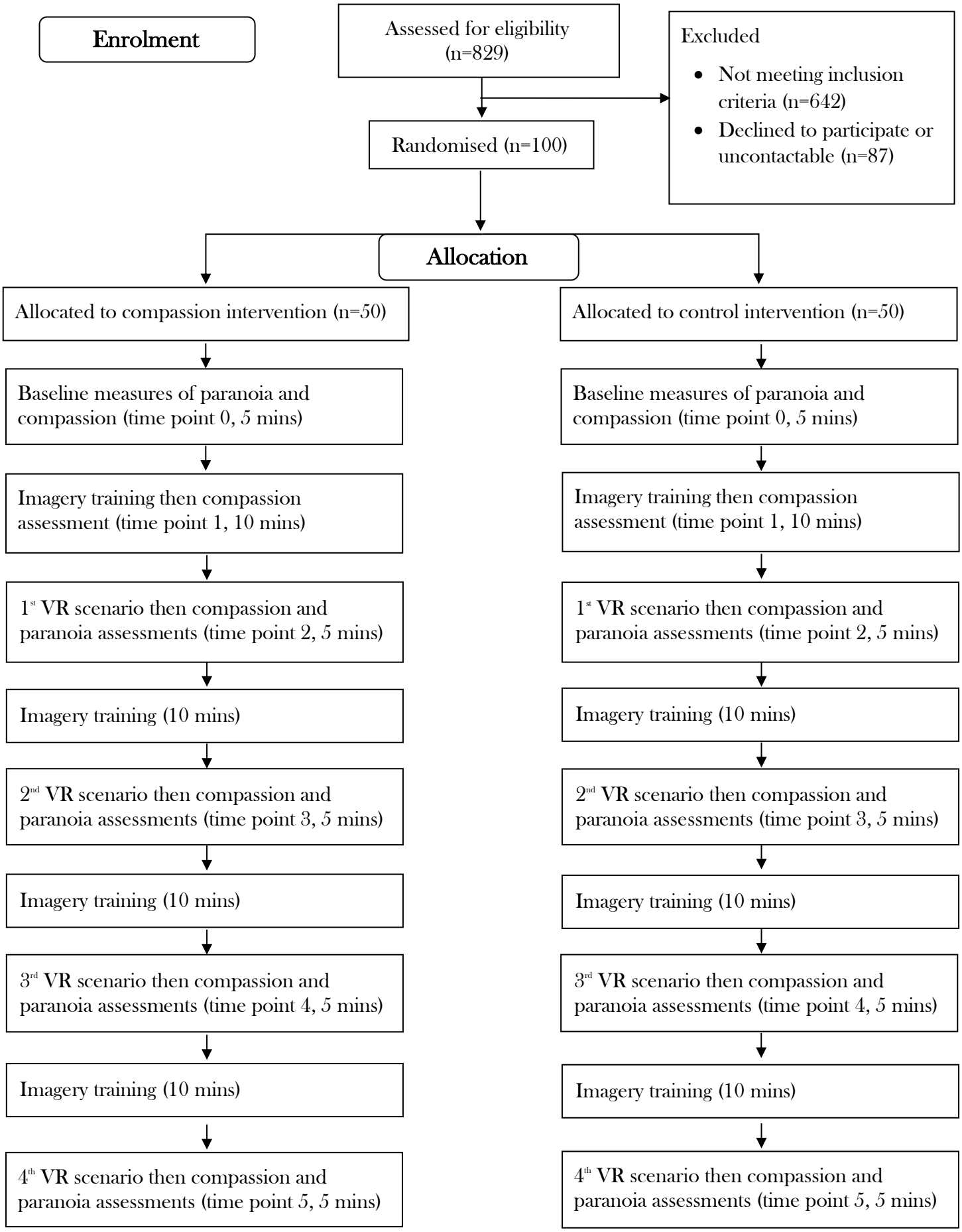

Figure 1. Experimental Procedure.

Imagery intervention

LKM uses visualisation, (e.g. imagining someone smiling at you) reflection (e.g. thinking about yours and others' positive qualities), and auditory techniques (e.g. internally repeating phrases such as 'I hope you have a good day'). A script was devised combining elements from a number of existing scripts and protocols (Hutcherson et al., 2008; Salzberg, 1995). As with study one, there were four stages of training. The first stage asked individuals to imagine receiving and sending warmth and love to one or more persons who they are very close to. For instance, it was explained:

"Reflect on their positive qualities...you could picture them being happy, maybe laughing with you"

"See if you can let yourself fill with warmth...maybe the flow of warmth is associated with a colour"

"You could repeat that you wish this person to feel happy, to have a nice day"

Individuals were then asked to imagine themselves on a bus or a train, and to try and send warmth and kindness to some of the strangers around them on the bus or train, including the driver. Each of the other stages required practising with different people, including someone who they disliked, a neutral acquaintance, and groups of family, friends, and strangers. The script for the intervention can be viewed in Appendix 2.3. The control condition was identical to study one. As in the previous study, participants entered a social situation in virtual reality in between each stage of imagery training, during which those in the compassion group were asked to further practise the exercise with the VR avatars.

Assessments

Measures of paranoia were identical to Chapter 3.

Compassion for others

Three visual analogue scales were averaged to form a measure of compassion for others used for analysis. At baseline and following the first imagery training session individuals were asked to imagine they were walking down a street before answering the analogue scales: 'Please mark on the line below how connected you would feel to the people around you'; 'Please mark on the line below how understanding you would feel of the people around you'; and 'Please mark on the line below how accepting you would feel of the people around you'. Following each VR

scenario, the questions were based on how connected, how understanding and how accepting of the VR avatars participants felt. These measures again ranged from 'Not at all' to 'Extremely'. Cronbach's alpha measure of internal consistency for the scale was 0.9. The concepts of connectedness, understanding, and acceptance were chosen as they are all key components of compassion included in both theories and measures of compassion (Neff, 2003; Pommier et al., 2019, Gilbert, 2006; Pommier, 2010), and together capture both affective and cognitive changes.

Positive affect

A visual analogue scale similarly ranging from 'Not at all' to 'Extremely' asked participants: 'Please mark on the line below how positive you feel right now'.

Analysis

Analysis was identical to Chapter 3. An additional mediation analysis was run to assess positive affect at the final time point as a mediator. R code from the analysis can be viewed in the Appendix 2.4.

Results

Demographic and baseline characteristic were very similar to study one (see Table 1). One participant had missing data for the final three time points due to running out of time after finding the first two stages of the compassion exercise particularly emotional.

Table 1. Baseline and demographic characteristics.

	Compassion (n=50)	Control (n=50)
Age (years), mean (SD)	26.9 (9.8)	28.5 (10.1)
Men/woman, *n/n*	27/23	32/18
Ethnicity, *n*		
White British/Irish	31	34
Non-White British/Irish	19	16
Employment status, *n*		
Unemployed	4	2
Full/Part-time employed	28	22
Student	17	26
Retired	1	0
GPTS Part B score at baseline, mean (SD)	30.5 (11.0)	32.5 (12.4)
Compassion for others score at baseline, mean (SD)	5.1 (2.0)	5.4 (1.7)

Hypothesis 1: Effect of condition on compassion for others

Figure 2 shows the mean scores and effect sizes for the two outcomes at each time point. The compassion group showed significantly higher levels of compassion for others at all follow-up time points relative to the control group. For the final outcome the group difference was 3.26, 95% C.I.=2.72;3.80, p=<0.0001, d=1.7.

Hypothesis 2: Effect of condition on paranoia

The compassion group showed significantly lower levels of paranoia relative to the control group at all follow-up time points. For the final outcome the group difference was –1.70, 95% C.I.=-2.50;-0.89, p=<0.0001, d=0.8.

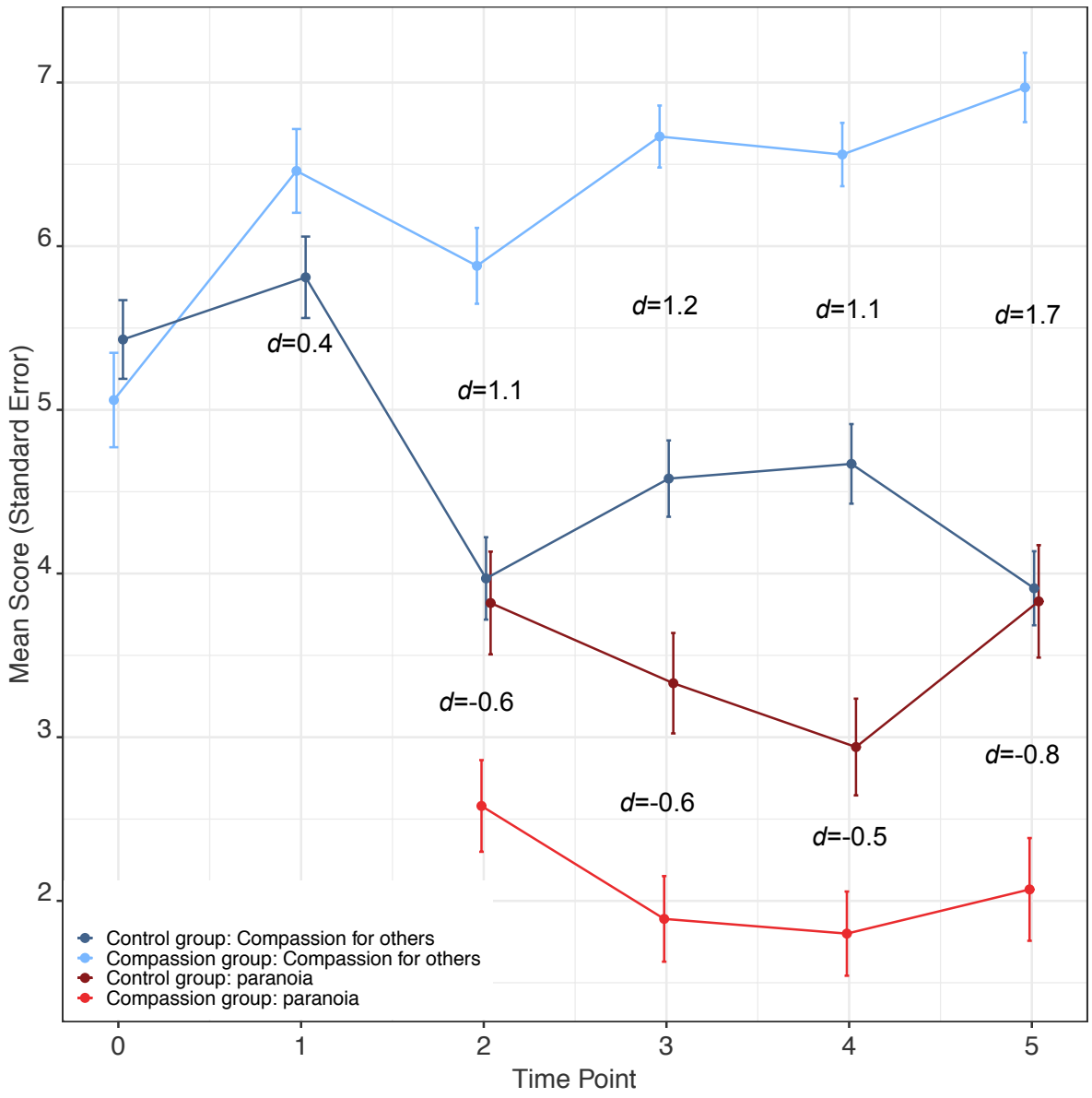

Figure 3. Scores and effect sizes for primary compassion and paranoia outcomes.

Hypothesis 3: Mediation

Table 2 shows the results from the mediation analysis. Change in compassion for others at the mid and final outcomes explained 34% and 67% respectively of the treatment effect on paranoia at the final outcome. Mediation analysis in the opposite direction indicated that changes in paranoia at the final outcome explained just 4% of the change in self-compassion at

the final time point. Change in positive affect at the final time point accounted for 47% of the change in paranoia at the final time point. Mediation in the opposite direction showed that change in paranoia accounted for 24% of the change in positive affect at final outcome.

Table 2. Total, direct, and indirect effect estimates from the mediation analysis.

	Mid time point as mediator	Final time point as mediator
Total effect (CI, *P*-value)	-1.73 (-2.55; -0.92), <0.000	-1.73 (-2.55;-0.92), <0.000
Direct effect (CI), *P*-value	-1.14 (-2.14; -0.14), 0.025	-0.58 (-1.67;0.51), 0.297
Indirect effect (CI, *P*-value)	-0.58 (-1.18; -0.02), 0.057	-1.16 (-1.94; -0.38), 0.003
Percentage mediation	33.57	66.89

Discussion

This chapter aimed to build participants' compassion for others in order to reduce paranoia, drawing on the hypothesis that paranoia builds partly on negative beliefs about others (Freeman et al., 2002). This is the first known randomised controlled experimental test of the loving kindness meditation technique in individuals with current paranoia.

As with Chapter 3, the interventionist-causal approach (Kendler & Campbell, 2009) of the study method allows for inferences to be made concerning both treatment development and causal mechanisms. There were large effect size increases in compassion for others at all time points in those trained in LKM compared to controls. This suggests that brief training in LKM, practised in VR social environments, is effective in increasing compassion for others in the short term, as operationalised by connectedness, understanding and acceptance of others. The success of the manipulation enabled the effects on paranoia to be determined. Those trained in LKM experienced significant decreases in paranoia compared to controls, which was mediated by increased compassion for others. Consequently, the same conclusions can be drawn about compassion for others as self-compassion in the previous chapter: compassion for others is likely be a contributory causal factor in paranoia, and training in LKM could be useful clinically in reducing paranoia. Many participants also reported how useful they found the training, suggesting that LKM is an acceptable as well as effective technique:

"I felt kinder to myself by the end and tried to be kinder towards others"

"I think I'll use this in situations where I don't feel as comfortable"

"It felt more like I was in a safer place...the people weren't just strangers"

Mediation analysis revealed that an increase in positive affect also explained some of the reduction in paranoia (47% compared to 67% for compassion). However, the reverse mediation estimate for the reduction in paranoia mediating the increase in positive affect was 24%, much higher than reverse mediation for compassion, which was just 4%. This may suggest that positive affect acts as a moderator rather than mediator.

The mechanisms underlying LKM have been debated (see Graser & Stangier et al., 2018 for a discussion), with some studies emphasising the importance of positive affect and others emphasising cognitive flexibility and perspective taking. As was noted in the previous chapter, a limitation of the study design used here is the difficulty in disentangling the exact causal pathways by which the techniques exert their effects. The findings regarding positive affect in

this study support the conclusion that changes in affect partly underly LKM, but given it's apparent effect as a moderator it is likely that other mechanisms, such as increased cognitive flexibility and alternative perspective taking, may also play a role.

This study also shares many of the other limitations noted in the previous chapter, including the un-blinded design, lack of generalisability to other compassion techniques, the lack of long-term follow up, and the use of a non-clinical sample. Given one participant in this study ran out of time due to finding the compassion exercise particularly emotional, it will be important in future to consider ways of preparing individuals for potentially experiencing high levels of emotion during LKM, particularly when using the intervention in clinical populations.

The study also has some additional strengths compared to the previous chapter, namely the use of novel wording in the outcome measures to ensure no priming effects, and the measurement of positive affect to demonstrate its role in the causal pathway. Overall, the study provides promising initial evidence that low compassion for others may be a contributory causal factor in the occurrence of paranoia, and that LKM may be a useful therapeutic technique for reducing paranoia.

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Chapter 5

Power posing for paranoia: A double-blind randomised controlled experimental test using virtual reality

This chapter has been adapted from the follow paper, attached in Appendix 6.3.
Brown, P., Waite, F., Rovira, A., & Freeman, D. (2020). Power posing for paranoia: A double-blind randomised controlled experimental test using virtual reality. Behaviour Research and Therapy, 132, 103691.

Abstract

Background: Paranoia is theorised to build upon negative beliefs about the self, including low self-esteem and inferior social rank. Power posing has been shown to increase feelings of power, and hence could be a way of helping to reduce negative beliefs, and thus reduce paranoia. The aim of this chapter is to test this hypothesis.

Method: One hundred participants with current paranoia and 50 individuals without paranoia were recruited. Using a double-blind randomised controlled experimental design, participants twice held powerful or neutral postures before entering neutral virtual reality social environments.

Results: In the sample reporting current paranoia at screening, those who held a powerful pose did not significantly increase in feelings of power by the end of testing in comparison to controls (group difference=0.67, C.I.=-1.12;1.46; p=0.098), or decrease in paranoia (group difference=0.23, C.I.=-1.17;0.72; p=0.634). In the sample reporting no current paranoia at screening, there was a small significant increase in powerful feelings by the end of testing in the powerful group compared to controls (group difference=1.13, C.I.=0.23;2.02; p=0.013), but no significant decrease in paranoia (group difference=0.71, C.I.=-2.16;0.74; p=0.338). Paranoia status was not a modifier on the relationship between condition and feelings of power.

Conclusions: Power posing results in only very small changes in self-reported feelings of power and has no subsequent effect on paranoia.

Introduction

The previous two chapters demonstrated the promise of using compassion interventions to reduce paranoia. This chapter focusses on an intervention that targets a different kind of negative self-belief, namely ideas about low levels of power and inferior social rank. Power posing is a technique that has previously been used as a method for increasing feelings of power. This study therefore tests for the first time whether power posing may be a beneficial technique for reducing paranoia.

Power posing is the taking of an expansive and open posture. In both humans and non-human primates, such a posture is reflective of high power and status, whereas contractive and closed postures reflect low power and status (de Waal, 1998; Carney, Hall & Smith LeBeau, 2005; Hall, Coats & LeNeau, 2005). Behavioural and physiological effects of power posing such as increased risk taking, increased testosterone, and decreased cortisol have been contested due to a lack of replication (e.g., Ranehill et al., 2015) and selective reporting (Simmons & Simonsohn, 2017). On the other hand, there have been replicated findings that power posing can increase self-reported feelings of power (Gronau et al., 2017; Cuddy, Schulz & Fosse, 2018), though the methodological quality of studies varies (Carney, Cuddy & Yap, 2015). For example, while most of the 33 studies included in Carney et al.'s (2015) review used randomised and controlled designs, it was rare that studies were well powered. Few reported power calculations, but given sample sizes rarely reached 100, studies typically only had power to detect large effect sizes. Moreover, the strength of participants' poses (i.e., to what extent they were successfully holding a power pose) was rarely rated, and few studies were preregistered. Given the evidence of selective reporting in power posing research (Simmons & Simonsohn, 2017) pre-registration is considered important.

Low levels of beliefs about power, control, and social rank are thought to be important in the occurrence of many mental health conditions (e.g. Watson, 1967; Radloff & Monroe, 1978; Benassi, Dufour & Sweeney, 1988, Allan & Gilbert, 1997). Paranoia specifically has been associated with feelings of low social rank and powerlessness, as well as submissive behaviours (Freeman et al., 2005). In an experimental study of 60 females reporting paranoia, it was found that reducing participants' height in VR social scenarios, as a proxy for reducing social rank, resulted in more negative views of the self and increased paranoia. Power posing has received considerable attention in the literature as a way to increase feelings of power and reduce anxiety, suggesting it may have the potential to be beneficial clinically (Cuddy, Wilmuth, Yap &

Carney, 2015). This chapter reports a double-blind, randomised controlled intervention study to test the effects of power posing on self-reported feelings of power and paranoia in individuals from the general population with current paranoia, using a similar design as in the previous two chapters.

The study firstly set out to test whether the psychological effect of power posing could be replicated. Therefore, the first hypothesis was that those who were randomised to take a powerful pose would report feeling more powerful than those who took a neutral pose. Secondly, it was hypothesised that those who assumed a powerful pose would experience decreased paranoid ideation in virtual reality (VR) social situations as compared to those who assumed the neutral pose. Finally, it was hypothesised that any decrease in paranoia experienced by the power posing group would be partially mediated by increased feelings of power.

Method

The recruitment and screening procedure, measures of paranoia, and VR set up were designed to be identical to the previous two experiments reported in Chapters 3 and 4.

Design

The study had a between-groups design, as in the previous two chapters, but there were differences in other design aspects. Each participant took part in a single 30-minute session. After completing baseline measures of paranoia and feelings of power, participants were randomised to the power or neutral condition. An independent researcher used an online generator to create the randomisation sequence with separate randomisation sequences created for the two participant samples: with and without paranoia at screening. The study was double-blind. Participants were unaware of study hypotheses or that they were being randomised to hold a powerful or neutral pose (they were provided with a cover story as to the reason for standing in a certain way), and the candidate (PB) was blind to which pose participants were randomised to hold. Participants held the powerful or neutral pose twice, once before each of two entries to VR social environments (the underground train then the lift). Figure 1 summarises the experimental procedure. The study was pre-registered with Open Science Framework and received ethical approval from the University of Oxford Central University Ethics Committee (CUREC).

Amendment to Protocol

After pre-registering the study, it was decided to collect data from an additional 50 participants who reported no paranoia at screening (the minimum score of 16 on the GPTS-B). Given power posing has never previously been tested in individuals with paranoia, it seemed important to be able to test the possibility that any difference in effect of the power manipulation between this study and previous studies could be due to the population selected i.e. the participants' paranoia, rather than the manipulation itself.

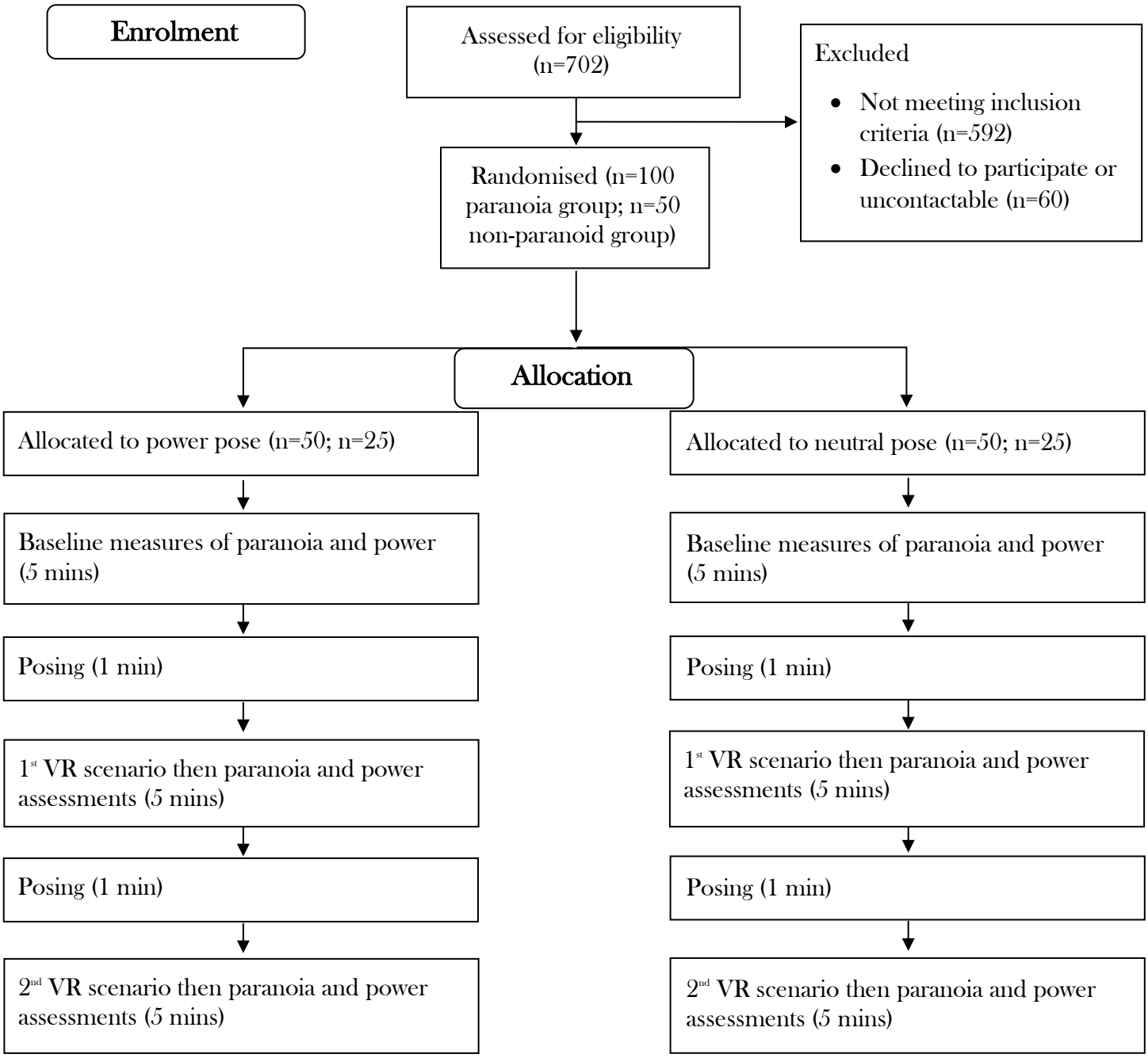

Figure 1. Experimental procedure.

Procedure

The study replicated procedure from previous studies on power posing. The power pose employed was that used in study one of Yapp et al. (2013) and Cuddy et al. (2015). The neutral control pose was adapted from Cuddy et al. (2015) to be neutral rather than low power by uncrossing feet and arms. Figure 2 shows both the powerful and neutral poses. Participants assumed poses for one minute, given this has previously been shown to be sufficient to elicit an effect (Carney, Cuddy & Yapp, 2010). Moreover, each participant in the present study would be posing twice, five minutes apart, leading to a total of two minutes of posing.

Figure 2. Power (left) and neutral (right) poses.

There were just two key differences between the current study and previous studies of power posing. Firstly, the control condition was designed to be a neutral pose, rather than a low power pose. This was to enable the detection of positive effects of power posing rather than potentially a negative effect of a contractive pose. Secondly, participants did not complete a filler task while posing. Previous studies have used tasks such as forming impressions of faces (Carney et al.,

2010) or verbal tasks (Ranehill et al., 2015). It was chosen not to employ a filler task during poses in the present study because the rationale given for using a social filler task is that power posing is most effective in a social context. However, many studies have found power-posing effects using filler tasks without social components (Ranehill et al., 2015; Fischer et al., 2011, studies 2 and 3; Yap et al., 2013, studies 2 and 3), suggesting the filler task does not serve any particular known purpose. Moreover, if power posing were to be used by individuals in their daily lives, for example before doing something challenging, this would presumably be done without a filler task.

To ensure the researcher was blind to randomisation group, participants received instructions on how to pose via a video displayed on a computer screen while the researcher was out of the room. Participants were informed that they were following instructions which would allow the VR tracking system to calibrate to their body. To increase the credibility of this, participants were asked to wear VR trackers on their arms and ankles for the duration of the study. Participants were video recorded while posing so that afterwards each participant could be rated on the strength of their power pose, or whether they correctly assumed the neutral pose. Two independent raters watched the videos, rating the power poses as strong, moderate or weak, and the neutral poses as correct or incorrect.

Assessments

Measures of paranoia were identical to Chapter 3.

Power

A visual analogue scale was used to measure self-reported feelings of power. At baseline and immediately after posing participants were asked: 'Please mark on the line below how powerful you feel right now'. After each entry to VR participants were similarly asked: 'Please mark on the line below how powerful you felt during the virtual reality scenario'.

VR scenarios

The VR set up was the same as in Chapters 2 and 3, except only two scenarios were required instead of four. Participants first entered the tube train with 13 avatars (four around them in the central area of the carriage) and then the lift scenario with four avatars.

Analysis

The analysis was planned identically to the previous two chapters (although with two outcome time points rather than four). Data were entered by an independent researcher and primary outcomes were double rated by a second independent researcher blind to both participant condition and study hypotheses. After deciding to collect data from an additional 50 participants without paranoia, analysis was planned that repeated the analysis separately on this group. R code from the analysis can be viewed in Appendix 3.5.

Results

There were no missing data. Table 1 shows the demographic and baseline characteristics of the participants. Participants were predominantly females and in their mid-thirties. Within the group who were recruited for reporting paranoia at screening, the mean GPTS-B scores of 35.8 and 32.1 in the power and control groups respectively indicated similar baseline levels of paranoia as in Chapters 3 and 4.

Table 1. Baseline and demographic variables by randomisation group.

	Group with paranoia		Group without paranoia	
	Power (n=50)	Control (n=50)	Power (n=25)	Control (n=25)
Age (years), mean (SD)	31.3 (11.4)	35.1 (12.3)	37 (14.8)	38.4 (14.5)
Men/woman, *n/n*	21/29	22/28	13/12	9/16
Ethnicity, *n*				
White British/Irish	36	37	17	16
Non-White British/Irish	14	13	8	9
Employment status, *n*				
Unemployed	3	7	1	2
Full/Part-time employed	32	36	18	19
Student	13	7	4	3
Retired	2	0	2	1
GPTS Part B score at baseline, mean (SD)	35.8 (15.4)	32.1 (16.1)	16.2 (0.6)	16.8 (3.2)
Powerful feelings at baseline, mean (SD)	4.9 (2.2)	5.6 (2.1)	6.6 (1.8)	6.6 (1.7)

Inter-rater reliability

Out of the 100 power posing videos in the participant group with paranoia (two videos per participant), 89 were rated as strong, 11 as moderate, and zero as weak by the first independent researcher. Ninety-two were rated as strong, 8 as moderate, and zero as weak by the second independent researcher. There was disagreement on the category for only five videos (but no pose was rated as weak). For the control group, all 50 individuals were rated by both independent researchers as correctly holding the neutral pose on both occasions.

Of the 50 power posing videos in the participant group who were recruited for reporting no paranoia at screening, 49 were rated as strong, zero as moderate, and one as weak by the first independent researcher, and 47 as strong, two as moderate and one as weak by the second rater. There was disagreement on two videos. All 25 individuals were rated by both independent researchers as correctly holding the neutral pose on both occasions.

Hypothesis 1: Effect of condition on feelings of power

Table 2 shows the mean scores and effect sizes for the two outcomes at each time point.

Group with paranoia at screening (n=100)

There were no significant differences between the experimental and control groups in self-reported feelings of power immediately after posing, or in the middle (after the first VR scenario) time point (group difference=0.66, C.I.=-1.30;1.45; p=0.102), or final (after the second VR scenario) time point (group difference=0.67, C.I.=-1.12;1.46; p=0.098).

Group without paranoia at screening (n=50)

Immediately after posing there were no significant differences between the power and control group in self-reported feelings of power. A significant difference was seen both at the middle time point (group difference=1.20, 95% C.I.=0.30;2.09, p=0.009), and at the final time point (group difference=1.13, C.I.=0.23;2.02; p=0.013).

Hypothesis 2: Effect of condition on paranoia

Group with paranoia at screening (n=100)

There were no significant differences in paranoia between the power and control groups at any time point (group difference at final time point=0.23, C.I.=-1.17;0.72; p=0.634).

Group without paranoia at screening (n=50)

There were no significant differences in paranoia between the power and control groups at any time point (group difference at final time point =0.71, C.I.=-2.16;0.74; p=0.338).

Due to the lack of change in paranoia mediation analysis was not performed.

Table 2. Scores for primary power and paranoia outcomes.

	Power group: mean (SD)	Control group: mean (SD)	Adjusted mean difference (95% CI)	*P*-value	Standardised effect size
Group with paranoia (n=50): Powerful feelings					
Baseline	4.90 (2.18)	5.60 (2.07)			
Time 1	5.26 (2.34)	5.88 (2.12)	-0.21 (-1.0; 0.58)	0.609	0.1
Time 2	4.91 (2.37)	4.67 (2.50)	0.66 (-0.13; 1.45)	0.102	0.3
Time 3	4.87 (2.61)	4.62 (2.16)	0.67 (-0.12; 1.46)	0.098	0.3
Group with paranoia (n=50): Paranoia					
Time 2	3.83 (2.31)	4.31 (2.41)	-0.62 (-1.56; 0.32)	0.201	-0.3
Time 3	3.68 (2.82)	3.77 (2.57)	-0.23 (-1.17; 0.72)	0.634	-0.1
Group without paranoia (n=25): Powerful feelings					
Baseline	6.66 (1.78)	6.61 (1.72)			
Time 1	7.20 (1.83)	6.88 (1.63)	0.28 (-0.61; 1.17)	0.539	0.2
Time 2	7.25 (1.77)	6.02 (2.47)	1.20 (0.30; 2.09)	0.009	0.7
Time 3	6.85 (1.85)	5.68 (2.64)	1.13 (0.23; 2.02)	0.013	0.6
Group without paranoia (n=25): Paranoia					
Time 2	2.77 (2.30)	3.52 (3.20)	-0.80 (-2.26; 0.64)	0.278	-0.3
Time 3	2.79 (2.62)	3.45 (2.12)	-0.71 (-2.16; 0.74)	0.338	-0.3

Post-hoc analysis

Given a significant effect for power posing was seen in the group without paranoia at screening, but not in the group with paranoia at screening, a group interaction was tested for, in case paranoia status was a moderator on the effect of condition on feelings of power. This was not significant (group difference=-0.48, C.I.=-1.5;0.55, p=0.36).

A significant overall sample effect that tested the effect of condition on feelings of power in all 150 participants in this model was seen, meaning that when combining both participant groups, those who held the powerful pose reported significantly higher feelings of power than controls (group difference=0.87, C.I.=0.04;1.71, p=0.041).

Discussion

This study tests for the first time whether power posing could increase feelings of power and reduce paranoia. The study benefited from being pre-registered, using a double-blind design, and measuring in-the-moment paranoia in neutral social situations via virtual reality simulations, as in the previous two chapters. Moreover, nearly all participants randomised to take a power pose were rated by independent researchers as doing so very strongly, and all of those in the control groups were rated as posing in the correct neutral position. Thus, it can safely be concluded that participants in the power groups were indeed power posing, and those in the control group were not. Small increases in feelings of power were seen in those who power posed, though this did not reach significance in the group reporting paranoia at screening. No effect on paranoia was seen in either group, meaning that power posing as administered did not change levels of paranoid ideation. The hypotheses were therefore not fully supported.

Nearly all aspects of the present study have been used in previous studies of power posing, all of which more conclusively report an effect of power posing on feelings of power. The measures, power stance, and use of deception was taken from Cuddy et al. (2015), the length of pose from Carney, Cuddy & Yapp, (2010), and the use of a video camera from Ranehill et al. (2015) to allow the study to be double-blind. Perhaps the only difference of note is that this study compared power posing to neutral posing, rather than contractive posing. In a recent commentary, Crede (2019) argues that previous reviews and meta-analyses of power posing (e.g., Gronau et al, 2017; Cuddy, Schulz & Fosse, 2018) fail to distinguish between negative effects of contractive posing and positive effects of power posing. The results of the present study could therefore be taken to support the hypothesis that previous findings of a power pose effect may partly be detecting a negative effect of contractive posing, rather than just a positive effect of power posing.

That no significant effect of power posing was seen immediately after posing and before entering VR in the group without paranoia at screening could suggest that the effects of power posing are only displayed within a social context, i.e., within the VR social environments in this study. However, Ranehill et al.'s (2015) study had no social element to it, yet they still found an effect on feelings of power. It is therefore not clear why no effect of power posing on feelings of power was seen immediately after posing. It may be that it takes time for the feelings of power to evoke, or perhaps that prior to entering VR participants were preoccupied with thoughts about what the VR scenarios would be like.

That power posing did not significantly increase feelings of power in the group reporting paranoia at screening suggested that power poses are perhaps less successful in this population, potentially because individuals with paranoia feel more exposed rather than powerful during power posing, or because the presence of a video camera was particularly unsettling to these individuals. However, the post-hoc analysis did not support this hypothesis. Paranoia status was not a moderator of the results, meaning the lack of effect in the group with paranoia was not due to the nature of the sample. This combined analysis also revealed a significant total sample effect of condition on feelings of power, suggesting that in the total group there was a significant increase in feelings of power in those who power posed. The lack of significant effect in the paranoia group alone could therefore be due to higher variability in this group. The large standard deviations seen in this group could support this interpretation.

Indeed the sample size of the study can be considered a limitation. The study was powered to detect only moderate to large effect sizes given that this size of effect is desirable for clinical interventions, but it is possible that a larger sample size would have resulted in a statistically significant effect of power posing. Additionally, although a cover story was used in order to create a double-blind design, the extent to which participants believed the cover story was not assessed. Given participants may have been familiar with the concept of power posing, it is possible that some participants – particularly those in the experimental condition – may have guessed the true aims of the study, thus compromising the double-blind design. A further limitation of the study is that there will be bias present in the recruitment process, as with Chapters 3 and 4. Finally, another limitation in common with the previous two chapters is that the study only tested one kind of manipulation. Future research could look at adaptations of power posing that may elicit greater change, for example continuing to stand powerfully while in a challenging situation or making participants aware of the hypothesis in case a cognitive element helps to elicit change in feelings of power. Nonetheless, this study aimed to test the effects of power posing, and it seems clear from the results that power posing likely elicits only very small changes in feelings of power.

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Chapter 6

Parenting behaviours, negative beliefs, and paranoia: A network analysis and results from the National Comorbidity Survey-Adolescents (NCS-A)

This chapter has been adapted from the follow paper, attached in Appendix 6.4.
Brown, P., Waite, F., Freeman, D. (2021). *Parenting behaviour and paranoia: A network analysis and results from the National Comorbidity Survey-Adolescents (NCS-A). Social Psychiatry and Psychiatric Epidemiology 56, 593–604.*

Abstract

Background: Parenting behaviours - including the extent to which parents are protective, hostile, or caring - likely impacts the beliefs that children develop about themselves and others. Negative beliefs about the self and others are contributory factors to the occurrence of paranoia. The aim of this chapter is to assess whether there is an association between specific parenting behaviour and paranoia, and whether this association might be mediated by cognitive-affective variables such as low compassion and self-esteem.

Method: Cross-sectional associations of parenting and paranoia were examined in an epidemiologically representative cohort of 10,148 adolescents (National Comorbidity Survey-Adolescents; NCS-A) and a second dataset of 1,286 adults in Oxfordshire. Further, a network analysis was conducted with paranoia, parenting behaviour, and cognitive-affective variables (compassion, self-esteem, anxiety, and depression). Overprotectiveness, verbal abuse, physical abuse, and amount of care were assessed in both mothers and fathers separately.

Results: Nearly all parenting variables were significantly associated with paranoia, with parental verbal and physical abuse showing the largest associations. For example, the odds of reporting paranoia was over four times higher for those in the adult sample reporting a lot of severe paternal physical abuse, compared to those reporting none (OR=4.12, p<0.001, CI:2.47-6.85). Network analyses revealed high interconnectivity between paranoia, parenting style, and

cognitive-affective variables. The shortest path between paranoia and all parenting variables, except paternal abuse, was through maternal indifference, and not through any of the cognitive-affective variables.

Conclusion: There are associations between participants' self-reported experiences of parental behaviours and paranoia. Cognitive-affective variables such as low compassion and self-esteem were associated with paranoia and parenting behaviours but did not appear to mediate the relationship between parenting and paranoia, which is surprising.

Introduction

The experimental studies conducted in this thesis so far have focussed on identifying techniques to reduce the contribution of negative beliefs about the self and others in the occurrence of paranoia. This chapter considers how these negative beliefs may form in the first place. Cognitive mechanisms will inevitably be impacted by environmental and biological factors, the complexity of which needs to be built into explanatory models. The influence of the environment on the occurrence of paranoia has been found to be substantial; with one estimate suggesting non-shared environmental influences explain 49% of variance in paranoia (Zavos et al., 2014). Identifying factors that influence cognitive mechanisms is important for informing preventative work. An obvious potential contributory factor that could influence views of the self and others is parenting style. Previous research has predominantly focussed on the relationship between childhood trauma and paranoia, with less research investigating more precise links. This chapter therefore investigates the association between specific aspects of parenting, cognitive-affective processes (such as compassion and self-esteem), and paranoia.

Childhood physical abuse, sexual abuse, and other victimisation experiences have been associated with paranoia (Read et al., 2003; Janssen et al., 2004), with cognitive models suggesting these experiences exert influence via the development of negative beliefs about the self and others (Garety et al., 2001; Bentall et al., 2001). Parenting behaviour has also been posited as a plausible contributory factor to the development of negative beliefs (Gilbert, 2005). Parental behaviours have been investigated in relation to a number of mental health conditions. For example, over-protectiveness and low parental care have been associated with anxiety (Lieb et al., 2000; Spokas and Heimberg, 2009) and depression (Gotlib et al., 1988). Such parental behaviours have also been associated with schizophrenia. Read et al., (2008) review a number of studies investigating 'affectionless control', that is, high perceived overprotectiveness but low care by parents of individuals with schizophrenia. They found evidence for an association between affectionless control and schizophrenia, particularly among fathers. Parker, Tupling and Brown (1979) suggest that levels of parental protectiveness can range from excessive contact, intrusion, control, infantilization, and the prevention of independent behaviour to allowing of complete autonomy and independence. Similarly, levels of care can range from emotional warmth, affection, closeness, and empathy, to emotional coldness, neglect, and indifference. While it might be argued that the link between this kind of parental behaviour and schizophrenia is predominately genetic, Onstad et al., (1994) showed that for both monozygotic (MZ) and dizygotic (DZ) twins, the twin later diagnosed with schizophrenia

reported more overprotection than the other twin. Given MZ twins are genetically identical, this suggests the association between parental over-protection and schizophrenia symptoms is not purely a genetic one.

How might parenting behaviour link to paranoia? Gilbert (2005) argues that when parents are unable to create safe and warm environments, children will experience the under-stimulation of positive affect associated with the soothing system, and instead will become threat focussed, seeing others as a source of threat and themselves as vulnerable. Considering more precise relationships, perhaps the experience of overprotection could lead a child to develop schemas about the world as dangerous and themselves as vulnerable, in order to explain the protection. Similarly, experiencing low care from parents could lead a child to develop the kinds of negative self-beliefs that paranoia builds upon, e.g. that they are unworthy of care and therefore inferior to others. Finally, negative beliefs about the self and others are often developed in the context of adverse interpersonal experiences (Freeman, 2016). Experiencing abuse, particularly from a trusted figure such as a parent during childhood, could therefore also result in the development of negative schemes about the self and others. Indeed, a recent network analysis found that negative beliefs about the self and world accounted for associations between delusions and post-traumatic stress symptoms (Hardy et al., 2020). While paranoia has been shown to be associated with having an insecure attachment style (Pickering et al., 2008), and with experiencing abuse or being taken into institutional care (Bentall et al., 2012), its association with these more specific parental behaviours has not been determined.

A manipulation approach, as used in the previous chapters, could not be employed with parenting behaviours. Consequently, this chapter was only able to examine associations between parenting, cognitive affective processes, and paranoia, rather than explicitly testing cause and effect. Associations were tested in two samples (a national epidemiological group and a newly recruited sample of adults), and a network analysis (Epskamp, Borsboom & Fried, 2018; Robinaugh et al., 2019) was used in order to conceptualise the interplay between these variables and examine potential mediating pathways. Network analysis statistically estimates complex interactions (Borsboom & Cramer, 2013) thereby allowing visualisation of the strength of associations between groups of variables, while also giving insight into potential mediating processes. The visualisation of such complex interplay enables greater learning from cross-sectional data, and the drawing of potential mediating pathways helps to generate hypotheses for future research (Epskamp et al., 2018). More generally, the network approach is

increasingly seen as an important method for allowing psychological processes to be analysed as products of complex and dynamic systems (Borsboom et al., 2011).

The hypotheses were as follows. First, that regression analysis would show positive associations between maternal and paternal overprotectiveness and paranoia and between maternal and paternal abuse and paranoia, and negative associations between amount of maternal and paternal care and paranoia in both participant groups. Second, these associations would be apparent when analysing variables as part of a network. Third, within the network, cognitive-affective variables such as levels of anxiety and self-esteem would provide a mediating pathway between paranoia and parenting behaviours.

Method

Associations between parenting behaviour and paranoia were first tested in the National Comorbidity Survey Replication Adolescent Supplement (NCS-A, Kessler et al., 2009a) and then in a new survey conducted to assess the key variables in greater depth. The NCS-A survey was administered using computer assisted, face-to-face, individual interview by professional interviewers employed by the Survey Research Centre. The interview schedule was based on the World Health Organisation Composite International Diagnostic Interview (WMH-CIDI). Merikangas et al. (2009) report further details of the adaptions to measures in the NCS-A. A hard copy of the instrument is posted at www.hcp.med.harvard.edu.ncs. The new survey was administered via Qualtrics, an online questionnaire platform.

Participants

NCS-A

The NCS-A sample included 10,148 adolescents aged 13-17 years old. 9,244 adolescent students were selected from a representative sample of 320 schools in the same nationally representative sample as the National Comorbidity Survey-Replication (NCS-R) (response rate 74.7%). The remaining 904 participants were from the same households of those that took part in the National Comorbidity Survey-Replication (NCS-R)(response rate 85.9%). The mean age was 15.18 years (SD = 1.51) and 48.9% (n=4,962) of the sample were male and 51.1% (n=5,186) female.

Oxfordshire participant group

The second participant group consisted of 1,231 adults (aged 18 or over). Participants took part in the survey as part of the screening process for the experimental study reported in the previous chapter, via social media adverts in the region of Oxfordshire, UK. The mean age of this survey group was 41.54 years (SD=15.95). Data on participant gender was not collected for the first 207 participants. Of the remaining 1,024 participants, 23.7% (n=243) were male and 76.3% (n=781) female. It is typical for online surveys to receive a considerably higher response rate from women (Sax, Gilmartin & Gryant, 2003; Smith, 2008).

Measures

NCS-A participants

Paranoia

Participants were asked to respond to the following statement with 'true', 'false', or 'don't know': "People often make fun of me behind my back'. This item has previously been used as a brief measure of paranoia (Waite and Freeman, 2017). A correlation difference test supported the internal validity of the measure by showing that this single-item measure of paranoia (n=857) had a significantly higher correlation with a 16-item measure of paranoia (the Green et al. Paranoid Thoughts Scale-Part B, Green et al., 2008) (r=0.56), than with a measure of anxiety (r=0.38), z=15.00, p<0.0001.

Parental behaviour

Participants were asked to respond to the following statements with 'a lot', 'some', 'a little', or 'not at all' for both mother and father figures separately: 'How much did he/she really care about you?'; 'How overprotective was he/she?'. Participants were asked to respond to the following lists and statements with 'often', 'sometimes', 'not very often', or 'never' for both mother and father figures separately: 'When you were growing up, how often did he/she do any of these things to you?': 'insulted or swore, shouted, yelled or screamed, threatened to hit' (verbal abuse (List A)); 'pushed, grabbed or shoved, threw something, slapped or hit' (physical abuse (List B)); 'kicked, bit or hit with a fist, beat up, choked, burned or scalded, threatened with a knife or gun' (severe physical abuse (List C)).

Oxfordshire participant group

The Oxfordshire participant group completed the same measures of paranoia and parental behaviour described for the NCS-A dataset, as well as the following measures.

Paranoia

Participants completed the Green et al. Paranoid Thoughts Scale - Part B (GPTS-B; Green et al., 2008), the same measure of paranoia used in the previous three chapters.

Parental behaviour

The Measure of Parenting Style (MOPS; Parker et al., 1997) was used. This contains 15 items measuring specific maternal parenting behaviours and the same 15 items measuring paternal parenting behaviours. It was developed to overcome shortcomings of the Parental Bond Instrument (Parker, Tupling & Brown, 1979) and assesses reported parental indifference, abuse, and over-control separately for mothers and fathers. Higher scores reflect higher reported levels of each behaviour. Alpha coefficients of internal consistency for each of the six subscales range from 0.76-0.93 (Parker et al., 1997).

Although two of the subscales were named differently from the parenting questions included in the NCS-A dataset (indifference vs amount of care and over-control vs. over-protection), they were taken in this study to be measuring the same constructs. This was justified upon Parker et al.'s (1979) descriptions of both over-protection and care described above. The items measuring abuse in the MOPS were similar to those in the NCS-A dataset in separately measuring both physical and verbal abuse.

Self-compassion

The self-compassion scale-short form (SCS-SF) was used (Raes, Pommier, Neff & Van Gucht, 2011). The scale consists of 12 items asking about how respondents typically act towards themselves in difficult times, rated on a Likert scale of one (almost never) to five (almost always), meaning higher scores reflect higher levels of self-compassion. There are six subscales but use of a total score is recommended when using the short form. The SCS-SF demonstrates good internal consistency (Cronbach's alpha > 0.85 and a near-perfect correlation with the long form of the scale when using total scores ($r > 0.96$) (Raes, Pommier, Neff & Van Gucht, 2011).

Compassion for others

Participants were given the Compassion Scale (Pommier, 2011), a 24-item scale measuring how respondents typically act towards others. As with the SCS-SF, items are rated on a Likert scale of one (almost never) to five (almost always) and there are six subscales, but a total score can also be used. Higher scores reflect higher levels of compassion for others. The scale demonstrates good internal consistency (cronbach's alpha = 0.9) (Pommier, 2011).

Anxiety and Depression

The Patient Health Questionnaire-4 (PHQ-4, Kroenke, Spitzer, Williams & Lowe, 2009) is a brief four-item scale for anxiety and depression that has been well-validated for measuring anxiety and depression in the general population (Lowe et al., 2010). Two items measure anxiety over the past two weeks and two measure depression over the past two weeks. Higher scores reflect greater anxiety and depression. Internal consistency for the scale is good (cronbach's alpha = 0.85) (Kroenke et al., 2009). The two-item measure of anxiety used has shown high sensitivity for identifying generalised anxiety (88%), panic (76%) and social anxiety (70%) as well as moderate sensitivity for PTSD (59%) (Kroenke, et al., 2007).

Self-esteem

The Rosenberg Self-Esteem Scale (Rosenberg, 1965) is a highly used ten-item measure of global self-worth that measures positive and negative feelings about the self. Items are answered using a four-point Likert scale ranging from strongly agree to strongly disagree. Scores range from 10 to 30. Five items are reverse scored so that higher total scores indicate higher self-esteem. The scale demonstrates excellent internal consistency (cronbach's alpha = 0.91) (Sinclair et al., 2010)

Analysis

NCS-A data

The NCS-A data were analysed using the Statistical Package for the Social Sciences (SPSS, version 24, IBM corp., 2016). The data were weighted to adjust for within-household differential probabilities of respondent selection. Details of the rationale and process of weighting have previously been reported (Kessler et al., 2009a, 2009b). Logistic regressions were used to test the associations between the assessments of parental behaviour and paranoia. Standard mediation analyses were not conducted due to the cross-sectional nature of the data (Maxwell and Cole, 2007). Gender was included as a co-variate in all analyses. All tests were two-tailed. The primary analysis was conducted separately for mother and father figures, given that interactions between them would be based on small amounts of data for key categories.

Oxfordshire data

First, identical logistic regressions as above were conducted using the same measures of parenting and paranoia as were included in the NCS-A dataset. Second, simple regressions were conducted for the more in-depth measures of parenting and paranoia completed by the Oxfordshire participant group.

Network analysis with the measures from the Oxfordshire survey was conducted in R, version 3.6.1 (R Core Team, 2013). The R code for analysis can be viewed in Appendix 4.2. A network modelling approach was used to estimate the partial correlations between paranoia and the other measures. In network analysis, variables are represented by nodes. Two nodes may be connected by an edge. Edges represent an association between two variables after controlling for all other variables included in the network i.e. a partial correlation. The absence of an edge between two variables indicates that the partial correlation is zero after controlling for all other variables, known as conditional independence. Associations are visualised in a network where the thickness and saturation of the edge colour corresponds to the strength of the relationship (Epskamp, et al., 2012).

Using the package qgraph, a Gaussian graphical model was fitted (Epskamp, et al., 2012). A regularisation technique with the Least Absolute Shrinkage and Selection Operator (LASSO) was used in order to overcome any potential sampling variation and limit the estimation of false positives (Tibshirani, 1996). The LASSO regularisation shrinks estimates by employing a penalty that limits the sum of the partial correlation coefficients (Epskamp & Fried, 2018). The degree of regularisation is controlled by a tuning parameter, which is selected to optimise the model fit by minimising the Extended Bayesian Information Criterion (EBIC) (Foygel & Drton, 2010). The EBIC hyperparameter is set between 0 and 0.5, with a lower parameter resulting in more potential false edges being retained, and a higher parameter potentially omitting true edges from the network (Epskamp & Fried, 2018). A hyperparameter of 0.3 was therefore chosen. Using the package bootnet a non-parametric bootstrap with 5000 interactions was conducted, in order to construct 95% confidence intervals for each edge (Epskamp & Borsboom, 2018). Due to the method of regularisation edge weights are biased towards zero. Consequently, reported confidence intervals cannot be interpreted as a significance test against zero (Epskamp & Borsboom, 2018). An edge weight difference test can be conducted in order to investigate whether specific edges are significantly different in weight to each other. However, this was not done because this test tends to have low power and thus find fewer significant differences than are truly present. Additionally, the analysis does not correct for multiple

testing, meaning results must be interpreted with considerable caution (Epskamp, Borsboom & Fried, 2018).

Two separate network models were constructed to show the shortest path between paranoia and every other variable, and between the parenting variable found to have the strongest edge with paranoia, and every other variable using Dijkstra's algorithm (Dijkstra, 1959). The shortest path represents the quickest route for an interaction to occur between two variables, calculated using the strength of edge weights along each potential route. In this way, even though two nodes may share a direct path, an indirect route via an intermediary node may consist of stronger associations and therefore be a quicker route. Redundant edges are then supressed. Such a network is helpful for highlighting likely mediation pathways.

Following network estimation, it is typical to consider network inference, by assessing centrality indices (Fried et al., 2018). Centrality refers to the relative importance or influence of individual nodes, indexed by various different measures. Three types of centrality are most commonly estimated: node strength (the sum of all edges of a given node to all other nodes), betweenness (the number of times a specified node lies between two other nodes on their shortest connecting edge) and closeness (the inverse of the summed length of all shortest edges between a node and all other nodes). Centrality was therefore estimated using the package qgraph, and the stability of these estimates assessed through estimating network models based on subsets of the data, known as case-dropping. An alternative method is to construct confidence intervals for centrality indices through bootstrapping, but this method is considered to introduce a greater level of bias than case dropping (Epskamp, Borsboom & Fried, 2018). To quantify stability, the CS-coefficient was calculated, which quantifies the maximum proportion of cases that can be dropped to retain, with 95% certainty, a correlation with the original centrality of higher than 0.7 (Epskamp, Borsboom & Fried, 2018). This was computed using the corStability function. An estimate of 0.5 and above indicates sufficient stability (Epskamp, Borsboom & Fried, 2018).

Results

Hypothesis 1: Associations between parenting style and paranoia

Twenty-three per cent (n = 2,302) of participants in the NCS-A participant group endorsed the paranoia item "People often make fun of me behind my back". In the Oxfordshire group 18% (n = 226) endorsed the paranoia item. Table 1 summarises the results of the logistic regressions for both participant groups. Odds ratios of above 1.0 indicate a positive association, whereas odds ratios of below 1.0 indicate a negative association.

In the NCS-A participant group, reporting 'a lot' of maternal or paternal overprotectiveness was significantly associated with having a higher likelihood of reporting paranoia. For example, the odds of reporting paranoia was 1.62 times higher for those who reported 'a lot' of overprotectiveness from their mother figure, compared with those who reported 'none'. Conversely, in the Oxfordshire participant group, the odds ratios were in the opposite direction suggesting a negative association between reporting overprotectiveness and reporting paranoia. However, in only one instance did this reach statistical significance, and the confidence intervals for these results were also wide and mostly crossing 1.0. Patterns for all other variables across the two samples were consistent. Reporting verbal abuse and physical abuse were associated with a higher likelihood of reporting paranoia, and reporting a lot of care was conversely associated with a low likelihood of reporting paranoia.

Table 2 displays the results of the regressions in the Oxfordshire sample. The GPTS-B was significantly positively correlated with all subscales of the MOPS indicating that higher levels of parental indifference, control and abuse were associated with greater endorsement of paranoid thoughts. Anxiety and depression were also significantly positively correlated with paranoia, whereas higher levels of self-compassion, compassion for others, and self-esteem were significantly negatively correlated with paranoia.

Table 1. The cross-sectional relationship between parental behaviours and paranoia, controlling for gender.

Dependent variable: 'People often make fun of me behind my back'

Reference group: 'Not at all'/'Never'

	NCS-A Sample				Oxfordshire Sample			
	N (no. who endorsed paranoia item / no. who did not endorse paranoia item / % who endorsed paranoia item)	Odds ratio	p-value	95% C.I.	N (no. who endorsed paranoia item / no. who did not endorse paranoia item / % who endorsed paranoia item)	Odds ratio	p-value	95% C.I.
Overprotectiveness								
Mother figure								
A lot	2,962 (852, 2110, 28.8)	1.62	<0.001**	1.31-1.99	229 (39, 190, 17.0)	0.674	0.095	0.43-1.07
Some	2,834 (559, 2275, 19.7)	1.12	0.310	0.90-1.38	282 (45, 237, 16.0)	0.626	0.039*	0.40-0.98
A little	2,387 (408, 1979, 17.1)	0.95	0.664	0.77-1.18	194 (31, 163, 16.0)	0.615	0.050*	0.38-1.00
Not at all	893 (163, 730, 18.3)				257 (62, 195, 24.1)			
Father figure								
A lot	2,512 (720, 1792, 28.7)	1.31	0.002**	1.12-1.55	132 (23, 109, 17.4)	0.872	0.616	0.51-1.49
Some	2,362 (456, 1906, 19.3)	0.89	0.180	0.75-1.06	214 (37, 177, 15.3)	0.896	0.629	0.58-1.40
A little	2,565 (477, 2088, 18.6)	0.93	0.383	0.79-1.10	228 (38, 190, 16.7)	0.854	0.479	0.55-1.32
Not at all	1,637 (329, 1308, 20.1)				388 (79, 309, 20.4)			

Verbal abuse (List A)								
Mother figure								
Often	363 (128, 235, 35.3)	2.17	<0.001**	1.70-2.78	172 (54, 188, 31.4)	2.57	0.001**	1.51-4.39
Sometimes	1,262 (376, 886, 29.8)	1.79	<0.001**	1.51-2.11	222 (56, 166, 25.2)	1.82	0.026*	1.07-3.08
Not very often	2,432 (544, 1888, 22.4)	1.38	<0.001**	1.19-1.59	310 (38, 272, 12.3)	0.97	0.911	0.57-1.66
Never	5,044 (939, 5044, 18.6)				258 (29, 229, 11.2)			
Father figure								
Often	302 (109, 193, 36.1)	1.50	<0.001**	1.15-1.96	126 (52, 74, 41.3)	4.12	<0.001**	2.47-6.85
Sometimes	1,230 (360, 870, 29.3)	1.19	0.003**	1.01-1.40	198 (45, 153, 22.7)	2.03	0.004**	1.25-3.30
Not very often	2,075 (407, 1668, 19.6)	0.76	0.041*	0.66-0.88	272 (39, 233, 14.3)	1.29	0.303	0.79-2.09
Never	5,494 (1111, 4383, 20.2)				366 (41, 325, 11.2)			
Physical abuse (List B)								
Mother figure								
Often	99 (44, 55, 44.4)	2.61	<0.001**	1.72-3.96	87 (23, 64, 26.4)	1.93	0.028*	1.07-3.47
Sometimes	392 (129, 263, 32.9)	1.71	<0.001**	1.35-2.15	154 (49, 105, 31.8)	2.47	<0.001**	1.53-3.98
Not very often	877 (236, 641, 26.9)	1.34	0.001**	1.12-1.60	278 (50, 228, 18.0)	1.34	0.183	0.87-2.06
Never	7,734 (1578, 6156, 20.4)				443 (55, 388, 12.4)			
Father figure								
Often	97 (41, 56, 42.3)	1.98	0.002**	1.29-3.03	64 (24, 40, 37.5)	2.77	0.001**	1.52-5.02
Sometimes	338 (107, 231, 31.7)	1.36	0.018*	1.05-1.76	137 (39, 98, 28.5)	1.98	0.005**	1.23-3.17
Not very often	632 (163, 469, 25.8)	1.08	0.451	0.88-1.33	223 (42, 181, 18.8)	1.37	0.152	0.89-2.10

Never	8,035 (1676, 6359, 20.9)				538 (72, 466, 13.4)			
Severe physical abuse (List C)								
Mother figure								
Often	23 (11, 12, 47.8)	3.18	0.006**	1.39-7.30	14 (5, 9, 35.7)	1.89	0.293	0.58-6.18
Sometimes	39 (12, 27, 30.8)	1.56	0.212	0.78-3.12	19 (4, 15, 21.1)	0.80	0.705	0.244-2.60
Not very often	108 (39, 69, 36.1)	1.91	0.002**	1.27-2.89	42 (16, 26, 38.1)	2.35	0.014*	1.19-4.64
Never	8,933 (1926, 7007, 21.6)				887 (152, 735, 17.1)			
Father figure								
Often	27 (8, 19, 29.6)	1.13	0.779	0.48-2.67	15 (5, 10, 33.3)	2.20	0.178	0.70-6.93
Sometimes	58 (15, 43, 25.9)	1.04	0.904	0.57-1.91	34 (15, 19, 44.1)	3.97	<0.001**	1.92-8.19
Not very often	100 (32, 68, 32.0)	1.41	0.124	0.91-2.19	55 (23, 32, 41.8)	3.69	<0.001**	2.08-6.55
Never	8,918 (1933, 6985, 21.7)				858 (134, 724, 15.6)			
How much care								
Mother figure								
A lot	8,757 (1879, 6878, 21.5)	0.52	0.190	0.20-1.38	635 (81, 554, 12.8)	0.25	0.001**	0.12-0.56
Some	192 (58, 134, 30.2)	0.69	0.471	0.25-1.90	200 (51, 149, 25.5)	0.54	0.126	0.24-1.19
A little	51 (14, 37, 27.5)	0.56	0.313	0.18-1.74	95 (31, 64, 32.6)	0.64	0.304	0.28-1.49
Not at all	18 (7, 11, 38.9)				32 (14, 18, 43.8)			
Father figure								
A lot	8,217 (1719, 6498, 20.9)	0.47	0.001**	0.30-0.72	574 (82, 492, 14.3)	0.39	0.002**	0.22-0.70

Some	531 (149, 382, 28.1)	0.67	0.094	0.42-1.07	216 (40, 176, 18.5)	0.41	0.005**	0.22-0.77
A little	177 (55, 122, 31.1)	0.77	0.324	0.45-1.30	102 (25, 77, 24.5)	0.51	0.044*	0.26-0.98
Not at all	93 (35, 58, 37.6)				70 (30, 40, 42.9)			

*Significant at $p < 0.05$. **Significant at $p < 0.01$.

Table 2. Correlations between GPTS-B and all other measured variables.

	n	Correlation with GPTS-B (Pearson)	*p*-value
Mother indifference	1,252	0.298	<0.001
Mother control	1,252	0.302	<0.001
Mother abuse	1,252	0.270	<0.001
Father indifference	1,174	0.280	<0.001
Father control	1,174	0.287	<0.001
Father abuse	1,174	0.264	<0.001
Self-compassion	867	-0.407	<0.001
Compassion for others	867	-0.226	<0.001
Self-esteem	866	-0.435	<0.001
Anxiety	867	0.473	<0.001
Depression	867	0.482	<0.001

Hypotheses 2 and 3: Network analysis

Figure 1 shows the fully estimated network. Table 3 displays edge weights from paranoia to all other variables and their 95% confidence intervals. The network is highly interconnected within and between the parenting variables, cognitive-affective variables, and paranoia, confirming the presence of the significant associations seen in the regression results. Paranoia was most significantly associated with anxiety, with slightly smaller associations to all of the other cognitive-affective variables. The largest edges between paranoia and parenting behaviours were between paranoia and maternal indifference, and between paranoia and paternal abuse. A slightly smaller edge was present between paranoia and maternal control, with only very weak edges between paranoia and paternal indifference, paternal control, and maternal abuse. The strongest edge between the parenting variables and the cognitive-affective variables was between maternal control and self-compassion.

Table 3. Edge weights and confidence intervals between paranoia and all other variables.

	Edge weight to paranoia (r)	95% confidence interval
Mother indifference	0.08	0.01;0.15
Mother control	0.03	-0.03;0.09
Mother abuse	0.00	-0.04;0.05
Father indifference	0.01	-0.03;0.05
Father control	0.00	-0.04; 0.05
Father abuse	0.06	-0.01;0.12
Self-compassion	-0.03	-0.08;0.03
Compassion for others	-0.11	-0.19;-0.03
Self-esteem	-0.05	-0.11;0.01
Anxiety	0.19	0.11;0.26
Depression	0.10	0.03;0.17

Figure 2a shows the shortest paths from paranoia to the other variables. The shortest path between paranoia and all parenting variables, except paternal abuse, was through maternal indifference, indicating that a proportion of the relationship between paranoia and the parenting variables is mediated by maternal indifference. Paternal abuse, however, retained its direct relationship with paranoia. The shortest path between paranoia and all cognitive-affective variables, except compassion for others, was through anxiety, suggesting that anxiety may partially mediate the relationship between paranoia and these variables. Figure 2b shows the shortest paths from maternal indifference to all other variables. Together these figures show that the shortest paths to paranoia are separate for parenting behaviour and cognitive-affective variables.

A plot of centrality estimates can be viewed in Figure 3. The nodes differ substantially in their centrality estimates. Paternal control and depression have the highest strength, whereas paranoia and maternal indifference have the highest betweenness and closeness. A plot from the case dropping analysis can be viewed in Figure 4. Betweenness and closeness both drop quite steeply, suggesting low stability, with node strength appearing flatter and thus more stable.

This interpretation is supported by the CS-coefficients. The CS-coefficient indicates that the strength estimate (CS(cor = 0.749)) is stable and interpretable. However, this was not the case for betweenness (CS(cor = 0.05)) or closeness (CS(cor = 0.05)) which are considerably below the cut off of 0.5. Thus, the differences between nodes in their betweenness and closeness as depicted in figure 3 cannot be interpreted as true differences. It is often the case that betweenness and closeness are not reliably estimated (Epskamp, Borsboom & Fried, 2018), so this result is unsurprising.

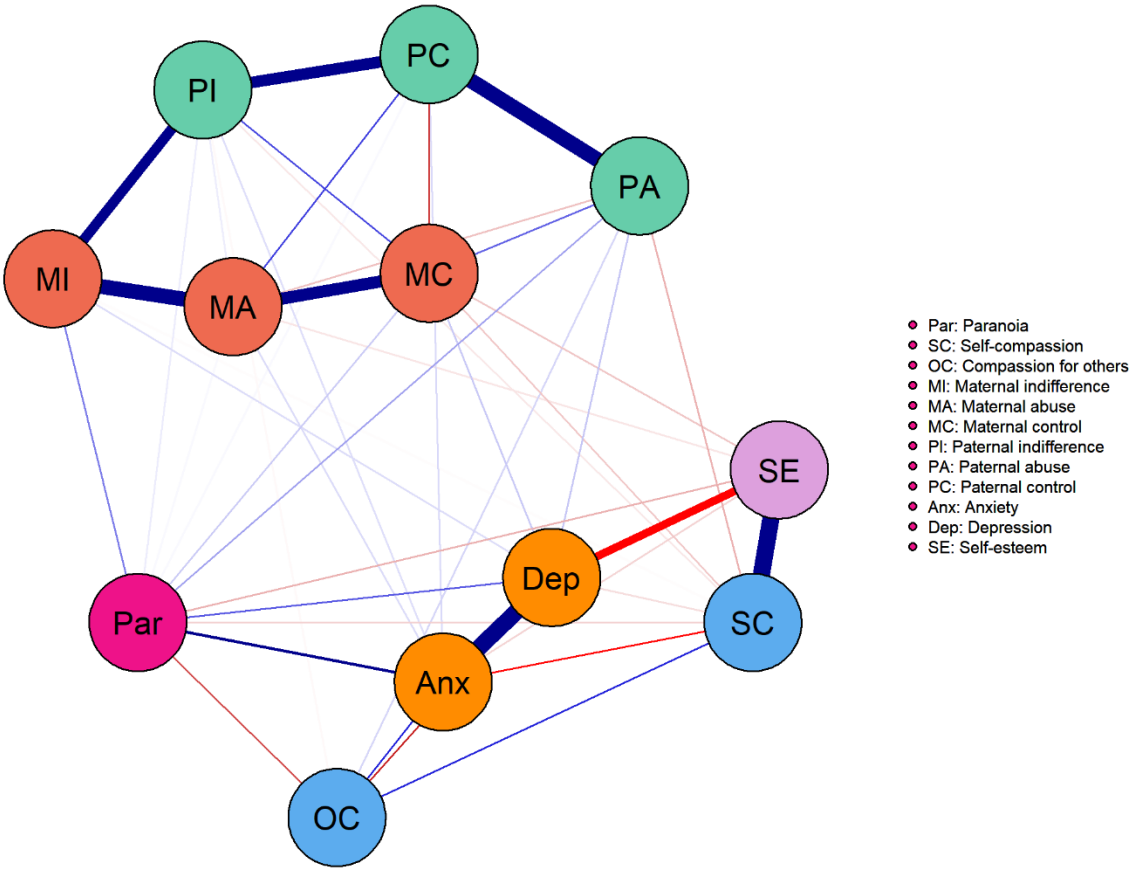

Figure 1. Fully estimated network. Blue lines indicate positive associations; red indicates negative association. Line thickness and colour saturation correspond to strength of relationship.

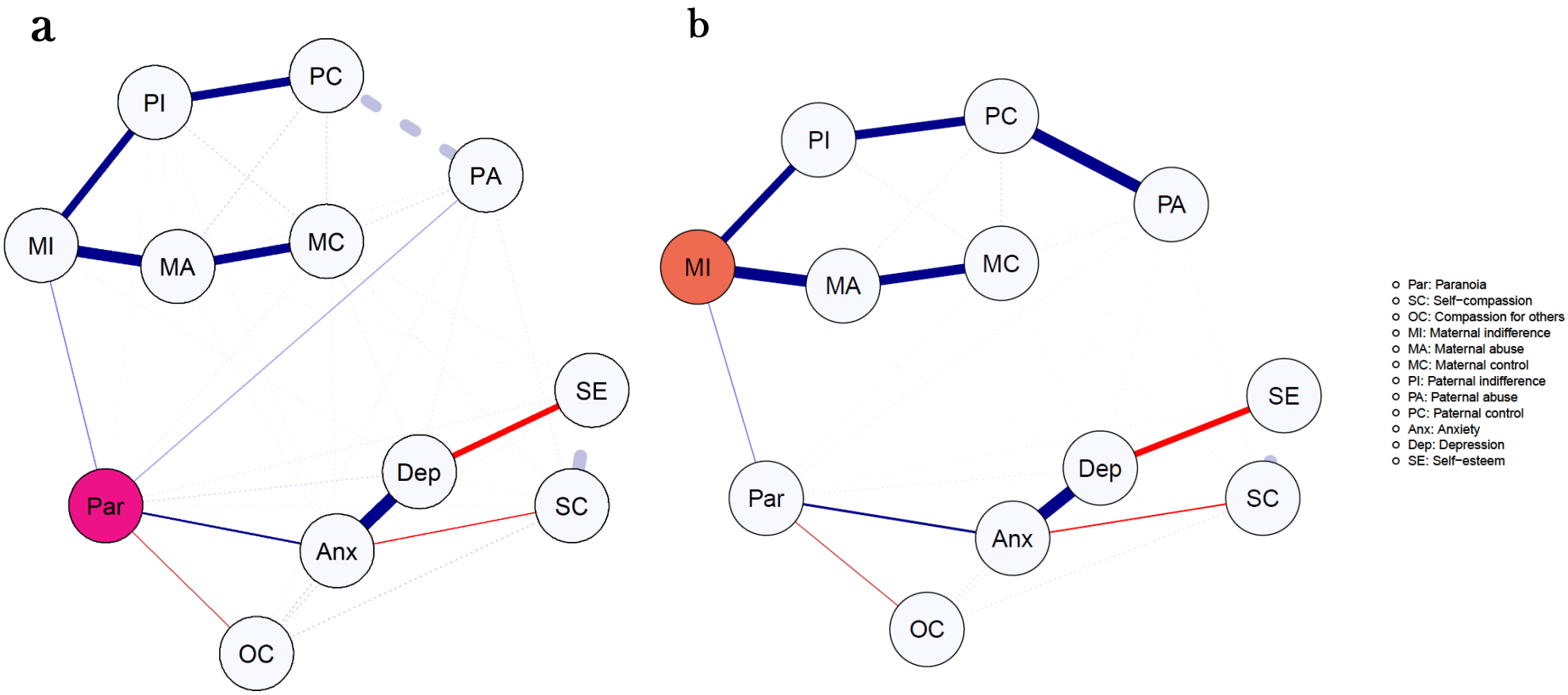

Figure 2. Shortest path analysis.

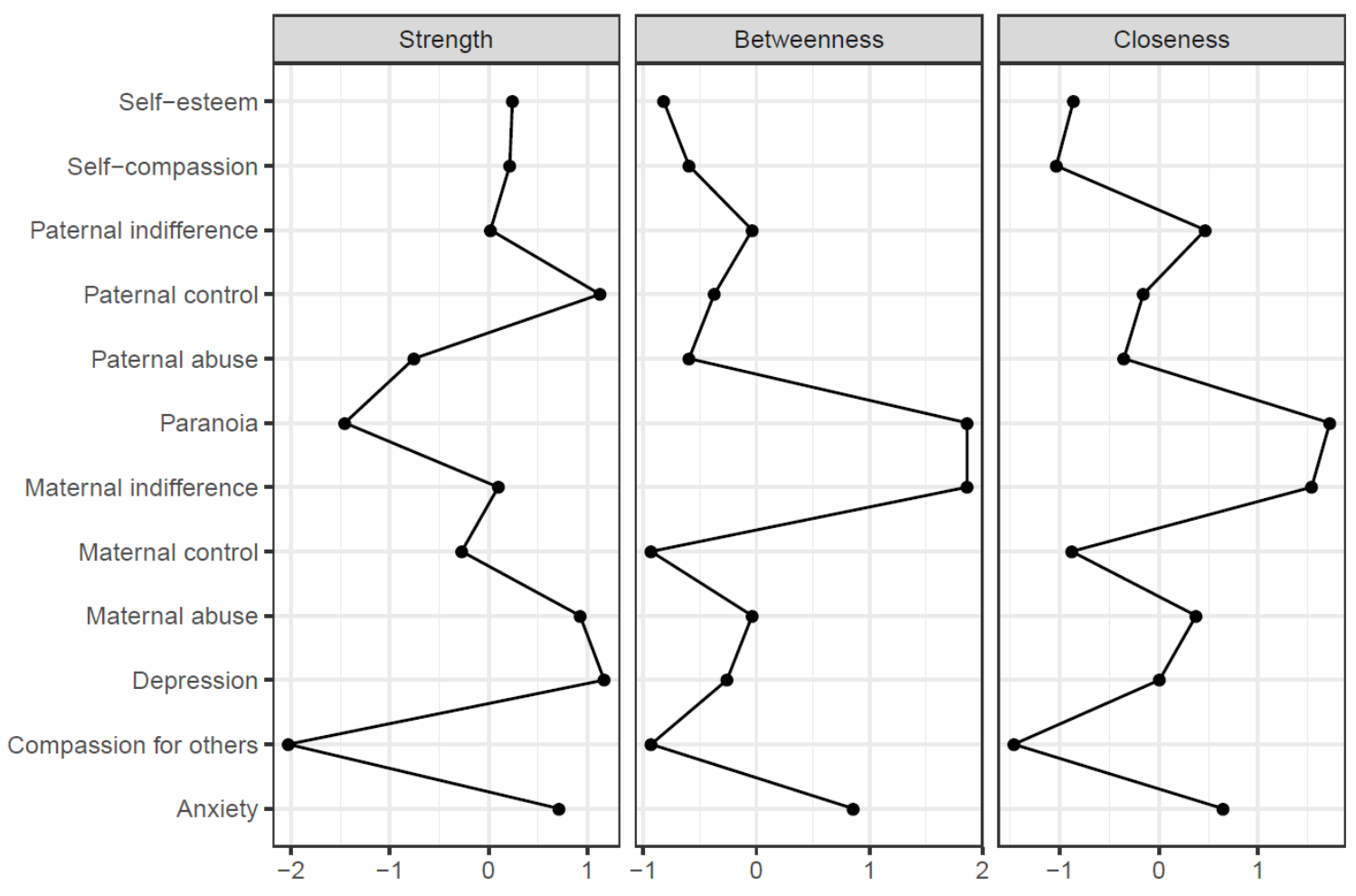

Figure 3. Plot of centrality estimates.

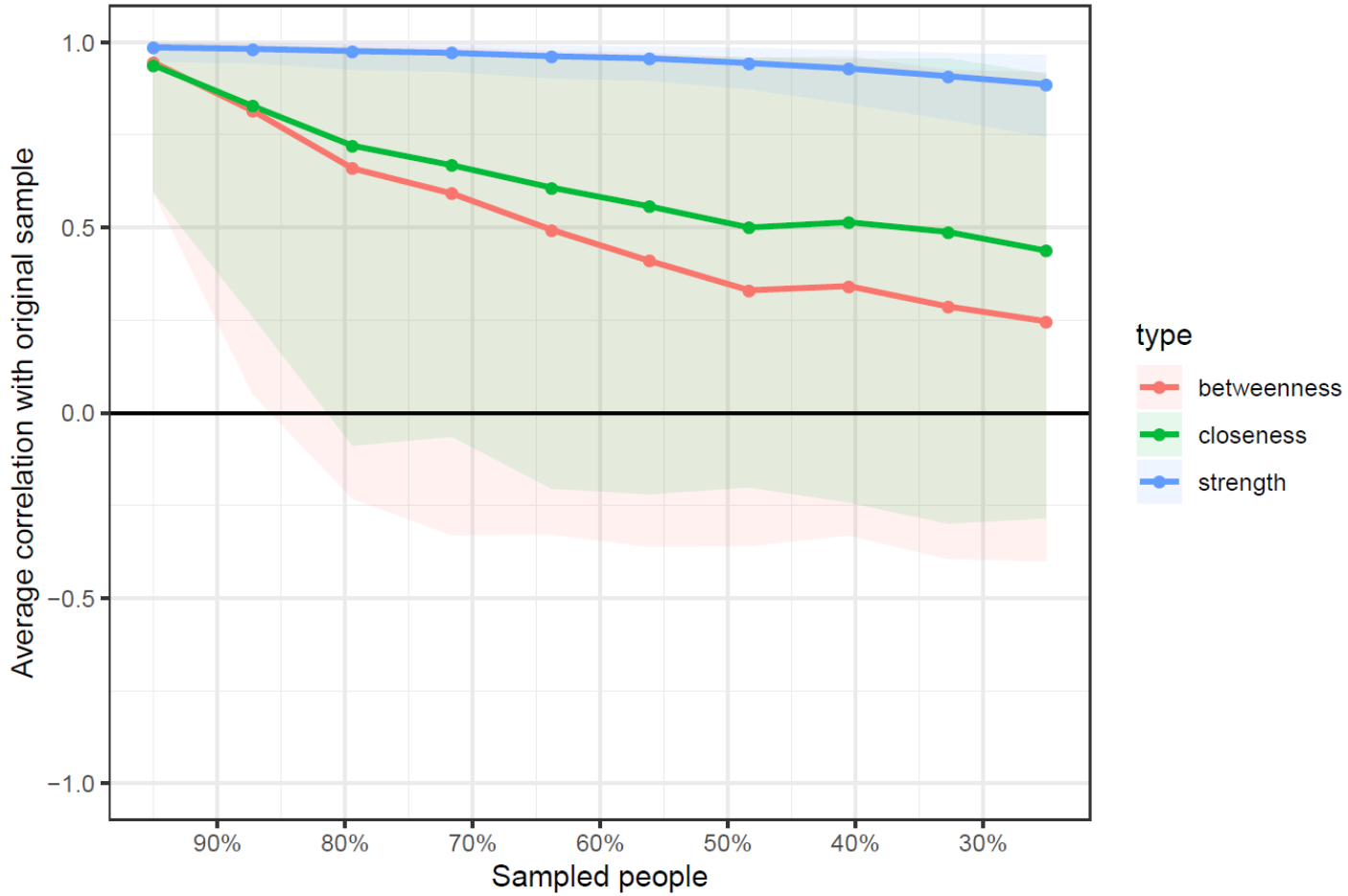

Figure 4. Case dropping analysis.

Discussion

This chapter presents an investigation into potential links between specific parental behaviours - maternal and paternal overprotectiveness, abuse, and care - and paranoia. While this thesis has so far used the manipulation method to gain precise causal evidence, manipulation of these kinds of parenting behaviours was not possible. Collecting longitudinal data would have been the next route to achieving precise causal evidence but was not possible within the scope of a single thesis chapter. Consequently, associations were examined cross-sectionally, using two datasets and statistical modelling, to try and advance some of the conclusions that could be drawn from the data.

Associations were first analysed in a large epidemiological adolescent cohort, then replicated in a smaller non-epidemiological adult sample. The limitation of the brief measures used in the adolescent cohort was addressed by replicating associations in the adult participant group using stronger measures of the concepts, as well as adding several important cognitive-affective variables into the analysis. Finally, relationships were visualised in a network, enabling the strength of relationships and potential mediating pathways to be explored. Building on previous findings that patients with persecutory delusions report low parental care and high overprotectiveness during childhood (Rankin, Bentall, Hill & Kinderman, 2005; Valiente, Romero, Hervas & Espinosa, 2014), all three levels of analysis in the current study revealed positive associations between paranoia and parental overprotection, indifference, and abuse, consistent with the first two hypotheses. It was found that the cognitive-affective variables were associated with both parental behaviours and paranoia, but that they were not likely to be mediating the pathway between paranoia and parenting behaviour. Instead mediation in this dataset is most likely to occur via maternal indifference, given the shortest path from paranoia to all parenting variables except paternal abuse was through maternal indifference.

Regressions using the single item measures of parenting and paranoia revealed consistent patterns across both participant groups. Increased levels of paranoia were associated with an increased likelihood of reporting parental verbal and physical abuse and lack of care. In the NCS-A group there were also clear associations between the single item measure of increased parental over-protectiveness and paranoia, which was not replicated in the Oxfordshire participant group. It is not clear why this was the case. Analysis of the more extensive measures still showed a positive association between mother and father over-control and paranoia in this group. It is possible that the brief measure of over-protection did not satisfactorily capture the

experiences of control measured in the MOPS. Correlations between the GPTS and MOPS showed similar levels of association with paranoia for all six subscales (maternal and paternal indifference, abuse, and control). Despite previous research finding stronger associations between reported paternal behaviour and schizophrenia, than maternal behaviour and schizophrenia (Read et al., 2008), this was not found to be the case in this analysis.

The network analysis revealed a highly interconnected network. There were associations in the full network between parenting behaviours and cognitive affective variables such as self-compassion, and between these variables and paranoia. This supported the possibility that parenting behaviours may contribute to paranoia via these variables i.e. beliefs about the self and others. However, the parenting and cognitive-affective variables also very clearly clustered separately, with the shortest path analyses suggesting that their links to paranoia were also separate. Consequently, the mediation hypothesis was not supported. It is possible that other constructs not measured are mediators. For example, attachment style was not measured because there are conceptual problems with the reliance on self-reported attachment style (Read & Gumley, 2008) and the interest was in more specific parenting behaviours. However, a measure of attachment style may have helped illuminate mediating pathways, by providing a measure of how individuals represent, internalize, and respond to their parents' behaviours. Future research could examine where variables such as attachment style lie in the causal chain, along with other potentially relevant developmental variables such as family structure or sibling relationships.

The centrality stability analysis found the only stable measure of centrality was node strength. Paternal control, depression and maternal abuse had the highest node strength, suggesting these variables might be the most influential in the network and thus could be the best targets for intervention. However, caution is needed. Centrality does not necessarily imply high causality (Dablander & Hime, 2019). Moreover, much of the node strength of depression is accounted for by its single relationship with anxiety, rather than multiple strong connections. Similarly, much of the strength of paternal control is accounted for by its relationship with paternal indifference and paternal abuse. Thus, no clear inferences from the estimates of node strength can be made with confidence.

There are a number of limitations to the study. First, demographic confounds such as socio-economic status and cognitive variables such as IQ were not tested. Previous studies assessing the relationship between early-life adversities and symptoms of psychosis have found that these

variables are associated with paranoia (e.g. Bentall et al., 2012). True associations between parental behaviours and paranoia may be smaller once accounting for these factors. Second, although well-validated, the measure of anxiety and depression was very brief. This was in order to minimise participant burden, particularly considering neither variable was of primary interest for this analysis. Nonetheless, edge strengths and mediating pathways concerning these variables may have been slightly altered had a more extensive measure been used. Third, as with all previous studies reported in this thesis, there will be bias in the recruitment process for the adult Oxfordshire sample. Recruitment was achieved primarily through social media advertisements. Participants in this group were also predominantly female. Fourth, Fried et al., (2018) argue there are three key limitations on many network studies: small samples yielding low power, few studies using clinical samples, and few studies replicating network analysis in multiple datasets. While the sample used in the present study was reasonably sized for the number of nodes, the sample was non-clinical, and the network was tested in only one dataset due to the NCS-A dataset only including a very brief measure of paranoia. Thus, inferences from the network analysis are arguably limited.

Finally, the biggest limitation is that the studies were cross-sectional, limiting causal inference. It cannot be determined whether these parental behaviours contribute to the development of paranoia, whether paranoia impacts parental relationships and thus parental behaviours, whether paranoia biases report of parental behaviours, or whether a confounding variable can explain the associations. However, regarding the possibility that paranoia biases the report of parental behaviours, it has been shown that patient reports of early experiences do tend to be unaffected by current symptoms, accurate when judged against reports of siblings, and stable over long periods, including times of acute illness versus remission (Fisher et al., 2011; Parker et al., 1982; Rankin, Bentall, Hill & Kinderman, 2005). Moreover, regarding the possibility that a confounding variable explains the relationship, a number of potentially confounding cognitive-affective variables were included in the analysis yet were not mediating variables. On the other hand, there are a number of other variables that were not measured. For example, attachment style, bullying, and other victimisation experiences could be mediators. Additionally, although the two-item measure of anxiety included has shown sensitivity to identifying multiple anxiety disorders (Kroenke et al., 2007), other more in-depth or specific measures of may have revealed a mediating link that the two-item measure did not capture.

Bradford Hill (Hill, 1965) argues that when judging whether effects might be causal, the strength and consistency of associations, temporal sequence of events, and the existence of

plausible mechanisms should be considered. Upon these criteria, it seems a causal relationship between parenting and paranoia is certainly a possible explanation of the data, whereby parental abuse, indifference, and over-control could act as contributory causal factors in the development of paranoia. Further work testing this hypothesis is needed. For example, studies on longitudinal datasets would allow a greater degree of inference as to whether or not these links go beyond correlation, and studies in clinical populations would allow investigation of any association present in more severe cases of paranoia. Further research is also needed to test the replicability of cognitive-affective variables not mediating the relationship between parenting and paranoia. This area is complex to research; there is reliance on retrospective reports and it is difficult to disentangle environmental and genetic contributions. However, this study provides initial evidence that there is a plausible mechanistic route that may be in action here.

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Chapter 7

Implementing virtual reality cognitive therapy on inpatient psychiatric wards: an interim report of a qualitative investigation into staff and patient views

The introduction and method sections of this chapter have been adapted from the following paper, attached in Appendix 6.5.
Brown, P., Waite, F., Lambe, S., Rosebrock, L., Freeman, D. (2021). Virtual Reality Cognitive Therapy in Inpatient Psychiatric Wards: Protocol for a Qualitative Investigation of Staff and Patient Views Across Multiple National Health Service Sites. JMIR Research Protocols, 9(8), e20300.

Further data collection was completed after submission of this thesis.

Abstract

Background: Automated VR therapy could allow many more patients to receive evidence-based psychological therapy. Patients on inpatient psychiatric wards in particular have very limited access to such therapy. The gameChange automated VR cognitive therapy is targeted at helping patients overcome anxious avoidance and re-engage in everyday situations (e.g. walking down a street, taking a bus, going to a shop). This treatment target may fit well for many patients preparing for discharge from psychiatric wards. This chapter explores the views of psychiatric hospital staff and patients regarding the potential to have automated VR cognitive therapy available on wards.

Method: The number of focus groups conducted was extremely restricted due to the Covid-19 pandemic. Initially it was planned to visit 1-2 wards at 5 NHS mental health trusts across England, but for a 14-month period it was not possible to visit any wards. Therefore, this chapter reports the findings from two patient focus groups and two staff interviews from a single ward. One focus group was conducted in March 2020 before the pandemic, and the remainder

were conducted in June 2021 after restrictions on conducting research were eased. Focus group questions were derived from the Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability (NASSS) framework. Firstly, expectations of VR therapy were discussed, then participants were given the opportunity to briefly try the gameChange VR therapy. Questions then focused on opinions about the therapy and investigated feasibility of adoption.

Results: Three themes were shared across both patients and staff: a surpassing of expectations, a belief that VR could help, and practical considerations around implementation. Five further themes were identified from the patient participants only: a desire for therapy, initial concerns, VR as a positive experience, concerns about VR therapy on inpatient wards, and ways of improving the therapy. Two further themes were identified from the staff participants: positive expectations of VR, and barriers and facilitators. Overall, there was considerable enthusiasm and recognition of the potential of having VR available on the wards, both for the delivery of psychological therapy, as well as using headsets for entertainment and relaxation. Participants were particularly impressed by how immersive the technology was and reported positive views of the automated virtual coach in the gameChange VR therapy. The most significant barrier to implementation was the practical limitation of providing appropriate space for staff members to deliver the therapy.

Conclusion: From this initial investigation, a key takeaway is the enthusiasm and positive feedback from all participants. Patients and staff alike viewed the automated VR therapy positively, believing it would be feasible and potentially helpful to have available. Further focus groups with patients and staff at a range of other wards will be important to identify additional barriers and facilitators to implementation.

Introduction

This thesis has so far focussed on developing greater precision in our understanding of potential causes and treatments for paranoia. However, translational treatments are only of use if they can be implemented into services, allowing individuals to receive them. Therefore, for the final chapter of this thesis it was considered important to study implementation. As outlined in Chapter 1, automated VR therapy has the potential to markedly scale up the delivery of translational psychological therapy. Current provision of psychological therapy, particularly for psychosis, is often limited (Haddock et al., 2014). This is particularly the case on inpatient psychiatric wards, which are predominantly occupied by patients with psychosis (NHS Benchmarking, 2019). Additionally, VR seems particularly appropriate for use on inpatient wards because it would allow patients to practise entering and coping with the everyday challenging situations that they have been removed from, but that they will have to face upon discharge. Little is known about the possibility of using VR therapy on inpatient wards. This chapter therefore assessed the views of psychiatric hospital staff and patients regarding implementation in this setting, identifying likely barriers and facilitators.

Psychiatric wards

Over the past 60 years, there has been an increasing move away from inpatient care and towards providing care in the community whenever possible (Papoulias, Csipke, Rose, McKellar, & Wykes, 2014). However, inpatient admission remains an important part of the care pathway when a person's illness cannot be sufficiently managed in the community (Nigel Crisp, 2015). Qualitative investigations suggest that inpatient admission is needed to provide safety and protection from difficult environments, with many patients coming from places that they found too stressful and where they were at risk of hurting themselves or others (Lindgren, Ringnér, Molin, & Graneheim, 2019).

The shift in strategy towards community care has led to a reduction in the provision of inpatient beds. Bed numbers in England fell by 62% between 1987/88 and 2009/10 from almost 70,000 to fewer than 35,000 (Nigel Crisp, 2015). For adults in England there are now just 18,000 beds, despite increases in the number of people in contact with mental health services (NHS Benchmarking, 2019). The number of admissions to psychiatric wards has fallen in accordance with reduced bed numbers, with a 19% reduction since 2011/12. However, bed occupancy remains high: 95% in 2019 (NHS Benchmarking, 2019). Average length of stay and

numbers of involuntary admissions (i.e. individuals detained under the mental health act) are also increasing (CQC, 2018). Currently in the UK, the average length of stay in psychiatric wards is approximately 46 days. First admissions tend to be briefer, with an average length of 35 days. Length of stay is longer – an average of 60 days – for those admitted involuntarily, compared to 37 days for those voluntarily admitted (Dimitri et al., 2018). In 2019, 40% of admissions were involuntary and the majority (62%) of all occupied bed days were by patients with psychosis (NHS Benchmarking, 2019), with these individuals also being the most likely to be detained (Wood, Williams, Billings, & Johnson, 2019). It is clear that the need for inpatient admission remains, but with reduced capacity the severity of illness required for admission has increased.

Inpatient wards are the most expensive form of care, with each acute adult bed costing up to £180,000 per year, the equivalent cost of supporting 44 people through a community mental health team over a year (Crisp, Smith, & Nicholson, 2016). The lack of available beds and pressures to meet targets for lower bed occupancy rates (Lodge, 2012) means ward staff are often forced to focus on achieving acute symptom reduction in patients, rather than improvement in social functioning or coping ability (Dimitri et al., 2018). Pressures are compounded by the limited availability of trained staff (Clarke & Wilson, 2009), a reliance on agency staff, and high levels of staff burnout (Johnson et al., 2011). Opportunities for staff-patient engagement in therapeutic relationships and collaborative care focused on recovery can therefore be limited (Haddock et al., 2016; Wood et al., 2019). Delivery of one-to-one or group psychological therapy is infrequent (Khan, 2011), with wards having very limited input from qualified psychologists (Radcliffe & Bird, 2016) and treatment being predominantly pharmacological (Clarke & WIlson, 2009).

A further challenge to recovery is the lack of meaningful activity on wards, with patients often feeling bored and lonely (Lindgren et al., 2019). Qualitative reports suggest that time is filled primarily with meals, smoking, and trying to look for someone to talk to (Jones et al., 2010), and that for some patients the feeling of constantly waiting is stressful and overwhelming (Lindgren, Aminoff, & Graneheim, 2015). One patient from a qualitative study described 'All you did was just sitting around and there was nothing for you to do...no program to keep you busy...it's not good...I stagnate' (Roe & Ronen, 2003). The provision of meaningful occupation

has been recognised by both staff and patients as central to recovery and wellness (Janner, 2007; Mckeown et al., 2016), but pressures on staff time often prevent it.
The lack of both therapy provision and engagement in meaningful activities means that patients are often unprepared for discharge. Although patients can access escorted and eventually unescorted leave from the ward (RCP, 2019), it is unclear how frequently this forms part of the therapeutic preparation for discharge, for example, using leave to practise coping with some of the difficult situations that may have led to a patient's admission in the first place. Consequently, although symptoms may be reduced upon discharge, patients can be ill-equipped with the skills they need to continue their recovery.

Leaving hospital often entails the re-emergence of pre-existing stressors which contributed to admission (Chung et al., 2019; Steffen, Kösters, Becker, & Puschner, 2009). This may explain why risk of relapse and re-hospitalisation immediately post discharge is high (Lay, Kawohl, & Rössler, 2019). Rates of suicide among patients in their first three months after discharge are also high, estimated at 100 times the global suicide rate, with a particular risk in the first week after discharge (Chung et al., 2019). Significant anxiety about leaving hospital, sometimes known as 'discharge grief' can be common (Jones et al., 2010). There is a clear need for greater focus on safe transition and discharge preparation. To do so, it is argued that wards must shift from a focus of predominantly observing and monitoring patients with the aim of acute symptom reduction, to actively encouraging engagement in activities and their own care management (Crisp et al., 2016; Lindgren et al., 2019).

Virtual reality therapy on inpatient wards

Immersive virtual reality (VR) technology may provide a way of facilitating patients' preparation for discharge from wards. Difficulties interacting with the social world lie at the heart of most mental health problems (Freeman et al., 2017), and it is clear that patients on wards require greater support to re-enter the external social world, which they previously found challenging (Lindgren et al., 2019), and which they are unable to access while staying on a ward. The delivery of an automated VR therapy can also be facilitated by a wider range of professionals on the ward and is not constrained to a therapist trained in specialist one-to-one psychological therapies, which is key for psychiatric wards given the shortages of qualified staff (Clarke & Wilson, 2009).

The gameChange therapy (Freeman, Yu, et al., 2019) was used as an exemplar of VR therapy to participants in this study for a number of reasons. First, the therapy was created with substantial patient involvement. Second, it is designed to help patients re-engage with the social world, a treatment target which fits well with the goals of inpatient care. Third, it is automated, and fourth, it was contemporaneously being tested in a multi-site randomised controlled trial meaning collaborations within other mental health trusts were in place.

The key mechanism utilised by the gameChange therapy concerns safety-seeking behaviours, framed in the therapy as defence behaviours. These defences are behaviours that individuals employ to help them feel safer. However, these behaviours actually serve to maintain thoughts and feelings of fear by preventing the processing of disconfirmatory evidence. Dropping defence behaviours during difficult situations allows patients to re-learn concepts of safety (Clark, 1999). The gameChange therapy therefore helps patients to identify their defence behaviours and encourages them to try dropping them in virtual social situations, thus helping to achieve new learning concerning feelings of safety and confidence. The current gameChange therapy includes six virtual scenarios: a street, café, pub, GP surgery, corner shop, and bus, with five levels of difficulty within each scenario. The user-centred design process for this therapy has been described in a recent paper (Lambe et al., 2020).

A virtual coach, Nic, guides patients through each situation and suggests new behaviours to test out. The therapy does not require a trained cognitive behavioural therapist or clinical psychologist to deliver it. While there is still someone in the room with the patient, this individual can be a peer supporter, psychology assistant, social worker or healthcare assistant, rather than a highly trained psychological therapist. This individual's role is to set up the equipment and provide any advice, support, and encouragement required in addition to Nic, and to answer any questions. VR delivery staff therefore require only brief initial training and then ongoing supervision with a psychologist. Within the gameChange randomised controlled trial patients are offered 6-8 weekly therapy sessions supported by a member of staff, typically an assistant psychologist, peer support worker or clinical psychologist. If the gameChange therapy were to be delivered to patients on wards, higher doses, perhaps daily, would be feasible.

Having VR headsets accessible on wards would also allow the use of freely available VR programmes such as physical activity games, relaxation, and meditation exercises which could be used by patients as therapeutic activities that lessen boredom and more generally enhance recovery. The feasibility of this has increased greatly due to continuous hardware improvements and reduction in costs. This means VR equipment now requires less space, is less technical, and is more user friendly than it has previously been.

Implementation framework

Implementation frameworks provide an overview of the factors that typically shape and influence the implementation process (Meyers, Durlak, & Wandersman, 2012). This study used the Nonadoption, Abandonment, and Challenges to the Scale-Up, Spread, and Sustainability (NASSS) framework for healthcare technologies (Greenhalgh et al., 2017) to inform the study design. The NASSS draws together a number of implementation models and theories and covers seven domains relating to healthcare technology implementation: the condition or illness, the technology, the value proposition, the adopter system, the organisation, the wider context, and embedding and adaptation over time. Challenges regarding each domain can be classified simple (straightforward, predictable, few components), complicated (multiple interacting components or issues), or complex (dynamic, unpredictable, not easily disaggregated into constituent components). Staff and patients were in a position to inform three of these domains with regard to implementation of VR therapy: the condition and illness that the therapy is designed for, the intended adopters of VR therapy, and the organisation. Other frameworks were also considered, for example Normalisation Process Theory (NPT) (Murray et al., 2010). However, the NASSS framework covers a wider range of potential barriers and facilitators to implementation that may be relevant at any point from design through to continued implementation, where-as NPT is more retrospective in nature.

Objectives

The study objectives were threefold:

1. To obtain staff and patient initial expectations of VR and VR psychological therapy;
2. To gain staff and patient views of an automated VR therapy (gameChange) after briefly trying it;
3. To identify potential differences and requirements for implementation across healthcare sites.

Ethical review

The gameChange trial received Health Research Authority (HRA) approval and Health and Care Research Wales approval (IRAS 256895, The gameChange Trial). The trial received ethical approval from the NHS South Central - Oxford B Research Ethics Committee (19/SC/0075). The trial has been registered (ISRCTN17308399) and the protocol published (Freeman et al., 2019). The present study received ethical approval as part of a substantial amendment.

Method

In order to increase the methodological quality and reporting, this chapter follows the guidance from the 32-item Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong, Sainsbury, & Craig, 2007).

Patient and Public Involvement

In line with the Guidance for Reporting Involvement of Patients and the Public – Short Form (GRIPP2-SF, (Staniszewska et al., 2017)) the aims, methods, results and reflections on PPI are reported.

There has been considerable patient and public involvement (PPI) in the development of the gameChange therapy and the running of the clinical trial. Within the present study, the aim was to ensure all study documentation (topic guide, information sheet, and consent form) was engaging and understandable, and to involve service users in the design of the study. A Lived Experience Advisory Panel (LEAP), facilitated by the McPin Foundation, contributed to the development of the study. Having been involved with the gameChange trial, the LEAP was familiar with the VR that would be demonstrated and thus well placed to reflect on how this would work in the focus groups. Several members had also been inpatients themselves, allowing them to give important advice about how focus groups could best be conducted on the wards. All study documentation was sent electronically to the LEAP for feedback, and an in-person discussion about the study design took place. Many areas of the study documentation were re-phrased to make them more inclusive and comprehensible, and many suggestions for how to maximise engagement in focus groups were given. These included key times on the ward to avoid (e.g. visiting hours, meal and medication times), reducing the power dynamic in focus groups (e.g. by emphasising that the researchers are here to learn from participants, not the other way round), ensuring the researchers state that the focus group ground rules also apply to themselves, and asking certain questions without putting people on the spot (e.g. by offering post-it notes or asking a question before a break). Time was also spent considering what topics should be included in the topic guide, and how questions should be phrased. Although PPI was considerable, involvement could also have been further strengthened. For example, not all ten LEAP members were able to attend the in person meeting. If time had

allowed, another in person meeting may have enabled incorporation of a greater number of viewpoints.

Context of data collection

There were a number of challenges anticipated to affect the data collection process. Wards can be chaotic environments, with unpredictable events and many patients experiencing high levels of distress, making the facilitation of focus groups difficult (Radcliffe & Bird, 2016). The staff pressures and shortages typically seen on wards were expected to make it difficult for staff to schedule time for a focus group or interview in advance. For those able to take part, it was assumed that time may be limited, preventing the discussion of all relevant topics. Additionally, some wards would be unlikely to frequently have a suitable room available for conducting focus groups and interviews, so limitations on when focus groups or interviews would be conducted were expected, compounded by the need to avoid key times on the ward, for example, ward rounds, medication dispensary, visiting hours, mealtimes, and any structured activities offered on the ward. To minimise these issues, it was aimed to be as flexible as possible with the data collection, with challenges and disruptions to data collection prepared for as much as possible.

The greatest challenge to data collection, however, was not anticipated. Data collection began in March 2020, then paused for 14 months due to the COVID-19 pandemic. During this time it was not possible to visit the wards. Initially it has been planned to visit 1-2 wards at all five NHS mental health trusts where the gameChange trial was recruiting, however this was not possible in the time available after the pandemic restrictions lifted in June 2021.

Participants

The gameChange trial recruited from five NHS mental health trusts across the UK (Avon and Wiltshire Mental Health Partnership NHS Trust, Greater Manchester Mental Health NHS Foundation Trust, Cumbria Northumberland Tyne and Wear NHS Foundation Trust, Nottinghamshire Healthcare NHS Foundation Trust, and Oxford Health NHS Foundation Trust) with principal investigators (PIs) and trial coordinators at each site. The trial was open to patients from all mental health services, but almost all participants were outpatients. Working with PIs and trial coordinators at each site, local psychiatric wards were approached. Only acute psychiatric wards were included, rather than rehabilitation wards, given these are the most numerous type. Due to the busy nature of wards and frequent lack of room availability,

convenience (volunteer) sampling was used in the first instance. It was then planned to use purposive sampling to ensure that a range of staff are seen (e.g. those involved in decision-making as well as those who are more directly involved in day-to-day clinical care).

Staff working in either the delivery or management of clinical care on the wards were invited to take part. NHS patients staying on wards were recruited according to the following criteria:

Inclusion criteria

- Participant is willing and able to give informed consent for participation in the study.
- Aged 18 years or above.
- Willing to consent to being audio recorded.
- Sufficient English language skills to participate in the focus group/interview.

Exclusion criteria

- High levels of associated risk to self or others via participation in the study e.g. actively suicidal.
- Photo sensitive epilepsy (use of VR is not recommended for those with photo-sensitive epilepsy).

Capacity to consent was assessed after the participant had read the information sheet and before they signed the consent form. Patients received a small payment for taking part.

The final sample included in this chapter comprised two patient focus groups, each with three participants, from a single male ward, and two individual interviews with members of staff working on this ward. The first patient focus group was conducted in March 2020, and the remaining data collected in June 2021.

Procedure

In the weeks leading up to the site visit, staff and patients were informed of the study and focus group dates arranged. Staff and patients received participant information sheets and were given time to discuss this with others. Ward staff were relied upon to initially introduce the study and go through the information sheet with patients, given staff were more familiar to patients. Before taking consent, participants were taken through the information sheet again to ensure

they understood and could ask questions. After consenting, a demographic questionnaire asked participants their age, gender, and ethnicity, and staff were asked to their job role. Patient diagnosis was not recorded given patients themselves may not have been willing or able to disclose this, and it would be unnecessary to add to staff burden by asking them to provide this patient information. All data collection took place on the ward.

Focus groups and interviews initially asked questions relating to the first objective (initial expectations of VR and VR therapy), before giving all participants the opportunity to put on a VR headset and try the gameChange VR therapy for a few minutes. They met the virtual coach, Nic, and tried one or two levels of a scenario (e.g. the bus, the café). Participants chose which scenario and level they entered – though patients were encouraged to try easier levels to begin with. Further questions then focused on objectives two (views on the automated VR therapy) and three (requirements for implementation).

Focus groups and interviews

Focus groups were the primary choice of data collection because they allow individuals to consider ideas together as well as highlighting differences in thoughts and ideas between participants (Catterall & Maclaran, 1997). They also allow participants to express ideas spontaneously, in a way that is less structured in accordance with the researchers' prejudices (Bertrand, Brown, & Ward, 1992). Given most participants were expected to be unfamiliar with VR, a group setting was likely to be helpful in allowing individuals to consider a range of viewpoints and questions raised by other group members in order to inform their opinions. The group setting was also considered likely to be most constructive for generating ideas about potential challenges around the implementation of VR therapy, as well as solutions to challenges, because individuals can build upon each other's suggestions.

Topic guide

Informed by the NASSS framework, the semi-structured topic guide was created to cover all three objectives. Separate but similar topic guides were created for staff and patients. The LEAP, and several experts in qualitative research fed into the first drafts of the patient topic guide and both guides were piloted on colleagues in order to refine question phrasing and to test their estimated length. The following rationale for the study was shared with participants at

the start of the topic guide: 'We've created a new therapy, which had a lot of input from people with lived experience of psychosis and other mental health problems. We'd really like to hear your views about a few things and be able to use your feedback and involve you in how we develop things in the future.' The topic guide was reviewed after conducting the first focus group. No significant changes were made, though two questions were slightly rephrased (e.g. 'Who would you like to deliver VR therapy to you?' was changed to read 'If this were to be available on the ward, who would you like to be doing it with you?')

Analysis

Focus groups and interviews were audio recorded and transcribed verbatim. Field notes from each focus group and interview were also transcribed. Field notes recorded factors such as group dynamic and nonverbal cues to add context to the transcript of the audio recordings. For practical reasons, transcripts were not returned to participants for comment or correction.

A thematic analysis was performed (Braun & Clarke, 2013) separately for staff and patient data, although similarities and differences between the analyses were considered. All data were entered into NVivo (NVivo, 2018) in order to provide a transparent audit trail. The transcribed data were read and re-read to ensure familiarity, before developing a preliminary coding framework that was discussed and adapted during supervision. An extract of the coding and reflexive log, with examples of adaptations made, can be viewed in Appendix 5.4. Details regarding each code were recorded in memos in Nvivo. Themes were derived from the data. Diverse cases and minor themes were considered, as breadth was considered as important as frequency.

Reflexivity

Both focus groups were led by the candidate (PB) and co-facilitated by a clinical psychologist (SL). The two staff interviews were led solely by the candidate (PB). PB introduced herself as a researcher in mental health working at the Department of Psychiatry, University of Oxford, and SL introduced herself as a clinical psychologist working in the same department. Consideration was given to how our professional backgrounds may impact data collection and analysis. For example, existing knowledge, expectations, and hopes regarding VR therapy may have impacted how the focus groups are conducted. A reflexive log was kept, an extract from which can be viewed in Appendix 5.4, and to try to minimise these potential biases, the topic guide

was closely adhered to, as this was created largely from the NASSS implementation framework rather than personal experience and expectations. Both PB and SL have past experience of conducting qualitative research. PB also attended a training course in qualitative research in preparation for leading the study. Consideration was given to the fact that both PB and SL are young, white, middle class, and female, and that visible indicators of socio-economic status could impact participant engagement. Participants were frequently reminded that the aim of the study was to hear and learn from their views, and that the facilitators wanted participants to be as honest and open as possible about any concerns or criticisms they may have.

Results

Analysis of two patient focus groups and two individual staff interviews are reported in this chapter. Although analysed separately, there were three themes that were shared across both patients and staff. These were: a surpassing of expectations, a belief that VR could help, and practical considerations around implementation. Five further themes were identified from the patient participants only, and two staff further from the staff only.

Patient focus groups

Three male patients took part in the first group and three males in the second. These were participants that members of staff had previously identified as being interested in taking part, having capacity to consent, and who were available at the time the focus group was due to start. In each case there were further patients who may have been eligible to take part, but who were either discharged shortly before the focus group took place or were unavailable due to visitors or being asleep at the time. Four participants were White British and two were Irish, with an age range of 18-54. Table 1 displays participants' demographic characteristics. Patients within each group were known to each other. In the second patient group only, two of the patients had previously met the candidate (PB) the day before where the study had been introduced during a group patient meeting. The first group took place in a private space on the ward and lasted one hour 44 minutes. The second group took place in the communal dining and living area of the ward due to Covid-19 restrictions limiting the numbers of people allowed in the smaller, separate rooms, and lasted one hour and 17 minutes. In this second group a member of ward staff was also present throughout most of the group, and several other members of staff as well as patients passed through the room during the group, occasionally stopping to listen for a short time. All six participants entered at least one scenario of the gameChange VR therapy.

Eight themes were identified from the data. The first two comprised considerations that participants had before trying out the VR, and the remaining six were derived from discussions had afterwards. All participants contributed to the content of all themes.

Table 1. Participant demographic characteristics.

Participant Number	Age	Gender	Ethnicity	Job role
Patients				
1	37	Male	White British and Irish	-
2	54	Male	Irish	-
3	53	Male	White British	-
4	18	Male	White British	-
5	34	Male	White British	-
6	Missing	Male	White British	-
Staff				
1	28	Male	White British	Activities Coordinator (FTE)
2	58	Male	Any other White Background	Healthcare Assistant (FTE)

Desire for therapy

Participants in both groups described a lack of psychological therapy being available on the ward, with medication being the primary form of treatment: 'we just get filled with pills, there's no talking therapies or anything like that' (participant 3). Participants in the first group were also very aware of some of the resource limitations contributing to there being a lack of therapy available: 'the room and the money is obviously not enough'. This desire for treatment beyond medication led to a sentiment of being 'up for trying anything' (participant 1) and a lot of interest in trying out the VR: 'I'm interested to try it' (participant 4); 'I'm intrigued to find out' (participant 1).

Initial concerns about VR

Participants in the first group discussed many concerns that initially came to mind before trying the VR therapy. These included practical concerns such as hygiene, safety, and which members of staff would support the VR user, as well as concerns about whether wearing a headset would be embarrassing or difficult to manage for those who hear voices. One participant also reported

scepticism as to whether the therapy could be really be helpful for people who struggle with anger and self-harm: 'I'm sceptical, because if I get angry I self-harm, so this VR is just going to be a distraction' (participant 2). Conversely, participants in the second group had significantly more positive expectations of the therapy, for example: 'I think that's really good...I think practising with stuff like this, yes, it would really help' (participant 4). The only concern raised by one member of this group was ensuring there was a safe space where you wouldn't walk into obstacles: 'you have to be in a safe-ish place, you don't want to walk outside' (participant 5).

Surpassing of expectations

After trying the VR for themselves many participants reported feeling surprised and impressed. Participants had expected it to feel unrealistic and game-like ('I thought it would be like a video game, but no', participant 2), which had made it initially hard to see how VR could be useful therapeutically. After trying it, however, it quickly became clear to participants how and why it could work as a therapeutic tool: 'I was sceptical before coming in, but I get it now' (participant 3); 'Yes, so was I' (participant 2). There was considerable discussion by all participants of how surprisingly real it felt: 'it feels very, very real actually' (participant 1); 'it was very realistic' (participant 4).

VR as a positive experience

There was considerable enthusiasm for the VR therapy, with reactions to trying it including 'Wow, wow...that was really good' (participant 4), 'I felt quite good about it, and it was fun' (participant 6), 'I think it's excellent' (participant 1), and '[that was] really, really interesting' (participant 3). The second group also voiced a desire to try out more of the VR: 'I'd like to do more of it' (participant 4) and felt the VR would be popular on the wards ('I think there would probably be a big line, a bit queue, to use it daily I think, to be honest', participant 4),

VR could help in many ways

Across the two groups participants felt the automated gameChange VR therapy would be helpful in a number of ways, including for social anxiety ('good for practising social situations, definitely' participant 3), confidence building, assisting independence, helping people to develop new perspectives, providing an escape from the ward ('I already feel as though I've been out today by just being in that experience, and I actually feel better than when I arrived, so it clearly can help', participant 1), and providing stimulus on the ward. The first group in

particular also felt there were a huge array of potential uses for VR beyond the specific gameChange therapy that was demonstrated. These included helping autistic people to practise making eye contact, providing an explanation for STOP (an anger management technique), mindfulness training, staff training in what it's like to have certain psychotic experiences, and patient assessment and diagnosis. As participant 1 said: 'I think there's sort of endless possibilities'. Two participants also felt that the automation of the therapy would be beneficial for saving resources: 'it would save a lot of man power, wouldn't it, like with doctors and nurses and things like that' (participant 4); 'it could save a lot of time', (participant 5). One participant did note, however, that while it was easy to see the potential of VR to help with certain difficulties, for others it was more difficult: 'social situations as he said, brilliant, but like for self-harming...I don't know how it would help people like that' (participant 2).

Practicalities of implementation

Where the VR could be physically located on the ward, who would support patients to use it, and which patients it might be offered to when was discussed. Both groups agreed that for structured therapy interventions like gameChange it would be important to have a private space available: 'so like the games room we've got, to have like a VR room or something like that on the wards' (participant 4). Regarding who would be present to support the patient to use the VR, it was, unsurprisingly, clear that patients would want to feel comfortable with the person supporting them, regardless of their profession: 'if it was on the ward here, I'd want to be able to say A, B, or C, but not D...because if it's someone that you're not so sure about you're just not going to engage with them' (participant 3); 'someone who you feel comfortable around', (participant 2). When asked about the possibility of a peer professional – i.e. someone with lived experience of a mental health problem who has received training in providing psychological support and confidentiality – being present rather than a member of ward staff this was seen as a positive option: 'they'd be brilliant' (participant 2); 'they're then speaking from experience, aren't they' (participant 1). Both groups also noted that psychological therapy may not be appropriate for individuals when they first arrive on the ward: 'initially you might not be at the stage to do any talking therapies' (participant 3); 'they've got to get used to like the real surroundings and things like that, but then once they're a lot calmer and a lot [more] settled, I think it's more of like a transition back into the real world' (participant 4).

Concerns about VR therapy on inpatient wards

Participants in the first group in particular also raised concerns regarding how VR therapy could be implemented onto wards. These included staff seeing the VR as a burden due to it needing constant supervision ('staff could see it as an imposition, because they're too busy taking people out on fag breaks', participant 3), it getting broken or forgotten about, ('It's all very well investing in the technology but...is it going to get forgotten about?', participant 1; 'some people would bust it' participant 3) and it becoming a substitute for further cuts to funding of existing psychological therapies ('I think the danger of course is that the technology becomes the substitute for government cuts or lack of funding...it shouldn't be used as the substitute just because we don't have sufficient funding', participant 1). This last point was echoed by members of the second group who similarly noted how it should be an addition rather than substitute for face-to-face time with a therapist as in traditional therapy ('human interaction is very important...so I think that needs to be kept, but just as like another therapy', participant 4).

Ways of improving the gameChange VR therapy

Several ways of improving the therapy were also discussed. These included the potential to vary avatars and in particular, the virtual coach Nic, to the preferences of the user, and having some scenarios that put you at ease better, as it was felt that nearly all the avatars appeared hostile. While participants in both groups found Nic a helpful and reassuring presence, two participants in the first group also felt that Nic made too much eye contact: 'I was getting freaked out because she's just staring me in the eye the whole time' (participant 3). This group also suggested that Nic could be presented as a peer professional, for example 'a patient with your own characteristics that's out in the community' (participant 1), feeling that 'if it's presented as a peer supporter, even though it's not real I think that would make you feel a little bit more relaxed' (participant 3). These participants then went onto discuss the kinds of things Nic could say if she was presented as a peer supporter, for example: 'I know this is difficult, I used to have problems with this myself' (participant 3).

Staff interviews

Two individual staff interviews took place with members of staff from the same ward that the patients were recruited from. Both participants were male and of white ethnicity. One participant was an Activities Coordinator on the ward, and one was a Healthcare Assistant.

Both were recruited after expressing interest in taking part in the study after seeing a patient focus group conducted on the ward. Interviews took place in a private room off the ward, with only the candidate (PB) and the interviewee present in each case. The first interview lasted 51 minutes and the second 55 minutes. Five themes were derived from the data; three were convergent with the patient accounts and two were distinct.

Positive expectations of VR therapy before trying it

Both members of staff felt that the gameChange therapy sounded rational, helpful, and that it focussed on an important treatment target: 'it makes perfect sense...it's definitely something that I think could be really useful...just giving them a bit more confidence' (participant 1); 'it's a very good idea...you can learn new skills, because you are immersed in the situation in a controlled way' (participant 2). Participant 1 also felt it would be particularly helpful for those patients who are more isolated and engage less in more typical ward activities. These positive views of the VR therapy were underpinned by positive views of psychological therapy in general: 'really, really important. I think patients having access to as much psychological therapy as available is great' (participant 1); 'the more the better' (participant 2). As such, neither participant had particular concerns about the use of VR therapy and its potential use on the ward (e.g. 'I don't think I have any concerns', participant 1), although queries were raised about whether or not we know it to be cost effective yet (participant 1), and whether motion sickness was still a problem on newer technology (participant 2). There was, however, acknowledgment that the therapy would likely suit some patients better than others. Participant 1 noted that 'it would be good for people that are a little bit more open-minded, or have experience of the technology before' but may be challenging for people with 'more state paranoia and a bit more scepticism about things'. Similarly, participant 2 noted that 'it would have to be appropriate for where they are in their mental state; I guess not everyone would be ready to benefit from it'.

Surprise and surpassing expectations

Even given their initial positive expectations, both staff members still felt surprised by aspects of the therapy and found it surpassed their expectations: 'It's better than I thought it would be' (participant 2). This was particularly with regards to the realism and immersiveness: 'it was a little bit more of a shock to me actually, to realise how all-encompassing it is...how real it is' participant 1). Participant 1 also described finding the VR surprisingly easy to use and navigate with the use of the two handsets.

VR therapies like gameChange would help patients

The expectation that VR therapy would be helpful for patients was maintained after trying the therapy for themselves: 'it's going to be an extremely powerful therapeutic tool' (participant 2). Participant 1 described how it would help patients 'bridge that gap' between staying in and getting out, and participant 2 similarly described the benefits of 'in-situ' learning in places that are 'causing them apprehension', which may otherwise be avoided if patients 'are not sure that they would be able to cope'. Both participants spoke positively about Nic, noting she was 'really clear for people to understand' (participant 1) and 'really reassuring' (participant 2). Again there was discussion of the kinds of patient it may be more or less helpful for. Participant 1 felt that it would be ideal for anyone with anxiety, but may be challenging for those with more severe paranoia, as well as for anyone who struggles with spatial awareness or who would feel uncomfortable having something put over their eyes and ears. Participant 2 described how successful use could be impacted by quite a range of factors, including the nature of their difficulties, 'how acutely unwell' they are, and 'how much insight they have'. A number of ideas for expanding the therapy were also suggested, including increasing the range of environments – for example participant 1 suggested a simulated ward environment might be helpful for those patients struggling to leave their rooms, increasing the number of levels to be able to include some that are even more challenging, and increasing how interactive the therapy is.

Practicalities of implementation

Both participants felt that if VR therapy were to be implemented on the wards, its usage by individual patients would need to be discussed among the clinical team and then prescribed by a clinician in line with the evidence base with regards to number and frequency of sessions: 'it would have to be prescribed...based on the evidence' (participant 2). Ideally therapy would take place in a private, spacious room, dedicated to the VR, but in practise it would likely be a case of using whatever space was available. Participant 2 suggested it may sometimes be possible to use a room off the ward, on the wider hospital site, if patients under section were granted the appropriate leave from the ward. Both participants thought the therapy could fit well into existing 1:1 time that staff have allocated with patients on a daily basis already, so long as the set up and take down was quick: 'they set time aside to sort of have one-to-ones with patients...I think you could incorporate it into that hour' (participant 1).

In terms of which staff could deliver the therapy, both participants thought that training lots of staff in a range of roles would be helpful: 'I think just having lots of people trained on the ward in it is probably the best way to go rather than having one person' (participant 1). There was agreement that staff would be 'very much willing be trained in it' (participant 1) and would find it enjoyable to be able to 'see the benefits' of the treatment (participant 2). Participant 1 also noted that having a member of ward staff 'that can sort of head it up' and 'train the rest of the ward' would be helpful to ensure the maintenance and continued use of the equipment. It was also suggested, however, that to begin with, it may be helpful to have staff from outside the ward come and 'train the whole ward' (participant 1) or even to deliver the therapy to patients given external staff would be 'more competent and committed' and could then 'get the ward staff involved' (participant 2).

Barriers and facilitators

The final theme comprised barriers and facilitators to implementation that were discussed at various points during the two interviews. Participant 1 described the challenge of there often being 'lots of bank staff that come in' when there are staff shortages, and that these staff members then would not be trained in the delivery of VR therapy. Both participants also acknowledged a current barrier of where the equipment would be used and stored. Adjustments would be needed in the existing ward rooms, for example clearing sufficient space, and there may not always be somewhere available. Lack of staff time, on the other hand, was not considered a barrier: 'I wouldn't say the time is a constraint, no, no...if we're spending more time engaging in therapy with someone that can only be a positive' (participant 1).

Facilitators included having someone responsible for maintaining the equipment, for instance ensuring it's 'charged and well looked after' (participant 1) and ensuring appropriate training and ongoing supervision. For example, it was considered important to have someone you 'can report back to with any concerns' (participant 1) and to potentially be able to discuss recordings of therapy sessions during supervision (participant 2). Better staffing levels was also noted as a facilitator (participant 1), as was having posters available to advertise and explain to patients a bit about what the therapy involves and how they could use it (participant 1).

Discussion

This chapter reports an initial qualitative investigation into staff and patient views on the potential to have automated VR cognitive therapy available on inpatient psychiatric wards. Due to the 14 months where data collection was not possible, only two patient focus groups and two staff interviews were able to be included in this chapter, comprising eight total participants, as opposed to the minimum total of 50 participants that had been planned. Nonetheless, it is clear from these initial data that amongst both staff and patients there was considerable enthusiasm for trying something new, particularly something designed to have a specific therapeutic benefit, and that participants were impressed by the potential of the automated VR therapy to help patients, while potentially overcoming some of the resourcing challenges that traditional therapies face.

There was considerable overlap between staff and patient views, indeed three themes (a surpassing of expectations, a belief that VR therapy could be helpful, and considerations around the practicalities for implementation) were consistent between the two analyses. Particularly striking was that regardless of participants' prior expectations, nearly all participants felt surprised by aspects of gameChange, noting it surpassed their expectations, particularly with regards to how real it felt. Additionally, although staff and patients alike felt that upon first arrival to the ward VR therapy may not be helpful for some patients due to higher acuity of clinical symptoms, psychological therapy is certainly something that was wanted by patients and thought by staff to be important for aiding recovery while on the ward. Patients staying in hospital may often be thought of as being too unwell to benefit from much psychological therapy (MindTech, 2019), but the engagement of the participants in these focus groups could arguably be seen as testament to their ability to engage in therapy.

Other similarities between the staff and patient groups included a belief that VR therapy could be very helpful and overlap in the practical solutions concerning where and with whom it could be used. Within these topics, however, there was also variation in the discussion between staff and patients. Staff primarily discussed some of the factors which would moderate how successful VR therapy might be (for example, level of insight and severity of paranoia), whereas patients discussed the ways in which different types of VR therapy could help with a variety of problems ranging from anxiety to autism. Within the practicalities theme, staff considered in greater detail who might be able to feasibly deliver VR therapy to patients within the remit of

their roles, where-as patients understandably discussed in greater detail who they might feel most comfortable having to support them. Taken together, the discussions highlight the likely need to be flexible with how VR could be used on wards, with continued consideration of the needs and perspectives of both staff and patients.

Revisiting the NASSS framework

The topic guide aimed to consider three domains of the NASSS framework: the condition or illnesses that the technology is designed to help, the intended adopters of the technology, and the organisation where it would be implemented. With regards to the condition, the gameChange automated VR therapy is designed to help anyone who may feel anxious or lack confidence in everyday social situations. Patients and staff alike agreed that this would be a relevant treatment target for many individuals on the ward, but that factors such as acuity, comorbidities, and insight could complicate successful use. Interestingly, patients in particular also identified many wider applications of VR for helping with a range of difficulties beyond anxiety. With regards to the intended adopters, a crucial takeaway from the initial data in this study is the enthusiasm and positive feedback of all participants. Given studies suggesting that acceptance by staff can often be the single most important determinant of whether new technologies succeed at a local level (Greenhalgh, et al., 2017; Wade, Elliot & Hiller, 2014), and that it is the staff whose time and responsibilities may be most impacted by the implementation of VR therapy, the enthusiasm of the two staff members in this study is particularly promising. However, it must also be noted that the staff most likely to volunteer their time to take part in an interview may be those with the most time available and the most interest in technology, therapy, or innovation. They may therefore be more likely to give positive feedback. Additionally, these staff members were not in roles that would typically involve decision making with regards to what is available on the ward. This kind of recruitment bias may be one reason real-world uptake of digital mental health interventions is typically lower than in research (Baumel, Edan & Kane, 2019). Future data collection must aim to reduce this bias by scheduling focus groups into a usual or mandatory staff meeting or training time, rather than only speaking to those who volunteer to make the time to be interviewed. Regarding domain five, the organisation, the two staff members reported that their ward would have the capacity and motivation to take on this kind of change. It was felt that use of VR could fit into existing ward routines, i.e., 1:1 time that staff already have dedicated to spending with patients, and that given the likely benefit to patients, VR therapy would not be seen as a burden

or get in the way of any service goals. However, given this is again based on the views of only two staff members, caution may be needed.

Barriers and facilitators to implementation

A number of barriers were discussed by participants. Space to use the equipment appeared to be the most significant barrier, something which would likely vary considerably across different wards. Staff did feel this could be overcome, however, through adapting current spaces or making use of rooms off the ward. While staff time was not seen as a barrier when the ward is working at usual capacity, the reliance on bank or agency staff that sometimes occurs due to staff shortages was discussed as a potential problem. This might mean that having external staff, such as peer professionals, hired to come to the ward to deliver therapy, in addition to training ward staff, could be the most feasible way of implementing VR therapy, particularly given patients responded positively to the concept of peer professionals. This also fits with recommendations within the NHS Long Term Plan to recruit a workforce of Peer Support Workers in acute settings (NHS 2019a, NHS 2019b) given recent evidence that their recruitment to deliver interventions for patients can have a number of positive implications, including reducing readmission to hospital (Johnson et al., 2018).

It was notable that the experience of trying the VR therapy helped participants to better understand the ways in which it could be helpful. To maximise the buy-in of wards where the therapy could be implemented, a likely facilitator will be to ensure that as many staff as possible have the chance to try out the VR for themselves, to help them understand first-hand what the VR is like and how it might be helpful. Additionally, when introducing the technology to patients, it will be important to address some of the concerns that patients raised in this study, for example, by providing information on the safety of the equipment and how it is sanitized for hygiene purposes.

Potential of VR

While participants were enthusiastic about the potential of gameChange, a highly targeted, theory-driven psychological therapy, to benefit patients staying on the ward, there was a shared belief that having VR headsets available for other activities such as games and mindfulness exercises would also be helpful. It was clear that the device was seen as something that could be

helpful in many different ways. Implementing any new activity to the ward would seemingly be met positively, with the potential for it to have a therapeutic effect being an additional benefit.

The wider uses of VR will need to be factored into staff training and the assessment of evidence on the cost-effectiveness and clinical impact of having VR therapy available on wards. Moreover, it will be important to consider how to ensure gameChange is continued to be used as a structured psychological therapy that requires careful, and typically supported, engagement over a number of sessions, separate to any other VR programmes such as games that may be used more freely by patients. The automation of VR therapy already helps enormously in ensuring treatment fidelity, but it may still be necessary to ensure that gameChange is only accessed when someone trained in its delivery and who is receiving regular supervision is available to support the user, and that a protocol and timetable for its planned use with a patient is followed. This may of course be challenging, indicative of the more general difficulty of implementing a highly targeted psychological therapy in a setting where the environment can sometimes be busy and unpredictable.

In addition, it must be acknowledged that implementation and scaling up in itself also typically leads to a loss of precision and fidelity whatever the setting. Attrition can occur over time due to train the trainer schemes and the differing needs and resources of services across different locations. The use of manuals, protocols, and auditing and monitoring can help with this to an extent, but in community and inpatient services alike it will be important to conduct further feasibility work in each service in advance of implementation in order to identify barriers and facilitators that can be removed and used respectively.

Limitations

There were several limitations to the study. Most significantly, due to the Covid-19 pandemic recruitment took place on only one acute psychiatric ward, with only eight total participants. Multiple stakeholder involvement is considered important for implementation research (Allan, Bradstreet, et al., 2019; Dixon & Patel, 2020), which is why it was planned to conduct focus groups with patients and staff of varying professional groups and at five different NHS mental health trusts across England. While data collection is still ongoing, the findings from the data reported in this chapter need to be interpreted with appropriate caution. Different stakeholders will need to be involved in order to consider other aspects of implementation. In particular,

staff involved in the decision making on wards, such as consultants and managers. Regarding the remaining domains of the NASSS framework not explored within this study, domain two (the technology) will require input from individuals with detailed knowledge of the technology design, supply, and future evolution, and domain three (the value proposition) will require input from those who have access to empirical evidence on the clinical and commercial value of the technology. Additionally, the expertise of policymakers will be required for domain six (the external context for innovation).

It has also been suggested that participants in implementation studies may represent a more highly motivated group of service users who are less representative of the whole population (Greenwell, Sereda, Coulson, & Hoare, 2016). This may be a limitation of the participant group – both staff and patient alike – that were recruited here. Patient diagnosis was also not recorded, nor were patients asked about their specific mental health difficulties. While several participants described the difficulties they had, and how VR would or would not be able to help with them, not all participants chose to discuss this. Additionally, the focus group environment, while it has a number of benefits, may have been one where some of the participants did not feel entirely comfortable, for example due to low self-confidence or conflicts between individuals on the ward. Indeed, one patient within the second group spoke considerably less than the rest. Consequently, it could have been that not every participant fully shared their views.

Strengths

The study also had several strengths. The study design, methodology, and documentation received feedback from a LEAP, helping to ensure the study was engaging and acceptable to patients. Additionally, the majority of implementation research is retrospective (Allan, Bradstreet, et al., 2019). This study benefited from prospectively assessing feasibility of implementation in this setting. Prospective assessment of digital interventions allows for optimisation prior to implementation, in order to increase the likelihood of long-term use and the meeting of clinical and scientific standards (Allan, Mcleod, et al., 2019).

Conclusion

It is important to consider how healthcare technologies can be integrated into existing health services (Mohr, Burns, Schueller, Clarke, & Klinkman, 2013). There have been significant

recent advances in digital mental health care, and in particular for the opportunity of automated VR therapy to increase access to translational psychological therapy. The study reported in this chapter provides valuable insight into how VR might fare in implementation on psychiatric inpatient wards. From this very initial work it is clear there is much enthusiasm for the possibility, a wide range of patients who would potentially find it helpful, and a number of ways it may be feasible to implement.

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Chapter 8

Conclusions

In the opening of this thesis the need to improve outcomes for patients diagnosed with psychosis was highlighted. Effect sizes for CBT for psychosis are small to moderate, and access to CBT is highly limited, as one participant in Chapter 7 poignantly described: 'we just get filled with pills, there's no talking therapies or anything like that'. The aim in the thesis was to see whether there is potential for outcomes to be improved by taking a translational approach to treatment development. In this concluding chapter, the findings of each chapter are summarised and situated in the context of existing literature. Overall limitations of the thesis and directions for future research and clinical practice are discussed.

Summary of thesis

Chapter 1 introduced three methods for helping to achieve greater precision in our understanding and treatment of paranoia, which the subsequent six chapters would investigate and make use of: specificity, manipulation, and VR. In Chapter 2, a systematic review found that the manipulation method, despite its many benefits, has been infrequently used in research on delusions and hallucinations. Using all three techniques, Chapters 3 and 4 respectively found that interventions to increase compassion for the self via creation of a compassionate coach, and compassion for others via loving kindness meditation, led to significant reductions in paranoia. Mediation analysis showed that changes in paranoia were largely explained by changes in compassion in both studies. These results support the conclusion that low compassion for the self and others may be contributory causal factors in the development of paranoia that can be targeted therapeutically. Chapter 5 conversely found that power posing led only to very small increases in feelings of power that had no effect in reducing paranoia. An effect may have been found had the study been more highly powered. However, this thesis is interested in techniques that have the potential to bring about clinically significant changes. Consequently, it seems likely that power posing is not, at least on its own, the most valuable therapeutic technique to pursue. Chapter 6 examined the potential contribution of specific parenting behaviours to paranoia. Parental over-control, verbal abuse, physical abuse, and lack of care were all associated with paranoia, suggesting the potential for a causal pathway to be at

work, although this could not be concluded from the cross-sectional analysis. The network analysis did not support that these associations were mediated by cognitive affective variables such as low compassion and self-esteem. Further work testing the replicability of this finding and using longitudinal datasets is needed. Finally, Chapter 7 qualitatively assessed the feasibility of using VR in order to be able to implement evidence-based psychological therapy on inpatient wards, where patients typically have limited access to such therapy. Thematic analysis suggested that despite having a number of initial concerns about how the therapy might work, there was considerable enthusiasm for the prospect of having VR therapy available on wards, with patients and staff alike believing it could have many benefits. There were clear barriers, including having a space where the VR equipment could be used and stored, and how to ensure appropriate use of the therapy is maintained if the headsets are also used for games and other activities. Detailed manuals and protocols would need to be developed to ensure fidelity of training and delivery. However, at this initial stage it is clear there is support from patients and staff alike regarding the potential of VR therapy, and continuation of this qualitative work will be helpful for further consideration of barriers and facilitators to implementation.

Overall, this thesis has tested several important methods that may go towards improving the efficacy and accessibility of treatments for paranoia. However, the search for precision does need to be considered in the context of acknowledging the complexity of psychotic experiences. There is considerable heterogeneity in clinical symptoms among individuals with psychosis, and interventions found to be successful at the population level will not always hold at an individual level (Eronen, 2020). For example, although the two compassion interventions tested in Chapters 3 and 4 successfully increased levels of compassion and reduced paranoia at a group level, some individuals inevitably found the training challenging and did not benefit from it. This could be for a number of reasons. Some individuals struggle with imagery tasks of any kind, or find imagery exercises embarrassing (Hackman, Benett-Levy & Holmes, 2013). Psychotic experiences may also interact with an individual's ability to perform certain exercises. For example, those with more severe symptoms may have fears of compassion, making compassionate imagery tasks particularly difficult (Martins et al., 2018).

Even when an intervention is successful at an individual level, single interventions like those tested in this thesis are unlikely to be sufficient alone for recovery. Individuals with psychosis are often unemployed (Cella, Edwards & Wykes, 2016), have poor physical health (Lindamer et al., 2018), and more generally have a background of adversity and social disadvantage (Bentall, Wickham, Shevlin & Varese, 2012; Freeman, 2016). While targeted cognitive

interventions may decrease many of the barriers to being able to begin overcoming these challenges, interventions will likely still need to be conducted in the context of other supportive programmes that more directly help patients to live independently, find work, and improve their physical health (Cella, Edwards & Wykes, 2016). This may be of particular importance for inpatients, where there is often even greater comorbidity of health and social problems.

On the other hand, single interventions still have the potential to have multiple positive outcomes. Freeman's (2016) cognitive model predicts that successfully reducing the impact of one causal mechanism will result in subsequent effects on other mechanisms in the model. This would predict, for example, that participants who received the intervention targeting compassion for others likely also improved in self-compassion and vice versa. Indeed, one participant who received the intervention targeting compassion for others stated: 'I felt kinder to myself by the end and tried to be kinder towards others'. This fits with quotes from other qualitative accounts. For example, one patient, when describing their recovery from psychosis, stated that 'If you are feeling compassion for others, then you feel it yourself as well naturally and you almost just, you know, just become compassionate in total'. It may be that focussing on one compassion intervention is sufficient to target compassion for the self and others, enabling patients to choose which intervention appeals to them most. The knock-on effects of interventions may also generalise further. If sustained and embedded into daily life, the compassion interventions may also have subsequent effects on reducing worry and increasing belief flexibility, given the inter-relation between different causal mechanisms (Freeman, 2016). However, this remains to be tested in future research.

As noted in Chapter 1, beliefs about the self and others appears to be an area that many patients want help with (Freeman, Taylor et al., 2019), and if successfully targeted, could be a way of helping to increase the uptake of CBT techniques into daily life and enhance long-term recovery. Nonetheless, offering patients choice, and multiple different interventions, will always be important. The Feeling Safe Programme (Freeman et al., 2016; Freeman et al., 2021) is a translational treatment for persecutory delusions that has been developed to do exactly this. Patients choose from a menu of treatment modules: improving sleep, reducing worry, increasing self-confidence, reducing the impact of voices, improving reasoning processes, and behavioural tests to reduce safety behaviours. Each module contains one or more interventions, with patients typically completing three or four modules in total. A randomised controlled trial with 130 patients with persecutory delusions found that the Feeling Safe Programme saw high levels of uptake and engagement and led to large reductions in delusion severity and conviction

compared to an active control condition, befriending. Offering patients this level of input and choice, combined with targeted, translational interventions, may be an important avenue to improving outcomes, including increasing engagement in therapy, and enhancing long-term recovery.

While each of the six modules of The Feeling Safe Programme are based on the six putative causal factors in Freeman's (2016) model that have manipulationist support, not all of the techniques within each module have been tested in relation to paranoia. The work from this thesis therefore helps shed light on which interventions within the 'building self-confidence' module might be most helpful: training self-compassion through the creation of a compassionate coach and compassion for others through loving kindness meditation are likely to be more valuable techniques than power posing.

Limitations

There are limitations to this thesis, beyond the limitations of each individual study. First, the thesis is deliberately narrowly focussed. With the exception of the systematic review and qualitative study, the research conducted only focussed on one psychotic experience: paranoia. It is likely that interventions targeting negative beliefs about the self and others are important for many psychotic experiences, such as hearing voices, and negative symptoms such as flattened affect. However, this was not assessed. Similarly, parenting behaviours may play a role in other psychotic experiences, but measures were not included to test this.

Second, while the thesis has shown the benefits of using the manipulation method, this method has been considered by some to be time consuming and resource intensive (Lincoln & Peters, 2019). Indeed, only three intervention techniques could be tested within this thesis, and in non-clinical samples. On the other hand, in the long term this methodological approach may actually bring about savings in time and resource. Rather than conducting costly large RCTs combining multiple cognitive interventions then having to investigate which parts of the interventions were actually leading to change, beginning with small, targeted, manipulation studies allows the building of treatments that we know will have powerful outcomes.

Perhaps the most significant limitation of the manipulation method in the context of this thesis is that psychological interventions typically impact multiple psychological variables, beyond the single variable of interest (Eronen, 2020). As a result, it is generally not possible to hold all but

one psychological variable constant. Accordingly, as was found in Chapter 4, loving kindness meditation not only increased compassion for others, but also positive affect. Although positive affect in this case was measured and found to be a less strong mediator than compassion, there will have been other variables that were not measured, but which the intervention may similarly have had an effect on. For example, loving kindness may have increased self-confidence, or increased attentional focus, and these may also have played a role in reducing paranoia. To an extent measuring the impact of every individual variable is not important. The aim of Chapter 4, for instance, was solely to assess the role of compassion for others, and mediation analysis confirmed that the changes in paranoia were significantly explained by changes in compassion for others. However, within this, it cannot be concluded how the compassionate imagery exerted an effect, because as discussed in Chapter 1, a mediator is not necessarily the same as a mechanism of change. Compassion may work at an affective level (e.g. by reducing distress), a cognitive level (e.g. by modifying beliefs about the self and others), a behavioural level (e.g. by acting more kindly), or physiological level (e.g. anxiety reduction). Indeed compassionate mind training (CMT) as a whole aims for change at all these levels through various techniques. Given only single, brief interventions were tested in this thesis, it seems most plausible that changes were at the cognitive and/or affective level. However, without measuring all these variables the manipulation method does not enable us to draw firm conclusions about exactly how the compassion manipulations exerted their effect. Moreover, even if multiple variables had been measured, mediation analysis does not allow analysis of how multiple variables interact with each other. Therefore, there is a limit for the conclusions that can be drawn from the manipulation studies.

Future directions

Much of the work in this thesis falls in the earliest stages of treatment development. The obvious next stages of the pathway would be to develop and test the compassionate coach and loving kindness meditation techniques in clinical populations. Forkert, Brown, Freeman & Waite (2021) recently tested a four-week self-compassion intervention using compassionate coach imagery. In a case series with 12 patients with psychosis, it was found that the intervention significantly increased self-compassion and decreased paranoia, both of which were maintained at a six-week follow-up. This study benefited from measuring a number of mechanisms in addition to compassion and paranoia. The intervention increased self-esteem

and positive beliefs about the self and others and decreased negative beliefs about the self and others. These findings provide support that the compassionate coach exercise promotes change at the cognitive level. This study took the first step in developing the compassionate coach exercise for patients with severe paranoia. A future study is required that tests the intervention in a randomised controlled design. A range of cognitive, affective, behavioural, and physiological measures could also be included in order to examine the mechanistic picture in greater detail. Loving kindness mediation could also be tested in this way.

Given the transdiagnostic nature of compassionate mind techniques (CMT), the compassion interventions tested in this thesis could also be applied to other mental health problems. They may likewise be useful in helping families of individuals with psychosis develop more compassionate responses to their family member's difficulties, as well as to themselves (Gumley et al., 2010).

Research that goes beyond testing single compassion interventions is also needed in order to be able to fully apply compassion focussed therapy (CFT) to the difficulties of psychosis. In their model of compassion focussed recovery from psychosis, Gumley et al. (2010) argue that therapy needs to help patients cultivate a compassionate self-reflective stance, with compassion being described by Gilbert et al., (2006) as a whole new 'way of being'. To achieve long term changes, CMT aims to impact neurophysiological systems that underpin the affect of soothing (Gilbert, 2005b; Hackman et al., p197). There is some evidence that both the compassionate coach and loving kindness meditation can result in physiological changes, through increasing or supressing output in certain areas of the brain responsible for emotional regulation, for example the amygdala and left ventral anterior cingulate cortex (Mayhew & Gilbert, 2008; Lee et al., 2012; Gilbert, 2014; Lawrence & Lee, 2014). However, these changes are likely to result from more extensive practise of imagery exercises (Lee et al., 2012). Research investigating the best ways to embed compassion techniques easily into daily life would therefore be beneficial. Moreover, it would be helpful to investigate the extent to which a number of different CMT techniques are needed in order achieve a long-term compassionate 'way of being', or whether extensive practise using a single technique is equally or more beneficial.

There is also an interesting question of how future research best investigates the role of causal mechanisms and therapeutic interventions. A major theme of this thesis has been achieving precision through gaining a better understanding of causal mechanisms, and mechanisms of change in therapy. Chapter 1 described two routes to achieving causal evidence in clinical

psychology: short-term randomised controlled experimental studies using manipulation, and causal-interventionist randomised controlled trials (RCTs) using sustained treatment techniques. Chapters 3, 4, and 5 made use of the former approach, and this chapter has recommended the latter approach as a method for building on this work. However, there are criticisms to causal-interventionist methodology, particularly with regards to testing mediation.

There are criticisms both of Baron and Kenny's (1986) specific approach to testing mediation – used in Chapters 3, 4, and 5 – as well as of mediation analysis in general. In terms of Baron and Kenny's approach, also known as the causal steps approach, it has been argued that this method has low power to detect an indirect effect (Fritz & MacKinnon, 2007; MacKinnon, Lockwood, Hoffman, West & Sheets, 2002). If a variable's effect on the outcome is partly carried through a mediator, the causal steps approach is less likely than other methods to be able to detect that effect. This was not considered a problem in the context of the research in this thesis, however, given the interest was in detecting medium to large effects. Another criticism is that the causal steps approach suggests stopping testing mediation if it is found that either path a (the association between the independent variable and mediator) or path b (the association between mediator and outcome) are not significant. Accordingly, in Chapter 5 mediation was not tested because no significant increase in feelings of power (path a) was seen. Yet, it is in fact possible for an indirect effect to be significant even if one of its constituent paths is not (Hayes, 2009), suggesting it may be incorrect to stop at this early stage just because path a or b is not significant. However, these cases are uncommon and only likely to be seen when the indirect effect is small (Shrout & Bolger, 2002), again making this criticism less relevant to the studies in this thesis. Within a manipulation design the proposed mediator is generally expected to be proximal to both the independent variable and outcome, making it important to be able to demonstrate significant paths a and b before concluding there is mediation.

Finally, the causal steps approach is criticised for not allowing assessment of the significance of the mediation effect (Wood, Goodman, Beckmann, & Cook, 2008). Baron and Kenny (1986) recommend using Sobel's test to assess the significance, which was the method employed to do so in Chapters 3 and 4. In a similar vein to the wider causal steps approach, Sobel's test is known to have low power, producing conservative estimates when effect and sample size are small (MacKinnon, Warsi & Dwyer, 1995). Bootstrapping is therefore a suggested, more powerful, alternative (Bollen & Stine, 1990; Shrout & Bolger, 2002). However, with the large effect sizes and moderately sized sample of the manipulation studies in this thesis, this criticism was also not considered especially problematic.

There are three further criticisms of the causal-interventionist and mediation method more generally (Hoffman, Curtis & Hayes, 2020). One criticism is that this method explores mechanisms of change only at a group level. As already discussed, the complexity of psychopathology means interventions that are successful at the group or population level will not always hold at the individual level. When considering processes of change, i.e. how interventions work, it has been argued that this issue is not just a limitation, but a significant problem. Hoffman et al. (2020) argue that it cannot be assumed that all the influences on outcomes unfold in the same sequence and pattern for all individuals. Consequently, the authors argue that not only do group averages obscure clinically important individual differences in change processes but go as far to conclude that there is 'no legitimate way to apply findings of classic mediational studies to individual recipients of care without making entirely implausible statistical assumptions'. Consequently, they argue that investigating mechanisms of change at the group level, as is typically done in mediation analysis, should be avoided.

A second criticism is that mediation analysis is unidirectional, meaning bi-directional relationships and feedback loops are not accounted for. Hoffman et al. (2020) point out that therapeutic change is never a simple summation of the patient's response. The patient responds to the therapist, and the therapist responds to the patient. Earlier responses impact later ones, and feedback loops develop. Any statistical model that cannot account for such relationships may therefore be an invalid representation of what is really happening.

A third criticism is that mediation analysis does not adequately account for the dynamic, non-linear process of therapy. Therapy trajectories, when successful, will show a general trend in one direction. However, within this trend there will be peaks and troughs and likely some sudden gains (also known as tipping points), varying between individuals. Again, temporal mediation analysis sheds no light on these processes.

As with the criticisms of the specific causal steps approach, these three criticisms are less relevant to the kind of manipulation study conducted in the three experimental studies in this thesis. These studies lie at the very start of treatment delivery. They were brief, and targeted. Therefore, the potential impact of feedback loops, bi-directional variables, and multiple mechanisms is reduced as compared to therapeutic interventions conducted over several weeks or months. However, if the compassion interventions, for example, were to be developed and tested in a longer-term trial, other methods may be useful to test in addition. Hoffman et al.

(2020) suggest the creation of individual dynamic networks as a promising approach. This involves systematically examining change processes in each individual through ecological momentary assessment (EMA) data. After developing networks at an individual level, theory-based models that aggregate across individuals can be developed. High density longitudinal EMA data can be embedded into trials of psychological therapies, providing a large dataset suitable for network analysis.

However, the individual dynamic network approach is yet to be tested empirically and there are concerns over how many valid measures patients could feasibly be asked to complete on such a regular basis when using EMA. There is a careful balance required between density and validity of measures. Moreover, dealing with the typically higher levels of missing data in this approach is a challenge. Nonetheless, as discussed in the opening chapter, given the best evidence typically comes from triangulation (Bradford Hill, 1965), this approach may also be a helpful one to use.

To extend the work of Chapter 6, replication and longitudinal analysis will be important. Network analysis is often conceived as a tool to generate hypotheses (Epskamp et al., 2018). From the results of Chapter 6 a plausible hypothesis is that there is a causal relationship between parenting behaviours and paranoia. Disentangling genetic and environmental contributions is challenging, and of course, manipulation is difficult in this area. Nonetheless, if prospective studies found that parenting behaviours during childhood predicted later paranoia, while controlling for factors such as adversity, child behavioural and emotional problems, and IQ, this would suggest it is worth testing interventions that might be helpful. For example, there is some evidence of the success of home support programmes to help mothers, particularly in in disadvantaged areas, to provide safe and stimulating environments for their children (Van der Kolk, 2014). The more targeted and evidence based such programmes can be in terms of the parental behaviours they promote versus discourage, the more successful they are likely to be.

Finally, the next steps for Chapter 7 will be continuing to speak to staff and patients on inpatient wards in a variety of locations across the UK, as had originally been planned. Female wards will need to be visited, and ideally rehabilitation wards as well as acute wards. The views of staff working in all roles on wards must also be captured. An implementation toolkit could then be developed, and implementation could be piloted on a small number of wards.

In conclusion, this thesis shows that taking a precise, targeted approach in the early stages of treatment development may allow for the creation of more powerful therapeutic interventions in clinical populations. In particular, the evidence from this thesis supports the use of two compassionate imagery exercises for reducing paranoia: the development of a compassionate coach and loving kindness meditation. It has also begun to explore from where negative cognitions may arise. Finally, the thesis highlights how innovations in technology may allow these kinds of therapeutic interventions to be implemented at scale.

"Without minute neatness of execution, the sublime cannot exist! Grandeur of ideas is founded on precision of ideas" – William Blake

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List of Appendices

Chapter 3

1.1 Participant Information Sheet

Participant Information Sheet:

Is the experience of virtual reality affected by imagery exercises?

This sheet explains the key information regarding the study we would like to invite you to take part in, including why we are conducting the research and what would be required of you. Before you decide whether you would like to take part please read this information sheet. Please feel free to raise any queries or ask us if anything is unclear or you would like further information.

Key Facts:

This part of the study will involve putting on a headset displaying an immersive computer environment (please see pictures below). It is a bit like a video game. You will be guided as to what you should do when you view the scenes.

Your participation in this study is entirely voluntary and you may stop and withdraw at any point without having to provide a reason and without penalty.

Pictures of the headset used for the virtual reality and a tube scenario:

What is the purpose of the study?

Imagery can affect how we feel in social situations. The purpose of this study is to see if a particular type of imagery task can increase confidence in social situations. We will investigate this using the latest virtual reality technology. Virtual reality is a computer-generated world, a bit like a video game, but where you can walk about almost like in a real situation. The results of the study will have implications for helping to create new treatments for those who have difficulty interacting in social situations.

Do I have to take part?

No. You are not obliged in any way to take part. Participation is entirely voluntary and you may freely decide whether or not to take part. You may ask any questions before you decide, and if you do decide to take part you are free to withdraw yourself of your data from the study at any point, without having to give a reason, and without penalty.

What will happen if I take part?

After you have read this sheet you will sign a consent form if you are willing to take part. You will then complete two short questionnaires before starting main part of the study. You will be randomised to complete one of two imagery exercises, both of which involve trying to generate a certain image in your mind with the guidance of the researcher, and will then enter four separate virtual reality environments. Each environment will last about 3 minutes. Two will be inside a lift and two inside a tube-train carriage. You will be given guidance in what to do throughout. In between the experiences you will be asked to complete the same two questionnaires again. The study will not last longer than one hour and you will be reimbursed £10.

Are there any potential risks involved in taking part?

It is very unlikely that you will suffer any harm or distress from taking part. It can very occasionally happen that an individual experiences slight nausea (like car sickness) after being in virtual reality. However, our testing on several hundreds of people has not found this problem with our equipment; it is generally only reported with much older equipment.

Are there any benefits to taking part?

You may find that the imagery technique you learn in the second part of the study is helpful for you to use in everyday social situations in order to increase your confidence. There are no specific benefits to taking the online survey.

Who has reviewed the study?

This study has been reviewed by and received ethics clearance through the University of Oxford Central University Research Ethics Committee, an independent group of people.

Will my taking part be kept confidential?

All information you provide will be kept entirely confidential. The only personal data obtained at screening is your email address in order to contact you if you are eligible. This will be destroyed if you are not eligible and answer that you do not wish to be contacted about any similar studies. Your data will be given a unique code that does not contain your name or any personal information when it is stored. No link between your name and your code will exist. Only the researcher and the researcher's supervisors will have access to the data and all data will be destroyed within 10 years of the research being completed. Data will be included in a student's thesis but will be fully anonymised.

Who is funding the study?

The study is funded by Mental Health Research UK.

How can I raise a complaint?

If you have a concern about any aspect of this study, please contact Poppy Brown (01865 618262) or her supervisor Professor Freeman (01865 613109) who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the relevant chair of the Research Ethics Committee at the University of Oxford who will see to resolve the matter in a reasonably expeditious manner.

Chair, Medical Sciences Inter-Divisional Research Ethics Committee; Email: ethics@medsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford, OX1 2JD

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1.2 GPTS-B

Please read each of the statements carefully. They refer to thoughts and feelings you may have had about others over the last month. Think about the last month and indicate the extent of these feelings from 1 (Not at all) to 5 (Totally).

Part B:

	Not at all (1)	2	3	4	Totally (5)
1. Certain individuals have had it in for me.	❍	❍	❍	❍	❍
2. I have definitely been persecuted.	❍	❍	❍	❍	❍
3. People have intended me harm.	❍	❍	❍	❍	❍
4. People wanted me to feel threatened, so they stared at me.	❍	❍	❍	❍	❍
5. I was certain people did things in order to annoy me.	❍	❍	❍	❍	❍
6. I was convinced there was a conspiracy against me.	❍	❍	❍	❍	❍
7. I was sure someone wanted to hurt me.	❍	❍	❍	❍	❍
8. I was distressed by people wanting to harm me in some way.	❍	❍	❍	❍	❍
9.I was preoccupied with thoughts of people trying to upset me deliberately.	❍	❍	❍	❍	❍
10. I couldn't stop thinking about people wanting to confuse me.	❍	❍	❍	❍	❍
11. I was distressed by being persecuted.	❍	❍	❍	❍	❍
12. I was annoyed because others wanted to deliberately upset me.	❍	❍	❍	❍	❍
13. The thought that people were persecuting me played on my mind.	❍	❍	❍	❍	❍
14. It was difficult to stop thinking about people wanting to make me feel bad.	❍	❍	❍	❍	❍
15. People have been hostile towards me on purpose.	❍	❍	❍	❍	❍
16. I was angry that someone wanted to hurt me.	❍	❍	❍	❍	❍

1.3 Baseline visual analogue scale measuring self-compassion

Please mark on the line below how **kind** you are feeling towards yourself **right now:**

Not at all kind — 0 10 20 30 40 50 60 70 80 90 100 — Extremely kind

Please mark on the line below how **compassionate** you are being towards yourself **right now:**

Not at all compassionate — 0 10 20 30 40 50 60 70 80 90 100 — Extremely compassionate

1.3 Post VR visual analogue scale measuring paranoia

Please mark on the line below how **vulnerable** you felt during the **virtual reality** scenario:

Not at all vulnerable — 0 10 20 30 40 50 60 70 80 90 100 — Extremely vulnerable

Please mark on the line below how much you felt **under threat** during the **virtual reality** scenario:

Not at all under threat — 0 10 20 30 40 50 60 70 80 90 100 — Extremely under threat

1.4 Post VR visual analogue scale measuring self-compassion

Please mark on the line below how **kind** you felt towards yourself whilst in the **virtual reality** scenario:

Not at all kind — 0 10 20 30 40 50 60 70 80 90 100 — Extremely kind

Please mark on the line below how **compassionate** you were towards yourself whilst in the **virtual reality** scenario:

Not at all compassionate — 0 10 20 30 40 50 60 70 80 90 100 — Extremely compassionate

1.5 Script for creation of a compassionate coach

Creating a Compassionate Coach

Introduction

In this session I am going to ask you to bring to mind a certain image. Generating images in our minds can be quite a useful and powerful tool. We often use our imaginations in order to problem-solve, to think through different consequences of a situation, or we may imagine something in order to make us feel a bit more confident when approaching a difficult situation. For example, some people when they have to speak in front of others, like to imagine their audience in their underwear to help ease their nerves. Or footballers before a match may imagine themselves scoring a goal in order to feel more prepared. When creating an image, it tends to be easiest to focus firstly on what your image looks like, and then to think about the different qualities of the image in order to make it clearer and more detailed. Then you might even develop other sensory aspects of your image, for example you may think it has a certain sound or smell. So to go back to the example of the footballer, they might first imagine seeing the ball go into the goal, and then they might also think about the sound the ball makes when it hits their boot, and then they might connect with the physical sensation of kicking the ball...so maybe the impact of the ball against their foot, their leg as it swings forward form their hip, perhaps their arms, head and neck also swing upwards as they kick the ball. They might even bring to mind the smell of the grass and mud. Focussing on some of these sensations can be very powerful.

I'll first explain a bit about the kind of image I want you to develop, and then we'll go into the first stage of actually creating it. Feel free to ask me any questions at any point, and don't worry if you find creating the image difficult, just do what you can. We'll be building your image in several stages, so you'll have the chance to reflect and ask me any questions in between. I'm not going to ask you to describe your image to me during the study. Everyone's images are very different.

About compassion

The particular image you'll be creating is of a sort of guide or teacher, that we call a compassionate coach. This coach has all the qualities of kindness, warmth, strength and

confidence. All the things we may need when facing a difficult situation. Don't try to build the image just yet, as I'm first going to explain a bit more about what compassion is, and therefore what a compassionate coach is. Compassion can mean different things to different people, so I'll tell you a bit about what I mean by compassion.

Compassion is grounded in kindness. But it's also more than that. It's about noticing when things are difficult and working out how to manage those situations. Your compassionate coach is someone who helps you to be happy and to have confidence. We might not have ever been taught how to be self-compassionate, and so this image may help to guide you in developing self-compassion. Sometimes your coach may help you to be more understanding and kinder towards yourself. At other times they may coach you in how to approach difficult situations and help give you the strength to negotiate any challenges. They can provide you with warmth, wisdom, strength, and nurture, at any time that you might find you need it in everyday life. So, in the same way as when you think about food, this thought alone can immediately make you feel hungry, when you think about your compassionate coach, this should help you to think of yourself with kindness, warmth and confidence. This is because when you imagine doing or feeling something, many of the same brain responses occur as when you are actually doing or feeling that thing. So, creating this image has the potential to evoke powerful and useful feelings.

Your compassionate coach is completely your own creation, your own personal ideal. They have all the qualities of compassion and confidence. And they are complete and perfect for you. Perhaps there was a teacher, or friend, or someone who you looked up to, who might help to form part of your coach. It is important that it's not purely someone that you know, as your coach is perfect, and superhuman, in a way that none of us can be. So, it may be a combination of all your favourite people. Or it may be something from nature, like a tree that seems strong and wise and comforting, or an animal. It's fine if the image doesn't really make sense. For example, your image might be of the sun, but with the voice of a celebrity, like Morgan Freeman or David Attenborough, and it might smell of something like lavender. It doesn't have to be something that is possible in the real world.

Creating a compassionate coach may well feel like a difficult, unusual task. Most of us have never done something like this before. But if you can try as much as possible to build an image, and to let it support and guide you, you may well start to find it a useful tool, even if you previously thought it isn't something that you would find helpful.

Does all this, including the concept of the compassionate coach make sense? Are there already some ideas of an image that come to mind? Do you have any questions?

If you're ready, we'll begin developing your compassionate coach. If you want to stop the exercise at any point that's completely fine. If you're confused about anything just let me know and we can stop and restart. I'll be turned towards the computer so that I'm not facing you. And when your mind wanders to other things, which it will, just try as much as possible to gently bring your attention back to focussing on your image and the feelings it evokes in you.

Stage 1

Begin by sitting comfortably. When generating an image, it can help to start off by focussing on your posture and your breathing so that you're then relaxed and able to then fully focus on developing your image. I'll be asking lots of open questions, but you don't need to answer these aloud, they're just there for you to think about, to help you develop your image.

Sit in a relaxed, open posture by planting your feet on the ground, releasing any tension in your shoulders and placing your hands wherever is most comfortable, perhaps on your lap or knees. Relax your face, your mouth, and if you feel comfortable enough, close your eyes, or if you prefer let your eyes find a point in the mid-distance to gently focus on.

Firstly take a few slow, deep breaths...In...out....in....out...Focus your attention on your breath. As you breathe out, imagine you are breathing out all of the tension in your body.

Try to start to build an image of your compassionate coach. Anything that easily comes to mind. It might be an animal, an object, like a tree or a colour, or a human-like figure, from fantasy or a fictional film or story. Some people develop a clear, detailed image, while others create a hazy image. The most important thing is the qualities your coach has, and the way you feel in their presence. Take a moment to see what image comes to mind.

Your compassionate coach cares for you and wants you to be at your best in any situation you face. They understand that thoughts can be difficult and that emotions can be confusing and overwhelming, and that this is not our fault, it is just the way human minds work.

Think about what qualities you might like your coach to have in particular. Care? Strength? wisdom? Genuineness? Hope?

Picture your compassionate coach being with you, allowing them to be with you in a way that helps you to feel calm, safe and confident.

Whenever your mind wanders, just gently bring back your attention to focussing on your coach, the strength and confidence you're starting to build with your mind and body.

I'd also like you to try and think about the different aspects of your coach. Imagine and focus on what your compassionate coach looks like: their size, their colour, their shape, their appearance.

Do they have a facial expression and body posture as they listen to you with care and acceptance?

Do they perhaps even have a certain smell? What does your compassionate coach sound like? Soothing? Calm? Low?

Does your compassionate coach have a texture?

Spend some time with your compassionate coach, they are there just for you, to comfort you and soothe you in any time of distress. They have your best interests at heart. They are someone who cares about you and strengthens your confidence, who makes you feel like you can face all of life's challenges. Notice how it feels to have someone care so deeply about you. Notice how it feels in your body. Notice the warmth, the kindness, the calm. Let this make you feel warmer, calmer and kinder towards yourself and others.

And then when you are ready, you can bring your attention gently back in to the room. Begin to move your fingers, your toes and gently open your eyes.

Reflection

How did you find that? Were you able to generate the image? It's okay to say no. How did it feel for your coach to show those feelings of warmth and kindness?

Do you have any questions?

It's okay if some of the qualities or aspects I describe don't fit well with your coach. For example, it may be that your coach doesn't speak to you or doesn't seem to have a particular texture. That's ok, just focus on the qualities and features that are most helpful for you.

We're about to return to the imagery, and this time to invite your coach to help with a difficult situation. This is just an everyday situation, nothing too challenging or upsetting. It may be something that makes you feel a bit uncomfortable, is a bit stressful, or perhaps makes you nervous. For example, it could be a situation at work, perhaps a particular meeting, presentation or interview. Or perhaps a disagreement with a friend or family member. Or it could be something you're scared of. Just an everyday situation that would be good to have some support from your coach with. You don't need to describe it to me. I'll give you a moment to think of something.

Have you got one in mind that you're happy to use?

We'll now return to the imagery. Again, don't worry if it feels difficult, just try and remain relaxed and do whatever you can.

Practise with the compassionate coach

So once again begin by sitting comfortably, taking a relaxed and open posture, planting your feet on the ground, closing your eyes if you like, relaxing your shoulders. Then take some slow and deep breaths...in...out...in ....out, gently releasing all of the tension from your body.

Now begin to bring your difficult situation to mind. And imagine that your coach is there with you.

Focussing on affect

They are giving you their full attention. They know everything about this situation and understand it completely from your perspective. They recognise the challenge and empathise with how you are feeling. They care deeply about you. With your coach there, you are not alone. You have someone with you, alongside you and able to help you face this situation. Notice their warmth, kindness, and strength, allow this to make you feel warmer, and kinder to yourself.

Whenever your mind wanders, just gently bring back your attention to focussing on your coach and the strength and confidence you're building with your mind and body.

Having your coach by your side, caring deeply about you and understanding this challenge may be enough for you to feel confident and calm about this situation.

Focussing on cognition

You may also want to take some advice or guidance from your coach. Remember, your coach gives you exactly what you need in this moment. They know you and are there just for you.

They understand what it is like to be in this situation. Your compassionate coach has both the wisdom and strength to help you with this. Your coach cares about you and you can trust in their advice. They always have your best interests at heart.

They may offer another perspective or way of viewing things. Perhaps they help you step back and see things differently. Maybe there are even things you can learn from this situation, something helpful you couldn't see before? Your coach can help you to let go of critical thoughts, recognising that you are doing your best in a challenging situation. Maybe they give you a motto or phrase you can remind yourself of in this and other situations.

Perhaps your coach helps you to see a funny side to the situation, they might be able to make you smile or even laugh.

Your coach gives you exactly what you need in this moment. They know you and are there just for you. It may be that all you want in this situation is just for them to be alongside you, supporting you. Helping you to feel calmer and kinder towards yourself.

Remember, whenever your mind wanders, just gently bring your attention back to focussing on your coach, the sense of warmth and confidence you're building in your mind and body.

Focussing on physiology

With your coach by your side you can let go of any worries and physical strain. They help you to feel calm and confident, which allows all physical anxiety and tension to melt away. You might notice this in your shoulders as they melt down, your chest at ease, stomach softens, and face softens. Your feet are grounded with the floor. An inner strength is within your body. Your posture may be tall and open, conveying the calm confidence you feel.

Focussing on behaviour

Your coach gives you the confidence to take the actions you need to, if you need to in this situation. They give you exactly what you need in this moment. They know you and are there just for you.

Notice what this calm and confidence feels like in your body and mind.... showing you that you can face this difficulty, and any future challenges, however big or small.

In a moment you can gently come back to the room bringing these feelings of calm, compassion and confidence with you. Letting these feelings transfer from your coach to you, so that you yourself feel kinder and more confident.

Begin to move your fingers and toes. Allow your eyes to softly open. Bring the sense of calm and confidence with you. A confidence knowing that you can face this situation and any future challenges.

Entering VR

You are now going to enter the London Underground in virtual reality. And I'd like you to take everything we've just practised into the situation with you. As I explained earlier you just need to get onto the tube, staying in the central area, then get off when you arrive at the next station.

Try to keep the image of your compassionate coach in mind throughout. The point of the compassionate coach is that they can guide and support you in everyday situations and environments. So, this is an opportunity to practise using and being with your coach. Some people find the tube quite stressful; others find it completely fine. Regardless of how you feel about the tube, let your coach give you support and confidence, let them help you to feel kinder and calmer.

It will obviously be quite distracting to be on the tube in VR for the first time, so it may be very difficult to keep your image in mind, and that's absolutely fine but just try and retain from this moment on throughout the whole experience, those feelings of calm, confidence and compassion towards yourself and others.

You may hear my voice from time to time just voicing a reminder to try and bring your coach and the feelings of calm and confidence to mind.

Any questions?

Stage 2

We'll now do another stage of developing your compassionate coach. So once again plant your feet on the ground... let your eyes close...relax your muscles...your shoulders...your jaw...taking some deep breaths. Then when you are ready bring your compassionate coach to mind again.

Bring back into mind the features of your image, using all your senses to experience being with them. Really focus on what they look like...what they sound like...smell like...feel like....

Whenever your mind wanders, just gently bring back your attention to focussing on your coach, and the strength and confidence you're continuing to build with your mind and body.

Feel the qualities of your coach flowing into you...compassion...calm...warmth...strength. How does it feel? Is it noticeable in any particular parts of your body? Allow yourself to feel calmer, yet stronger, and most of all, kinder towards yourself and others.

The more powerful you can allow these feelings to be, the more easily they will come to mind whenever you begin to think about your coach.

When you are ready, you can bring your attention gently back in to the room, bringing with you the feelings of calm, kindness, and confidence. Retaining the experience in both your mind and body. Begin to move your fingers, your toes, and gently open your eyes.

Entering VR

You are now again going to enter the tube train in virtual reality again. I'd like you to carry with you the image of your coach and all the feelings of warmth and confidence that they provide. Now you know what to expect with the tube it should hopefully be a bit easier to do this, but again don't worry if you find yourself getting distracted a lot. I'll remind you from time to time.

Stage 3

We'll return to the image of your coach now. So as before, sit in a comfortable and open posture...gently closing your eyes...taking some deep breaths...in...and out....in ...and out...then bring your compassionate coach to mind.

Remember that your coach is unique and perfect for you. They provide whatever it might be that you need in any situation, however easy or difficult.

If you are ever struggling with confidence or if you're in any kind of challenging situation, what specifically would you like your coach to offer you? Remember that they know you, and are there just for you, giving you whatever you need. It may be that they are they simply alongside you, helping you to feel kind and confident. Or do they give you some guidance and advice, helping you to see different perspectives, helping you to smile?

Whenever your mind wanders, just try to gently bring back your attention to focussing on your coach, the warmth and kindness you're building with your mind and body.

Being with your coach allows physical tension to be released. Feel this now in your body. Practise letting go of any strain in every part of your body from bottom to top, your feet sinking into the floor, your stomach and your chest softening, your shoulders melting down, jaw relaxing.

Your coach has all the qualities of kindness...warmth...strength...and nurture. They understand the difficulties that you go through...they always want you to feel calm, safe and confident.

When you are ready, you can bring your attention gently back in to the room. Bringing your compassionate coach and the feelings of warmth, kindness and confidence with you. Begin to move your fingers, your toes, and gently open your eyes.

Entering VR

You are now going to go into VR again, this time it'll be a lift. You just need to enter the lift, go up, stay on the lift when the doors open, then come back down again. Again, I'd like you to really try to practise keeping your image of your compassionate coach in mind throughout, helping you to feel safe and confident, retaining those feelings of warmth and kindness. But don't worry if you find yourself very distracted, that's to be expected.

Stage 4

This is now the last section. Again, just take a few deep breaths...relaxing your body...letting any tension that has built up be released. Then bring your compassionate coach to mind.

Practise experiencing what it is like to focus on the feeling that your compassionate coach really values you and cares about you unconditionally.

Focus on your image, which is looking at you with great warmth. They wish that you be happy and that you have confidence. Allow yourself to experience their compassion and kindness...letting yourself also become more compassionate, and kinder, in the knowledge that you can always rely on your compassionate coach to offer you their strength, wisdom and acceptance.

Whenever your mind wanders, just try to gently bring back your attention to focussing on your coach and the warmth and kindness you're building with your mind and body.

Imagine the compassion flowing from your coach to you. Allow yourself to take pleasure in these feelings of warmth, comfort and connectedness for a while...let these feelings transfer to you so that you feel warmer and kinder to yourself and others.

When you are ready, bring your attention gradually back in to the room, bringing all this calm and confidence with you.

Entering VR

You will now enter the final virtual reality environment, which will be the lift with one more person in it. Just like before please stay on the lift, which will take you up and back down, when you can exit. Once again, really imagine your coach is there with you, helping you to feel confident and kind to yourself and others.

1.6 Script for creation of a weather forecaster

Creating a weather forecaster

Introduction

I am going to ask you to bring to mind a certain image. When creating an image, it tends to be easiest to focus firstly on what your image looks like, and then to think about the different qualities of the image in order to make it clearer and more detailed. Then you might even develop other sensory aspects of it, for instance you may think it has a certain sound or smell. So, for example, sometimes before a match, footballers imagine themselves scoring a goal as a form of practise. They might first imagine seeing the ball go into the goal, and then they might also think about the sound the ball makes when it hits their boot before flying into the goal, and then they might focus on what it feels like to kick the ball. So, there's lots of things you can think about with an image.

You will develop your image in four stages, of which this is the first. In the second to fourth stage, I will guide you through developing the image in greater detail. In between each stage you will enter a virtual reality environment. I'll be here throughout to tell you what to do and answer any questions. Don't worry if you find creating the image difficult, just do what you can. I won't ask you to describe your image to me during the study. Everyone's images are very different.

Do you have any questions?

Stage 1

The image I'm going to ask you to bring to mind is going to be a very impersonal and un-emotive image of a weather forecaster. You can be as creative as you like with the image, it doesn't have to be a human weather forecaster. It can be a combination of anything that comes to mind. So long as it is a neutral character that doesn't elicit any kind of emotion. Whenever your mind wanders during the exercise, try to just bring back your attention to focussing on your weather forecaster.

Begin by sitting comfortably. When generating an image, it can help to start off by focussing on your posture and your breathing so that you're then relaxed and able to then fully focus on developing your image.

So, sit in a relaxed, open posture by planting your feet on the ground, releasing any tension in your shoulders and placing your hands wherever is most comfortable, perhaps on your lap or knees. Relax your face, your mouth and jaw, and if you feel comfortable enough, close your eyes, or if you prefer, let your eyes find a point in the mid-distance to gently focus on.

Firstly take a few slow, deep breaths...in...out...in...out...Focus your attention on your breath. As you breathe out, imagine you are breathing out all of the tension in your body.

Start to build an image of some kind of weather forecaster. An image that provides commentary on the current and future weather conditions. This is because it can be interesting to know about the weather for the forthcoming days and weeks. The forecaster simply describes to you, and everybody else, the various weather conditions.

The image of a weather forecaster that you develop does not have to be one of a typical, human, weather forecaster, but can be entirely your own creation. Anything that easily comes to mind, whether human or non-human. What is important is that they are informative in what they report and neutral in their manner. It is best that it is not based on anyone that you know.

See what image comes to mind – you can be creative. It does not matter if it's hazy image or if it is in fact quite clear and detailed. It should, however, be a very impersonal and unemotive image. Because the most important thing is simply the ability for this forecaster to be able to describe the weather in the most informative way. Take a moment to see what image comes to mind.

You may notice that your mind wanders to other things. Just bring your mind back to focusing attention on your weather forecaster.

Hold the image of this weather forecaster in mind, someone who describes facts and detail about the current and upcoming weather conditions to you and everybody else.

When you are ready, bring your attention back in to the room. Begin to move your fingers, your toes and gently open your eyes.

Entering VR

You can now leave your image behind you as you are now going to enter the London Underground in virtual reality. When the tube train doors open please step onto the tube and you will be taken to the next station. When you arrive at the next platform you can exit the tube and take off the headset. You don't need to do anything else.

Stage 2

We'll now do another stage of developing your weather forecaster. So once again plant your feet on the ground...let your eyes close...relax your muscles...your shoulders...your jaw... taking some deep breaths. Then when you are ready bring the image of the weather forecaster to mind again.

Imagine and focus on what this weather forecaster looks like: their size...their colour...their shape...their appearance.

They are a neutral and professional character, but do they use any particular gestures when they inform everyone about the weather?

Do they perhaps even have a certain smell?

What do they sound like when they read the forecast? Are they loud or quiet? Do they have an accent? Do they speak quickly or slowly?

When you are ready, you can bring your attention gently back in to the room.

Entering VR

You'll now go back onto the VR tube train.

Stage 3

So as before, sit in a comfortable and open posture...gently closing your eyes...taking some deep breaths...in...and out....in...and out...then bring the image of the weather forecaster to mind.

Think about what sort of facts and details the weather forecaster might describe. Perhaps they might report on the current outside temperature, the amount of rain or snow, whether it will be sunny at any point, or how windy it will be?

And consider in what way they communicate this information? Do they provide an hour-by-hour forecast? Or do they provide a more general description of what each day will be like? How many days in advance do they report the information?

Remember that this forecaster is neutral and professional, they simply describe the weather to you and everyone else.

When you are ready, bring your attention gently back in to the room.

Entering VR

You will now enter the virtual reality again. This time you're going to be going into a lift instead of a tube. You'll be in front of the lift doors. When they open, please enter the lift. You will go up to the top floor and back down to the bottom again, when you can exit the lift and take off the headset. You do not need to do anything else.

Stage 4

This is now the last section. Again take a few deep breaths, relaxing, and letting any tension that has built up be released from your body. Then Bring the image of the weather forecaster to mind.

Practise listening to this weather forecaster, thinking about what information they are reporting, their commentary on the current or future weather conditions. What detail do they provide? In what way do they describe the weather?

Focus on the information they have reported. Rehearse any particular bits of information.

When you are ready, bring your attention gently back in to the room. Begin to move your fingers, your toes and gently open your eyes.

Entering VR

You will now enter the final virtual reality environment, which will be the lift with one more person in it. Just like before please stay on the lift, which will take you up and back down, when you can exit.

1.7 R code used for analysis

```
# __Load packages ----
library(tidyverse)
library(nlme)
library(broom)
library(readr)
library(multcomp)

# __Load functions ----
source("scripts/functions-calc-medation-results.R")

# __Load data ----
# Long format and prepare for analysis
# s1 = study one
# par = combined under threat and vulnerable measure
# self-comp = combined self-compassion and self-kindness measure

data_long_par_s1 <- read_csv("data/data_long_par_s1.csv")
data_long_self_comp_s1 <- read_csv("data/data_long_self_comp_s1.csv")

# 1. Make control group the reference group
data_long_par_s1 <- data_long_par_s1 %>%
  mutate(condition = factor(condition, levels = c("control",
"compassion")))

data_long_self_comp_s1 <- data_long_self_comp_s1 %>%
  mutate(condition = factor(condition, levels = c("control",
"compassion")))


# 2. Hypothesis 1 ----
self_comp_lme_s1_h1 <- lme(self_comp ~ self_comp_t0 + condition +
factor(time) + condition * factor(time),
                           random = ~1|id,
```

```
                        data = data_long_self_comp_s1)

# Look at summary
summary(self_comp_lme_s1_h1)

# Look at residuals
qqnorm(resid(self_comp_lme_s1_h1))

# Define contrast statements for each time point, extract estimates and
95% CIs
contrast_matrix_h1_t1 <- rbind("Compassion Time1 vs Control Time1" =
c(0,0,1,0,0,0,0,0,0,0))
summary(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t1))
confint(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t1))

contrast_matrix_h1_t2 <- rbind("Compassion Time2 vs Control Time2" =
c(0,0,1,0,0,0,0,1,0,0,0))
summary(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t2))
confint(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t2))

contrast_matrix_h1_t3 <- rbind("Compassion Time3 vs Control Time3" =
c(0,0,1,0,0,0,0,0,1,0,0))
summary(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t3))
confint(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t3))

contrast_matrix_h1_t4 <- rbind("Compassion Time4 vs Control Time4" =
c(0,0,1,0,0,0,0,0,0,1,0))
summary(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t4))
confint(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t4))

contrast_matrix_h1_t5 <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,1,0,0,0,0,0,0,0,1))
summary(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t5))
confint(glht(self_comp_lme_s1_h1, contrast_matrix_h1_t5))
```

```
# 3. Hypothesis 2 ----
par_lme_s1_h2 <- lme(par ~ gpts_t0 + condition + factor(time) + condition
* factor(time),
                     random = ~1|id,
                     data = data_long_par_s1)
# Look at summary
summary(par_lme_s1_h2)

# Look at residuals
qqnorm(resid(par_lme_s1_h2))

# Define contrast statements for each time point, extract estimates and
95% CIs
contrast_matrix_h2_t2 <- rbind("Compassion Time2 vs Control Time2" =
c(0,0,1,0,0,0,0,0,0))
summary(glht(par_lme_s1_h2, contrast_matrix_h2_t2))
confint(glht(par_lme_s1_h2, contrast_matrix_h2_t2))

contrast_matrix_h2_t3 <- rbind("Compassion Time3 vs Control Time3" =
c(0,0,1,0,0,0,1,0,0))
summary(glht(par_lme_s1_h2, contrast_matrix_h2_t3))
confint(glht(par_lme_s1_h2, contrast_matrix_h2_t3))

contrast_matrix_h2_t4 <- rbind("Compassion Time4 vs Control Time4" =
c(0,0,1,0,0,0,0,1,0))
summary(glht(par_lme_s1_h2, contrast_matrix_h2_t4))
confint(glht(par_lme_s1_h2, contrast_matrix_h2_t4))

contrast_matrix_h2_t5 <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,1,0,0,0,0,0,1))
summary(glht(par_lme_s1_h2, contrast_matrix_h2_t5))
confint(glht(par_lme_s1_h2, contrast_matrix_h2_t5))



# 4. Hypothesis 3  ----
```

```
# 4.1 Mediation self-compassion t5 ----

# Path a
# Relationship between self-compassion and condition
self_comp_lme_s1_h3a <- lme(self_comp ~ self_comp_t0 + gpts_t0 + condition
+ factor(time) + condition * factor(time),
                            random = ~1|id,
                            data = data_long_self_comp_s1)
# Look at summary
summary(self_comp_lme_s1_h3a)

# Contrast Statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,1,0,0,0,0,0,0,0,1))

# Path c
# Relationship between paranoia and condition
self_comp_lme_s1_h3c <- lme(par ~ gpts_t0 + self_comp_t0 + condition +
factor(time) + condition * factor(time),
                            random = ~1|id,
                            data = data_long_par_s1)
# Look at summary
summary(self_comp_lme_s1_h3c)

# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,1,0,0,0,0,0,1))

# Path cd and b
self_comp_lme_s1_h3cd <- lme(par ~ gpts_t0 + self_comp_t0 + self_comp_t5 +
condition + factor(time) + condition * factor(time),
                             random = ~1|id,
```

```
                                data = data_long_par_s1)
# Look at summary
# Coefficient of mediator at designated time point (b) and its standard
error (b_se)
summary(self_comp_lme_s1_h3cd)

# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
contrast_matrix_h3cd <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,0,1,0,0,0,0,0,1))

# Function for extracting required numbers
path_cd_est_s1_t5 <- tidy(summary(glht(self_comp_lme_s1_h3cd,
contrast_matrix_h3cd)))$estimate[[1]]
path_cd_se_s1_t5 <- tidy(summary(glht(self_comp_lme_s1_h3cd,
contrast_matrix_h3cd)))$std.error[[1]]

path_b_est_s1_t5 <-
summary(self_comp_lme_s1_h3cd)[["coefficients"]][["fixed"]][["self_comp_t5
"]]
path_b_se_s1_t5 <- 0.0935421

path_a_est_s1_t5 <- tidy(summary(glht(self_comp_lme_s1_h3a,
contrast_matrix_h3a)))$estimate[[1]]
path_a_se_s1_t5 <- tidy(summary(glht(self_comp_lme_s1_h3a,
contrast_matrix_h3a)))$std.error[[1]]

path_c_est_s1_t5 <- tidy(summary(glht(self_comp_lme_s1_h3c,
contrast_matrix_h3c)))$estimate[[1]]
path_c_se_s1_t5 <- tidy(summary(glht(self_comp_lme_s1_h3c,
contrast_matrix_h3c)))$std.error[[1]]

# __Estimates and percent mediation ----

# Joint function to get a table with results for all effects and 95 CIs
```

```
med_results_s1_t5 <- calc_mediation(path_a_est = path_a_est_s1_t5,
path_a_se = path_a_se_s1_t5,
                                    path_b_est = path_b_est_s1_t5,
path_b_se = path_b_se_s1_t5,
                                    path_c_est = path_c_est_s1_t5,
path_c_se = path_c_se_s1_t5,
                                    path_cd_est = path_cd_est_s1_t5,
path_cd_se = path_cd_se_s1_t5)

# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s1_t5, path_b_est =
path_b_est_s1_t5, path_c_est = path_c_est_s1_t5)

# 4.2 Mediation self-compassion t3 ----

# Path a
# Relationship between self-compassion and condition
self_comp_lme_s1_h3a_t3 <- lme(self_comp ~ self_comp_t0 + gpts_t0 +
condition + factor(time) + condition * factor(time),
                               random = ~1|id,
                               data = data_long_self_comp_s1)
# Look at summary
summary(self_comp_lme_s1_h3a_t3)

# Contrast Statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a_t3 <- rbind("Compassion Time3 vs Control Time3" =
c(0,0,0,1,0,0,0,0,0,1,0,0))

# Path c
# Relationship between paranoia and condition
self_comp_lme_s1_h3c_t3 <- lme(par ~ gpts_t0 + self_comp_t0 + condition +
factor(time) + condition * factor(time),
                               random = ~1|id,
                               data = data_long_par_s1)
# Look at summary
```

```
summary(self_comp_lme_s1_h3c_t3)

# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c_t3 <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,1,0,0,0,0,0,1))

# Path cd and b
self_comp_lme_s1_h3cd_t3 <- lme(par ~ gpts_t0 + self_comp_t0 +
self_comp_t3 + condition + factor(time) + condition * factor(time),
                                random = ~1|id,
                                data = data_long_par_s1)

# Look at summary
# Coefficient of mediator at designated time point (b) and its standard
error (b_se)
summary(self_comp_lme_s1_h3cd_t3)

# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
contrast_matrix_h3cd_t3 <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,0,1,0,0,0,0,0,1))

# Function for extracting required numbers
path_a_est_s1_t3 <- tidy(summary(glht(self_comp_lme_s1_h3a_t3,
contrast_matrix_h3a_t3)))$estimate[[1]]
path_a_se_s1_t3 <- tidy(summary(glht(self_comp_lme_s1_h3a_t3,
contrast_matrix_h3a_t3)))$std.error[[1]]

path_cd_est_s1_t3 <- tidy(summary(glht(self_comp_lme_s1_h3cd_t3,
contrast_matrix_h3cd_t3)))$estimate[[1]]
path_cd_se_s1_t3 <- tidy(summary(glht(self_comp_lme_s1_h3cd_t3,
contrast_matrix_h3cd_t3)))$std.error[[1]]
```

```
path_b_est_s1_t3 <-
summary(self_comp_lme_s1_h3cd_t3)[["coefficients"]][["fixed"]][["self_comp
_t3"]]
path_b_se_s1_t3 <- 0.0989203

path_c_est_s1_t3 <- tidy(summary(glht(self_comp_lme_s1_h3c_t3,
contrast_matrix_h3c_t3)))$estimate[[1]]
path_c_se_s1_t3 <- tidy(summary(glht(self_comp_lme_s1_h3c_t3,
contrast_matrix_h3c_t3)))$std.error[[1]]

# __Estimates and percent mediation ----
# Estimates
# Joint function to get a table with results for all effects and 95 CIs
med_results_s1_t3 <- calc_mediation(path_a_est = path_a_est_s1_t3,
path_a_se = path_a_se_s1_t3,
                                    path_b_est = path_b_est_s1_t3,
path_b_se = path_b_se_s1_t3,
                                    path_c_est = path_c_est_s1_t3,
path_c_se = path_c_se_s1_t3,
                                    path_cd_est = path_cd_est_s1_t3,
path_cd_se = path_cd_se_s1_t3)

med_results_s1_t3
# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s1_t3, path_b_est =
path_b_est_s1_t3, path_c_est = path_c_est_s1_t3)


# 4.3 Reverse mediation ----

# Path a
# Relationship between self-compassion and condition
par_lme_s1_h3a_rev <- lme(par ~ self_comp_t0 + gpts_t0 + condition +
factor(time) + condition * factor(time),
                          random = ~1|id,
```

```
                              data = data_long_par_s1)
# Look at summary
summary(par_lme_s1_h3a_rev)

# Contrast Statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a_rev <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,1,0,0,0,0,0,1))

# Path c
# Relationship between paranoia and condition
self_comp_lme_s1_h3c_rev <- lme(self_comp ~ gpts_t0 + self_comp_t0 +
condition + factor(time) + condition * factor(time),
                              random = ~1|id,
                              data = data_long_self_comp_s1)
# Look at summary
summary(self_comp_lme_s1_h3c_rev)

# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c_rev <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,1,0,0,0,0,0,0,0,1))

# Path cd and b
self_comp_lme_s1_h3cd_rev <- lme(self_comp ~ gpts_t0 + self_comp_t0 +
par_t5 + condition + factor(time) + condition * factor(time),
                               random = ~1|id,
                               data = data_long_self_comp_s1)

# Look at summary
# Coefficient of mediator at designated time point (b) and its standard
error (b_se)
summary(self_comp_lme_s1_h3cd_rev)
# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
```

```
contrast_matrix_h3cd_rev <- rbind("Compassion Time5 vs Control Time5" =
c(0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1))

summary(glht(self_comp_lme_s1_h3cd_rev, contrast_matrix_h3cd_rev))

# __Estimates and percent mediation ----

# Function for extracting required numbers
path_cd_est_s1_t5_rev <- tidy(summary(glht(self_comp_lme_s1_h3cd_rev,
contrast_matrix_h3cd_rev)))$estimate[[1]]
path_cd_se_s1_t5_rev <- tidy(summary(glht(self_comp_lme_s1_h3cd_rev,
contrast_matrix_h3cd_rev)))$std.error[[1]]

# Changing self_comp_t5 for par_t5
path_b_est_s1_t5_rev <-
summary(self_comp_lme_s1_h3cd_rev)[["coefficients"]][["fixed"]][["par_t5"]
]
path_b_se_s1_t5_rev <- 0.0497199

path_a_est_s1_t5_rev <- tidy(summary(glht(par_lme_s1_h3a_rev,
contrast_matrix_h3a_rev)))$estimate[[1]]
path_a_se_s1_t5_rev <- tidy(summary(glht(par_lme_s1_h3a_rev,
contrast_matrix_h3a_rev)))$std.error[[1]]

path_c_est_s1_t5_rev <- tidy(summary(glht(self_comp_lme_s1_h3c_rev,
contrast_matrix_h3c_rev)))$estimate[[1]]
path_c_se_s1_t5_rev <- tidy(summary(glht(self_comp_lme_s1_h3c_rev,
contrast_matrix_h3c_rev)))$std.error[[1]]

# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s1_t5_rev, path_b_est =
path_b_est_s1_t5_rev, path_c_est = path_c_est_s1_t5_rev)
# Figure ----
require(ggplot2)
s1_figure <- read.csv("s1_figuredata.csv")
```

```
#create tiff file high res
tiff("s1_figure.tiff", width = 176, height = 160, units = 'mm', res = 300)

#set margins
par(mar=c(5,5,4,5)+.1)

# Means Plot with Standard Error bars
# The errorbars overlapped, so use position_dodge to move them
horizontally
pd <- position_dodge(0.1) # move them .05 to the left and right

s1_figure$Group <- paste(s1_figure$Allocation, s1_figure$Outcome, sep="_")

ggplot(s1_figure, aes(x=Time, y=Mean, colour=Group)) +
  geom_errorbar(aes(ymin=Mean-SE, ymax=Mean+SE), width=.1, position=pd) +
  geom_line(position=pd) +
  geom_point(position=pd) +
  scale_y_continuous(breaks = c (1,2,3,4,5,6,7,8,9)) +
  xlab("Time Point") +
  ylab("Mean Score (Standard Error)") +
  scale_colour_manual(values = c("steelblue1",  "firebrick2",
"steelblue4", "firebrick4"), name="",    # Legend label, use darker colors
                      breaks=c("Control_Compkind", "Compassion_Compkind",
                               "Control_Threatvuln",
"Compassion_Threatvuln"),
                      labels=c("Control group: Self-compassion",
"Compassion group: Self-compassion",
                               "Control group: paranoia", "Compassion
group: paranoia")) +
  theme_bw() +
  theme(axis.text.x =
element_text(colour="grey20",size=12,angle=0,hjust=.5,vjust=.5,face="plain
"),
        axis.text.y =
element_text(colour="grey20",size=12,angle=0,hjust=1,vjust=0,face="plain")
```

```
,
        axis.title.x =
element_text(colour="grey20",size=12,angle=0,hjust=.5,vjust=0,face="plain"
),
        axis.title.y =
element_text(colour="grey20",size=12,angle=90,hjust=.5,vjust=.5,face="plai
n")) +
  theme(legend.justification=c(0,0),
        legend.key.size = unit(0.3, "cm"),
        legend.position=c(0.003,0.01))
s1_figure

#save
dev.off()

#save as eps
s1_figure <- read.csv("s1_figuredata.csv")

setEPS()
postscript("s1_figureB.eps")

plot(rnorm(100), main="s1_figure")

#set margins
par(mar=c(5,5,4,5)+.1)

# Means Plot with Standard Error bars
# The error bars overlapped, so use position_dodge to move them
horizontally
pd <- position_dodge(0.1) # move them .05 to the left and right

s1_figure$Group <- paste(s1_figure$Allocation, s1_figure$Outcome, sep="_")

ggplot(s1_figure, aes(x=Time, y=Mean, colour=Group)) +
  geom_errorbar(aes(ymin=Mean-SE, ymax=Mean+SE), width=.1, position=pd) +
```

```
  geom_line(position=pd) +
  geom_point(position=pd) +
  scale_y_continuous(breaks = c (1,2,3,4,5,6,7,8,9)) +
  xlab("Time Point") +
  ylab("Mean Score (Standard Error)") +
  scale_colour_manual(values = c("steelblue1",  "firebrick2",
"steelblue4", "firebrick4"), name="",    # Legend label, use darker colors
                      breaks=c("Control_Compkind", "Compassion_Compkind",
                               "Control_Threatvuln",
"Compassion_Threatvuln"),
                      labels=c("Control group: Self-compassion",
"Compassion group: Self-compassion",
                               "Control group: paranoia", "Compassion
group: paranoia")) +
  theme_bw() +
  theme(axis.text.x =
element_text(colour="grey20",size=12,angle=0,hjust=.5,vjust=.5,face="plain
"),
        axis.text.y =
element_text(colour="grey20",size=12,angle=0,hjust=1,vjust=0,face="plain")
,
        axis.title.x =
element_text(colour="grey20",size=12,angle=0,hjust=.5,vjust=0,face="plain"
),
        axis.title.y =
element_text(colour="grey20",size=12,angle=90,hjust=.5,vjust=.5,face="plai
n")) +
  theme(legend.justification=c(0,0),
        legend.key.size = unit(0.3, "cm"),
        legend.position=c(0.003,0.02))

s1_figure
#save
dev.off()
```

Chapter 4

2.1 Baseline visual analogue scale measuring compassion for others

Imagine you are walking down a street. It could be any street either that you know or don't know.

Please mark on the line below how **connected** to the other people on the street you think you would feel:

Not at all connected — 0 10 20 30 40 50 60 70 80 90 100 — Extremely connected

Please mark on the line below how **accepting** of other people on the street you would feel:

Not at all accepting — 0 10 20 30 40 50 60 70 80 90 100 — Extremely accepting

Please mark on the line below how **understanding** of other people on the street you would feel:

Not at all understanding — 0 10 20 30 40 50 60 70 80 90 100 — Extremely understanding

Please mark on the line below how **positive** you feel **in general right now**:

Not at all positive — 0 10 20 30 40 50 60 70 80 90 100 — Extremely positive

2.2 Post VR visual analogue scale measuring compassion for others

Please mark on the line below how **connected** to the people around you **in VR** you felt:

Not at all connected 0 10 20 30 40 50 60 70 80 90 100 Extremely connected

Please mark on the line below how **accepting** of the other people around you **in VR** you felt:

Not at all accepting 0 10 20 30 40 50 60 70 80 90 100 Extremely accepting

Please mark on the line below how **understanding** towards the other people around you **in VR** you felt:

Not at all understanding 0 10 20 30 40 50 60 70 80 90 100 Extremely understanding

Please mark on the line below how **positive** you felt whilst **in VR**:

Not at all positive 0 10 20 30 40 50 60 70 80 90 100 Extremely positive

2.3 Script for practising loving kindness meditation

Introduction

- I'm going to start by talking to you a bit about compassion, what we really mean by the term compassion and why it is an important thing to be thinking about, and we're then going to do an imagery exercise that is based somewhat on compassion and related concepts
- Are you able to bring to mind a time someone was kind to you and think what that meant or how it felt...it could be something as small as making you a cup of tea, or saying something nice, noticing you were down or making you laugh? Are these thoughts something you feel you can bring to mind?
- Compassion grounded in acts of kindness like these, but compassion also goes a number of steps further
- Involves a belief that *everyone* deserves to be happy and to not be in pain or suffering, regardless of our opinion of some of these people
- To achieve this belief, this compassion for other people, we need to untangle the differences between blame and responsibility: when we blame someone, we are essentially judging them as a bad person, where-as when we just hold them responsible for something, we judge the action, and not necessarily the person as bad
- It can be important not to blame people for things, as people may have reasons for acting or appearing a certain way that we can't see; it's important to try and remember this
- Also, we are a largely product of our genes and environments, there are many factors about us and our lives that actually we didn't' choose which can be another reason we perhaps shouldn't always blame or judge people for things, and instead try to be compassionate
- So, to be compassionate is firstly to take an open and understanding view towards people and their actions, and to not judge or blame them, even if they are responsible for a bad action, and secondly to be compassionate is to want to try and alleviate distress in all other people in whatever way we can, even those people who we don't like

- The reason that achieving this can be important is because greater compassion is associated with better wellbeing, and we think also even stronger immune systems because of the reduction in stress and tension it can help with
- Our brains continue to change and grow throughout our adult lives; practising certain exercises, such as ones in compassion, can actually change our brains in positive ways
- Compassion can help us strengthen relationships in our lives, help us to be more understanding and feel more similar or connected to other people, and therefore make us feel more relaxed, confident and safe in everyday life

Explanation of what will happen

I'm going to take you through an exercise that involves visualising and imagining some things that aim to increase how compassionate we feel to those around us. It may feel like a very difficult and certainly unusual task, but you just need to try and give it go, try to remain relaxed and focussed throughout, and just follow the exercise as much as possible. Don't worry if you find you can't really do it; it does take practise. If you want to ask me any questions or stop the exercise at any point that's fine.

The first part of the exercise is going to ask you to bring to mind one or two people who you really care about, and who care about you. They might be a friend or family member or a long-term partner. You can use someone who is no longer in your life, so long as bringing them to mind doesn't make you feel upset or make you really miss them. The exercise will be easiest if they are someone you have known for a long time, who is quite positive and loving, and perhaps not too judgmental or critical of you. Take as long as you like to think of someone, or two people if you don't think one single person meets that description, and let me know when you've thought of someone. If you don't have anyone that's also okay just let me know.

How many people are you thinking of? Do you feel happy to use them?

If you find it hard using two people you can at any point start to focus on just one, or you can switch between them, or imagine both together. Whatever's easiest for you.

If you're now ready, we'll begin by focussing firstly on posture and breathing just to relax and release tension. Sit in a comfortable, open posture by planting your feet on the ground, releasing any tension in your shoulders and placing your hands wherever is most comfortable, perhaps on your lap or knees. Try to relax your whole face, your mouth, your jaw; and if you

feel comfortable enough, close your eyes, or if you prefer, let your eyes find a point in the mid-distance to gently focus on. I'll be turned towards the computer so that I'm not facing you. If you start to feel uncomfortable at any point just shift your posture to however makes you feel most relaxed. I'll be asking some open questions, you don't need to answer anything out loud, just consider them in your head. And when you find your mind wanders or if you start to feel bored just try and re focus of the pleasant feelings and memories the exercise may evoke.

Take a few slow, deep breaths...Focus your attention on your breath. As you breathe out, imagine you are breathing out all of the tension in your body.

Stage one Part 1: loved person

Try to visualise the person(s) who you care about being near to you. If you find it hard to bring them to mind maybe focus first on a couple of their features e.g. their hair, their eyes, or where they are standing or sitting. As you imagine them being near to you, try to reflect on their positive qualities and attributes; what about them makes you happy...what makes you feel connected to them...are there any acts of kindness they have done...maybe something they once helped you with or a time they listened to you, or just held your hand, smiled or gave you a hug?

If you find your mind wandering to other things, just gently bring your attention back to imagining this person(s), and how focussing on their positive attributes and your being loved by them makes you feel.

If it feels natural, visualise them smiling at you, and imagine them sending you their unconditional love and warmth. You could picture them being happy, maybe laughing with you; and imagine them being accepting of everything about you, and of the world around them. See if you can actually feel yourself fill with warmth as you receive their love and their kindness, their acceptance of you exactly how you are. Can you feel this warmth in your body?

It's ok if some of this feels difficult with the person(s) you have in mind. If you're using two people you could switch between them, or focus on them at the same time, or start to just imagine one of them. Just keep trying to do what you can.

Some people find it helpful to use a phrase at this point. For example, you may wish to try out imagining the person(s) you care about saying something to you, such as 'I hope you have a

good day, I hope you feel happy, I hope you aren't in pain'. You can use any phrase that feels meaningful and imagine your loved one(s) repeating it to you.

For some people using a phrase can feel strange and distracting...so you may prefer to imagine them sending their warmth and love in a different, non-verbal way. You may wish to feel their warmth and kindness flowing into you. Maybe this flow of love is associated with a colour. Or maybe it feels like they are extending out rays of light onto you. Or, you could try to imagine their love and kindness flowing like water towards you. Have a go at using any of these methods, the phrase, the flow of light, colour or water, or any of your own. Maybe the warmth feels like a pulse, or like the wind. Try and find the easiest way to imagine them sending you their warmth, love and kindness without worrying if your mind keeps wandering or if don't feel any of the methods feel right for you, everyone uses different methods, and sometimes it can be difficult to achieve at all. You can experiment with your other senses. Sometimes it feels easier to associate the flow of warmth with a sound or even a smell, or taste. If you can, try to really notice what receiving their warmth feels like. Can you feel it anywhere in your body?

I'd now like you to switch your image round, so that you now send these things back to the person(s) you've been picturing. So firstly, you may want to reflect on one or two of your own positive qualities or values...or perhaps a time you were kind or gave a gift, or maybe just a hug or a smile. Then visualise yourself sending happiness, warmth and kindness back to them. Try to accept every aspect of them, all their qualities, good and bad.

Whenever you start to find your mind wandering, just gently bring your attention back to visualising this person you care about, and the warmth of the connection between you

You may want to try using a phrase again, perhaps repeating that you wish them to be happy, to be laughing, to not be in any pain.

Or you could again try to imagine sending a colour, rays of light, water, or a sound or smell, to help visualise your kindness flowing from you to them. Keep practising, getting used to these feelings of warmth, not worrying about how difficult you may be finding the exercise. Just keep trying as best you can to picture or feel the warmth and kindness being sent from you to the person you care about.

Notice if you can feel the warmth anywhere in your body, before sending it to this person you care about, accepting them, wishing them to be happy.

Then when you are ready, you can bring your attention gently back in to the room. Begin to move your fingers, your toes and gently open your eyes.

Reflection

How did you find that? Did you find you were able to imagine both parts? So firstly, your loved one(s) sending you their love and kindness, and then you sending them back to you. It's an unusual thing to imagine so don't worry if you found it difficult. Did you find it helpful to use a method of sending love and kindness, like a phrase or a colour? Any other senses? Some of these methods feel very alien to some people, where-as for other people it really helps, but it is worth giving them ago even they don't immediately feel right. Or you might find you don't need any particular method.

It's important to remember that each of these stages is essentially a form of practice, you may not be able to do it straight away.

Do you have any questions?

Stage 1 Part 2: Imagining a bus ride

We're now going to practice the same technique but sending it to strangers rather than people you care about, so it's likely to be a bit more difficult and stranger. The reason for doing this is essentially because it generally makes us feel better to think kind thoughts about other people. I'll explain what to try and do as we go through the exercise. Does that sound ok? So if you again, like before, sit comfortably, try to relax and close your eyes if you like. Take a few slow breaths.

And then I'd like you to imagine you're on a bus or a train, it doesn't matter which, just settle on whichever comes most easily to mind. The image can be as detailed as you like or as you find easy to hold in mind. The detail isn't important but to first help you picture the bus or train maybe you think about its colour, who the driver is, where the seats are, what the hand holds look like. Then imagine yourself sitting on a seat at the very back on the bus or train. There's someone else in a seat just in front of you, another person to your side, and the driver at the front.

Then I want you to try and send warmth and kindness like before to these other people around you. These people are just strangers who you don't know much about. It tends to be easiest to send warmth to one person at a time. So maybe you can now start to feel feelings of warmth building in yourself...noticing how it feels...maybe bringing to mind the person you care about if that helps you bring positive feelings back in to mind...then start trying to send this warmth to the driver...you can create a couple of features for this person if that helps to keep them in mind...maybe what they look like...what they're wearing. Once you feel focussed you can try sending your warmth to the driver, using similar methods as you did with the person you care about...or maybe you want to change technique. You could repeat that you wish this person to feel happy, to have a nice day. You could try and send kindness via rays of light or some kind of pulse, or other flow.

If you find your mind wandering, or feel frustrated or bored that's okay, just try to gently refocus your attention on the bus or train and try to regenerate some feelings of warmth within you. Now maybe you try and send kindness and warmth for the person in front of you...it's ok if it feels strange and uncomfortable...just keep practising, maybe first focusing on a couple of their physical features if that is helpful. Then feel the warmth within you and really try to send it out to reach this person, wishing them to have a good day and to not be in any pain. Then finally you could try and extend this to the person to the side of you... really practice trying to send them kindness and warmth, and wishes that they be happy...however strange it may feel.

Then when you are ready you can bring your attention gently back in to the room. Begin to move your fingers, your toes and gently open your eyes.

Entering VR

You're now going to enter the London underground in VR. And I'd like you to pick one of the characters, or a group of people if you prefer, who is on the tube with you and try to practice sending warmth and kindness to them, like we've just practised. It might feel strange to be staring at someone, but that's ok. You can pick whoever you like, perhaps whoever looks the easiest to send warmth to.

You can try the same techniques as before or try new ones. It will be very distracting at first when you get on the tube because there's a lot going on, so take a few moments to get used to it, then I'll voice a reminder for you to pick someone to begin sending warmth to.

If you get bored doing the exercise that's ok, you can take a moment, and then try to refocus, either on the same person or a different person.

Stage two: Hostile person

We're now going to practise sending warmth and kindness like before, to someone you dislike, perhaps someone who is quite hostile and does not seem very kind. The reason I'm asking you to do this is firstly because feeling dislike for other people is quite an unpleasant thing, and in fact it can feel quite relieving and calming to achieve the very difficult task of being compassionate towards such a person and wishing them happiness. Secondly, it's probably the most difficult exercise to do, and if you can even start to feel even a small amount of compassion for someone you dislike, it will hopefully feel a lot easier to feel it for other people who you don't have a dislike for.

The person you choose should be someone who you would really rather not try and send love and warmth to. It's up to you whether you choose someone who you feel a lot of emotional discomfort or not. The more you dislike the person the harder it will be. So, at the lesser end of the scale, you could choose someone who, for example, you perhaps find slightly irritating. Much more difficult would be someone who has actually treated you badly. The aim of this is not at all to make you feel negative or upset, so don't feel the need to pick someone really challenging, particularly if you find the exercise quite difficult to visualise. You don't want to feel distracted by negative thoughts of this person for the rest of the study. It's a huge achievement if you can even start to send a little bit of warmth to someone who you dislike a little bit.

Take as long as you need to think of someone. If you really can't think of anyone that you know personally, you could use someone famous, like a politician who you dislike. Just let me know when you've thought of someone.

Is it someone you know? Is it quite a mild dislike or quite strong? Can you picture them/some features of their physical appearance? If not, it can be helpful to create a couple.

Ok so we're going to do the task just like before, but instead using this hostile person. It will likely feel very difficult and maybe unpleasant, but just do whatever you can.

So once again begin by sitting comfortably. Sitting in a relaxed and open posture, planting your feet on the ground, closing your eyes if you like...relaxing your shoulders. Then take some slow and deep breaths...gently releasing all of the tension from your body.

Now bring to mind the person who you've thought of. You can focus on a couple of their physical features first if that helps you to bring them to mind e.g. their hair colour, their height, what they are wearing.

It can be very uncomfortable to try and send warmth to someone who we don't like or don't respect. So, it's important to try and separate your vision of this person from anything unpleasant they may have done. Try to remember that everyone is deserving of care and love, so that they can learn from their mistakes. We are not freeing them of responsibility, we are just being compassionate to their own difficulties.

Try as best as you can to start sending your kindness and warmth to this person...using whatever technique you find easiest. You might want to imagine extending your own positive qualities or memories towards them or saying that you wish them to have a good day and to not be in pain, trying to repeat this to them. Or maybe imagine the colour or other quality that you may have used before.

Try not to let your mind wander to thoughts of what this person may have done that is wrong, but instead just imagine them as a person like any other, deserving of love and kindness, that you can try and help to send them. Keep practising as best you can.

Be wary of letting your compassion for them turn into pity. The aim of this is not to look down on this person, but to really attempt to separate some of their bad qualities from them as a person, and to feel that they are deserving of forgiveness, love and kindness like everyone else. Maybe there was a reason for their actions that you weren't aware of, or perhaps you can remember some nice things about them or something that helps you to understand them better. Are there even any qualities that they have in common with other people who you care a lot about? The answer may be no and that's okay, but sometimes it can help to try and look for these things.

Continue practising as best you can. Maybe you use a different method this time, even if it feels difficult. Maybe you try using a different sense to send your warmth, by associating the warmth with a sound or smell.

And then when you are ready, switch back to the first task that we did, where you imagine the person(s) you care about being with you, them sending you their love and their kindness, filling you with warmth, and you in turn sending it back to them. Allow yourself to feel relieved that you are no longer visualising the person you dislike, and happy that you attempted the task. Let yourself refocus on the positive connection you have with the person you care about and who cares about you...maybe bringing to mind a positive memory you have with them...even just a time you hugged or exchanged a gift or just focussing on the warmth that exists between you.

Then when you are ready, you can bring your attention gently back in to the room. Begin to move your fingers, your toes and gently open your eyes.

Entering VR

You'll now go back onto the tube train. Now you know more what to expect with the VR environment I'd like you to try and again practice sending warmth and kindness to one or more of the people. You can use the same or different characters. If you're feeling quite confident with the task maybe you want to choose the person you think looks the most difficult to send warmth to, or maybe you want to try several people or one area of the train at once, so it feels less like you're staring just at one person.

Stage 3: Acquaintance

We are now going to do another stage of the same exercise, but this time using a fairly neutral person. So, if you can I'd like you to bring to mind an acquaintance you have, someone you don't have any particularly positive or neutral feelings towards, probably who you don't know very well. It could be someone you saw on your way here today, or maybe someone you've seen or met briefly around where you live...again it tends to be easiest if you can bring to mind some of their physical features just to help you imagine them. Take as long as you like to think of someone...if you can't just let me know.

So once again plant your feet on the ground. Relax your muscles, your shoulders, your jaw, taking some deep breaths. Then bring to mind the person you've thought of. To help you picture them you could firstly focus on what they look like, or where you are picturing them.

Then when you're ready, using whatever techniques you've found have worked before, try to direct warmth, wishes of happiness, and kindness towards this person.

If your mind wanders or you lose focus just try to gently bring your attention back to firstly imagining this person...and then to the warmth building within you, and then to you sending this warmth to them.

You might also want to imagine extending your own positive qualities or memories towards them, or saying that you wish them to be happy, to be laughing, and not to be in pain. Or another phrase that feels more comfortable or meaningful. Or maybe imagining a colour or other quality flowing into them. It may feel strange or boring, but try to allow yourself to keep practising, trying to notice the warmth within you, flowing out to them.

Then when you're ready you can bring your attention gently back in to the room. Begin to move your fingers, your toes and gently open your eyes.

Entering VR

You'll now go into the lift in VR. I'd again like you to practice sending warmth and kindness to the people around you. You can do one person at a time, or only focus on one person throughout the whole lift. Or you could try and do the whole lift at once. Just experiment with what works best for you.

Stage 4: All beings

This final stage might feel harder in terms of the visualisation. The aim is to extend the warmth that you send to all kinds of other people, essentially the whole world. As before I'll explain how to do this as we go. Are you happy to give it a go?

Again take a few deep breaths. Relaxing your body and letting any tension that has built up be released.

Firstly, bring back into mind the feelings and sensations we've been practising, perhaps imagining your loved one(s) again, sending their love and you sending it back to them. Let yourself fill with warmth.

And then try to extend these feelings to various groups of other people. You might want to start off with trying to send love and kindness to your whole family, or to a group of your friends. Remember to use whatever techniques you find easiest, maybe starting by imagining them in a group around you, then trying to really feel and notice the warmth in your body and sending that onwards to them, repeating certain phrases to them if that helps.

You could also try sending your love and compassion to all children in the world, for example. This can be difficult to imagine, so you might do this by actually imagining groups of children in front of you and using your phrase or other technique, or it may be easier to imagine sending your love in all different directions out from you, trying to reach children all over the world. Maybe you send out rays of light or a pulse, or a message wishing them love and happiness.

If this feels very difficult or if you find your mind wandering a lot, you can always at any point return to picturing the person you care about that you used earlier, focusing on sending warmth and kindness to them, before then trying again to extend it out to other people.

If you find you can extend the exercise to different people, you can then experiment with other groups, for example, extending to all adults, people from all cultures and all backgrounds, or to different continents/countries, imagining them around you, or letting warmth leave you in all directions. And then to people you may not normally interact with much, that might be a group of hospital patients, or perhaps a group of people in prison.

Keep allowing yourself to fill with warmth, noticing it in your body if you can before sending it outwards. If your mind wanders, just gently refocus on the warmth you're trying to send out.

You could also extend it to everyone you pass in the street, the people who bump into you and ignore you, all drivers on the road even when they drive badly. Practise with as many different groups of people as you feel you can.

Then when you are ready, you can bring your attention gently back in to the room. Begin to move your fingers, your toes, and gently open your eyes.

Entering VR

You will now enter the final virtual reality environment, which will be the lift with one more person in it. Just like before please stay on the lift, which will take you up and back down, when you can exit. This is the final opportunity to practice sending warmth and kindness to the

people around you in VR in whatever way you feel is easiest. If you found the last exercise worked, you could try extending it to the entire lift. Or, for example, you might want to try the person who looks hardest to send warmth to, it's up to you.

2.4 R code used for analysis

```
# __Load packages ----
library(tidyverse)
library(nlme)
library(broom)
library(readr)
library(multcomp)


# __Load functions ----
source("scripts/functions-calc-medation-results.R")

# __Load data ----
# Long format and prepare for analysis

# s2 = study two
# par = combined under threat and vulnerable measure
# others_comp = combined connected, understanding and accepting measures

data_long_par_s2 <- read_csv("data/data_long_par_s2.csv")
data_long_others_comp_s2 <- read_csv("data/data_long_others_comp_s2.csv")
data_long_positive_s2 <- read_csv("data/data_long_positive_s2.csv")

# 1. Make control group the reference group
data_long_par_s2 <- data_long_par_s2 %>%
  mutate(condition = factor(condition, levels = c("control", "compassion")
))

data_long_others_comp_s2 <- data_long_others_comp_s2 %>%
  mutate(condition = factor(condition, levels = c("control", "compassion")
))

data_long_positive_s2 <- data_long_positive_s2 %>%
  mutate(condition = factor(condition, levels = c("control", "compassion")
))

# 2. Hypothesis 1 ----
others_comp_lme_s2_h1 <- lme(others_comp ~ others_comp_t0 + condition + fa
ctor(time) + condition * factor(time),
                             random = ~1|id,
                             data = data_long_others_comp_s2,
                             na.action = na.omit)

# Look at summary
summary(others_comp_lme_s2_h1)

# Look at residuals
qqnorm(resid(others_comp_lme_s2_h1))

# Define contrast statements for each time point, extract estimates and 95
% CIs
```

```
contrast_matrix_h1_t1 <- rbind("Compassion Time1 vs Control Time1" =  c(0,
0,1,0,0,0,0,0,0,0,0))
summary(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t1))
confint(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t1))

contrast_matrix_h1_t2 <- rbind("Compassion Time2 vs Control Time2" =  c(0,
0,1,0,0,0,0,1,0,0,0))
summary(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t2))
confint(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t2))

contrast_matrix_h1_t3 <- rbind("Compassion Time3 vs Control Time3" =  c(0,
0,1,0,0,0,0,0,1,0,0))
summary(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t3))
confint(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t3))

contrast_matrix_h1_t4 <- rbind("Compassion Time4 vs Control Time4" =  c(0,
0,1,0,0,0,0,0,0,1,0))
summary(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t4))
confint(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t4))

contrast_matrix_h1_t5 <- rbind("Compassion Time5 vs Control Time5" =  c(0,
0,1,0,0,0,0,0,0,0,1))
summary(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t5))
confint(glht(others_comp_lme_s2_h1, contrast_matrix_h1_t5))

# 3. Hypothesis 2 ----
par_lme_s2_h2 <- lme(par ~ gpts_t0 + condition + factor(time) + condition
* factor(time),
                     random = ~1|id,
                     data = data_long_par_s2,
                     na.action = na.omit)
# Look at summary
summary(par_lme_s2_h2)

# Look at residuals
qqnorm(resid(par_lme_s2_h2))

# Define contrast statements for each time point, extract estimates and 95
% CIs
contrast_matrix_h2_t2 <- rbind("Compassion Time2 vs Control Time2" = c(0,0
,1,0,0,0,0,0,0,0))
summary(glht(par_lme_s2_h2, contrast_matrix_h2_t2))
confint(glht(par_lme_s2_h2, contrast_matrix_h2_t2))

contrast_matrix_h2_t3 <- rbind("Compassion Time3 vs Control Time3" = c(0,0
,1,0,0,0,1,0,0,0))
summary(glht(par_lme_s2_h2, contrast_matrix_h2_t3))
confint(glht(par_lme_s2_h2, contrast_matrix_h2_t3))

contrast_matrix_h2_t4 <- rbind("Compassion Time4 vs Control Time4" = c(0,0
,1,0,0,0,0,1,0,0))
summary(glht(par_lme_s2_h2, contrast_matrix_h2_t4))
confint(glht(par_lme_s2_h2, contrast_matrix_h2_t4))
```

```
contrast_matrix_h2_t5 <- rbind("Compassion Time5 vs Control Time5" = c(0,0
,1,0,0,0,0,0,1))
summary(glht(par_lme_s2_h2, contrast_matrix_h2_t5))
confint(glht(par_lme_s2_h2, contrast_matrix_h2_t5))


# 4. Hypothesis 3  ----
# 4.1 Mediation others compassion t5 ----

# Path a
# Relationship between others compassion and condition
others_comp_lme_s2_h3a <- lme(others_comp ~ others_comp_t0 + gpts_t0 + con
dition + factor(time) + condition * factor(time),
                              random = ~1|id,
                              data = data_long_others_comp_s2,
                              na.action = na.omit)
# Look at summary
summary(others_comp_lme_s2_h3a)

# Contrast Statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a <- rbind("Compassion Time5 vs Control Time5" =  c(0,0,
0,1,0,0,0,0,0,0,0,1))


# Path c
# Relationship between paranoia and condition
others_comp_lme_s2_h3c <- lme(par ~ gpts_t0 + others_comp_t0 + condition +
factor(time) + condition * factor(time),
                              random = ~1|id,
                              data = data_long_par_s2,
                              na.action = na.omit)
# Look at summary
summary(others_comp_lme_s2_h3c)

# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c <- rbind("Compassion Time5 vs Control Time5" =  c(0,0,
0,1,0,0,0,0,0,1))

# Get p value
summary(glht(others_comp_lme_s2_h3c, contrast_matrix_h3c))


# Path cd and b
others_comp_lme_s2_h3cd <- lme(par ~ gpts_t0 + others_comp_t0 + others_com
p_t5 + condition + factor(time) + condition * factor(time),
                               random = ~1|id,
                               data = data_long_par_s2,
                               na.action = na.omit)


# Look at summary
```

```
# Coefficient of mediator at designated time point (b) and its standard er
ror (b_se)
summary(others_comp_lme_s2_h3cd)


# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
contrast_matrix_h3cd <- rbind("Compassion Time5 vs Control Time5" =  c(0,0
,0,0,1,0,0,0,0,0,1))

# Get p value
summary(glht(others_comp_lme_s2_h3cd, contrast_matrix_h3cd))

# Function for extracting required numbers
path_cd_est_s2_t5 <- tidy(summary(glht(others_comp_lme_s2_h3cd, contrast_m
atrix_h3cd)))$estimate[[1]]
path_cd_se_s2_t5 <- tidy(summary(glht(others_comp_lme_s2_h3cd, contrast_ma
trix_h3cd)))$std.error[[1]]

path_b_est_s2_t5 <- summary(others_comp_lme_s2_h3cd)[["coefficients"]][["f
ixed"]][["others_comp_t5"]]
path_b_se_s2_t5 <-  0.1178416

path_a_est_s2_t5 <- tidy(summary(glht(others_comp_lme_s2_h3a, contrast_mat
rix_h3a)))$estimate[[1]]
path_a_se_s2_t5 <- tidy(summary(glht(others_comp_lme_s2_h3a, contrast_matr
ix_h3a)))$std.error[[1]]

path_c_est_s2_t5 <- tidy(summary(glht(others_comp_lme_s2_h3c, contrast_mat
rix_h3c)))$estimate[[1]]
path_c_se_s2_t5 <- tidy(summary(glht(others_comp_lme_s2_h3c, contrast_matr
ix_h3c)))$std.error[[1]]

# __Estimates and percent mediation ----

# Joint function to get a table with results for all effects and 95 CIs
med_results_s2_t5 <- calc_mediation(path_a_est = path_a_est_s2_t5, path_a_
se = path_a_se_s2_t5,
                                    path_b_est = path_b_est_s2_t5, path_b_
se = path_b_se_s2_t5,
                                    path_c_est = path_c_est_s2_t5, path_c_
se = path_c_se_s2_t5,
                                    path_cd_est = path_cd_est_s2_t5, path_
cd_se = path_cd_se_s2_t5)

# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s2_t5, path_b_est = path_b_est_
s2_t5, path_c_est = path_c_est_s2_t5)


# 4.2 Mediation others compassion t3 ----
# Mediation others compassion at mid time point

# Path a
```

```
# Relationship between others-compassion and condition
others_comp_lme_s2_h3a_t3 <- lme(others_comp ~ others_comp_t0 + gpts_t0 +
condition + factor(time) + condition * factor(time),
                                 random = ~1|id,
                                 data = data_long_others_comp_s2,
                                 na.action = na.omit)
# Look at summary
summary(others_comp_lme_s2_h3a_t3)

# Contrast Statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a_t3 <- rbind("Compassion Time3 vs Control Time3" =  c(0
,0,0,1,0,0,0,0,0,1,0,0))

# Path c
# Relationship between paranoia and condition
others_comp_lme_s2_h3c_t3 <- lme(par ~ gpts_t0 + others_comp_t0 + conditio
n + factor(time) + condition * factor(time),
                                 random = ~1|id,
                                 data = data_long_par_s2,
                                 na.action = na.omit)
# Look at summary
summary(others_comp_lme_s2_h3c_t3)


# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c_t3 <- rbind("Compassion Time5 vs Control Time5" =  c(0
,0,0,1,0,0,0,0,0,1))

# Get p value
summary(glht(others_comp_lme_s2_h3c_t3, contrast_matrix_h3c_t3))

# Path cd and b
others_comp_lme_s2_h3cd_t3 <- lme(par ~ gpts_t0 + others_comp_t0 + others_
comp_t3 + condition + factor(time) + condition * factor(time),
                                  random = ~1|id,
                                  data = data_long_par_s2,
                                  na.action = na.omit)

# Look at summary
# Coefficient of mediator at designated time point (b) and its standard er
ror (b_se)
summary(others_comp_lme_s2_h3cd_t3)


# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
contrast_matrix_h3cd_t3 <- rbind("Compassion Time5 vs Control Time5" =  c(
0,0,0,0,1,0,0,0,0,0,1))

# Get p value
summary(glht(others_comp_lme_s2_h3cd_t3, contrast_matrix_h3cd_t3))
```

```
# Function for extracting required numbers
path_a_est_s2_t3 <- tidy(summary(glht(others_comp_lme_s2_h3a_t3, contrast_
matrix_h3a_t3)))$estimate[[1]]
path_a_se_s2_t3 <- tidy(summary(glht(others_comp_lme_s2_h3a_t3, contrast_m
atrix_h3a_t3)))$std.error[[1]]

path_cd_est_s2_t3 <- tidy(summary(glht(others_comp_lme_s2_h3cd_t3, contras
t_matrix_h3cd_t3)))$estimate[[1]]
path_cd_se_s2_t3 <- tidy(summary(glht(others_comp_lme_s2_h3cd_t3, contrast
_matrix_h3cd_t3)))$std.error[[1]]

path_b_est_s2_t3 <- summary(others_comp_lme_s2_h3cd_t3)[["coefficients"]][[
["fixed"]][["others_comp_t3"]]
path_b_se_s2_t3 <-  0.1299478

path_c_est_s2_t3 <- tidy(summary(glht(others_comp_lme_s2_h3c_t3, contrast_
matrix_h3c_t3)))$estimate[[1]]
path_c_se_s2_t3 <- tidy(summary(glht(others_comp_lme_s2_h3c_t3, contrast_m
atrix_h3c_t3)))$std.error[[1]]

# __Estimates and percent mediation ----

# Estimates
# Joint function to get a table with results for all effects and 95 CIs
med_results_s2_t3 <- calc_mediation(path_a_est = path_a_est_s2_t3, path_a_
se = path_a_se_s2_t3,
                                    path_b_est = path_b_est_s2_t3, path_b_
se = path_b_se_s2_t3,
                                    path_c_est = path_c_est_s2_t3, path_c_
se = path_c_se_s2_t3,
                                    path_cd_est = path_cd_est_s2_t3, path_
cd_se = path_cd_se_s2_t3)


# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s2_t3, path_b_est = path_b_est_
s2_t3, path_c_est = path_c_est_s2_t3)



# 4.3 Reverse mediation others compassion t5 ----

# Path a
# Relationship between others-compassion and condition
others_comp_lme_s2_h3a_rev <- lme(par ~ others_comp_t0 + gpts_t0 + conditi
on + factor(time) + condition * factor(time),
                          random = ~1|id,
                          data = data_long_par_s2,
                          na.action = na.omit)
# Look at summary
summary(others_comp_lme_s2_h3a_rev)

# Contrast Statements
```

```
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a_rev <- rbind("Compassion Time5 vs Control Time5" =  c(
0,0,0,1,0,0,0,0,0,1))
summary(glht(others_comp_lme_s2_h3a_rev, contrast_matrix_h3a_rev))

# Path c
# Relationship between paranoia and condition
others_comp_lme_s2_h3c_rev <- lme(others_comp ~ gpts_t0 + others_comp_t0 +
condition + factor(time) + condition * factor(time),
                                  random = ~1|id,
                                  data = data_long_others_comp_s2,
                                  na.action = na.omit)
# Look at summary
summary(others_comp_lme_s2_h3c_rev)

# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c_rev <- rbind("Compassion Time5 vs Control Time5" =  c(
0,0,0,1,0,0,0,0,0,0,0,1))

summary(glht(others_comp_lme_s2_h3c_rev, contrast_matrix_h3c_rev))

# Path cd and b
others_comp_lme_s2_h3cd_rev <- lme(others_comp ~ gpts_t0 + others_comp_t0
+ par_t5 + condition + factor(time) + condition * factor(time),
                                   random = ~1|id,
                                   data = data_long_others_comp_s2,
                                   na.action = na.omit)

# Look at summary
# Coefficient of mediator at designated time point (b) and its standard er
ror (b_se)
summary(others_comp_lme_s2_h3cd_rev)


# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
contrast_matrix_h3cd_rev <- rbind("Compassion Time5 vs Control Time5" =  c
(0,0,0,0,1,0,0,0,0,0,0,0,1))

# __Estimates and percent mediation ----

# Function for extracting required numbers
path_cd_est_s2_t5_rev <- tidy(summary(glht(others_comp_lme_s2_h3cd_rev, co
ntrast_matrix_h3cd_rev)))$estimate[[1]]
path_cd_se_s2_t5_rev <- tidy(summary(glht(others_comp_lme_s2_h3cd_rev, con
trast_matrix_h3cd_rev)))$std.error[[1]]

path_b_est_s2_t5_rev <- summary(others_comp_lme_s2_h3cd_rev)[["coefficient
s"]][["fixed"]][["par_t5"]]
path_b_se_s2_t5_rev <- 0.0430746

path_a_est_s2_t5_rev <- tidy(summary(glht(others_comp_lme_s2_h3a_rev, cont
```

```
rast_matrix_h3a_rev)))$estimate[[1]]
path_a_se_s2_t5_rev <- tidy(summary(glht(others_comp_lme_s2_h3a_rev, contr
ast_matrix_h3a_rev)))$std.error[[1]]

path_c_est_s2_t5_rev <- tidy(summary(glht(others_comp_lme_s2_h3c_rev, cont
rast_matrix_h3c_rev)))$estimate[[1]]
path_c_se_s2_t5_rev <- tidy(summary(glht(others_comp_lme_s2_h3c_rev, contr
ast_matrix_h3c_rev)))$std.error[[1]]

# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s2_t5_rev, path_b_est = path_b_
est_s2_t5_rev, path_c_est = path_c_est_s2_t5_rev)



# 4.1 Mediation positive affect t5 ----

# Path a
# Relationship between others compassion and condition
positive_lme_s2_h3a <- lme(positive ~ positive_t0 + gpts_t0 + condition +
factor(time) + condition * factor(time),
                           random = ~1|id,
                           data = data_long_positive_s2,
                           na.action = na.omit)
# Look at summary
summary(positive_lme_s2_h3a)

# Contrast Statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a_pos <- rbind("Compassion Time5 vs Control Time5" =  c(
0,0,0,1,0,0,0,0,0,0,0,1))

# Path c
# Relationship between paranoia and condition
positive_lme_s2_h3c <- lme(par ~ gpts_t0 + positive_t0 + condition + facto
r(time) + condition * factor(time),
                           random = ~1|id,
                           data = data_long_par_s2,
                           na.action = na.omit)
# Look at summary
summary(positive_lme_s2_h3c)

# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c_pos <- rbind("Compassion Time5 vs Control Time5" =  c(
0,0,0,1,0,0,0,0,0,1))

# Get p value
summary(glht(positive_lme_s2_h3c, contrast_matrix_h3c_pos))


# Path cd and b
positive_lme_s2_h3cd <- lme(par ~ gpts_t0 + positive_t0 + positive_t5 + co
```

```
ndition + factor(time) + condition * factor(time),
                                random = ~1|id,
                                data = data_long_par_s2,
                                na.action = na.omit)


# Look at summary
# Coefficient of mediator at designated time point (b) and its standard er
ror (b_se)
summary(positive_lme_s2_h3cd)


# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
contrast_matrix_h3cd_pos <- rbind("Compassion Time5 vs Control Time5" =  c
(0,0,0,0,1,0,0,0,0,0,1))

# Get p value
summary(glht(positive_lme_s2_h3cd, contrast_matrix_h3cd_pos))

# Function for extracting required numbers
path_cd_est_s2_t5 <- tidy(summary(glht(positive_lme_s2_h3cd, contrast_matr
ix_h3cd_pos)))$estimate[[1]]
path_cd_se_s2_t5 <- tidy(summary(glht(positive_lme_s2_h3cd, contrast_matri
x_h3cd_pos)))$std.error[[1]]

path_b_est_s2_t5 <- summary(positive_lme_s2_h3cd)[["coefficients"]][["fixe
d"]][["positive_t5"]]
path_b_se_s2_t5 <-  0.0718840

path_a_est_s2_t5 <- tidy(summary(glht(positive_lme_s2_h3a, contrast_matrix
_h3a_pos)))$estimate[[1]]
path_a_se_s2_t5 <- tidy(summary(glht(positive_lme_s2_h3a, contrast_matrix_
h3a_pos)))$std.error[[1]]

path_c_est_s2_t5 <- tidy(summary(glht(positive_lme_s2_h3c, contrast_matrix
_h3c_pos)))$estimate[[1]]
path_c_se_s2_t5 <- tidy(summary(glht(positive_lme_s2_h3c, contrast_matrix_
h3c_pos)))$std.error[[1]]

# __Estimates and percent mediation ----

# Joint function to get a table with results for all effects and 95 CIs
med_results_s2_t5 <- calc_mediation(path_a_est = path_a_est_s2_t5, path_a_
se = path_a_se_s2_t5,
                                    path_b_est = path_b_est_s2_t5, path_b_
se = path_b_se_s2_t5,
                                    path_c_est = path_c_est_s2_t5, path_c_
se = path_c_se_s2_t5,
                                    path_cd_est = path_cd_est_s2_t5, path_
cd_se = path_cd_se_s2_t5)

# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s2_t5, path_b_est = path_b_est_
```

```
s2_t5, path_c_est = path_c_est_s2_t5)


# 4.3 Reverse mediation positive t5 ----

# Path a
# Relationship between others-compassion and condition
positive_lme_s2_h3a_rev <- lme(par ~ positive_t0 + gpts_t0 + condition + f
actor(time) + condition * factor(time),
                           random = ~1|id,
                           data = data_long_par_s2,
                           na.action = na.omit)
# Look at summary
summary(positive_lme_s2_h3a_rev)

# Contrast Statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a_rev_pos <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,1,0,0,0,0,0,1))
summary(glht(positive_lme_s2_h3a_rev, contrast_matrix_h3a_rev_pos))

# Path c
# Relationship between paranoia and condition
positive_lme_s2_h3c_rev <- lme(positive ~ gpts_t0 + positive_t0 + conditio
n + factor(time) + condition * factor(time),
                                   random = ~1|id,
                                   data = data_long_positive_s2,
                                   na.action = na.omit)
# Look at summary
summary(positive_lme_s2_h3c_rev)

# Contrast Statements
# Treatment effect (c) and its standard error (c_se)

contrast_matrix_h3c_rev_pos <- rbind("Compassion Time5 vs Control Time5" =
c(0,0,0,1,0,0,0,0,0,0,0,1))

summary(glht(positive_lme_s2_h3c_rev, contrast_matrix_h3c_rev_pos))

# Path cd and b
positive_lme_s2_h3cd_rev <- lme(positive ~ gpts_t0 + positive_t0 + par_t5
+ condition + factor(time) + condition * factor(time),
                                    random = ~1|id,
                                    data = data_long_positive_s2,
                                    na.action = na.omit)

# Look at summary
# Coefficient of mediator at designated time point (b) and its standard er
ror (b_se)
summary(positive_lme_s2_h3cd_rev)


# Contrast Statement
# Treatment effect (cd (for c dash)) and its standard error (cd_se)
```

```
contrast_matrix_h3cd_rev_pos <- rbind("Compassion Time5 vs Control Time5"
=  c(0,0,0,0,1,0,0,0,0,0,0,1))

# __Estimates and percent mediation ----

# Function for extracting required numbers
path_cd_est_s2_t5_rev <- tidy(summary(glht(positive_lme_s2_h3cd_rev, contr
ast_matrix_h3cd_rev_pos)))$estimate[[1]]
path_cd_se_s2_t5_rev <- tidy(summary(glht(positive_lme_s2_h3cd_rev, contra
st_matrix_h3cd_rev_pos)))$std.error[[1]]

path_b_est_s2_t5_rev <- summary(positive_lme_s2_h3cd_rev)[["coefficients"]
][["fixed"]][["par_t5"]]
path_b_se_s2_t5_rev <- 0.0485439 # figure out a way to extract this one so
we dont have to copy paste

path_a_est_s2_t5_rev <- tidy(summary(glht(positive_lme_s2_h3a_rev, contras
t_matrix_h3a_rev_pos)))$estimate[[1]]
path_a_se_s2_t5_rev <- tidy(summary(glht(positive_lme_s2_h3a_rev, contrast
_matrix_h3a_rev_pos)))$std.error[[1]]

path_c_est_s2_t5_rev <- tidy(summary(glht(positive_lme_s2_h3c_rev, contras
t_matrix_h3c_rev_pos)))$estimate[[1]]
path_c_se_s2_t5_rev <- tidy(summary(glht(positive_lme_s2_h3c_rev, contrast
_matrix_h3c_rev_pos)))$std.error[[1]]

# Percent mediation
calc_pct_mediation(path_a_est = path_a_est_s2_t5_rev, path_b_est = path_b_
est_s2_t5_rev, path_c_est = path_c_est_s2_t5_rev)

# Figure ----
require(ggplot2)
s2_figure <- read.csv("s2_figuredata.csv")
s2_figure


#create tiff file high res
tiff("s2_figureR01.tiff", width = 176, height = 160, units = 'mm', res = 3
00)

#set margins
par(mar=c(5,5,4,5)+.1)

# Means Plot with Standard Error bars
# The error bars overlapped, so use position_dodge to move them horizontal
ly
pd <- position_dodge(0.1) # move them .05 to the left and right


s2_figure$Group <- paste(s2_figure$Allocation, s2_figure$Outcome, sep="_")

ggplot(s2_figure, aes(x=Time, y=Mean, colour=Group)) +
  geom_errorbar(aes(ymin=Mean-SE, ymax=Mean+SE), width=.1, position=pd) +
  geom_line(position=pd) +
```

```
  geom_point(position=pd) +
  scale_y_continuous(breaks = c(2,3,4,5,6,7,8,9)) +
  xlab("Time Point") +
  ylab("Mean Score (Standard Error)") +
  scale_colour_manual(values = c("steelblue1",  "firebrick2", "steelblue4"
, "firebrick4"), name="",    # Legend label, use darker colors
                      breaks=c("Control_others_comp", "Compassion_others_c
omp", "Control_Threatvuln", "Compassion_Threatvuln"),
                      labels=c("Control group: Compassion for others", "Co
mpassion group: Compassion for others",
                               "Control group: paranoia", "Compassion grou
p: paranoia")) +
  theme_bw() +
  theme(axis.text.x = element_text(colour="grey20",size=12,angle=0,hjust=.
5,vjust=.5,face="plain"),
        axis.text.y = element_text(colour="grey20",size=12,angle=0,hjust=1
,vjust=0,face="plain"),
        axis.title.x = element_text(colour="grey20",size=12,angle=0,hjust=
.5,vjust=0,face="plain"),
        axis.title.y = element_text(colour="grey20",size=12,angle=90,hjust
=.5,vjust=.5,face="plain")) +
  theme(legend.justification=c(0,0),
        legend.key.size = unit(0.3, "cm"),
        legend.position=c(0.001,0))


#save
dev.off()



#saving as eps

setEPS()
postscript("s2_figureB.eps")

plot(rnorm(100), main="s2_figure")


#set margins
par(mar=c(5,5,4,5)+.1)

# Means Plot with Standard Error bars
# The errorbars overlapped, so use position_dodge to move them horizontall
y
pd <- position_dodge(0.1) # move them .05 to the left and right


s2_figure$Group <- paste(s2_figure$Allocation, s2_figure$Outcome, sep="_")

ggplot(s2_figure, aes(x=Time, y=Mean, colour=Group)) +
  geom_errorbar(aes(ymin=Mean-SE, ymax=Mean+SE), width=.1, position=pd) +
  geom_line(position=pd) +
  geom_point(position=pd) +
```

```
  scale_y_continuous(breaks = c(2,3,4,5,6,7,8,9)) +
  xlab("Time Point") +
  ylab("Mean Score (Standard Error)") +
  scale_colour_manual(values = c("steelblue1",  "firebrick2", "steelblue4"
, "firebrick4"), name="",    # Legend label, use darker colors
                      breaks=c("Control_others_comp", "Compassion_others_c
omp", "Control_Threatvuln", "Compassion_Threatvuln"),
                      labels=c("Control group: Compassion for others", "Co
mpassion group: Compassion for others",
                               "Control group: paranoia", "Compassion grou
p: paranoia")) +
  theme_bw() +
  theme(axis.text.x = element_text(colour="grey20",size=12,angle=0,hjust=.
5,vjust=.5,face="plain"),
        axis.text.y = element_text(colour="grey20",size=12,angle=0,hjust=1
,vjust=0,face="plain"),
        axis.title.x = element_text(colour="grey20",size=12,angle=0,hjust=
.5,vjust=0,face="plain"),
        axis.title.y = element_text(colour="grey20",size=12,angle=90,hjust
=.5,vjust=.5,face="plain")) +
  theme(legend.justification=c(0,0),
        legend.key.size = unit(0.3, "cm"),
        legend.position=c(0.001,0.002))


dev.off()
```

Chapter 5

3.1 Participant Information Sheet

Emotion and Virtual Reality

Participant Information Sheet: R62149/RE001

Professor Daniel Freeman (Principal Investigator)

01865 613109 daniel.freeman@psych.ox.ac.uk

Poppy Brown (PhD student)

01865 618262; poppy.brown@psych.ox.ac.uk

This sheet explains the key information regarding the study we would like to invite you to take part in, including why we are conducting the research and what would be required of you. Before you decide whether you would like to take part, please read this information sheet. Please feel free to raise any queries or ask us if anything is unclear or you would like further information.

Key Facts:

- The online questionnaire should take about 5-10 minutes to complete. The second part of the study will last about 30 minutes.
- The second part of study will involve putting on a headset displaying an immersive computer environment (please see pictures below). It is a bit like a video game. You will be guided as to what you should do when you view the scenes.
- Your participation in this study is entirely voluntary and you may stop and withdraw at any point without having to provide a reason and without penalty.

Pictures of the headset used for the virtual reality and a tube scenario:

What is the purpose of the study?

The purpose of the study is twofold. Firstly, we want to collect data on how well our virtual reality technology can track the physical movement of different individuals. Secondly, we want to collect data on how individuals typically feel in certain situations. Virtual reality is a computer-generated world, a bit like a video game, but where you can walk about almost like in a real situation. The results of the study will have implications for helping to develop virtual reality treatments for those who have difficulty interacting in social situations.

Do I have to take part?

No. You can ask questions about the research before deciding whether or not to participate. If you do agree to participate, you may withdraw yourself from the study at any time, without giving a reason, by advising the researchers of this decision. If you choose to withdraw it will not be possible to delete your data from the dataset due to dat being entirely anonymous.

What will happen if I take part?

The first part of the study requires taking an online screening questionnaire that will take between 5 and 10 minutes to complete. You will be asked to give consent and provide an email address before completing the questionnaires so that if you are eligible you can be contacted

and invited to take part in the second part of the study that will take place in the Department of Psychiatry. If you are not eligible to participate you will not be contacted within a week and your contact details destroyed unless you say you are happy to be contacted again. If you are not eligible you will not be contacted.

In the second part, you will be invited for a single visit. The researcher will go through this sheet with you and answer any questions, and you will sign a consent form if you are willing to take part. You will then complete one short questionnaire about your recent social experiences and one about your mood before starting main part of the study. You will twice be asked stand in the centre of the room while the virtual reality system calibrates to your body. A computer will display instructions on how to do this as you will be alone in the room. You will be video recorded while waiting for the VR to calibrate just to it can be checked afterwards that you followed the instructions. You will then enter two virtual reality environments. The first will be inside a tube-train carriage, the second inside a lift. You may remove the headset at any point meaning it is not a problem for claustrophobic individuals. After each VR experience you'll be asked to complete two questionnaires about how you felt whilst in virtual reality. The study takes about 30 minutes and you will be reimbursed £10.

Are there any potential risks involved in taking part?

It is very unlikely that you will suffer any harm or distress from taking part. It can very occasionally happen that an individual experiences slight nausea (like car sickness) after being in virtual reality. However, our testing on several hundreds of people has not found this problem with our equipment; it is generally only reported with much older equipment.

Are there any benefits to taking part?

There will be no direct benefit to you from taking part in this research.

What happens to the data provided?

The information you provide as part of the study is the **research data**. Any research data from which you can be identified (eg. your name), is known as **personal data**. All information you provide will be kept entirely confidential. The personal data obtained at screening is whether

you have a diagnosis of a severe mental illness, your email address, name and age in order to check you are over aged 18 and to contact you if you are eligible. This data will be destroyed if you are not eligible and answer that you do not wish to be contacted about any similar studies. Information about mental illness diagnosis collected online will be deleted from the online server and not downloaded from Qualtrics. Consent forms obtained during the in-person study session will be stored in a locked filing cabinet separately to any other data and destroyed within five years. All other research data will be given a unique code that does not contain your name or any personal information when it is stored. No link between your name and your code will exist. The video recording will be immediately transferred to an encrypted file on the university drive and deleted from the video camera itself. The video will only be seen by the researchers and will be deleted from the university drive at the end of the study unless you consent to it being kept and used for other research purposes. Only the researcher and the researcher's supervisors will have access to the data. Data will be included in a student's thesis but will be fully anonymised.

Will the research be published?

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. The research will be written up as a 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. The thesis will be openly accessible.

Who is funding the study?

The study is funded by Mental Health Research UK.

Who has reviewed the study?

This study has been reviewed by and received ethics clearance through the University of Oxford Central University Research Ethics Committee, an independent group of people.

How can I raise a complaint or a concern about the study?

If you have a concern about any aspect of this study, please contact Poppy Brown (01865 618262) or her supervisor Professor Freeman (01865 613109) who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the relevant chair of the Research Ethics Committee at the University of Oxford who will see to resolve the matter in a reasonably expeditious manner.

Chair, Medical Sciences Inter-Divisional Research Ethics Committee; Email: ethics@medsci.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 http://www.admin.ox.ac.uk/councilsec/compliance/gdpr/individualrights/.

CONTACT DETAILS

Poppy Brown (PhD student)

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Tel. Number: 01865 618262; Email: poppy.brown@psych.ox.ac.uk

Professor Daniel Freeman (MRC Senior Clinical Fellow/ Hon. Consultant Clinical Psychologist)

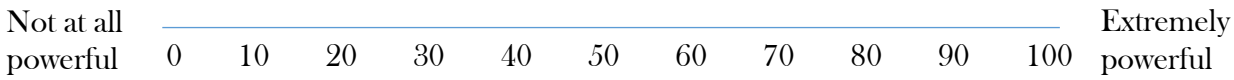
Tel. Number: 01865 613109 Email: daniel.freeman@psych.ox.ac.uk

Dr. Felicity Waite (Research Clinical Psychologist and NIHR Research Fellow)

Email: felicity.waite@psych.ox.ac.uk

3.2 Baseline visual analogue scale measuring feelings of power

Please mark on the line below how **powerful** you feel **right now**:



1.4 Post VR visual analogue scale measuring feelings of power

Please mark on the line below how **powerful** you felt during the **virtual reality scenario:**

Not at all powerful — 0 10 20 30 40 50 60 70 80 90 100 — Extremely powerful

3.3 Instructions provided to participants via video for holding poses

Neutral pose condition

Stand in the centre of the room near the marked cross.

You do not need the headset on for this.

Stand with your feet together so there is no space between them. Please look down at your feet to check they are completely together.

Bring your arms in front of you and hold one of your wrists with your other hand so that your elbows are close against your body.

We will now hold this position for about a minute.

Thank you. You can now open the door for the researcher to return.

Power pose condition

Stand in the centre of the room near the marked cross.

You do not need the headset on for this.

Place your feet at least shoulder width apart. As far apart as is comfortable.

Stand up tall, roll your shoulders back and down, so our chest is slightly out.

Place your hands on your hips keeping your shoulders down and chest slightly out.

Take a moment to get comfortable and relaxed in this position.

Tilt you chin upwards and make sure you are standing up tall, so your full height is measured.

We will now hold this position for about a minute.

Thank you. You can now open the door for the researcher to return.

3.4 Debrief

Emotion and Virtual Reality: Debrief

Thank you for taking part in this study. This document provides some additional detail about what the study aimed to look at.

We are interested in looking at the relationship between self-confidence and feelings of mistrust towards others. Half of the participants in this study were asked to assume postures that aimed to increase feelings of power and self-confidence, and the other half were asked to assume neutral postures, in order to act as a control. Please do not inform the researcher which condition you were in or what posture you held.

Our analysis will look at whether the powerful postures did increase levels of self-confidence compared to the control image, and whether this consequently affected levels of mistrust felt towards the characters in virtual reality.

It was necessary to conceal the true aim of the study because we did not want expectations (e.g. thoughts that standing in this posture is *meant* to make me feel more powerful) to bias your responses. We therefore said the postures were a means of testing our VR tracking system, which was in fact not the case.

Your data will remain confidential at all times; it will be allocated a number, which means that when the data are analysed you will not be identifiable. If you are no longer happy to take part in this project, please let me know as soon as possible. Additionally, if you have any questions or if you have any concerns regarding mistrust of others or self-compassion and would like to speak to someone, please do not hesitate to contact me by email: poppy.brown@psych.ox.ac.uk.

If you have a concern about any aspect of this study, please contact Poppy Brown (01865 618262) or her supervisor Professor Freeman (01865 613109) who will do their best to answer your query. The researcher should acknowledge your concern within 10 working days and give you an indication of how they intend to deal with it. If you remain unhappy or wish to make a formal complaint, please contact the relevant chair of the Research Ethics Committee at the University of Oxford who will see to resolve the matter in a reasonably expeditious manner.

Chair, Medical Sciences Inter-Divisional Research Ethics Committee; Email: ethics@medsci.ox.ac.uk; Address: Research Services, University of Oxford, Wellington Square, Oxford, OX1 2JD

3.5 R code used for analysis

```
# Load packages ----
library(tidyverse)
library(nlme)
library(broom)
library(readr)
library(multcomp)

# Paranoid sample analysis ----
# Load data ----
# par = combined under threat and vulnerable measure

pp_long_par <- read_csv("data/pp_long_par.csv")
pp_long_power <- read_csv("data/pp_long_power.csv")

# make control the reference group
pp_long_par <- pp_long_par %>%
  mutate(condition = factor(condition, levels = c("control", "power")))

pp_long_power <- pp_long_power %>%
  mutate(condition = factor(condition, levels = c("control", "power")))

# Hypothesis 1 ----

power_lme_h1 <- lme(powerful ~ powerful_t0 + condition + factor(time) +
                      condition*factor(time),
                    random = ~1|id,
                    data = pp_long_power)

# summary
summary(power_lme_h1)

# residuals
plot(power_lme_h1) # don't want there to be a pattern
```

```
qqnorm(resid(power_lme_h1))

# contrast statements
contrast_matrix_h1_t1 <- rbind("Time 1" = c(0,0,1,0,0,0,0))
summary(glht(power_lme_h1,contrast_matrix_h1_t1 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t1 ))

contrast_matrix_h1_t2 <- rbind("Time 2" = c(0,0,1,0,0,1,0))
summary(glht(power_lme_h1,contrast_matrix_h1_t2 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t2 ))

contrast_matrix_h1_t3 <- rbind("Time 3" = c(0,0,1,0,0,0,1))
summary(glht(power_lme_h1,contrast_matrix_h1_t3 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t3 ))

# Hypothesis 2 ----
par_lme_h2 <- lme(par ~ gpts + condition + factor(time) +
                    condition*factor(time),
                  random = ~1|id,
                  data = pp_long_par,
                  na.action = na.omit)
table(pp_long_par$condition)

# summary
summary(par_lme_h2)

# residuals
qqnorm(resid(par_lme_h2))

# contrast statements

contrast_matrix_h2_t2 <- rbind("Time 2" = c(0,0,1,0,0))
summary(glht(par_lme_h2,contrast_matrix_h2_t2 ))
confint(glht(par_lme_h2,contrast_matrix_h2_t2 ))

contrast_matrix_h2_t3 <- rbind("Time 3" = c(0,0,1,0,1))
summary(glht(par_lme_h2,contrast_matrix_h2_t3 ))
```

```
confint(glht(par_lme_h2,contrast_matrix_h2_t3 ))



# Hypothesis 3, mediation using time point 3 (final timepoint) ----



# Path a, power and condition
power_lme_h3a <- lme(powerful ~ powerful_t0 + gpts + condition + factor(tim
e) +
                       condition*factor(time),
                     random = ~1|id,
                     data = pp_long_power,
                     na.action = na.omit)

summary(power_lme_h3a)

# contrast statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a <- rbind("Time3 " =  c(0,0,0,1,0,0,0,1))
summary(glht(power_lme_h3a, contrast_matrix_h3a))

a <- 0.6694
a_se <- 0.4045



# Path c
# Relationship between paranoia and condition
par_lme_h3a <- lme(par ~ gpts + powerful_t0 + condition + factor(time) +
                     condition*factor(time),
                   random = ~1|id,
                   data = pp_long_par,
                   na.action = na.omit)

summary(par_lme_h3a)

contrast_matrix_h3a <- rbind("Time3 " =  c(0,0,0,1,0,1))
summary(glht(par_lme_h3a, contrast_matrix_h3a))
```

```
c <- -0.329
c_se <- 0.482

#Path c' and b

par_lme_h3a_bc <- lme(par ~ gpts + powerful_t0 + powerful_t3 + condition +
factor(time) +
                        condition*factor(time),
                      random = ~1|id,
                      data = pp_long_par,
                      na.action = na.omit)

summary(par_lme_h3a_bc)

b <-  -0.330526
b_se <- 0.0896714

contrast_matrix_h3a <- rbind("Time 3" =  c(0,0,0,0,1,0,1))
summary(glht(par_lme_h3a_bc, contrast_matrix_h3a))

cd <- -0.1171
cd_se <- 0.4660

Indirect_effect <- a*b
Indirect_effect_SE <- sqrt(b^2*a_se^2 + a^2*b_se^2)
Indirect_effect_SE
Indirect_effect_LL <- Indirect_effect - 1.96*Indirect_effect_SE
Indirect_effect_UL <- Indirect_effect + 1.96*Indirect_effect_SE

Sobel_test <- Indirect_effect/Indirect_effect_SE
p_value_Sobel_test <- 2*(1-pnorm(abs(Sobel_test)))
p_value_Sobel_test
Indirect_effect
Indirect_effect_LL
Indirect_effect_UL
Direct_effect <- cd
```

```
cd

Total_effect <- c

Direct_effect_SE <- cd_se
Total_effect_SE <- c_se
Direct_effect_LL <- Direct_effect - 1.96*Direct_effect_SE
Direct_effect_UL <- Direct_effect + 1.96*Direct_effect_SE
Total_effect_LL <- Total_effect - 1.96*Total_effect_SE
Total_effect_UL <- Total_effect + 1.96*Total_effect_SE
Direct_effect_LL
Direct_effect_UL
Total_effect_LL
Total_effect_UL

Perc_mediated <- Indirect_effect/Total_effect*100
Perc_mediated

# Reverse mediation ----

# Path c,
power_lme_rev <- lme(powerful ~ powerful_t0 + gpts + condition + factor(tim
e) +
                       condition*factor(time),
                     random = ~1|id,
                     data = pp_long_power,
                     na.action = na.omit)

summary(power_lme_rev)

# contrast statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3 <- rbind("Time3 " =  c(0,0,0,1,0,0,0,1))
summary(glht(power_lme_rev, contrast_matrix_h3))

c <- 0.6694
c_se <- 0.4045
```

```
# Path a
# Relationship between paranoia and condition
par_lme_rev <- lme(par ~ gpts + powerful_t0 + condition + factor(time) +
                     condition*factor(time),
                   random = ~1|id,
                   data = pp_long_par,
                   na.action = na.omit)

summary(par_lme_rev)

contrast_matrix_h3 <- rbind("Time3 " =  c(0,0,0,1,0,1))
summary(glht(par_lme_rev, contrast_matrix_h3))

a <- -0.329
a_se <- 0.482

#Path c' and b

par_lme_rev_bc <- lme(powerful ~ gpts + powerful_t0 + par_t3 + condition +
factor(time) +
                        condition*factor(time),
                      random = ~1|id,
                      data = pp_long_power,
                      na.action = na.omit)

summary(par_lme_rev_bc)

b <-  -0.1082665
b_se <- 0.0634979



contrast_matrix_h3 <- rbind("Time 3" =  c(0,0,0,0,1,0,0,0,1))
summary(glht(par_lme_rev_bc, contrast_matrix_h3))

cd <- 0.6301
cd_se <- 0.4027
```

```
Indirect_effect <- a*b
Indirect_effect
Total_effect <- c
Perc_mediated <- Indirect_effect/Total_effect*100
Perc_mediated #


# Non-paranoid sample analysis ----

# Load data ----
# par = combined under threat and vulnerable measure

hp_long_par <- read_csv("data/hp_long_par.csv")
hp_long_power <- read_csv("data/hp_long_power.csv")

# make control the reference group
hp_long_par <- hp_long_par %>%
  mutate(condition = factor(condition, levels = c("control", "power")))

hp_long_power <- hp_long_power %>%
  mutate(condition = factor(condition, levels = c("control", "power")))

# make powerful and par numeric variables
# powerful_n <- as.numeric(hp_long_power$powerful)
# par_n <- as.numeric(hp_long_par$par)

# Hypothesis 1 ----

power_lme_h1 <- lme(powerful ~ powerful_t0 + condition + factor(time) +
                      condition*factor(time),
                    random = ~1|id,
                    data = hp_long_power,
                    na.action = na.omit)

# summary
```

```
summary(power_lme_h1)

# residuals
plot(power_lme_h1)
qqnorm(resid(power_lme_h1))

# contrast statements
contrast_matrix_h1_t1 <- rbind("Time 1" = c(0,0,1,0,0,0,0))
summary(glht(power_lme_h1,contrast_matrix_h1_t1 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t1 ))

contrast_matrix_h1_t2 <- rbind("Time 2" = c(0,0,1,0,0,1,0))
summary(glht(power_lme_h1,contrast_matrix_h1_t2 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t2 ))

contrast_matrix_h1_t3 <- rbind("Time 3" = c(0,0,1,0,0,0,1))
summary(glht(power_lme_h1,contrast_matrix_h1_t3 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t3 ))

# Hypothesis 2 ----
par_lme_h2 <- lme(par ~ gpts + condition + factor(time) +
                    condition*factor(time),
                  random = ~1|id,
                  data = hp_long_par,
                  na.action = na.omit)

# summary
summary(par_lme_h2)

# residuals
qqnorm(resid(par_lme_h2))

# contrast statements

contrast_matrix_h2_t2 <- rbind("Time 2" = c(0,0,1,0,0))
summary(glht(par_lme_h2,contrast_matrix_h2_t2 ))
confint(glht(par_lme_h2,contrast_matrix_h2_t2 ))
```

```
contrast_matrix_h2_t3 <- rbind("Time 3" = c(0,0,1,0,1))
summary(glht(par_lme_h2,contrast_matrix_h2_t3 ))
confint(glht(par_lme_h2,contrast_matrix_h2_t3 ))


# Hypothesis 3, mediation with time point 3 (final timepoint) ----


# Path a, power and condition
power_lme_h3 <- lme(powerful ~ powerful_t0 + gpts + condition + factor(time
) +
                      condition*factor(time),
                    random = ~1|id,
                    data = hp_long_power,
                    na.action = na.omit)

summary(power_lme_h3)

# contrast statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3a <- rbind("Time3 " =  c(0,0,0,1,0,0,0,1))
summary(glht(power_lme_h3, contrast_matrix_h3a))

a <- 1.2843
a_se <- 0.4218


# Path c
# Relationship between paranoia and condition
par_lme_h3 <- lme(par ~ gpts + powerful_t0 + condition + factor(time) +
                    condition*factor(time),
                  random = ~1|id,
                  data = hp_long_par,
                  na.action = na.omit)

summary(par_lme_h3)
```

```
contrast_matrix_h3a <- rbind("Time3 " =  c(0,0,0,1,0,1))
summary(glht(par_lme_h3, contrast_matrix_h3a))

c <- -0.7367
c_se <- 0.7286



#Path c' and b

par_lme_h3a_bc <- lme(par ~ gpts + powerful_t0 + powerful_t3 + condition +
factor(time) +
                        condition*factor(time),
                      random = ~1|id,
                      data = hp_long_par,
                      na.action = na.omit)

summary(par_lme_h3a_bc)

b <-  -0.738532
b_se <- 0.1642655



contrast_matrix_h3a <- rbind("Time 3" =  c(0,0,0,0,1,0,1))
summary(glht(par_lme_h3a_bc, contrast_matrix_h3a))

cd <- 0.2195
cd_se <-0.6720



Indirect_effect <- a*b
Indirect_effect_SE <- sqrt(b^2*a_se^2 + a^2*b_se^2)
Indirect_effect_LL <- Indirect_effect - 1.96*Indirect_effect_SE
Indirect_effect_UL <- Indirect_effect + 1.96*Indirect_effect_SE

Sobel_test <- Indirect_effect/Indirect_effect_SE
Sobel_test
```

```
p_value_Sobel_test <- 2*(1-pnorm(abs(Sobel_test)))
p_value_Sobel_test
Indirect_effect
Indirect_effect_LL
Indirect_effect_UL
p_value_Sobel_test
Direct_effect <- cd
cd

Total_effect <- c

Direct_effect_SE <- cd_se
Total_effect_SE <- c_se
Direct_effect_LL <- Direct_effect - 1.96*Direct_effect_SE
Direct_effect_UL <- Direct_effect + 1.96*Direct_effect_SE
Total_effect_LL <- Total_effect - 1.96*Total_effect_SE
Total_effect_UL <- Total_effect + 1.96*Total_effect_SE
Direct_effect_LL
Direct_effect_UL
Total_effect_LL
Total_effect_UL

Perc_mediated <- Indirect_effect/Total_effect*100
Perc_mediated
c
cd

# Reverse mediation ----

# Path c
power_lme_rev <- lme(powerful ~ powerful_t0 + gpts + condition + factor(tim
e) +
                       condition*factor(time),
                     random = ~1|id,
                     data = hp_long_power,
                     na.action = na.omit)
```

```
summary(power_lme_rev)

# contrast statements
# Treatment effect (a) and standard error (a_se)
contrast_matrix_h3 <- rbind("Time3 " =  c(0,0,0,1,0,0,0,1))
summary(glht(power_lme_rev, contrast_matrix_h3))

c <- 1.2843
c_se <- 0.4218


# Path a
# Relationship between paranoia and condition
par_lme_rev <- lme(par ~ gpts + powerful_t0 + condition + factor(time) +
                     condition*factor(time),
                   random = ~1|id,
                   data = hp_long_par,
                   na.action = na.omit)

summary(par_lme_rev)

contrast_matrix_h3 <- rbind("Time3 " =  c(0,0,0,1,0,1))
summary(glht(par_lme_rev, contrast_matrix_h3))

a <- -0.7367
a_se <- 0.7286

#Path c' and b

par_lme_rev_bc <- lme(powerful ~ gpts + powerful_t0 + par_t3 + condition +
factor(time) +
                        condition*factor(time),
                      random = ~1|id,
                      data = hp_long_power,
                      na.action = na.omit)

summary(par_lme_rev_bc)
```

```
b <-  -0.1873864
b_se <- 0.0532778


contrast_matrix_h3 <- rbind("Time 3" =  c(0,0,0,0,1,0,0,0,1))
summary(glht(par_lme_rev_bc, contrast_matrix_h3))

cd <- 1.1371
cd_se <- 0.3977


Indirect_effect <- a*b
Indirect_effect
Indirect_effect_SE <- sqrt(b^2*a_se^2 + a^2*b_se^2)
Indirect_effect_LL <- Indirect_effect - 1.96*Indirect_effect_SE
Indirect_effect_UL <- Indirect_effect + 1.96*Indirect_effect_SE

Sobel_test <- Indirect_effect/Indirect_effect_SE
p_value_Sobel_test <- 2*(1-pnorm(abs(Sobel_test)))
p_value_Sobel_test
Total_effect <- c
Perc_mediated <- Indirect_effect/Total_effect*100
Perc_mediated



# Combined paranoid and control samples ----

# Load data ----
# par = combined under threat and vulnerable measure

combined_long_par <- read_csv("data/combined_long_par.csv")
combined_long_power <- read_csv("data/combined_long_power.csv")

# make control the reference group
combined_long_par <- combined_long_par %>%
```

```
  mutate(condition = factor(condition, levels = c("control", "power")))

combined_long_power <- combined_long_power %>%
  mutate(condition = factor(condition, levels = c("control", "power")))

# make powerful and par numeric variables
# powerful_n <- as.numeric(combined_long_power$powerful)
# par_n <- as.numeric(combined_long_par$par)

# Hypothesis 1 ----

power_lme_h1 <- lme(powerful ~ powerful_t0 + gpts + sample + condition + fa
ctor(time) +
                      sample*condition,
                    random = ~1|id,
                    data = combined_long_power,
                    na.action = na.omit)

# summary
summary(power_lme_h1)

# tests paranoia status as a moderator
contrast_matrix_h1_t2 <- rbind("SPCP" = c(0,0,0,0,0,0,0,1))
summary(glht(power_lme_h1,contrast_matrix_h1_t2 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t2 ))

# overall group effect
contrast_matrix_h1_t2 <- rbind("CP" = c(0,0,0,0,1,0,0,0))
summary(glht(power_lme_h1,contrast_matrix_h1_t2 ))
confint(glht(power_lme_h1,contrast_matrix_h1_t2 ))


# Hypothesis 2:
par_lme_h2 <- lme(par ~ gpts + condition + factor(time) +
                    condition*factor(time),
                  random = ~1|id,
                  data = combined_long_par,
```

```
                  na.action = na.omit)

# summary
summary(par_lme_h2)

# residuals
qqnorm(resid(par_lme_h2))

# contrast statements

contrast_matrix_h2_t2 <- rbind("Time 2" = c(0,0,1,0,0))
summary(glht(par_lme_h2,contrast_matrix_h2_t2 ))
confint(glht(par_lme_h2,contrast_matrix_h2_t2 ))

contrast_matrix_h2_t3 <- rbind("Time 3" = c(0,0,1,0,1))
summary(glht(par_lme_h2,contrast_matrix_h2_t3 ))
confint(glht(par_lme_h2,contrast_matrix_h2_t3 ))
```

Chapter 6

4.1 Qualtrics questionnaires

Q13 Please answer the below statement with, True, False, or don't know:

"People often make fun of me behind my back"

- ○ True (1)
- ○ False (2)
- ○ Don't know (3)

Q14 The next questions ask about both your mother (or mother figure) while you were growing up.

If you did not have a mother (figure) of any sort while growing up, then please answer accordingly below.

- ○ I had no mother or mother figure of any sort (1)
- ○ I had a mother or mother figure for some or all of my childhood (2)

Skip To: Q21 If: I had no mother or mother figure of any sort

Q15 Please answer the below questions in reference to your MOTHER (or mother figure)

"How much did she really care about you?

- A lot (1)
- Some (2)
- A little (3)
- Not at all (4)

Q16 "How over protective was she?"

- A lot (1)
- Some (2)
- A little (3)
- Not at all (4)

Q17 When you were growing up how often did she do any of the following things to you:

"insulted, swore, shouted, yelled or screamed, threatened to hit"

- ○ Often (1)
- ○ Sometimes (2)
- ○ Not very often (3)
- ○ Never (4)

Q18 When you were growing up how often did she do any of the following things to you:

"pushed, grabbed or shoved, threw something, slapped or hit"

- ○ Often (1)
- ○ Sometimes (2)
- ○ Not very often (3)
- ○ Never (4)

Q19 When you were growing up how often did she do any of the following things to you:

"kicked, bit or hit with a fist, beat up, choked, burned or scalded, threatened with a knife or gun"

- ○ Often (1)
- ○ Sometimes (2)
- ○ Not very often (3)
- ○ Never (4)

Q20 During your first 16 years how 'true' are the following statements about your MOTHER's (or mother figure) behaviour towards you.

	Not true at all (6)	Slightly True (7)	Moderately true (16)	Extremely True (3)
Overprotective of me (1)	○	○	○	○
Verbally abusive of me (2)	○	○	○	○
Over controlling of me (3)	○	○	○	○
Sought to make me feel guilty (4)	○	○	○	○
Ignored me (5)	○	○	○	○

Critical of me (6)	○	○	○	○
Unpredictable towards me (7)	○	○	○	○
Uncaring of me (8)	○	○	○	○
Physically violent or abusive of me (9)	○	○	○	○
Rejecting of me (10)	○	○	○	○
Left me on my own a lot (11)	○	○	○	○
Would forget about me (15)	○	○	○	○
Was uninterested in me (12)	○	○	○	○
Made me feel in danger (13)	○	○	○	○
Made me feel unsafe (14)	○	○	○	○

Q21 The next questions ask about both your father (or fatherfigure) while you were growing up.

If you did not have a father (figure) of any sort while growing up then please answer accordingly below.

- ○ I had no father or father figure of any sort (1)
- ○ I had a father or father figure for some or all of my childhood (2)

Skip To: Q27. If: I had no father or father figure of any sort

Q22 Please answer the below questions in reference to your FATHER (or father figure)

"How much did he really care about you?

- ○ A lot (1)
- ○ Some (2)
- ○ A little (3)
- ○ Not at all (4)

Q23 "How over protective was he?"

- A lot (1)
- Some (2)
- A little (3)
- Not at all (4)

Q24 When you were growing up how often did he do any of the following things to you:

"insulted, swore, shouted, yelled or screamed, threatened to hit"

- Often (1)
- Sometimes (2)
- Not very often (3)
- Never (4)

Q25 When you were growing up how often did he do any of the following things to you:

"pushed, grabbed or shoved, threw something, slapped or hit"

- ○ Often (1)
- ○ Sometimes (2)
- ○ Not very often (3)
- ○ Never (4)

Q26 When you were growing up how often did he do any of the following things to you:

"kicked, bit or hit with a fist, beat up, choked, burned or scalded, threatened with a knife or gun"

- ○ Often (1)
- ○ Sometimes (2)
- ○ Not very often (3)
- ○ Never (4)

Page Break

Q26 During your first 16 years how 'true' are the following statements about your FATHER's (or father figure's) behaviour towards you.

	Not true at all (6)	Slightly True (7)	Moderately true (16)	Extremely True (3)
Overprotective of me (1)	○	○	○	○
Verbally abusive of me (2)	○	○	○	○
Over controlling of me (3)	○	○	○	○
Sought to make me feel guilty (4)	○	○	○	○
Ignored me (5)	○	○	○	○
Critical of me (6)	○	○	○	○
Unpredictable towards me (7)	○	○	○	○
Uncaring of me (8)	○	○	○	○
Physically violent or abusive of me (9)	○	○	○	○
Rejecting of me (10)	○	○	○	○
Left me on my own a lot (11)	○	○	○	○

Would forget about me (15)	○	○	○	○
Was uninterested in me (12)	○	○	○	○
Made me feel in danger (13)	○	○	○	○
Made me feel unsafe (14)	○	○	○	○

Q47 Please indicate how often you behave in the stated manner, using the following scale:
1 = Almost never and 5 = Almost always

	Almost never (1)	(2)	(3)	(4)	Almost always (5)
When I fail at something important to me I become consumed by feelings of inadequacy (1)	○	○	○	○	○

I try to be understanding and patient towards those aspects of my personality I don't like (2)	○	○	○	○	○
When something painful happens I try to take a balanced view of the situation (3)	○	○	○	○	○
When I'm feeling down, I tend to feel like most other people are probably happier than I am (4)	○	○	○	○	○
I try to see my failings as part of the human condition (5)	○	○	○	○	○
When I'm going through a very hard time, I give	○	○	○	○	○

myself the caring and tenderness I need (6)					
When something upsets me I try to keep my emotions in balance (7)	○	○	○	○	○
When I fail at something that's important to me, I tend to feel alone in my failure (8)	○	○	○	○	○
When I'm feeling down I tend to obsess and fixate on everything that's wrong. (9)	○	○	○	○	○
When I feel inadequate in some way, I try to remind myself that feelings of inadequacy	○	○	○	○	○

are shared by most people (10)					
I'm disapproving and judgmental about my own flaws and inadequacies (11)	○	○	○	○	○
I'm intolerant and impatient towards those aspects of my personality I don't like (20)	○	○	○	○	○

Q48 Please indicate how often you behave in the stated manner, using the following scale:
1 = Almost never and 5 = Almost always

	Almost never (1)	(2)	(3)	(4)	Almost always (5)
When people cry in front of me, I often	○	○	○	○	○

don't feel anything at all (1)					
Sometimes when people talk about their problems, I feel like I don't care (2)	○	○	○	○	○
I don't feel emotionally connected to people in pain (3)	○	○	○	○	○
I pay careful attention when other people talk to me (4)	○	○	○	○	○
I feel detached from others when they tell me their tales of woe (5)	○	○	○	○	○
If I see someone going through a difficult time, I try to	○	○	○	○	○

be caring toward that person (6)					
I often tune out when people tell me about their troubles (7)	○	○	○	○	○
I like to be there for others in times of difficulty (8)	○	○	○	○	○
I notice when people are upset, even if they don't say anything (9)	○	○	○	○	○
When I see someone feeling down, I feel like I can't relate to them (10)	○	○	○	○	○
Everyone feels down sometimes, it is part of being human (11)	○	○	○	○	○

Sometimes I am cold to others when they are down and out (12)	○	○	○	○	○
I tend to listen patiently when people tell me their problems (13)	○	○	○	○	○
I don't concern myself with other people's problems (14)	○	○	○	○	○
It's important to recognise that all people have weaknesses and no one's perfect (15)	○	○	○	○	○
My heart goes out to people who are unhappy (16)	○	○	○	○	○
Despite my differences with others, I	○	○	○	○	○

know that everyone feels pain just like me (17)					
When others are feeling troubled, I usually let someone else attend to them (18)	○	○	○	○	○
I don't think much about the concerns of others (19)	○	○	○	○	○
Suffering is just a part of the common human experience (20)	○	○	○	○	○
When people tell me about their problems, I try to keep a balanced perspective on the situation (21)	○	○	○	○	○

I can't really connect with other people when they're suffering (22)	○	○	○	○	○
I try to avoid people who are experiencing a lot of pain (23)	○	○	○	○	○
When others feel sadness, I try to comfort them (24)	○	○	○	○	○

Q50 The following statements about your general feelings towards yourself

	Strongly agree (1)	Agree (2)	Disagree (3)	Strongly disagree (4)

On the whole, I am satisfied with myself (1)	○	○	○	○
At times, I think I am no good at all. (2)	○	○	○	○
I feel that I have a number of good qualities. (3)	○	○	○	○
I am able to do things as well as most other people (4)	○	○	○	○
I feel I do not have much to be proud of. (5)	○	○	○	○
I certainly feel useless at times. (6)	○	○	○	○
I feel that I'm a person of worth, at least on an equal plane with others. (7)	○	○	○	○
I wish I could have more respect for myself (8)	○	○	○	○

All in all, I am inclined to feel that I am a failure. I (9)	○	○	○	○
I take a positive attitude toward myself. (10)	○	○	○	○

Q49 In the last two weeks, how often have you been bothered by the following problems?

	Not at all (1)	Several days (2)	More than half the days (3)	Nearly every day (4)
Feeling nervous, anxious or on edge (1)	○	○	○	○
Not being able to stop or control worrying (2)	○	○	○	○
Little interest or pleasure in doing things (3)	○	○	○	○
Feeling down, depressed, or hopeless (4)	○	○	○	○

4.2 R code used for network analysis

```
# Network analysis

# Load packages ----
library(tidyverse)
library(psych)
library(qgraph)
library(bootnet)
library(ggplot2)
library(mgm)
library(cocor)

# Load and sort data ----
ppdata_raw <- read.csv("power_screening_dataset.csv")
names(ppdata_raw)
nrow(ppdata_raw)

# Corr difference test ----
ppdata_complete1 <- na.omit(subset(ppdata_raw, select = c(gpts, makefun_pa
ranoia, anxiety)))
nrow(ppdata_complete1)
names(ppdata_complete1)

cor.test(ppdata_complete1$gpts, ppdata_complete1$makefun_paranoia)
cor.test(ppdata_complete1$anxiety, ppdata_complete1$makefun_paranoia)
cocor(~ makefun_paranoia + depression | makefun_paranoia + self_esteem, pp
data_raw)
opdata <- na.omit(subset(ppdata_raw, select = c(mother_protec, father_prot
ec,
                                                total_mother_control, tota
l_father_control)))
cor.test(opdata$mother_protec, opdata$total_mother_control)
summary(opdata$mother_protec)

# Create dataset for network ----
ppdata_net <- na.omit(subset(ppdata_raw, select = c(gpts, self_comp, other
s_comp, total_mother_care, total_mother_hostile,
                                                    total_mother_control,t
otal_father_care, total_father_hostile,
                                                    total_father_control,
anxiety, depression, self_esteem )))


# Demographics ----
# add in sex and age into dataset
ppdata_net_dems <- na.omit(subset(ppdata_raw, select = c(age, sex, gpts, s
elf_comp, others_comp, total_mother_care, total_mother_hostile,
                                                         total_mother_cont
rol,total_father_care, total_father_hostile,
                                                         total_father_cont
rol, anxiety, depression, self_esteem )))

nrow(ppdata_net_dems)
```

```
summary(ppdata_net_dems$age)
summary(ppdata_net_dems$sex)
names(ppdata_raw)

# write in datasat to use for network ----
write_csv(ppdata_net, "network dataset.csv")

# EBHIC network ----
ppdata_net <- read_csv("network dataset.csv")
names(ppdata_net)
colnames(ppdata_net) <- c("Par","SC", 'OC', 'MI', 'MA', 'MC', 'PI', 'PA',
'PC', 'Anx', 'Dep' ,'SE')

# for creating legend
names <- c("Paranoia", "Self-compassion", "Compassion for others", "Matern
al indifference" , 'Maternal abuse' , 'Maternal control' , 'Paternal indif
ference', 'Paternal abuse' , 'Paternal control' , 'Anxiety', 'Depression'
, 'Self-esteem')
groups <- rep("",12)

# Regularised network using EBIC glasso with tuning parameter of 0.3
# remove principal direction
glasso2 <- estimateNetwork(ppdata_net,
                           default = "EBICglasso",
                           tuning = 0.3)

# Create  layout
L2 <- matrix(c(
  -0.76600778,  -0.48885590,
  0.92750232,  -0.48860061,
  -0.21797050,  -1.00000000,
  -1.00000000, 0.41187972,
  -0.50398094, 0.33869361,
  0.03588496, 0.42635272,
  -0.58711760, 0.90697857,
  0.61540754, 0.65529454,
  0.03582510, 1.00000000,
  0.07437354,  -0.64466158,
  0.37339671,  -0.37112285,
  1.00000000,  -0.08912518), ncol=2,byrow=T)

# net of glasso2
fullnet2 <- plot(glasso2, minimum = 0, cut = 0.15, maximum = 1,
                 details = FALSE, layout = L2, esize = 20,
                 nodeNames = names, legend = T, groups = groups,
                 legend.mode ="style1", legend.cex = 0.3,
                 label.cex=0.85, label.prop=0.90,
                 color = c("deeppink2", rep("steelblue2", 2), rep("coral2"
,3),
                           rep("aquamarine3",3), rep("darkorange",2),"plum
"))

# dev.off()
```

```
# Centrality indices ----
# get raw values before plotting on graph
cent <- centrality(glasso2)
round(cent$OutDegree,2)
round(cent$Closeness,2)
cent$Betweenness

# centrality plot
# pdf("Centrality plot.pdf", width = 7, height = 7 * 2/3)

centralityPlot(glasso2, include = c("Degree", "Strength","Betweenness","Cl
oseness"), theme_bw = TRUE, labels = names)
#dev.off()
centralityPlot(glasso2, include = c("All"))

# Bootstrap to test stability of centrality estimates
set.seed(123)
Boot_centrality <- bootnet(glasso2, nBoots = 5000, default = "EBICglasso",
nCores = 8, statistics=c("Strength", "Closeness", "Betweenness"))

# plot centrality difference
#pdf("Boot_centrality_plot.pdf", width = 7, height = 7 * 2/3)
plot(Boot_centrality, statistics = c("Strength", "Closeness", "Betweenness
"), plot = "difference")
#dev.off()

# Case dropping to test stability of centrality estimates
pdf("all 3 Boot Case Drop plot.pdf", width = 7, height = 7 * 2/3)
case_drop <- bootnet(glasso2, nBoots = 5000, type = "case", nCores = 8,
                     statistics=c("Strength", "Closeness", "Betweenness"))
plot(case_drop, statistics = c("Strength", "Closeness", "Betweenness"))
dev.off()

# calculate the CS coefficient
corStability(case_drop)

# Shortest path -----
# Shortets path from paranoia
# make colours for shortpath
shortpathcolours <- plot(glasso2, minimum = 0, cut = 0.15, maximum = 1,
                         details = FALSE, layout = L2, esize = 20,
                         nodeNames = names, legend = T,groups = groups,
                         legend.mode ="style1", legend.cex = 0.3,
                         label.cex=0.85, label.prop=0.90,
                         color = c("deeppink2", rep("ghostwhite", 11)))

# pdf("A_shortpath.pdf", width = 8, height = 5)
shortpath1 <- pathways(shortpathcolours,
                       from = 1,
                       to = c(2:12))
# dev.off ()

# Shortest path from MI
# colours
```

```
shortpathcoloursMI <- plot(glasso2, minimum = 0, cut = 0.15, maximum = 1,
                           details = FALSE, layout = L2, esize = 20,
                           nodeNames = names, legend = T, groups = groups,
                           legend.mode ="style1", legend.cex = 0.3,
                           label.cex=0.85, label.prop=0.90,
                           color =
                             c( rep("ghostwhite", 3), "coral2", rep("ghost
white", 8)))

pdf("A_MIshortpath_final.pdf", width = 8, height = 5)
shortpath_MI <- pathways(shortpathcoloursMI,
                         from = 4,
                         to = c(1:3, 5:12))
dev.off()


# pdf("A_MIshortpath_final.pdf", width = 8, height = 5)
shortpath_MI <- pathways(shortpathcoloursMI,
                         from = 4,
                         to = c(1:3, 5:9))
# dev.off()

# EBHIC Bootstrap to get CIs for edges  ----
set.seed(123)
Boot1.glass <- bootnet(glasso2, nBoots = 5000, default = "EBICglasso", nCo
res = 8)

# confidence intervals of the edge weights
# pdf("Confidence intervals.pdf", width = 7, height = 7)
plot(Boot1.glass, order = "sample", plot = "interval", split0 = TRUE)
# dev.off()

#create dataframe of CIs
ci <- as.data.frame(summary(Boot1.glass))
View(ci)

# pull out edge weights

# paranoia  anx
anx <- ci[ci$id=="Par--Anx",]
anx$sample  # edge weight
anx$CIlower # lower CI
anx$CIupper # upper CI

# paranoia  dep
dep <- ci[ci$id=="Par--Dep",]
dep$sample  # edge weight
dep$CIlower # lower CI
dep$CIupper # upper CI

# paranoia  self-esteem
se <- ci[ci$id=="Par--SE",]
se$sample  # edge weight
se$CIlower # lower CI
```

```
se$CIupper # upper CI

# p sc
sc <- ci[ci$id=="Par--SC",]
sc$sample  # edge weight
sc$CIlower # lower CI
sc$CIupper # upper CI

# p oc
oc <- ci[ci$id=="Par--OC",]
oc$sample  # edge weight
oc$CIlower # lower CI
oc$CIupper # upper CI

# p pc
pc <- ci[ci$id=="Par--PC",]
pc$sample  # edge weight
pc$CIlower # lower CI
pc$CIupper # upper CI

# p mc
mc <- ci[ci$id=="Par--MC",]
mc$sample  # edge weight
mc$CIlower # lower CI
mc$CIupper # upper CI

# p fi
pi <- ci[ci$id=="Par--PI",]
pi$sample  # edge weight
pi$CIlower # lower CI
pi$CIupper # upper CI

# p mi
mi <- ci[ci$id=="Par--MI",]
mi$sample  # edge weight
mi$CIlower # lower CI
mi$CIupper # upper CI

# p mh
ma <- ci[ci$id=="Par--MA",]
ma$sample  # edge weight
ma$CIlower # lower CI
ma$CIupper # upper CI

# p fh
PA <- ci[ci$id=="Par--PA",]
PA$sample  # edge weight
PA$CIlower # lower CI
PA$CIupper # upper CI
```

Chapter 7

5.1 Participant Information Sheet

gameChange
Improving lives through VR therapy

PARTICIPANT INFORMATION SHEET

Finding Out NHS Staff and Patient Thoughts About Having Virtual Reality Therapy Available On Wards

You are invited to take part in some research. Before you decide to take part, we would like you to understand why this is being done and what it would involve. One of our team will go through the information sheet with you and answer any questions you have. Talk to others about this if you wish. Please ask us if anything is unclear or you would like more information.

A person wearing a Virtual Reality (VR) headset

Key facts:

We've created a therapy that uses virtual reality to help people feel more confident in everyday situations. Virtual reality (VR) is a computerised world, a bit like a video, but where you can walk about almost like in a real situation.

It looks like virtual reality is going to be used a lot in the future of treating mental health problems. Before it starts getting used on wards, we'd like to involve you in the development of the therapy. This study will give you a demonstration of the virtual reality therapy, and ask you your views on it. For example, we will ask questions such as 'Do you think this therapy might be helpful?'. The therapy was designed in collaboration with people who have lived experience of these problems.

It is important to note that you will not be receiving a therapy session, you will just have a taster of what the therapy involves, and then be able to give your feedback about it.

It is entirely your choice whether to take part or not. Your usual treatment will not be affected in any way by your decision. Even if you decide to take part, you will be free to leave at any time, for any reason.

What is the purpose of the study?

We'd like to hear your views about the possibility of having VR therapy on inpatient wards, so we can know whether it could be useful and how it might need to be improved for the future.

We would like to invite you to take part in a group discussion (or a one-to-one discussion with the researcher if you prefer) about your expectations and views of VR therapy. During the discussion you will be able to try out the therapy by wearing the VR headset. If you have photosensitive epilepsy you unfortunately will not be able to take part in the study. A researcher will check this with you before you consent to take part.

Who can take part in the research?

You have been invited because you are currently staying or working on a ward.

Do I have to take part?

No. It is up to you to decide whether to take part. Please read through this information sheet and discuss any questions you might have with a member of the research team, or your friends, family or other independent parties. We will then give you a consent form to sign if you agree

to take part. You are free to withdraw at any time, without giving a reason. Neither your usual treatment nor employment status will be affected if you withdraw from this study.

What will happen if I take part?

This research involves taking part in a focus group. A focus group is a bit like a group conversation where everyone can say however much or little they like in answer to a question or idea. It'll include talking about your expectations of virtual reality therapy and your experience of it after you've tried it. For example, the researcher might ask 'Do you think this therapy would be helpful?', and you can say what you think. The interviewer will audio-record the conversation, and also take some written notes, but they will seek your permission before doing this. During the focus group you will also be able to try out the therapy for a few minutes by wearing the headset.

The focus groups will last up to 1-2 hours and will be conducted separately for staff and patients. If you are an NHS patient you will be in a group with around 3-8 other patients, and if you are a staff member you will be in a group of around 3-8 other various other staff members from your organisation. Group allocations will be on a first come first serve basis.

If you would prefer not to take part in a focus group but instead to answer the questions alone with the researchers, then this can also be arranged.

We may also ask if we can video tape you while you try out the VR therapy so that we can learn about your first reactions to using VR. This would only be done with your permission.

Expenses and payment

If you are an NHS patient, you will you receive £15 as a thank you for taking part in the study.

What are the possible risks of taking part?

There are no anticipated disadvantages or risks of taking part. You are not expected to talk about anything that you don't want to, and if you feel that you don't want to carry on with the focus group at any point, then we can stop it immediately (with no negative consequences).

It can very occasionally happen that an individual experiences slight nausea (like car sickness) after being in virtual reality. However, our testing on several hundreds of people has not found this problem with our equipment; it is generally only reported with much older equipment. It is also not recommended to use VR if you have photosensitive epilepsy, so if this is something that affects you, you will not be able to take part. If you have any audio, visual, or mobility impairments you can let the research team know so that they can make any necessary adjustments for you.

What are the possible benefits of taking part?

There will be no specific benefits to taking part. However, your feedback is very valuable and will help to improve the use of the VR therapy in the future.

Will my taking part in the study be kept confidential?

The study team will keep your name confidential. To protect your identity, we will assign you a code and not use your name on any of the study documents.

If you are an NHS patient your clinical team will be told you are taking part in the study. What you share in the interview will be kept confidential unless you would like your clinical team to know. The exceptions to this are where there are significant concerns about a risk to you or other people. We will follow good clinical practice which involves appropriate communication with your clinical team.

If you are a member of NHS staff your taking part and anything you say will also be kept confidential. The exceptions to this are where there are significant concerns about a risk to you or other people.

This study may be monitored and/or audited to make sure that the research is following NHS and government regulations. As part of the monitoring and/or audit, select people involved in the trial from the University of Oxford and your local NHS Trust may be given access to your data.

What will happen to my data?

We will be using information from you in order to undertake this study. We are carrying out this research as we hope that it will help people. The University of Oxford is the sponsor for this research. As the sponsor, the University of Oxford will be responsible for looking after your information and making sure it is used properly. Organisations that hold this responsibility are known as "data controllers" in law.

Information that can be used to identify you (e.g. your name) helps the research team to keep in contact with you about the research study, make sure that relevant information about the study is recorded for your care, and ensure the quality of the study. The research team will need to use this type of information, but we will try to keep this to a minimum. We will not share this information with anyone outside the research team. We will keep information that might identify you for 3-6 months after the study has finished.

Your data will be stored securely with our research team at the University of Oxford. The focus group will be audio-recorded using a Dictaphone. Once the focus group is complete, the researcher will take the recording off the Dictaphone, save it onto a computer at the University of Oxford, and it will be protected with a password. The recording will then be permanently deleted from the Dictaphone. Any video recordings taken will also be immediately saved onto a computer at the University of Oxford, password protected, and permanently deleted from the video recorder. Only members of the research team will know the password or have access to the Dictaphones or video recorders. Audio recordings will also be anonymously transcribed, but original potentially identifiable audio files will also be used to aid analysis.

At the end of the study, all of the de-identifiable research data and any research documents with personal information, such as consent forms, will be stored at the University of Oxford for 10 years.

Your rights to access, change, or move your personal information may be limited, as we need to manage your information in specific ways in order for the research to be reliable and accurate.

You can find out more about how we use your information by contacting the research team, using the contact details given at the end of this document, or by visiting: http://www.admin.ox.ac.uk/councilsec/compliance/gdpr/individualrights.

What will happen if I don't want to carry on with the study?

Participation is voluntary and you may change your mind at any stage. Withdrawing from the study will not affect the care you receive from the NHS or your employment status. Data collected up to the point of withdrawal will be used unless you tell us not to.

What will happen to the results of this study?

The results of the study will be written up, looking at the themes of what participants have said. Direct quotes from the focus groups may be used in written reports, but these will be anonymised with no identifiable information. The results will be presented in a scientific paper and in conferences. This study will also be written up and included as part of one of the researcher's DPhil thesis.

Who is funding the study?

The study is funded by the NHS National Institute of Health Research (NIHR). The NIHR fund health and care research and translate discoveries into practical products, treatments, devices and procedures, involving patients and the public in all their work.

What if I have a complaint?

If you have any concerns about the study you can direct these to the researcher you are in touch with, or the project leads: Professor Daniel Freeman (Daniel.freeman@psych.ox.ac.uk) or Dr Felicity Waite (felicity.waite@psych.ox.ac.uk). If you wish to complain about any aspect of the way in which you have been approached or treated during the course of this study, you should contact Professor Daniel Freeman (contact details below) or you may contact the University of Oxford Clinical Trials and Research Governance (CTRG) office on 01865 616480 or the head of CTRG, email crtg@admin.ox.ac.uk.

In the unlikely event that you are harmed during the research, and this is due to someone's negligence, then you may have grounds for a legal action for compensation against the study sponsor and/or the NHS but you may have to pay your legal costs. The normal NHS complaints mechanisms will still be available to you. For example, the Patient Advisory Liaison Service (PALS) is a confidential NHS service that can provide you with support for any

complaints or queries you may have regarding the care you receive as an NHS patient. PALS is unable to provide information about this specific research study.

If you wish to contact the PALS team please call Freephone 0800 328 7971 or email PALS@oxfordhealth.nhs.uk [www.oxfordhealth.nhs.uk/support-advice/pals/].

Who has reviewed the study?

The study has been reviewed by an independent group of people, called a Research Ethics Committee to protect your safety, rights, wellbeing and dignity. This group includes both NHS staff and members of the public. This study has been reviewed and given favourable opinion by the South Central- Oxford B Research Ethics Committee (Reference: [19/SC/0075]).

CONTACT DETAILS

If you have any questions about this study, please do not hesitate to contact us:

Poppy Brown (Researcher), University of oxford. Email: poppy.brown@psych.ox.ac.uk Telephone number: 01865 618262	Ariane Petit (Local Site Trial Coordinator), University of oxford. Email: ariane.petit@psych.ox.ac.uk Telephone number: 01865 613173
Felicity Waite (Local Site Lead) University of oxford. Email: felicity.waite@psych.ox.ac.uk Telephone number: 01865 618192	Professor Daniel Freeman (Overall Trial Lead), University of Oxford and Oxford Health NHS Foundation Trust. Email: daniel.freeman@psych.ox.ac.uk Telephone number: 01865 613109

5.2 Topic guides

Topic Guide: Finding Out NHS Staff and Patient Thoughts About Having Virtual Reality Therapy Available on Wards

Introduction

- We've created a new therapy, which had a lot of input from people with lived experience of psychosis and other mental health problems.
- We'd really like to hear your views about a few things and be able to use your feedback and involve you in how we develop things in the future.
- It's important to know there are no right or wrong answers and you don't have to talk about anything you don't want to.
- Everything you say is confidential, (the only exception being if something you say suggests there is serious risk of harm to you or someone else)
- Please don't share with anyone outside of this room specific things about what people in the room might have said during the session
- Please try to listen and talk to each other more than you talk to me, it's great to have a group discussion with you bouncing off each other's thoughts and ideas. Give everyone the chance to speak and don't talk over each other, show respect for each other's views and roles
- Help yourself to snacks and drinks whenever you need
- If you need to pop out for the toilet or anything else, then please do
- The discussion today will take about an hour to an hour and a half, though it can be longer or shorter depending on how much you'd like to say
- If we can just go around the room and introduce ourselves, feel free to use a fake name if you prefer.
- To explain a bit more about what is going to happen. I've first got a few general questions that I'd like to ask, and then I'm going to show you the therapy we've created. You'll each be able to see it and try it out just for a few minutes. Then I'd like us to discuss what you think about the therapy.
- Any questions?

Staff topic guide

Aim one: exploring staff expectations of VR therapy

1. Has anyone ever tried Virtual Reality?
    a. What do you know about it? How did it make you feel?

2. We've created a psychological therapy that involves VR. Before I explain the therapy I'd also like to ask: What are your views on having psychological therapy of any sort available to patients on wards?

We've created a psychological therapy that involves VR. To enter VR, you put on a headset like this one. You can then see a computerised world. It's life sized so you can walk around as if it were real. The headset can be put on and taken off, whenever the user wants. VR headsets are very popular because they can also be used for playing games, so millions of people across the world now have a VR headset at home.

3. How do you think patients would feel about wearing a headset like this?

The therapy we've created is for people who may struggle or feel anxious in everyday situations. In VR you can enter computerised versions of everyday situations. VR is really helpful because our reactions in VR are similar to our reactions in the real world. So, if someone finds it scary or difficult to walk into a café in the real world, it will also feel difficult to walk into a virtual café in VR. But in VR you have the opportunity to try out and practise therapy techniques in these difficult situations, before you use them in the real world. Learning transfers between VR and the real world, so once someone starts to feel more confident in VR situations, this will also make them feel more confident in the real world.

Each scenario or environment in VR can have different levels of difficulty. So, for example, someone could first practise entering a café that only has one other person in it, then they could move up a level and try entering it with a few more people around it. At each level they could practise an activity such as standing in a queue and then ordering a drink. They can try out things that you might be too scary to do in the real world and see how it feels.

4. What are your initial thoughts about this?

5. Is this relevant to anything you do with patients?

I'll now explain a bit more about our therapy. The therapy is automated, which means in VR with you there is a character who will guide you in what to do. This character is called Nic. She might prompt you to explore the environment or try something out. A staff member e.g. a peer

supporter or nurse or psychology assistant would also be in the room assisting the person in VR. However, there would not always be a psychological therapist present while using this therapy, because Nic can provide guidance instead. Because a therapist does not need to be there all the time it means that far more people can have access to the therapy than is possible with other types of therapy, where you do need to have a therapist there with you all the time.

This will all become clearer when you get to try out the therapy.

6. Can you describe any immediate or initial concerns you have about VR therapy if any?

Demo of gameChange therapy:

In the therapy I'm showing you today there are six environments that you can enter in VR: a pub, a doctor's surgery, a street, a bus, a café and a shop. You can choose the difficulty of the environment e.g., how many people are around you. When you first put on the headset you'll be in a room where you can meet Nic, the VR coach. Would someone like to have a go first? *(All focus group members can spend a few minutes each trying the VR therapy. Audio recorder remains playing throughout)*

Aim two: Applying the NAASSS-CAT framework to assess feasibility of adoption

Domain 4: The intended adopters. What do front-line staff think of the technology?

7. Do you think this VR therapy could help patients, and if so, in what ways?

8. The technology will keep improving so that things look increasingly realistic, and the characters may become more interactive. Apart from these sorts of things, is there anything about the therapy you would change if it were to be implemented on the ward?

9. What are some of the things that surprised you about it?
    a. What did you think of Nic, and how it is automated?

Domain 1: The condition or illness

10. How would your patients feel using the VR?

11. What are the characteristics of your patients that might affect whether or not they benefit from VR therapy?
    a. Can you give an example of someone who would enjoy it?
    b. And someone who would have trouble about it?
    c. What's different about these patients?

Domain 4: The intended adopters: are there people indirectly affected by VR therapy?

Domain 5: The organisation: in particular: to what extent would organisational routines, pathways and processes need to change to accommodate VR therapy?

12. How might having VR on the ward work?
    a. Who could you see delivering therapy to patients? Why or why not might these people be willing to learn to deliver it? Might this change over time?
    b. How often could you see patients using it and when? And where?
    c. How does it fit with the current delivery of treatment on the ward?

13. What concerns do you have VR therapy impacting on patient safety or disrupting care?

14. In what ways might VR therapy make care more time-consuming?
    a. And in what ways might it save time?

15. In what ways might having VR on the ward affect the role of staff?
    a. In what ways might it make someone's job more difficult? Or easier?

16. What training/supervision would be needed in order to feel confident delivering the therapy to patients?

17. In what way does the therapy fit with or get in the way of any service goals?

18. What do you feel would need to happen for VR therapy to work in practise?
    a. What things would make it easier?
    b. What would make it difficult?

19. What previous examples are there of something new/a change being introduced into the ward?

Aim three: identifying potential differences across sites for implementation:

20. What things about your service might make it either particular easy or hard, or more or less relevant, to have VR therapy in practise?
    a. Physical location e.g. city centre
    b. Typical patient group

c. Staffing
d. Ward logistics

Do you have any other comments, recommendations or concerns?

Thank you so much for sharing your thoughts and ideas. We really appreciate you taking the time and it's been really helpful.

We will use your advice to help us develop this therapy and how we can implement it.

Patient topic guide

Aim one: exploring patient expectations of VR therapy

1. Has anyone ever tried Virtual Reality?
    a. What do you know about it? How did it make you feel?

2. We've created a psychological therapy that involves VR. Before I explain the therapy I'd also like to ask: What are your views on having *psychological* therapy of any sort available to patients on wards?

We've created a psychological therapy that involves VR. To enter VR, you put on a headset like this one. You can then see a computerised world. It's life sized so you can walk around as if it were real. The headset can be put on and taken off whenever you want. VR headsets are very popular because they can also be used for playing games, so millions of people across the world now have a VR headset at home.

1. What are you first thoughts about wearing a headset like this?

We've developed a therapy for people who may struggle or feel anxious in various everyday situations. I'll explain a bit about how we use VR in therapy. In VR you can enter computerised versions of everyday situations. VR is really helpful because our reactions in VR are similar to our reactions in the real world. So, if someone finds it scary or difficult to walk into a café in the real world, it will also feel difficult to walk into a virtual café in VR. But in VR you have the opportunity to try out and practise therapy techniques in these difficult situations, before you use them in the real world. Learning transfers between VR and the real world, so once someone starts to feel more confident in VR situations, this will also help them feel more confident in the real world.

Each scenario or environment in VR can have different levels of difficulty. So, for example, someone could first practise entering a café that only has one other person in it, then they could move up a level and try entering it with a few more people around it. At each level they could practise an activity such as standing in a queue and then ordering a drink. You can try out things that you might be too scary to do in the real world and see how it feels.

2. What are your first thoughts on this therapy?

I'll now explain a bit more about our therapy. The therapy is automated, which means in VR with you there is a character who will guide you in what to do. This character is called Nic. She

might prompt you to explore the environment or try something out. A staff member e.g. a peer supporter, nurse or psychology assistant, would also be in the room assisting the person in VR. However, there would not always be a psychological therapist present while using this therapy, because Nic can provide guidance instead. Because a therapist does not need to be there all the time it means that far more people can have access to the therapy than is possible with other types of therapy, where you do need to have a therapist there with you all the time.

This will all become clearer when you get to try out the therapy.

2. Do you have any immediate or initial concerns about VR therapy?

Demo of gameChange therapy:

In the therapy I'm showing you today there are six environments that you can enter in VR. A pub, a doctor's surgery, a street, a bus, a café and a shop. You can choose the difficulty of the environment e.g. how many people are around you. When you first put on the headset you'll be in a room where you can meet Nic, the VR coach. Would someone like to have a go first? (*All focus group members can spend a few minutes each trying the VR therapy. Audio recorder remains playing throughout).*

Aim two: Applying the NAASSS-CAT framework to assess feasibility of adoption

Domain 4: The intended adopters. What do patients and carers think of the technology?

3. What did you think of the VR therapy?

4. How would you feel about using VR therapy while on the ward?
    a. Would you use it if it were available? Why or Why not?
    b. What do you like about it?
    c. What do you dislike about it?
    d. In what way is it helpful?
    e. What surprised you about it?
    f. How easy did you find the VR to use?

5. How did you feel about the character (Nic) guiding you and not a real-life therapist?

6. What concerns do you have about the therapy or about VR?

7. The technology will keep improving so that things look increasingly realistic, and the characters may become more interactive. Apart from these sorts of things, what might you change about the therapy if you could change anything?

Domain 1: the condition or illness

8. What about your experiences that brought you to the ward might affect your use of VR?

Domain 4: The intended adopters. Are there people indirectly affected by the technology?

Domain 5: The organisation. To what extent would organisational routines, pathways and processes need to change to accommodate VR therapy?

9. If this were to be available on the ward, who would you like to be doing it with you?

10. What availability/access would you want to it?

11. What problems do you think there would be having the therapy available on the ward?

Do you have any other comments, recommendations or concerns?

Thank you so much for sharing your thoughts and ideas. We really appreciate you taking the time and it's been really helpful.

We will use your advice to help us develop this therapy and how we can implement it.

5.3 Poster advertising focus groups

5.4 Extracts from the coding and reflexive log

A reflexive and coding log were kept throughout. This was firstly to consider how the candidate's personal experiences and assumptions may be impacting the analysis, and secondly, to maintain a transparent audit trail. Below is an extract with illustrative examples of key considerations.

The initial coding framework developed by the candidate (PB) was discussed in supervision, which led to a reorganisation of certain themes and subthemes. A first example at the coding level was that there was initially a code group called 'ward environment', with sub codes such as medication, staff relationships, lack of therapy, and illness diversity. It was decided these should move to other relevant groups. For example, several were in reference to why there is a lack of therapy, and some were relevant to concerns about VR. These were therefore re-distributed accordingly. A second example at the theme level was that codes were initially structured into three overall themes: pre-VR expectations and experiences, thoughts after trying VR, and future and implementation. Following reflection, it was noted these were more deductive than inductive, and while helpful for organising the coding log in NVivo, they did not capture the nuance of participants' views. A third example shows how supervision led to a change in how a theme was described in the write up. Discussion was had around what the significance might be of the VR feeling much more real than participants expected. This led to a further review of the data, which highlighted that trying out the VR and experiencing its realism helped patients to understand how it could be helpful and reduced initial scepticism.

Attention was paid to which ideas had been introduced to participants by the group facilitators and which had been spontaneously suggested by participants to ensure this was accurately reflected in the analysis. For example, the idea of 'peer professionals' was introduced to patients by the interviewers, where-as the idea of Nic being presented as someone with lived experience of severe mental health problems was suggested by one of the patients.

Analysis and write up of the data included in the chapter was completed during the collection of additional data. Care was taken to ensure that insights from other focus groups not part of the current chapter's dataset did not influence the analysis.

Published Manuscripts

6.1 Publication 1: 'Twisting the Lion's Tail': Manipulationist tests of causation for psychological mechanisms in the occurrence of delusions and hallucinations

6.2 Publication 2: Virtual reality clinical-experimental tests of compassion treatment techniques to reduce paranoia

6.3 Publication 3: Power posing for paranoia: A double-blind randomised controlled experimental test using virtual reality

6.4 Publication 4: Parenting behaviour and paranoia: A network analysis and results from the National Comorbidity Survey-Adolescents (NCS-A)

6.5 Publication 5: Virtual reality cognitive therapy in inpatient psychiatric wards: Protocol for a qualitative investigation of staff and patient views across multiple National Health Service sites

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Review

‘Twisting the lion's tail’: Manipulationist tests of causation for psychological mechanisms in the occurrence of delusions and hallucinations

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HIGHLIGHTS

- Manipulationist-causal studies testing delusions and hallucinations are gathered.
- Forty-three studies manipulated psychological processes for psychotic experiences.
- Successful manipulation of a mechanism typically led to change in psychotic experiences.
- The studies potentially provide important treatment techniques.
- Causal tests are far too few, despite the potential for understanding and treatment.

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ABSTRACT

Over the past 20 years the importance of psychological processes in psychosis has gained increasing attention. However, it is key to determine the causal status of these processes in order to inform understanding and identify treatment targets. Studies that directly manipulate a psychological mechanism provide the most robust causal evidence. This review evaluates for the first time the extent of manipulationist causal evidence for the role of specific psychological mechanisms in delusions and hallucinations. A systematic search identified controlled experiments or targeted interventions that both manipulated a specific psychological mechanism and measured the effect on individual psychotic experiences. Forty-three manipulationist studies were found of which 40 measured paranoia, 11 measured hallucinations, and two measured grandiosity. Twenty-eight studies were experiments and 15 were targeted intervention trials. Only 18 used clinical samples. Manipulation of the specified psychological mechanism was demonstrated in 35 cases. Of these, 28 found a subsequent change in a psychotic experience. Negative affect and related psychological processing in relation to paranoia have been most tested. There is a small body of direct causal evidence for the role of psychological mechanisms in psychotic experiences – that highlight important novel treatment directions – but the manipulationist approach has been used too infrequently.

1. Introduction

1.1. The causal problem

*‘The very essence of causation [is] the ability to predict the consequences of abnormal eventualities and new manipulations…Viewing causality this way explains why scientists pursue causal explanations with such zeal and why attaining a causal model is accompanied by a sense of gaining “deep understanding” and “being in control.”’*Pearl (2009, page 415).

*‘Explanations and causal inference pervade our lives.’*Woodwood (2003, page 18).

*‘[Francis Bacon] taught that not only must we observe nature in the raw, but that we must also ‘twist the lion's tail’, that is, manipulate our world in order to learn its secrets.’*Hacking (1983, page 149).

Causal explanations are central to our daily interactions, since they allow us to predict, comprehend, and interact with our environment. It is not surprising, therefore, that the idea of conducting experiments that manipulate an aspect of nature in order to discover an effect was embedded into the first articulations of the scientific method by Francis Bacon in his *Novum Organum Scientiarum* (Bacon, 1620). Shadish, Cook, and Campbell (2002) highlight that even as laypersons we often instinctively use manipulation to discover effects: “to see what happens to

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our blood pressure if we exercise more, to our weight if we diet less, to our behaviour if we read a self-help book" (page 3). The premise of the manipulationist approach to causality is simply that "Y is a cause of Z if we can change Z by manipulating Y" (Pearl, 2009, page 417). The consensus in the philosophy of science is that manipulation is the key approach to be taken, when possible, for testing causal relationships. A causal relationship can be inferred from a correlation, but it is typically impossible to have any certainty about conclusions made in this way. Causal conclusions are based on an accumulation of different types of evidence (Bradford Hill, 1965) or on a triangulation of methods, but the most convincing evidence is provided by manipulationist data. Indeed, Holland (1986) argues that there is 'no causation without manipulation' (page 959).

There are two main methodological routes in clinical psychology to achieving the kind of causal evidence that is the focus of this review. First, there are the traditional short-term randomised controlled experimental studies that manipulate a mechanism (e.g. attentional focus, worry) and measure the immediate change in a particular outcome (e.g. social anxiety, paranoia). Second, there are interventionist-causal (Kendler & Campbell, 2009) randomised controlled trials that use sustained treatment techniques focused on an individual mechanism to produce change in the primary clinical outcome. Kendler and Campbell (2009, page 881) note how defining causation in terms of "what would happen under interventions" aligns well with the practical interests in mental health research, namely preventing and treating disorders. Conclusions from both kinds of study can be further strengthened by the use of mediation analysis (Dunn et al., 2015). In this instance, mediation analysis serves as an additional check that the mechanism manipulated is the most likely explanation for the observed effect. In this review paper, we wish to consider the degree to which a manipulationist approach, ideally with tests of mediated effects, has been applied to the psychological understanding of delusions and hallucinations.

1.2. Psychosis

The manipulationist approach relies on predicting the effect of a particular manipulation on a particular outcome. Hence, the outcome needs to be precisely specified. Yet outcomes in schizophrenia research are all-too-often imprecise: a collection of very different experiences are commonly treated as one. Our favoured approach to achieve precision in this research area is to focus on individual psychotic experiences, such as paranoia, grandiosity, hallucinations, and anhedonia. There is a large body of empirical evidence showing that individual psychotic experiences load onto relatively independent factors (e.g. Peralta & Cuesta, 1999; Ronald et al., 2014; Vazquez-Barquero, Lastra, Cuesta Nunez, Herrera Castanedo, & Dunn, 1996; Wigman et al., 2011). Notably, there is evidence that different psychotic experiences have differing levels of genetic and environmental risk (Zavos et al., 2014).

Research on individual psychotic experiences has also highlighted that each is best conceptualised as a quantitative trait, existing on a spectrum of severity in the general population, just as is seen for common emotional problems such as anxiety and depression (Plomin, Haworth, & Davis, 2009). Although psychotic experiences are most commonly studied in the context of schizophrenia, they are also common in the general population. For example, a spectrum of severity of paranoia (unfounded ideas that others intend to harm you) exists in the general population, with persecutory delusions representing the most severe form of paranoia (e.g. Elahi, Perez Algorta, Varese, McIntyre, & Bentall, 2017; Freeman, Pugh, Vorontsova, Antley, & Slater, 2010). This review will therefore make use of studies of either clinical or non-clinical psychotic experiences (i.e. at any point in the continuum). Non-clinical studies have the advantage that increasing, in the very short term, a potential causal factor is ethically more possible than when working with clinical groups.

Increasingly over the last few decades there has been an emerging psychological literature examining the causes of psychotic experiences. This has been largely provoked by the developing cognitive-behavioural therapy approaches for psychosis. Delusions (e.g. Bentall, Corcoran, Howard, Blackwood, & Kinderman, 2001; Freeman, 2016) and hallucinations (e.g. Morrison, Haddock, & Tarrier, 1995; Slade, 1976) have received the most psychological theorising and investigations, with less attention given to other psychotic experiences such as anhedonia (e.g. Strauss & Gold, 2012) or formal thought disorder (Goldberg & Weinberger, 2000). In the development of the new generation of psychological therapy for psychosis, The Feeling Safe Programme (Freeman et al., 2016) – a translational treatment for persecutory delusions – has been explicitly developed on the basis of a sustained programme of manipulationist studies. To date there has been no systematic assessment of how much of the supporting evidence overall cited for these wide variety of theoretical ideas comes from causal evidence provided by manipulation studies.

1.3. This review

We set out to examine the manipulationist literature with regard to delusions and hallucinations and psychological processes. We wanted to determine the number, quality, and focus of such studies. In particular, which psychotic experiences were assessed, how many studies used clinical versus non-clinical samples, how many were experimental studies versus interventionist-causal studies, and how many included mediation tests. The interest was in causal studies that use a randomised controlled design and a manipulation or treatment intervention targeting a single psychological mechanism.

2. Method

A search was carried out in Medline, Embase, and PsychInfo for peer reviewed English language papers using the following search terms: (halluc* OR delus* OR paranoi* OR persecut* OR psychotic OR psychosis OR "ideas of reference" OR grandios*) AND (experiment* OR manipulat* OR intervention* OR randomised OR randomized OR randomly) AND (mechanis* OR caus* OR maintenance OR maintaining) AND (emotion* OR cognit* OR social OR psychological*).

2.1. Inclusion criteria

Papers were required to have:

1. A manipulation of a specific psychological mechanism.
2. One or more individual psychotic experiences measured at outcome.
3. Random allocation to conditions.

2.2. Exclusion criteria

Papers were excluded if they were:

1. Case studies or case series.
2. Non-human studies.
3. Not available as a full text.

This search found 3618 papers (December 2018). Titles and abstracts were scanned and then full texts read as required. Citations and references of included papers were also checked. Fig. 1 presents a PRISMA diagram summary of the search process.

2.3. Quality assessment

The quality of included studies was assessed using a measure of methodological quality developed by Downs and Black (1998). This evaluates quality and risk in four areas: reporting, confounding, bias, and external validity. The measure was adapted to omit the final

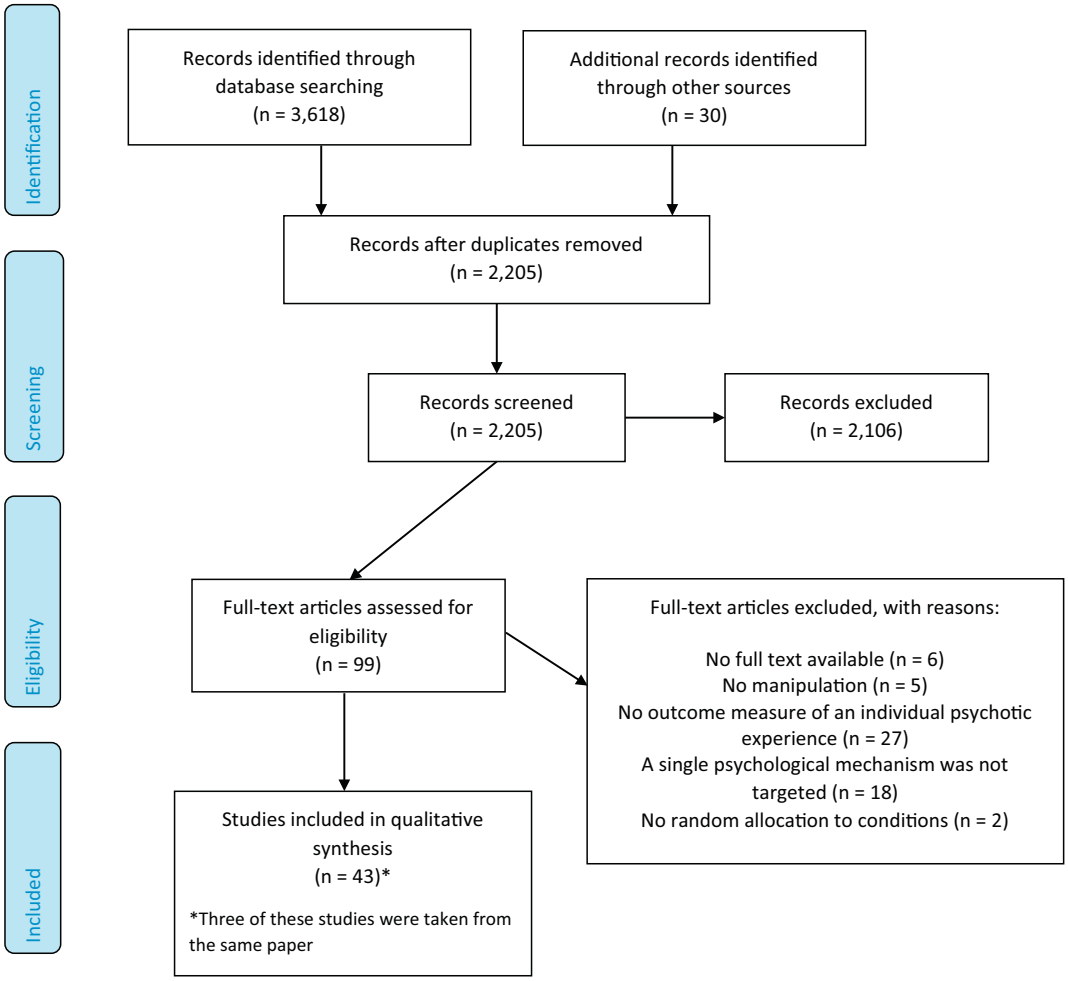

Fig. 1. PRISMA diagram of the search process.

question that assesses the power of a study, thereby allowing a maximum score of 27. Studies were assigned a grade according to their score: excellent (23–27), good (18–22), fair (13–17) or poor (0 − 12).

3. Results

A total of 43 manipulationist studies meeting the inclusion criteria were found. Just over half (n = 25) used non-clinical samples, and within these non-clinical studies the majority (n = 15) used student samples. There were only 18 studies on clinical populations. This gave a total of 5426 non-clinical participants (1671 when excluding one large-scale online trial by Freeman et al. (2017)) and 1509 clinical participants. Twenty-eight studies were experiments and 15 were targeted clinical intervention trials. Paranoia was measured at outcome in 40 studies, hallucinatory type experiences in 11 studies, and grandiosity in two studies. A total of 10 studies looked at multiple individual psychotic experiences at outcome. Summaries of the studies can be seen in Tables 1 and 2.

3.1. Studies of psychological mechanisms in non-clinical populations

3.1.1. Attention

The first manipulation studies conducted concerned attentional focus. If attention is frequently threat-focused then this may increase the frequency with which potential threats are identified, which in turn could increase future expectation of threat, and so have an effect on paranoid thoughts (Bentall & Kancy, 1989; Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002; Freeman, Garety, & Phillips, 2000). Two experiments manipulated participants to focus their attention towards a threat and measured paranoia as the outcome, but found contrasting results. Both studies used student samples with no requirement to have paranoid thinking and were rated as having somewhat poor methodological quality, however, suggesting caution may be required when drawing conclusions from the results.

Locascio and Snyder (1975) randomised 60 undergraduates to selectively attend to threatening or non-threatening stimuli or to no attentional manipulation. They found no significant differences in reported paranoia between the conditions. However, there was no check as to whether the attention manipulation was successful. Conversely, Bodner and Mikulincer (1988), who used a sample of 177 undergraduates, did successfully manipulate attention either to be focused on a threatening agent (the experimenter) or on the self. They found that paranoia increased when attention was focused on the experimenter versus on the self, but only when participants had also been given negative feedback implicating personal failure. This might suggest that for attentional bias to affect paranoia some sort of negative event or emotion is required. The difference in results between the two studies could also be explained by the bespoke measure of paranoia used by Bodner and Mikulincer (1988) predominantly assessing ideas of reference rather than of harm.

Three further experiments within the same report examined the effects of self-focussed attention as opposed to threat-focussed (Ellett & Chadwick, 2007). It has been argued that self-consciousness increases directed attention towards the self, leading to the belief that other people are doing likewise, thus increasing paranoia (Fenigstein & Vanable, 1992). Ellett and Chadwick found in their three studies that

Table 1
Manipulationist studies assessing non-clinical samples.

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Freeman, Dunn, Murray, et al. (2015)	Negative affect	121	Individuals reporting paranoid ideation	VASs, SSPS, PANSS suspiciousness subscale, CAPE, CAPS	THC administration increased paranoia, which was fully mediated by increased negative affect and anomalous experiences	Y	Y	Y	24, excellent
Lincoln et al. (2013)	Negative affect	71	Students	Paranoia checklist	Following a negative mood induction, a compassion focussed task led to fewer paranoid thoughts than a control condition. The effect was mediated by reduced negative emotion	Y	Y	Y	19, good
Lincoln et al. (2010)	Anxiety	90	Students	Paranoia checklist	Induced state anxiety resulted in increased state paranoia, partially mediated by an increased tendency to jump to conclusions	Y	Y	Y	20, good
Lincoln et al. (2009)	Anxiety	64	Undergraduates	Paranoia checklist	A stress induction caused a significant increase in paranoia, partially mediated by increased anxiety	Y	Y	Y	20, good
Martinelli et al. (2013)	Rumination	37	Students	SSPS	Following a paranoia induction, a distraction task significantly decreased paranoia where-as encouraging rumination led to maintained paranoia	Y	Y	N	22, good
McKie et al. (2017)	Rumination	32	Undergraduates	VAS measuring paranoia	Following a paranoia induction, a mindful self-focus task significantly decreased paranoia where-as ruminative self-focus maintained paranoia	Y	Y	N	18, good
Atherton et al. (2016)	Self-esteem	26	Males reporting paranoid ideation	SSPS	Compared to a high self-confidence manipulation, a low self-confidence manipulation led to significantly higher levels of paranoia	Y	Y	N	20, good
Ascone, Jaya, and Lincoln (2016)	Self-esteem	172	Female students	Paranoia checklist	Giving participants an unfavourable online social profile versus a favourable one had no significant effect on paranoia	Y	N	N*	21, good
Freeman, Evans, et al. (2014)	Self-esteem	60	Females reporting paranoid ideation	SSPS	Reducing participants' height in virtual reality led to increased paranoia that was mediated by changes in social comparison	Y	Y	Y	22, good
Kesting et al. (2013)	Self-esteem	76	General population	Paranoia checklist	Being excluded from a virtual ball game and receiving negative feedback on a test led to increased paranoia, which was mediated by decreased self-esteem	Y	Y	Y	23, excellent
Butler et al. (2019)	Interpersonal stress	97	General population	PDS	Receiving critical comments increased paranoia but had no effect on self-esteem. Receiving warm comments increased self-esteem. Then being excluded from a virtual ball game reduced self-esteem and increased paranoia	Y	Y	N	19, good
Reeve et al. (2017)	Sleep	68	General population	SPEQ	Sleep loss increased paranoia and hallucinations, but not grandiosity. Changes in psychotic experiences were mediated by changes in negative affect	Y	Y	Y	19, good
Meyhöfer et al. (2017)	Sleep	32	General population	PSI	Sleep deprivation induced psychosis-like experiences mimicking hallucinations. No effect on paranoia	Y	Y	N	20, good
Petrovsky et al. (2014)	Sleep	24	General population	PSI	Sleep loss led to increased perceptual distortions but delusional thinking and paranoia did not increase	Y	Y for hallucinations, N for paranoia	N	20, good
Freeman et al. (2017)	Sleep	3755		GPTS and SPEQ-H		Y	Y	Y	20, good

(*continued on next page*)

Table 1 (*continued*)

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
			Students with insomnia		CBT for insomnia reduced paranoia and hallucinations. Insomnia was the mediator of change in both cases				
Locascio and Snyder (1975)	Attention	60	Undergraduates	Bespoke fear/malevolence questionnaire as an index of paranoia	Increasing attention to threat did not increase paranoia	No check	N	N	18, good
Bodner and Mikulincer (1998)	Attention	177	Undergraduates	Bespoke paranoia self-report questionnaire	Increasing attention to threat led to increased paranoia in those who received feedback implicating personal failure as compared to when attention was focussed elsewhere	Y	Y	N	19, good
Westermann et al. (2014)	Emotional regulation strategy	86	Undergraduates	VAS measuring state delusional ideation	Using a reappraisal strategy, a suppression strategy or no strategy following an anxiety induction had no significant effect on delusional ideation	No check	N	N	15, fair
Lamster et al. (2017)	Loneliness	60	General population	Paranoia checklist	Reducing loneliness led to a significant reduction in state paranoia, moderated by proneness to psychosis. Inducing loneliness led to increased paranoia though not significantly	Y	Y	N	22, good
Ellett and Chadwick (2007a)	Self-awareness	60	Undergraduates	PS, PDS	Inducing high self-awareness resulted in more paranoid self-cognitions following both a failure and a neutral task as compared to low self-awareness	No check	Y	N	18, good
Ellett and Chadwick (2007b)	Self-awareness	40	Undergraduates	PS, PDS	Inducing high self-awareness resulted in more paranoid self-cognitions following a neutral task as compared to low self-awareness	No check	Y	N	18, good
Ellett and Chadwick (2007c)	Self-cognitions	30	Undergraduates	PS, PDS	A negative prime resulted in more paranoid self-cognitions than a positive prime following a failure task completed under a high self-awareness condition	No check	Y	N	18, good
Hutton et al. (2017)	Attachment	60	Students	PDS	A secure attachment prime did not protect against paranoid thinking	No check	N	N	21, good
Zimbardo et al. (1981)	Awareness of anomalous experiences	18	Students susceptible to hypnosis	"A clinically derived" paranoia scale and the paranoia and grandiosity subscales of the MMPI	Those who were hypnotised to experience hearing loss without being aware of this manipulation experienced higher paranoia and grandiosity than those who were aware of the manipulation	Y	Y	N	14, fair
Kaltsi, Bucci, and Morrison (2018)	Metacognitive beliefs about paranoia	110	University staff and students	Paranoia checklist	Following social exclusion via a virtual ball game, frequency of paranoid thoughts increased in those who received a positive beliefs induction. Distress of paranoid thoughts decreased in those who received a negative belief induction	Y for positive beliefs group. N for negative beliefs group	Y	N	19, good

Key: VAS = Visual analogue scale; SSPS = Social State Paranoia Scale; PANSS = Positive And Negative Symptoms Scale; CAPE = Community Assessment of Psychic Experiences; CAPS = Cardiff Anomalous Perception Scale; SPEQ = Specific Psychotic Experiences Questionnaire; PSI = Psychotomimetic States Inventory; GPTS = Green Paranoid Thoughts Scale; PDS = Paranoia and Depression Scale; SPEQ-H = Psychotic Experiences Questionnaire – Hallucinations subscale; PS = Paranoia Scale; PDS = Paranoia and Depression Scale; MMPI = Minnesota Multiphasic Personality Inventory.

* Stated intention to include mediation analysis in the analysis plan but refrained due to lack of effect of the manipulation on the outcome.

Table 2
Manipulationist studies assessing clinical samples.

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
Freeman, Emsley, Dunn, et al. (2015)	Negative affect	59	Patients with current delusions	VASs for paranoia and hallucinations, SSPS	Exposure to an urban street scene led to increased paranoia and voice hearing, mediated by increased anxiety (45%), depression (38%) and negative beliefs about others (45%)	Y	Y	Y	22, good
Freeman et al. (2016)	Safety-seeking behaviours	30	Patients with current delusions	VAS measuring persecutory concerns	Encouraging the dropping of safety behaviours led to large reductions in delusional conviction	Y	Y	N	19, good
Freeman et al. (2013)	Worry	67	Patients with persecutory delusions	CAPS, CDS	A worry induction increased a range of anomalous experiences including feelings of unreality, perceptual alterations and temporal disintegration. There was no effect on hallucinations	Y	N for hallucinations, Y for feelings of unreality	N	20, good
Foster et al. (2010)	Worry	24	Patients with persistent persecutory delusions and high levels of worry	PSYRATS delusions subscale, GPTS	A worry intervention led to reduced delusional distress. Indication that it might have also reduced the frequency of paranoid thoughts, but this was not statistically significant	Y	Y	N	21, good
Freeman, Dunn, Startup, et al. (2015)	Worry	150	Patients with persistent persecutory delusions	PSYRATS delusions subscale	A worry intervention led to a reduction in persecutory delusions. Change in worry accounted for 66% of improvement in delusions	Y	Y	Y	22, good
Lecomte et al. (1999)	Self-esteem	95	Diagnosis of schizophrenia	PANSS	A 12-week empowerment module reduced scores on the PANSS delusion and paranoia items. The effect dissipated when treatment stopped	N (maybe due to lack of sensitivity of measure used)	Y	N	21, good
Freeman, Pugh, et al. (2014)	Self-esteem	30	Patients with persistent persecutory delusions	GPTS	A brief CBT intervention aimed at reducing negative self-cognitions led to small but not significant reduction in paranoia	N	N	N	23, excellent
Freeman, Waite, Startup, et al. (2015)	Sleep	50	Patients with persistent delusions or hallucinations	PSYRATS	Following CBT for insomnia, confidence intervals for the positive symptom outcomes were wide, suggesting in some patients delusions and hallucinations were reduced but in some patients they increased	Y	N	N*	21, good
Garety et al. (2015)	Reasoning	101	Patients with current delusions	VASs measuring paranoia and hallucinations	A brief intervention aimed at increasing belief flexibility and reducing jumping to conclusions led to significant improvements in state paranoia. Mediation analysis showed that changes in reasoning mediated changes in paranoia, though this did not quite reach significance after adjusting for baseline confounders. No significant changes in hallucinations were found	Y	Y	Y	21, good
Khazaal et al. (2015)	Reasoning	172	Outpatients with persistent psychotic symptoms	PDI	Training in the ability to generate alternative hypotheses led to reduced delusional conviction, distress and preoccupation, which was maintained at a 6 month follow up	Y	Y	N	22, good
Ross et al. (2011)	Reasoning	34	Patients with current delusions	Question assessing delusional conviction	Reasoning training led to less conviction and more flexibility in delusions for some patients, but the finding was not significant	Y	N	N	22, good
So et al. (2015)	Reasoning	44	Patients with current delusions	PANSS, PSYRATS	Training in reasoning (four modules of standard metacognitive training) led to reduced scores on the PANSS positive and delusions subscales and the PSYRATS delusions and conviction subscales, mediated by improved belief flexibility	Y	Y	Y	24, good
Moritz et al. (2015)	Reasoning	70		Paranoia checklist		Y	N	N	19, good

(*continued on next page*)

Table 2 (*continued*)

Citation	Psychological Mechanism	N	Participant characteristics	Positive symptoms outcome	Comment on findings	Successful manipulation?	Significant effect on a psychotic experience?	Mediation analysis?	Risk of Bias score
			Patients with schizophrenia		Training in how to reduce 30 common cognitive biases led to a reduction in jumping to conclusions but not paranoia				
Craig et al. (2018)	Beliefs about voices	150	Patients with persistent auditory/verbal hallucinations	PSYRATS-AH	AVATAR therapy led to a significantly greater reduction in PSYRATS-AH total and subscale scores than did supporting counselling. By 24 weeks there were no differences	Y	Y	N	23, excellent
Birchwood et al. (2014)	Beliefs about voices	197	Patients with persistent command hallucinations	VCS, PANSS	Cognitive therapy to challenge perceived power of voices reduced compliance to voices at 18 month follow up but did not affect delusions or hallucinations	Y	N for delusions/ hallucinations but Y for following commands	Y (separate paper**)	20, good
Stinson et al. (2010)	Triggering cognitions	30	Patients with auditory hallucinations	PSYRATS-AH	No difference in severity of hallucinations following instruction to either focus on hallucination-triggering thoughts or on neutral thoughts	N	N	N	20, good
Ascone et al. (2017)	Compassion	51	Patients with paranoid ideation	Paranoia checklist	Following an induction of negative affect, a single session compassion focussed imagery intervention had no significant effect on paranoia as compared to a control imagery condition	Y for self-reassurance but N for self-compassion	N	N	22, good
Van den berg et al. (2016)	Trauma	155	Patients with a lifetime psychotic disorder and current PTSD	GPTS	Paranoia decreased significantly following the first session of trauma focussed therapy. At the end of the 8 sessions paranoia was lower in the treatment group compared to a waitlist group though the difference did not reach significance	Y	N	N	22, good

Key: VAS = Visual analogue scale; SSPS = Social State Paranoia Scale; CAPS = Cardiff Anomalous Perception Scale; CDS = Cambridge Depersonalisation Scale; PSYRATS = Psychotic Symptom Rating Scale; GPTS = Green Paranoid Thoughts Scale; PANSS = Positive And Negative Symptoms Scale; PDI = Peters Delusion Inventory; PSYRATS-AH = Psychotic Symptom Rating Scale – Auditory Hallucinations subscale; VCS = Voice Compliance Scale.

* Stated intention to include mediation analysis in the analysis plan but refrained due to lack of effect of the manipulation on the outcome.

** Birchwood et al. (2017).

paranoia increased in undergraduates following a manipulation to increase self-awareness e.g. via use of a camera and failure task. However, the lack of manipulation check means caution is needed with the interpretation of their results.

3.1.2. Self-esteem

Paranoia may build upon feelings that the self is vulnerable, arising from low self-esteem and viewing the self as inferior to others (Freeman, 2016). Four non-clinical studies successfully manipulated self-esteem, three of which saw the expected change in paranoia. Only two of the studies used populations selected for reporting paranoid ideation, but the methodological quality across all four studies was mostly strong. Various manipulations of self-esteem were used. Freeman et al. (2014) reduced the height (as a proxy for social rank and self-esteem) of 60 females reporting paranoid thoughts during an exposure to a social environment in virtual reality. This resulted in more negative self-esteem and a greater number of reported paranoid thoughts. The increase in paranoia was fully mediated by the changes in self-esteem. Atherton et al. (2016) used imagery and visualisation tasks to manipulate self-esteem, and Kesting, Bredenpohl, Klenke, Westermann, and Lincoln (2013) used exclusion from a virtual ball game, with both also finding significant change in paranoia at outcome. Conversely, Acone, Jaya and Lincoln, 2017 did not find a significant effect of manipulating self-esteem on paranoia, despite successfully altering participants' extent of social comparison. However, this study used a student sample who were not pre-selected for reporting paranoid thoughts, which might explain the absence of change in levels of paranoia.

A further study examined an important aspect of social environment (comments from others) on paranoia, and examined self-esteem as a moderator (Butler, Berry, Ellett, & Bucci, 2019). They randomised 97 individuals, predominately university students unselected for levels of paranoia, to receive critical, warm, or neutral comments. Self-esteem increased in those who received warm comments; no changes in the other groups were seen. However, those who received critical comments increased in state paranoia despite the lack of change in self-esteem. All groups were then subjected to social exclusion using a virtual ball game. Following exclusion, those who had received warm comments significantly decreased in self-esteem and increased in paranoia. No mediation analyses were included.

3.1.3. Rumination

Two experiments using student samples assessed whether changes in rumination led to changes in paranoia. Rumination may play a role in paranoia by increasing feelings of vulnerability, for example via perseverative appraisal of negative interpersonal experiences (Freeman, 2016; Freeman & Garety, 1999). This appraisal may also have effects by narrowing attention towards negative experiences and increasing anxiety. Martinelli, Cavanagh, and Dudley (2013) gave 37 participants a paranoia induction before randomising them to a task encouraging ruminative thinking or to a task encouraging distraction. They found that an increase in ruminative thinking led to the maintenance of paranoid thoughts whereas the distraction task decreased the experience of paranoid thoughts. This study scored highly on methodological rigour, and is supported by a similar experiment by McKie, Askew, and Dudley (2017). However, McKie et al. (2017) experiment was rated as having a high risk of bias due to a lack of blinding and no adjustment for potential confounders. Moreover, neither study included a mediation analysis.

3.1.4. Negative affect

Four studies examined negative affect as a putative causal mechanism in paranoia. All four studies found an alteration in negative affect led to a change in paranoia and were rated as having good methodological rigour, benefiting also from the use of mediation analysis. Lincoln, Peter, Schafer, and Moritz (2009) randomised 64 students to either a stress induction (via listening to building site noise) applied during a difficult question task or a control condition. Those in the stress condition experienced an increase in negative emotion and reported significantly more paranoid thoughts than those in the control condition, which was mediated by increased anxiety. This experiment is limited, however, by the use of a student sample not preselected for reporting paranoia, which is also the case for two of the other studies on negative affect (Lincoln, Hohenhaus, & Hartmann, 2013; Lincoln, Lange, Burau, Exner, & Moritz, 2010). Freeman et al. (2015) randomised 121 individuals reporting paranoid ideation to either the administration of THC, the active ingredient in cannabis, or a placebo. Those who received THC reported significantly more paranoid thoughts, and this was mediated by anxiety, depression, worry and negative thoughts about the self. This study was rated as having particularly high methodological quality and a low risk of bias.

3.1.5. Sleep

Disturbed sleep may contribute to the occurrence of psychotic experiences by increasing negative affect and anomalous perceptions (Freeman, 2016; Reeve, Sheaves, & Freeman, 2015). Unsurprisingly, sleep deprivation studies have only been carried out in non-clinical samples. It is also one of the few areas to give equal focus to hallucinations as well as to delusions. Three recent randomised controlled studies of sleep deprivation on the general population found that sleep loss increased perceptual distortions such as hallucinations (Reeve, Emsley, Sheaves, & Freeman, 2017; Meyhofer et al., 2017; Petrovsky et al., 2014). Out of these, only Reeve et al. (2017) also found an increase in paranoia. This was the most informative study as a number of psychotic experience outcomes were examined and mediation analyses were included. In a randomised order, 68 participants underwent three nights of restricted sleep and a control condition of three nights of normal sleep. Following sleep restriction, there were signficant increases in both paranoia and hallucinations, but no signficant changes in grandiosity. Mediation analysis revealed that changes in psychotic experiences were mediated by changes in negative affect and related processes. The effect of sleep deprivation on hallucinatory experiences is also supported by Meyhöfer, Kumari, Hill, Petrovsky, and Ettinger (2017) and Petrovsky et al. (2014). These studies did not find an increase in paranoia, however. This may have been due to the smaller sample size than in Reeve et al. (2017)

The most convincing causal test is provided by a large interventionist-causal model trial testing the effects of a sleep improvement programme on paranoia and hallucinations (Freeman et al., 2017). 3755 students with insomnia were randomised to either receive digital cognitive behavioural therapy (CBT) for insomnia or usual care. There was a large improvement in sleep and small improvements in paranoia and hallucinations in those who received the sleep intervention. Mediation analysis showed that improvements in sleep accounted for nearly 60% of the change in paranoia after treatment, with a similar effect found for hallucinations. This indicates that, at least in the specific population of young adults, disrupted sleep plays a contributory causal role in the occurrence of psychotic experiences.

3.1.6. Further psychological mechanisms

A number of further studies on different psychological mechanisms were also found, though these studies were generally rated as having a slightly higher risk of bias than most others included. The experience of internal anomalous experiences, such as unexplained anxious arousal, could be a causal mechanism in paranoia as misinterpretation of these experiences can lead to incorrect conclusions about the external world (e.g. that there is an external threat) (Freeman, 2016; Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001; Maher, 1974). Zimbardo et al. (1981) examined this mechanism, though it was rated as having a high risk of bias. Twelve students were hypnotised to experience hearing loss and randomised to either being made aware of the cause of this experience or to not being told about the cause, with a further six students

included in a control group. All participants then completed an anagram task in a social setting. Being unaware of the cause of the anomalous experience led to participants perceiving themselves as more irritated, hostile and unfriendly than the group who were made aware of the cause. They also reported greater paranoia and grandiosity than those in the awareness group.

Kaltsi, Bucci, and Morrison (2018) aimed to test specifically the causal role of metacognitive beliefs concerning paranoia in 110 university staff and students. They induced either positive or negative beliefs about paranoia i.e. that paranoia is productive in promoting safety vs. it is negative and promotes distress, before exposing participants to social exclusion via a virtual ball game. Frequency of paranoid thoughts increased significantly following exclusion in those who underwent the manipulation to induce positive beliefs. Distress concerning paranoid thoughts decreased in those who had the negative induction. However, the manipulation check showed that only the positive beliefs induction was successful; the negative beliefs induction did not successfully alter metacognitive beliefs, so caution is needed with the interpretation of this result.

The effects of attachment style are perhaps difficult to investigate experimentally. Attachment style might be expected to have an effect on psychotic experiences given its importance in the development of affect regulation, self-esteem, and understanding of interpersonal experiences (Sitko, Bentall, Shevlin, O'Sullivan, & Sellwood, 2014; MacBeth, Schwannauer, & Gumley, 2008). Hutton, Ellett, and Berry (2017) randomised 60 students (unselected for levels of paranoia) to experience a secure attachment prime, a positive affect prime or a neutral control condition. All participants then underwent a paranoia induction. Despite expectations that a secure attachment prime might buffer against paranoid thinking following a paranoia induction, no such differences were observed. Whether this is because attachment style does not causally affect paranoia or whether priming feelings of attachment style is not comparable to real attachment style is unclear. It is also possible that the attachment primes and/or the paranoia induction were unsuccessful.

There is also evidence from a non-clinical study that loneliness affects paranoia. Feeling distanced from people and lacking meaningful relations that make one feel valued might plausibly be expected to increase paranoia (Lamster, Lincoln, Nittel, Rief, & Mehl, 2017). Lamster, Nittel, Rief, Mehl, and Lincoln (2017) randomised 60 individuals to a high loneliness condition, a low loneliness condition, or a control group. The inductions did successfully alter feelings of loneliness, and it was also found that reducing loneliness significantly reduced paranoia, and increasing loneliness increased paranoia, although the differences were not statistically significant.

Lastly, a study by Westermann, Rief, and Lincoln (2014) instructed 86 undergraduates, unselected for paranoia, to respond to anxiety-provoking stimuli with a reappraisal strategy, expressive suppression strategy, or no strategy. Adaptive reappraisal of anxiety provoking situations has been shown to protect against psychopathology (Aldao, Nolen-Hoeksema, & Shweizer, 2010) but has not, aside from this study, been tested in relation to paranoia. However, state delusional ideation at outcome was not significantly different between those using each strategy. On the other hand, while the anxiety induction was successful, there was no check on strategy use meaning the extent to which each strategy was truly used by participants cannot be determined.

3.2. Studies of psychological mechanisms in clinical populations

3.2.1. Self-esteem

Two clinical intervention studies rated as having high methodological quality and low risk of bias found that increasing self-esteem reduced paranoia. Freeman et al. (2014) successfully increased self-esteem in 30 patients with persecutory delusions and found a moderate reduction in paranoia post-treatment. Lecomte et al. (1999) randomised 95 patients with a diagnosis of schizophrenia to receive either a 12-week empowerment module aimed at increasing self-esteem or treatment as usual (TAU). No increase in self-esteem was seen, although the authors suggest this may have been due to their self-esteem measure looking predominantly at global features of self-worth rather than more specific constructs that might be more relevant for the patient group. On the other hand, scores on both the paranoia and delusion items of the Positive and Negative Symptom Scale (PANSS) significantly decreased in the intervention group whereas they increased in the TAU group.

3.2.2. Worry and rumination

Three studies with good methodological rigour examined the role of worry in the occurrence of psychotic experiences. A worry induction on 67 patients with persecutory delusions led to an increase in anomalous experiences but not hallucinations (Freeman et al., 2013), and two interventions targeting worry also showed significant effects at outcome (Foster, Startup, Potts, & Freeman, 2010; Freeman et al., 2015). The strongest study randomised 150 patients with persistent persecutory delusions to receive either six sessions of a CBT worry treatment in addition to standard care or standard care alone (Freeman, Dunn, Startup, et al., 2015). It was found that the intervention significantly reduced both worry and persecutory delusions. Moreover, mediation analysis showed that change in worry accounted for 66% of the change in the persecutory delusions.

3.2.3. Negative affect

Three clinical studies investigated the causal relationship between negative affect, predominantly anxiety, and paranoia. An experiment by Freeman et al. (2015) was rated as having particularly good methodological quality. They found that upon randomising 59 patients with persecutory delusions to either go outside into a busy urban street or to stay inside, those in the former condition reported significantly more anxiety and negative thoughts about the self. Paranoid thoughts and voice hearing also significantly increased in this group. The increase in paranoia was mediated by increased anxiety, depression, and negative thoughts about others.

The second study concerned the anxiety-related psychological process of safety behaviours. Safety behaviours are actions designed to prevent certain feared catastrophes from occurring (Salkovskis, 1991). Such behaviours prevent individuals from receiving and processing evidence that goes against delusional beliefs, as they believe their feared catastrophe has not happened due to the use of safety behaviours rather than because their belief is inaccurate. Freeman et al. (2016) randomised 30 patients with persecutory delusions to enter a virtual reality social environment and either receive instruction to try to drop their usual safety behaviours or to keep using them. While it was not possible to ascertain the extent to which safety behaviours were fully dropped (although there were expected differences in objective movement in virtual reality), there were large reductions in the conviction with which persecutory delusions were held for the group instructed to reduce the use of safety behaviours.

It might be expected that increasing self-compassion in a clinical sample would reduce paranoia via a reduction in negative affect, as in Lincoln et al.'s (2013) non-clinical experiment. The only experiment to investigate this was by Ascone, Sundag, Schlier, and Lincoln (2017). 51 patients with paranoid ideation received a negative emotion induction via in sensu exposure to a recent distressing social situation and were then randomly assigned to a single session intervention using either compassionate imagery or control imagery. Skin conductance levels increased following the negative affect induction, suggesting the negative emotion induction increased physical stress, though no measure of subjective emotional distress was used. The compassionate imagery intervention significantly improved self-reassurance and happiness, but not self-compassion, and there was no change in paranoia at outcome.

3.2.4. Sleep

Only one intervention study targeting the improvement of sleep was found that used a clinical sample. Freeman et al. (2015) randomised 50 patients with persistent persecutory delusions or hallucinations to receive 12 weeks of CBT for insomnia in addition to standard care, or standard care alone. CBT was found to lead to significant reductions in insomnia as compared to standard care. However, the trial was insufficiently powered to determine with sufficient precision the effects of sleep improvement on hallucinations and delusions, which led to the subsequent OASIS trial (Freeman et al., 2017).

3.2.5. Reasoning biases

Six interventions, all having strong methodological quality, have successfully manipulated reasoning biases in clinical samples, with four out of the six finding a resultant change in paranoia. Reasoning biases may distort the appraisal or reappraisal of negative interpersonal events or anomalous experiences, thus increasing paranoia (Garety, Hemsley, & Wessely, 1991). Encouraging flexibility in belief formation might plausibly help reduce the impact of reasoning biases. The largest study was by Khazaal et al. (2015) who randomised 172 patients with psychosis to either a waitlist control or to an intervention using a card game targeting the ability to general alternative hypotheses. Belief flexibility improved following the intervention, and this group also reported significant decreases in delusion conviction, distress, and preoccupation, which was maintained at a six-month follow up. So et al. (2015) similarly demonstrated in their study of 44 patients with delusions that improved belief flexibility mediated reduced delusional conviction. A similar type of reasoning intervention by Garety et al. (2015) randomised 101 patients to receive brief computerised reasoning training to increase belief flexibility and reduce jumping to conclusions or an active control group involving basic computer activities. Belief flexibility improved and state paranoia reduced in those who received training. Mediation analysis showed that changes in reasoning mediated changes in paranoia. However, this effect did fall outside of conventional levels of statistical significance following adjustment for baseline confounders. Garety et al. (2015) also looked at the effect of training in belief flexibility on hallucinations, but found no improvements.

Two of the interventions examined the effects of reasoning training on the jumping to conclusions bias that is often seen in patients with delusions (Dudley, Taylor, Wickham, & Hutton, 2016). Moritz et al. (2015) randomised 70 patients with schizophrenia to receive six online presentations that taught about cognitive biases or to a waitlist control group. Although the teaching led to improvements in the jumping to conclusion bias, no significant changes in paranoia were seen. Similarly, Ross, Freeman, Dunn, and Garety (2011) found that a single session of reasoning training reduced jumping to conclusions, but it did not reduce delusional conviction significantly as compared to an attention control condition.

3.2.6. Beliefs about voices

Two interventionist-causal type trials attempted to change patients' beliefs about the voices that they hear. Both studies had good ratings of methodological quality. Craig et al. (2018) randomised 150 patients to receive AVATAR therapy or supportive counselling for 12 weeks. AVATAR therapy involved patients creating a computer screen avatar of their hallucination, and a therapist helping the person develop and practice a more helpful relationship with the avatar in order to facilitate change in beliefs about the actual voices. AVATAR therapy was successful in reducing patients' perceived omnipotence of voices, and also led to significant improvements in auditory hallucinations immediately post-treatment as compared to the supportive counselling group. Differences between the two randomised groups were not maintained at follow-up.

The COMMAND trial by Birchwood et al. (2014) randomised 197 patients who heard voices that they complied with to either receive treatment as usual or a cognitive behavioural therapy targeting beliefs about the voices. The intervention reduced compliance with command hallucinations and a mediation analysis showed that a reduction in voice omnipotence was the main mediator of change (Birchwood et al., 2017).

3.2.7. Further psychological mechanisms

One intervention was found that examined the effect of trauma-focused treatment on patients with a lifetime psychotic disorder and current PTSD. Trauma may contribute to the occurrence of paranoia in a number of ways, for example leading to negative schemas concerning the self and others (Bentall et al., 2001; Garety et al., 2001). Van Den Berg et al. (2016) randomised 155 patients to receive eight sessions of trauma focused therapy or to a waitlist control group. PTSD symptoms significantly decreased in the treatment group after 8 weeks. Paranoia also decreased significantly after the first session of treatment as compared to the control group. At the end of all eight treatment sessions paranoia was still lower in the treatment group than the waitlist group, though the difference did not reach statistical significance.

Finally, Stinson, Valmaggia, Antley, Slater, and Freeman (2010) argue that certain cognitions may be important for triggering auditory hallucinations. They therefore instructed 30 patients with persecutory delusions to either focus on their (previously identified) cognitive antecedents to auditory hallucinations, or to focus on neutral cognitions unrelated to their hallucinations while they entered a tube train ride in virtual reality. However, the occurrence of auditory hallucinations in VR was the same for both groups, thus not providing evidence that antecedent cognitions trigger auditory hallucinations.

4. Discussion

We searched the empirical literature, with no date restriction, for studies manipulating psychological mechanisms potentially involved in psychotic experiences. Only 43 manipulationist studies were found. Just 18 of these studies were with people being seen in clinical services for psychosis. For one of the most severe mental health problems, this is a very small number of causal research studies. Hence, arguably the key point highlighted by the review is the limited number of studies that have directly tested causal roles for psychological processes in psychosis. Interestingly, all but four of the included experiments and interventions were conducted in the last decade, with over two-thirds conducted in the last five years. This perhaps reflects an increasing awareness of the importance of the approach and its neglect hitherto in psychosis research.

Notably, nearly all of the manipulationist studies were on paranoia. This particularly follows an endeavour by Freeman and colleagues to build a much more efficacious treatment for persecutory delusions by explicitly using manipulationist studies chosen on the basis of a theoretical model (Freeman et al., 2016). In this work, persecutory delusions are conceptualised as threat beliefs, developed in the context of genetic and environmental risk (Zavos et al., 2014), that are maintained by several psychological processes including anxious avoidance (safety-seeking behaviours), excessive worry, low self-confidence, poor sleep, anomalous experiences, and reasoning biases (Freeman, 2016). The causal mechanisms of maintenance are set out in this theoretical account: safety-seeking behaviours prevents the receipt of disconfirmatory evidence that the person is safe; worry brings implausible ideas to mind, keeps them there, and exacerbates the distress; low self-esteem (negative self-beliefs and low positive self-beliefs) lead the person to feel inferior and vulnerable to harm from others; subjectively anomalous internal states (e.g. hallucinations) provoke fearful and unusual explanations; disrupted sleep increases anxiety, worry, low self-esteem and the anomalous internal states; and reasoning biases prevent the processing of alternative explanations. Hence numerous different manipulationist tests are identifiable. Each main aspect of the model has been tested in a manipulationist design, and, most notably,

typically in a targeted interventionist treatment trial that has directly tested a treatment innovation. There has also been a valuable strand of manipulationist studies focussed on treatment development that have followed the repeated identification from the late 1980's onwards of reasoning biases such as jumping to conclusions in patients with delusions (Garety et al., 2015). Overall, the findings provide consistent evidence for the potential benefit of clinical interventions in the treatment of persecutory delusions that target worry, self-esteem, and negative affect. Treatment studies focussing on reasoning biases have had more variable results, though those targeting belief flexibility in particular do seem especially promising. Given that the effect sizes for first generation cognitive behavioural therapy are small (Bighelli et al., 2018), the argument is that successfully targeting specific mechanisms (i.e. translational research) has the potential to build better treatments. The interventionist-causal trials covered in this review have begun to demonstrate this promise. In interventionist-treatment trials there is a valuable combination of causal test and clinical test of specific treatment techniques.

Other than the literature on sleep – which itself still requires further work in clinical samples – only two intervention studies tried to reduce hallucinations via targeting key psychological mechanisms (appraisals) (Birchwood et al., 2014; Craig et al., 2018). These appraisal-focussed hallucination trials have shown clinical benefits. No interventions have specifically targeted grandiosity. The file-drawer problem might contribute to the lack of experimental manipulation studies, but this is far less likely to be the case with clinical interventions, given that the preregistration of clinical trials now decreases the likelihood of such publication bias. More significant, therefore, is likely to be the time and difficulty involved in conducting such clinical intervention studies.

It is important to recognise that there are no single causes of psychotic experiences. Most causes are likely to be 'inus conditions' – an *insufficient* but *non-redundant* part of an *unnecessary* but *sufficient* condition' (Mackie, 1974). Each causal factor therefore only increases the probability of a particular psychotic experience occurring. A consequence of this is that the causal role of a mechanism can be difficult to detect without using a large sample size. Given this caveat, it is interesting that replicated findings are nonetheless seen in several areas, namely self-esteem, worry, negative affect, belief flexibility, and sleep, all in relation to paranoia.

It seems that when the psychological processes hypothesised in the psychological models of have been successfully manipulated then effects on psychotic experiences are seen. This is encouraging for the model and for the development of intervention. However, the findings in this review also perhaps indicate that research has been focused only on mechanisms in which there is a good deal of confidence in the relationship. As the field matures, we would hope to see novel mechanisms being successfully manipulated that are not found to have any effects on psychotic experiences, as would be expected in any well researched area.

Although in most cases methodological quality was strong, with risk of bias therefore being low, the included literature did have a number of limitations. Less than half of the included studies used mediation analysis, thus limiting to a degree the strength of causal inferences that are made. Moreover, six of the studies did not include a manipulation check. In cases where no effect on a psychotic experience was then found, it is unclear whether this was because the manipulation was unsuccessful or because the mechanism had no causal relationship to the outcome. Additionally, although the majority of samples included more than 50 participants, few included more than 100. Over half (15) of the non-clinical studies used student samples, making conclusions from these studies somewhat limited in their generalisability. Replications across different samples and with greater statistical power are needed, with a stronger focus on examining moderators and mediators of relationships.

4.1. Limitations of the review

There are number of limitations of the review. First, it cannot be guaranteed that the search strategy identified every study that would meet the inclusion criteria. While three different databases were searched, any study not including one word from each search string would not have been identified. Our scanning of citations and reference lists of included studies would have reduced the likelihood of this problem, but a number of studies may still not have been found. Second, the file-drawer problem means there may be unpublished studies that would have met criteria for inclusion in this review but have been missed. Fortunately, this is less of a problem for clinical trials given that they now need to be registered. Third, this review was limited to the positive symptoms of psychosis, specifically delusions and hallucinations. Negative symptoms of psychosis, such as anhedonia, were not examined. Finally, we chose to use Downs and Black (1998) scale of methodological quality, which has its limitations. The value of totalling a score for each study based on a wide variety of methodological questions, and giving it a rating based on this score, is rather questionable. Some aspects of method are more important than others, yet this method assigns equal weight to every aspect. Moreover, some of the questions within this tool are more appropriate for cohort studies than randomised controlled designs. To our knowledge there is no existing tool that focuses on the study design included in this review. Most tools are either solely for observational studies or for clinical trials.

4.2. Conclusion

As Shadish, Cook and Campbell (2002, page xv) state: "the rewards associated with being correct in identifying causal relationships can be high, and the costs of misidentification can be tremendous.". Conducting manipulation experiments and therapeutic interventions serves an important theoretical and clinical purpose. The results of the studies included in this review indicate that these methods have the potential to be informative, but have been insufficiently applied to the psychological understanding of psychosis.

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PB conducted the systematic review of the literature and wrote a first draft of the manuscript under the supervision of DF and FW. DF and FW edited the text and contributed to the writing.

Conflict of interest

None.

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Virtual reality clinical-experimental tests of compassion treatment techniques to reduce paranoia

Poppy Brown[1] ✉, Felicity Waite[1,2], Aitor Rovira[1,2], Alecia Nickless[3] & Daniel Freeman[1,2]

Paranoia may build on negative beliefs held both about the self and others. Compassionate imagery may be one way of reducing such negative beliefs, and hence paranoia. Two studies tested this idea, one targeting compassion for the self and one targeting compassion for others. Two-hundred individuals from the general population scoring highly for paranoia were recruited. The studies used a randomised controlled experimental design, with embedded tests for mediation. Study one targeted self-compassion via creation of a compassionate coach (CC) image. Study two targeted compassion for others via loving kindness meditation (LKM). Individuals repeatedly entered neutral virtual reality social environments. Changes in compassion and paranoia were assessed. Compared to controls, the CC group increased in self-compassion (group difference = 2.12, C.I. = 1.57;2.67, $p = <0.0001$, $d = 1.4$) and decreased in paranoia (group difference = −1.73, C.I. = −2.48; −0.98, $p = <0.0001$, $d = 0.8$). Change in self-compassion explained 57% of change in paranoia. Compared to controls, the LKM group increased their compassion for others (group difference = 3.26, C.I. = 2.72;3.80, $p = <0.0001$, $d = 1.7$), and decreased in paranoia (group difference = −1.70, C.I. = −2.50; −0.89, $p = <0.0001$, $d = 0.8$). Change in compassion for others explained 67% of change in paranoia. Targeting negative beliefs about the self and others using compassionate imagery causes reductions in paranoia. Tests in clinical populations are indicated.

Treatments for paranoia (unfounded ideas of harm from others) need considerable improvement. Our approach to improvement is translational. We manipulate key mechanisms identified from our theoretical model and measure the effect on paranoia. When the manipulation reduces a key mechanism it can also inform treatment development. This is called an interventionist-causal model approach[1]. We substantiate the effects of the manipulation with mediation analysis for change[2]. The studies we report in this paper test the effects of compassion interventions in individuals from the general population scoring highly for current paranoid ideation. Paranoid thoughts have consistently been shown to exist on a spectrum of severity in the population; many people have a few paranoid thoughts and a few people have many[3–6]. The most severe form of paranoid ideation, known as persecutory delusions, lies at one end of this continuum and builds upon common emotional concerns[5]. The whole spectrum of paranoid experiences share an underlying aetiology, supported by evidence of a consistent heritability between mild and severe paranoia[7]. It is therefore possible to learn about clinical extremes by studying individuals with lower levels of severity.

Negative beliefs about the self and about others are highly correlated with clinical and non-clinical levels of paranoia[8]. It is hypothesised that such beliefs lead to feeling inferior, apart, and vulnerable, and that paranoia builds upon such concerns[9]. Compassionate interventions have started to be used to target negative beliefs[10,11], and thus paranoia[12,13]. Self-compassion is strongly inversely correlated with negative ideas about the self[14], and with severity of positive and negative symptoms in schizophrenia[15,16]. Training in self-compassion – e.g. through creating a compassionate coach (CC) image – can therefore help to reduce negative self-beliefs and moderate feelings of threat[13]. Similarly, training in compassion for others – e.g. through loving kindness meditation (LKM) – increases positive beliefs about others and so may enable individuals with paranoia to learn to see other people as a source of safety, rather than threat[17].

In the first experimental test of compassion in relation to paranoia, Lincoln *et al.* (2012) found that practising compassionate coach imagery reduced paranoia in comparison to using neutral imagery ($d = 0.59$)[13]. We conducted two linked, randomised controlled tests of compassion interventions to reduce paranoia that built upon

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this experiment in three ways. First, we tested individuals reporting significant current paranoia. Second, we used immersive virtual reality (VR) to present participants with neutral social situations, and thus the opportunity to potentially form genuine paranoid ideation, which cannot be guaranteed by other means. Third, participants repeatedly entered different VR social experiences, enabling repeated measurement of key variables and thus temporal tests within the mediation analysis.

VR is increasingly being used in mental health research and treatment since individuals are typically more willing to enter the situations they find challenging in VR, and try out therapeutic techniques, because they know it is only a simulation[18]. VR has been used for treating patients with psychosis[19–21], as well as for research with individuals from the general population reporting paranoia[22–24]. These studies have clearly demonstrated that entering neutral VR environments provokes paranoid ideation in vulnerable individuals. Thus VR provides a way of exposing, with a high level of control, individuals to situations that they find challenging.

Study one hypothesised that compared to a control group: those who generated a CC would experience increased self-compassion and decreased paranoid ideation in VR. Further, this decreased paranoia would be mediated by increased self-compassion. Similarly, study two hypothesised that compared to the control group: those who practised LKM would experience increased compassion for others and decreased paranoia. Further, decreased paranoia would be mediated by increased compassion for others. Our focus was at a clinical intervention level of causal explanation (an interventionist-causal approach): testing the effect of clinical techniques on the main hypothesised mechanisms (self-compassion in study one, compassion for others in study two) and the key psychological outcome (paranoia). We did not set-out to establish further detail in the causal chain (e.g. how alterations in compassion may affect other psychological processes).

Study 1

Method. Ethical approval was received from the Central University Research Ethics Committee (CUREC) at the University of Oxford and the study was performed in accordance with relevant guidelines and regulations. Informed consent was obtained from all participants.

Participants. Participants were primarily recruited via social media and radio advertisements in Oxfordshire, UK. 740 participants were screened using questionnaires administered through Qualtrics. Exclusion criteria were: aged under 18 years; history of severe mental illness; photo-sensitive epilepsy; or self-identifying as having any significant visual, auditory, or mobility impairment. One-hundred individuals reporting six or more paranoid thoughts in the last month (a total score of 22 or above on the Green Paranoid Thoughts Scale Part B[25] (GPTS-B) took part. This cut off score captures the upper quartile of paranoia scores in the general population[26,27].

Design. The design was between-groups. Each participant was tested in a single one-hour session. Participants completed baseline measures and were then randomised to the compassion or control condition. Randomisation was carried out using an online generator by an independent researcher. There were four stages of imagery development and four periods in VR social environments. Two different VR scenarios were used (a tube train and a lift), each experienced twice. Figure 1 shows the experimental procedure.

Imagery interventions. We chose to train participants in creating an ideal compassionate coach unique to them. The coach provides strength, kindness, and warmth in order to help individuals feel better able to cope with everyday challenges. The aim is to harness the experience of being nurtured and eventually internalise it, so that a new and distinctive memory is created that can be easily accessed. A compassionate coach can have any identity, but must embody all the qualities of compassion, including strength, warmth, wisdom and kindness, and should encourage the individual to be kind toward them-self. A script was devised combining elements from a number of existing scripts[28–30] that aimed to make the task more accessible and easy to achieve. The image was developed in four stages. First, participants created their coach and focussed on their qualities, before bringing to mind a difficult situation from their life, and practising having their coach help them to cope with it. For instance, the experimenter explained:

"Spend some time with your compassionate coach; they are there just for you, to comfort you and soothe you in any time of distress. They have your best interests at heart. They are someone who cares about you and strengthens your confidence; who makes you feel like you can face all of life's challenges…With your coach there, you are not alone. You have someone with you, alongside you, and able to help you face this situation."

Each latter stage allowed for greater detail and other (e.g. sensory) aspects of the coach to be developed. In between each of the four stages participants entered a VR social situation, during which they practised being self-compassionate with support from their coach. The control condition was identical except the image generated was entirely neutral: a weather forecaster, and participants were not instructed to think about their image during the VR scenarios.

The two imagery tasks were designed to be as similar as possible, apart from the affect associated with the images. The CC was intended to be warm and supportive, whereas the weather forecaster was neutral and provided only a weather commentary. Participants were encouraged to relax and take deep breaths in both conditions.

Assessments. *Paranoia.* At baseline participants completed the Green Paranoid Thoughts Scale - Part B[25]. This is a 16-item scale assessing ideas of persecution such as 'I was convinced there was a conspiracy against me' and 'I was sure someone wanted to hurt me' on a 1–5 scale (1 = not at all, 5 = totally). Scores can range from 16–80; higher scores reflect greater paranoia. The scale is well validated for use in both clinical and non-clinical samples[31] and has strong concurrent validity with paranoia severity as assessed by clinical interviews and by controlled virtual reality tests[32,33]. Using item response theory analysis with over 10,000 individuals, the GPTS-B has been shown to demonstrate high reliability ($a > 0.95$) across both mild and severe ends of the paranoia spectrum[34]. Test-retest reliability has also been shown to be good, with an intra-class correlation coefficient of 0.81[25].

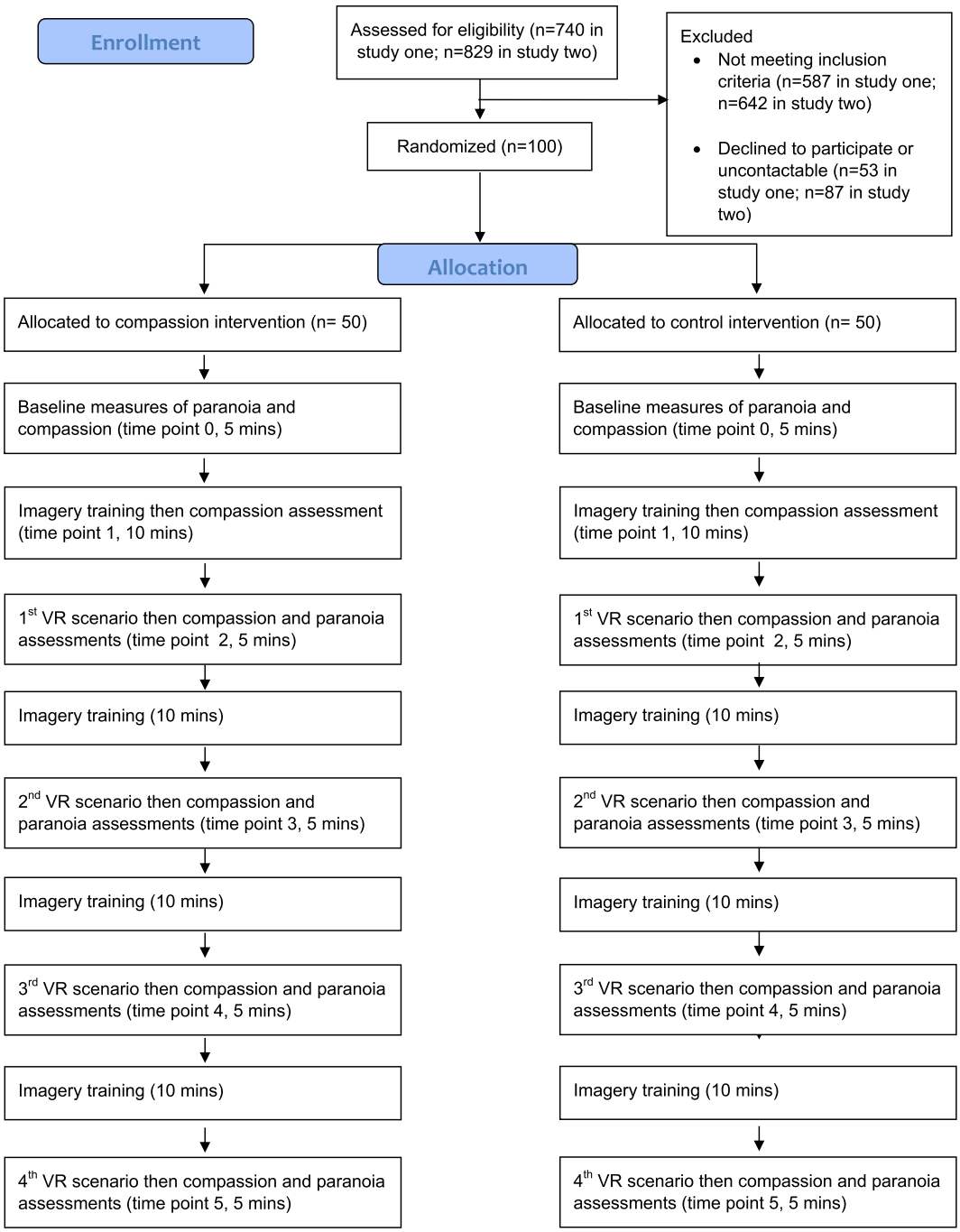

Figure 1. Experimental Procedure.

Two visual analogue scales were averaged to form a state measure of paranoia used for analysis. They were: 'Please mark on the line below how vulnerable you felt during the virtual reality scenario' and 'Please mark on the line below how much you felt under threat during the virtual reality scenario'. The scale ranged from 'Not at all' to 'Extremely'. These were completed after being in each VR environment. Cronbach's alpha measure of internal consistency for the scale was 0.83. Visual analogue scales were chosen due to their sensitivity to change. Paranoia as measured on such scales has been correlated with both GPTS scores and interviewer assessment of paranoia[32].

Self-compassion. Two visual analogue scales were also averaged to form a state measure of self-compassion for analysis. These were: 'Please mark on the line below how kind you are feeling towards yourself right now' and 'Please mark on the line below how compassionate you are being towards yourself right now'. As with the paranoia measures these ranged from 'Not at all' to 'Extremely'. Cronbach's alpha measure of internal consistency for the scale was 0.85.

Virtual Reality. *The VR system.* The VR setup included a tracking system allowing participants to move freely in an area of 3 × 3m. Participants wore a consumer VR head-mounted display (HMD), an HTC Vive PRO, with a resolution of 1440 × 1600 pixels per eye and a field of view of 110 degrees. It was powered by a computer with an Intel i7 CPU, a Nvidia GeForce GTX1080 graphics card, and Windows 10 operating system. The HMD includes an integrated audio system.

VR scenarios. Two scenarios of approximately three minutes were used: an underground tube train ride and a lift. These scenarios were based on those used in Freeman *et al.*[20]. The aim was to provide environments, although programmed to be neutral, that individuals with paranoia may find, to a degree, challenging, and thus helpful to practise the technique in. No specific instructions were given about observing the avatars or exploring the environments. The tube had a total of either 12–13 people on the carriage with three people in the central area near the participant in the first exposure and four in the second. The lift had either three or four avatars in it, for the first and second exposures respectively. The presence of an additional avatar in each second exposure aimed to increase the intensity of the social situation and prevent participants re-entering an identical scenario.

Analysis. The target sample size was 100 individuals randomised equally between the experimental (CC image) and control (neutral image) group. We wanted to be able to detect moderate to large effect sizes. To detect an effect size of 0.6 using two-tailed t-tests and 80% power a sample size of 45 per group would be required. The use of mixed effects models would also allow greater statistical power and therefore detection of somewhat smaller effect sizes.

We used a linear mixed effects regression model for each continuous outcome in order to account for the repeated measures at the four different time points. This addressed hypotheses one and two i.e. whether a relationship exists between condition (compassion or control) and self-compassion, and between condition (compassion or control) and paranoia. We calculated standardised effect sizes with Cohen's d, dividing the treatment effect by the shared standard deviation at baseline. To test the mediation hypothesis we tested two models. Firstly, we determined the extent of mediation of paranoia at the final time point, by self-compassion and self-kindness also at the final time point, as this is when the compassion intervention was complete and thus at its strongest. As a check on the direction of the relationship, we also conducted a reversed mediation test, putting paranoia at the final time point as the mediator and self-compassion at the final time point as the outcome. Due to the concern of conducting cross sectional mediation models, we also determined the extent of mediation of paranoia at the final time-point, by self-compassion and self-kindness at the mid time point, when half of the compassion intervention had been completed. This was able to assess mediation across time. The approach used was similar to that of Baron and Kenny (1986)[35] but used a linear mixed effects model at each step. Two separate linear mixed effects models showed that the intervention was correlated with the outcome, and with the mediator.

A third model then used the outcome as the response and both the intervention and mediator as covariates. Extracting the parameters as per Baron and Kenny enabled us to obtain the total, direct and indirect effects and also the percentage mediation. Baseline measures of outcome and mediator were included as covariates in all models. We used R version 3.4.2 for the statistical analysis. We opted to use this approach, as in Freeman *et al.* (2017)[36], as opposed to the method of using an instrumental variable approach with two-stage least squares, because the latter methodology has not been updated to include repeated measurements from the same participants. Since we had up to four repeated measurements per participant per outcome, we wanted to take advantage of all this information by using linear mixed effects models. Although randomisation ensures that the estimate of the intervention effect on the mediator and on the total intervention effect on the outcome are not affected by unaccounted confounders, the effect of the mediator on the outcome (path b) may still be affected by confounding[37]. We accounted for this by including baseline levels of the mediator and outcome in each of the linear mixed effects models.

Results. Participants were predominantly males in their late twenties, working full or part time. The mean age of participants was 29 (range 18–55 years). The mean GPTS-B scores of 35 and 33 in the compassion and control groups respectively indicated a much higher level of paranoia than in most analogue samples (e.g. 24.2 in Atherton *et al.*, 2016; 25.6 Freeman, Evans *et al.*, 2014)[22,23] and are over the cut off used for inclusion in some clinical trials for persecutory delusions (e.g. 29 in Garety *et al.*, 2017)[38]. Table 1 presents a summary of participant demographic and baseline characteristics. There were no missing data.

Hypothesis 1: Effect of condition on self-compassion. Figure 2 shows the mean scores and effect sizes for the two outcomes at each time point. The compassion group showed significantly higher levels of self-compassion at all follow-up time points relative to the control group. For the final outcome the group difference was 2.12, 95% C.I. = 1.57;2.67, $p = <0.0001$, $d = 1.4$.

Hypothesis 2: Effect of condition on paranoia. The compassion group showed significantly lower levels of paranoia relative to the control group for both the mid and final time points. For the final outcome the group difference was −1.73, 95% C.I. = 2.48; −0.98, $p = <0.0001$, $d = 0.8$.

Hypothesis 3: Mediation. Table 2 shows the results from the mediation analysis. Change in self-compassion at the mid and final outcomes explained 36% and 57% respectively of the treatment effect on paranoia at the final outcome. In comparison, mediation analyses in the opposite direction indicated that changes in paranoia at the final time point explained only 24% of the change in self-compassion at the final time point.

	Study one – self-compassion		Study two – compassion for others	
	Compassion (n = 50)	Control (n = 50)	Compassion (n = 50)	Control (n = 50)
Age (years), mean (SD)	28.7 (8.6)	29.4 (9.6)	26.9 (9.8)	28.5 (10.1)
Men/women, *n/n*	33/17	30/20	27/23	32/18
Ethnicity, *n*				
White British/Irish	34	35	31	34
Non White British/Irish	16	15	19	16
Employment status, *n*				
Unemployed	3	2	4	2
Full/Part-time employed	30	36	28	22
Student	17	12	17	26
Retired	0	0	1	0
GPTS Part B score at baseline, mean (SD)	35.4 (11.2)	32.6 (10.0)	30.5 (11.0)	32.5 (12.4)
Self-compassion and self-kindness score at baseline, mean (SD)	6.5 (1.8)	7.0 (1.5)	—	—
Compassion for others score at baseline, mean (SD)	—	—	5.1 (2.0)	5.4 (1.7)

Table 1. Baseline and demographic characteristics by randomisation group.

	Study one		Study two	
	Self-compassion mid time point as mediator	Self-compassion final time point as mediator	Compassion for others mid time point as mediator	Compassion for others final time point as mediator
Total effect (CI, *P*-value)	−1.81 (−2.56; −1.07), <0.000	−1.81 (−2.56; −1.07), <0.000	−1.73 (−2.55; −0.92), <0.000	−1.73 (−2.55; −0.92), <0.000
Direct effect (CI), *P*-value	−1.17 (−1.95; −1.40), 0.003	−0.80 (−1.59; 0.00), 0.050	−1.14 (2.14; −0.14), 0.025	−0.58 (−1.67; 0.51), 0.297
Indirect effect (CI, *P*-value)	−0.65 (−1.08; 0.22), 0.001	−1.04 (−1.52; −0.56), <0.000	−0.58 (−1.18; −0.02), 0.057	−1.16 (−1.94; −0.38), 0.003
Percentage mediation	35.84	57.43	33.57	66.89

Table 2. Total, direct, and indirect effect estimates from the mediation analysis.

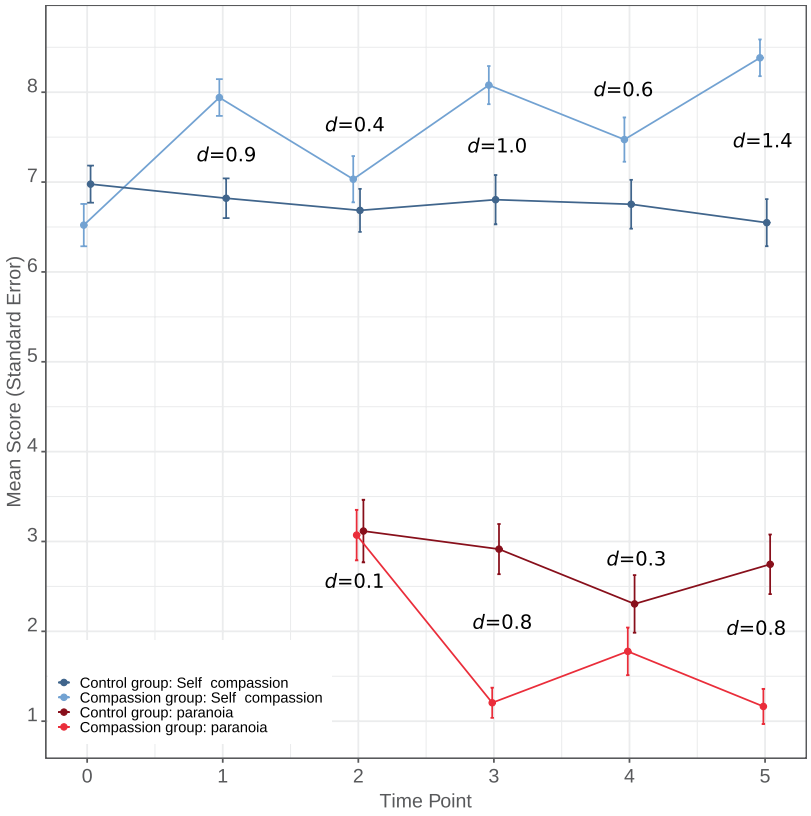

Figure 2. Scores and effect sizes for primary compassion and paranoia outcomes (study one).

Study 2

Method. The recruitment method for a new cohort of 100 individuals and the study design were identical to study one. The content of the imagery intervention, however, targeted compassion for others as opposed to self-compassion. Accordingly, additional measures were included that assessed compassion for others.

Study two had several differences to study one. Firstly, the outcome measures used novel wording that had not been discussed in the compassion intervention. Secondly, a measure of positive affect was included meaning it could be ascertained whether this may also be a mediator of change in paranoia. Finally, at the end of the study participants in the compassion group were asked to describe how they found the compassion training so that we gained qualitative feedback.

Imagery intervention. LKM uses visualisation, (e.g. imagining someone smiling at you) reflection (e.g. thinking about yours and others' positive qualities), and auditory techniques (e.g. internally repeating phrases such as 'I hope you have a good day'). A script was devised combining elements from a number of existing scripts and protocols[17,39]. As with study one there were four stages of training. The first stage asked individuals to imagine receiving and sending, warmth and love to one or more persons to whom they are very close. For instance, the experimenter explained:

"Reflect on their positive qualities…you could picture them being happy, maybe laughing with you"
"See if you can let yourself fill with warmth…maybe the flow of warmth is associated with a colour"
"You could repeat that you wish this person to feel happy, to have a nice day".

Individuals were then asked to imagine themselves on a bus or train and to try and send warmth and kindness to some of the strangers around them on the bus or train, including the driver. Each of the other stages required practising with different people, including someone whom they disliked, a neutral acquaintance, and groups of family, friends, and strangers. The control condition was identical to study one. As in the previous study, participants entered a social situation in virtual reality in between each stage of imagery training, during which those in the compassion group were asked to further practise the exercise with the VR avatars.

Assessments. *Paranoia.* Paranoia measures were identical to study one.

Compassion for others. Three visual analogue scales were averaged to form a measure of compassion for others used for analysis. At baseline and following the first imagery training session individuals were asked to imagine they were walking down a street before answering the analogue scales: 'Please mark on the line below how connected you would feel to the people around you', Please mark on the line below how understanding you would feel of the people around you' and Please mark on the line below how accepting you would feel of the people around you'. Following each VR scenario the questions were based on how connected, how understanding and how accepting of the VR avatars participants felt. These measures again ranged from 'Not at all' to 'Extremely'. Cronbach's alpha measure of internal consistency for the scale was 0.9.

Positive Affect. A visual analogue scale similarly ranging from 'Not at all' to 'Extremely' asked participants: 'Please mark on the line below how positive you feel right now'.

Analysis. Analysis was identical to study one. An additional mediation analysis was also run that assessed positive affect at the final time point as a mediator.

Results. Demographic and baseline characteristic were very similar to study one (see Table 1). One participant had missing data for the final three time points due to running out of time after finding the first two stages of compassion exercise particularly emotional.

Hypothesis 1: Effect of condition on compassion for others. Figure 3 shows the mean scores and effect sizes for the two outcomes at each time point. The compassion group showed significantly higher levels of compassion for others at all follow-up time points relative to the control group. For the final outcome the group difference was 3.26, 95% C.I. = 2.72;3.80, $p = <0.0001$, $d = 1.7$.

Hypothesis 2: Effect of condition on paranoia. The compassion group showed significantly lower levels of paranoia relative to the control group at all follow-up time points. For the final outcome the group difference was −1.70, 95% C.I. = −2.50; −0.89, p = <0.0001, $d = 0.8$.

Hypothesis 3: Mediation. Table 2 shows the results from the mediation analysis. Change in compassion for others at the mid and final outcomes explained 34% and 67% respectively of the treatment effect on paranoia at the final outcome. Mediation analysis in the opposite direction indicated that changes in paranoia at the final outcome explained just 4% of the change in self-compassion at the final time point. Change in positive affect at the final time point accounted for 47% of the change in paranoia at the final time point. Mediation in the opposite direction showed that change in paranoia accounted for 24% of the change in positive affect at final outcome.

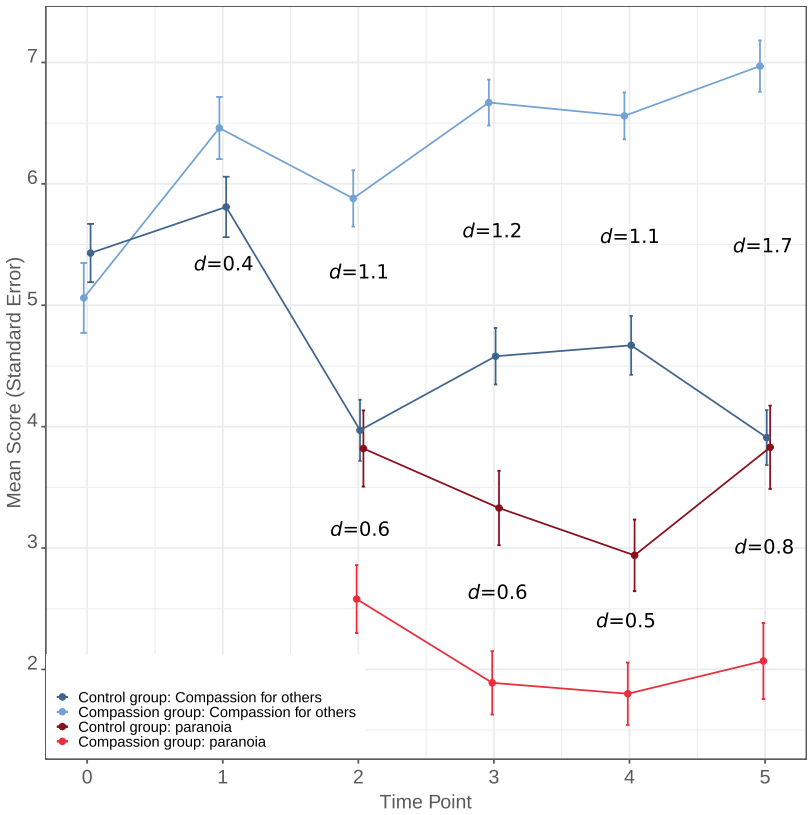

Figure 3. Scores and effect sizes for primary compassion and paranoia outcomes (study two).

General Discussion

This paper draws on the hypothesis that paranoia builds upon negative ideas about the self and others. To our knowledge, these were the first randomised controlled experimental tests of compassion intervention techniques in individuals with current paranoid ideation. The interventionist-causal approach allows for inferences to be made concerning both treatment development and causal mechanisms[1].

The first necessary stage in such an approach is for the treatment technique to alter the targeted mechanism, which was achieved. Both studies found large effect size increases in compassion at all time points. This demonstrates that even brief compassion interventions, when practised in VR social environments, are effective in increasing state compassion. There is therefore potential for both CC imagery and LKM to be tested as clinical techniques, perhaps with the aid of VR, in therapy for individuals with persecutory delusions. Anecdotally, participants reported finding it surprisingly easy to create their CC and found it useful to practise using their coach in VR social environments. Many based their coach on someone they knew, or on animals or trees, for example. Some chose inanimate shapes of a particular colour, and one individual used a perfected version of themselves. In study two participants also reported how useful they found the training:

"I felt kinder to myself by the end and tried to be kinder towards others"

"I think I'll use this in situations where I don't feel as comfortable"

"It felt more like I was in a safer place…the people weren't just strangers".

The success of the manipulations meant that the effects on paranoia could be determined. In both studies those who received the compassion intervention showed a large reduction in paranoia. Because of the manipulationist design of the studies (i.e. it was level of compassion that was targeted and altered) the inference is that low compassion for the self and for others is likely to be a contributory causal factor in the occurrence of paranoid thoughts. The mediation and reverse mediation analyses support this interpretation. Although study two found that increased positive affect may also be part of the causal pathway, the results suggest compassion was the stronger mediator. Moreover, the reversed mediation analysis of paranoia on positive affect was also quite large (24%) suggesting positive affect may act as a moderator rather than mediator.

It is interesting that effects were most evident at the middle and final time points. Particularly in study one there was a noticeable drop in compassion and increase in paranoia at the fourth time point. This is likely due to the fourth time point being the first experience of the VR lift scenario. The novelty of the scenario may have made it difficult for participants to employ their compassionate coach straight away. It is not clear why a similar drop was not seen in study two. In contrast, the middle and final time points were the second time participants experienced each VR scenario, with an additional avatar present in the scene. This perhaps increased the level of paranoia of the control groups, but not that of the compassionate groups, who could employ the compassionate imagery, which would have been established to a greater degree after the previous practicing.

There are a number of limitations to the studies. First, non-clinical samples were used meaning the results may not be generalisable to those experiencing more severe paranoia. Potential fears of compassion may first need to be investigated within clinical samples[40]. Moreover, each stage of imagery training would likely need to be extended to become its own session, with a gap of perhaps a week in between stages in order to allow consolidation of each training stage and further practise in daily life. Second, neither the researcher nor participants were blind to the intervention that participants were receiving, although participants were blind to the study hypotheses and the outcomes were self-report. Third, CC imagery and LKM are two of many compassion techniques. There may be other techniques, not tested here, that are better. Fourth, in study one the outcome measures used words that were included in the manipulation itself, i.e. self-compassion and kindness, which might mean increased identification with those words in the manipulation check was unsurprising. On the other hand, we tested a technique in the way that it would be administered in clinical practise: teaching patients about a concept, practising a technique to modify it, then asking if they feel improvement in it. Moreover, this issue was not present in study two, which used novel wording of outcome measures, yet similar effects were found. Fifth, there was no long term follow up. A follow up time point would have allowed us to assess mediation across time using the endpoint of the intervention as the mediator and follow up time point of paranoia as the outcome. The lack of follow up also means only the short-term effects of the manipulation were examined; it is unknown whether there were any lasting benefits. Given the briefness of the interventions we would not necessarily expect to see long-term effects. However, the results do show support for testing the interventions in patients with severe paranoia with investigation into longer-lasting effects (with consideration on how to embed the techniques into day-to-day life).

Finally, we explored only one level of causal explanation: that the techniques increased compassion and this impacted levels of paranoia. We did not set out to test the potential cascade of effects within this causal chain (e.g. by assessing other mechanisms or altering the control condition). Although study two assessed the impact of positive affect and found it to be a smaller mediator of change than compassion, it is always possible to further disentangle causal pathways, e.g. we could have also measured variables such as anxiety or attention. Similarly, compassionate coach imagery could be seen primarily as an exercise in receiving compassion rather than in self-compassion, but we did not measure this. We also cannot ascertain from these studies whether compassionate interventions work primarily at an affective level of whether they, for example, allow switching from social threat to affiliation processing systems. The findings from this study therefore open up a number of avenues for future research to discover greater knowledge about the causal chain.

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Author contributions

The study was conceived by P.B., F.W. and D.F. A.R. created the V.R. environments, P.B. completed recruitment and testing, and P.B. and A.N. conducted the analysis. P.B. wrote the first draft of the manuscript. D.F. and F.W. supervised the research project and contributed to the manuscript. All authors approved the final version of the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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Power posing for paranoia: A double-blind randomised controlled experimental test using virtual reality

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ABSTRACT

Paranoia is theorised to build upon feelings of inferior social rank. Power posing has been shown to increase feelings of power, and hence could reduce paranoia. One hundred participants with current paranoia and 50 individuals without paranoia were recruited. Using a double-blind randomised controlled experimental design, participants twice held powerful or neutral postures before entering neutral virtual reality social environments. In the paranoid sample, those who held a powerful pose did not significantly increase in feelings of power by the end of testing in comparison to controls (group difference = 0.67, C.I. = −1.12; 1.46; p = 0.098), or decrease in paranoia (group difference = −0.23, C.I. = −1.17; 0.72; p = 0.634). In the non-paranoid sample, there was a small significant increase in powerful feelings by the end of testing in the powerful group (group difference = 1.13, C.I. = 0.23; 2.02; p = 0.013), but no significant decrease in paranoia (group difference = −0.71, C.I. = −2.16; 0.74; p = 0.338). Paranoia status was not a modifier on the relationship between condition and feelings of power. We conclude that power posing results in only very small changes in self-reported feelings of power and has no subsequent effect on paranoia.

1. Introduction

Low levels of beliefs about control, power, and social rank may be important in the occurrence of many mental health conditions (e.g. Allan & Gilbert, 1997; Benassi, Dufour & Sweeney, 1988; Radloff & Monroe, 1978; Watson, 1967). For example, there is evidence that paranoia builds upon the feelings of vulnerability associated with ideas about inferior social rank (e.g. Freeman et al., 2005; Freeman, Evans et al, 2014). Identifying techniques to increase a person's feelings of power and social rank may be important in treatment development. Power posing may be one such technique. This study looks for the first time whether power posing may be a beneficial technique for reducing paranoia.

1.1. Power posing

Power posing is the taking of an expansive and open posture. In both humans and non-human primates, such a posture is reflective of high power and status, whereas contractive and closed postures reflect low power and status (De Waal, 1998; Carney et al., 2005; Hall, Coats & LeNeau, 2005). Behavioural and physiological effects of power posing such as increased risk taking, increased testosterone, and decreased cortisol have been contested due to a lack of replication (e.g. Ranehill et al., 2015) and selective reporting (Simmons & Simonsohn, 2017). On the other hand, there have been replicated findings that power posing can increase self-reported feelings of power (Cuddy, Schulz & Fosse, 2018; Gronau et al., 2017), though methodological quality of studies vary (Carney et al., 2015). For example, while most of the 33 studies included in Carney et al.'s (2015) review used randomised and controlled designs, it was rare that studies were well powered. Few reported power calculations, but given sample sizes rarely reached 100 studies typically only had power to detect large effect sizes. Moreover the strength of participants' poses were rarely rated, and few studies were preregistered. Given the evidence of selective reporting in power posing research (Simmons & Simonsohn, 2017) pre-registration is considered important.

1.2. Paranoia

First generation cognitive-behavioural therapies for paranoia (unfounded ideas that others intend you harm) require considerable improvement. Our approach to treating paranoia is translational. We manipulate key mechanisms from our theoretical model and measure the subsequent effect on paranoia. If the manipulation reduces paranoia

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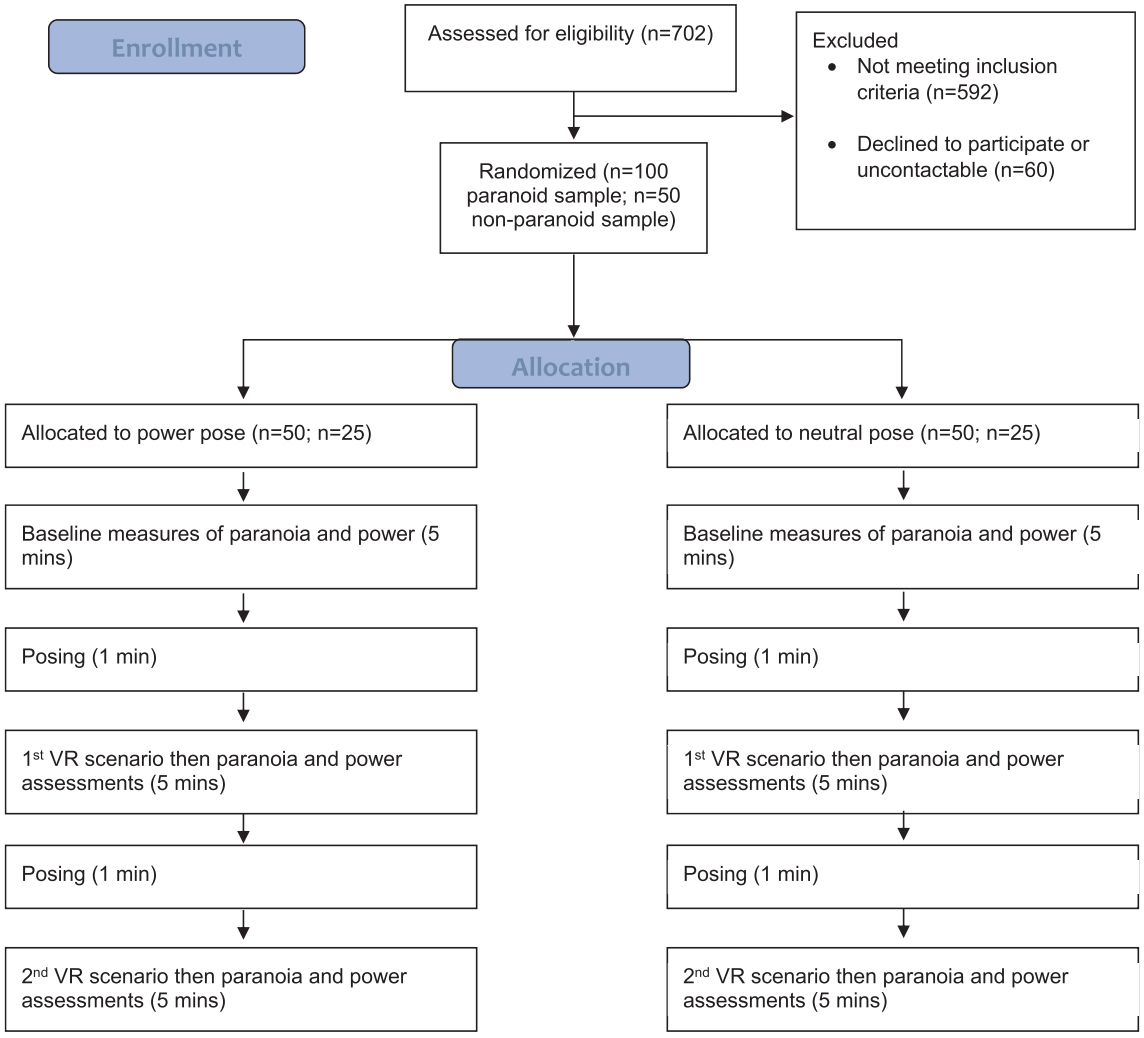

Fig. 1. Experimental procedure.

this informs treatment development. This is an interventionist-causal model approach (Kendler & Campbell, 2009), and we substantiate the effects of the manipulations with mediation analyses (Dunn et al., 2015). The approach is highly informative yet infrequently used (Brown et al., 2018). Paranoia is associated with feelings of inferior social rank (Freeman et al., 2005; Freeman, Evans et al, 2014) as well as other negative self-beliefs such as low self-esteem (Tiernan et al., 2014). A theoretical model includes the hypothesis that such negative beliefs about the self are a causal and maintenance factor in paranoia (Freeman, 2016). Decreases in self-esteem have been shown to predict increases in paranoid thoughts (Kesting et al., 2013), and several studies have used interventions to improve self-esteem, and thus reduce paranoia (e.g. Atherton et al., 2016; Freeman, Pugh et al., 2014; Lincoln, Hoenhaus & Hartmann, 2013).

1.3. The current study

We conducted a double-blind, randomised controlled intervention study to test the effects of power posing on self-reported feelings of power and paranoia in individuals from the general population with current paranoia. Paranoid thoughts exist on a spectrum of severity in the population. Many people have a few paranoid thoughts and a few people have many (Bebbington et al., 2013; Bird et al., 2018; Freeman et al., 2005; Wong et al., 2014). We can therefore learn about clinical extremes by studying individuals with less severe, but significant, levels of paranoia.

We firstly set out to test whether the psychological effect of power posing could be replicated. Therefore, our first hypothesis was that those who were randomised to assume a powerful pose would report feeling more powerful than those who assumed a neutral pose. Secondly, we hypothesised that those who assumed a powerful pose would also experience decreased paranoid ideation in virtual reality (VR) social situations as compared to those who assumed the neutral pose. We used VR in order to present participants with neutral social situations, and thus the opportunity to potentially form in-the-moment paranoid ideation. The presentation of neutral social situations guarantees an accurate measure of paranoia, as unfounded rather than genuine hostility is detected (Freeman et al., 2003). Previous studies have shown that objectively neutral VR social scenarios provoke feelings of paranoia in individuals reporting both mild and severe paranoia (e.g. Atherton et al., 2016; Freeman, Evans et al., 2014; Pot-Kolder et al., 2018). Finally, we hypothesised that any decrease in paranoia experienced by the power posing group would be partially mediated by increased feelings of power.

Two recent studies have used a very similar methodology to the current study (Brown, Waite, Rovira, Nickless, & Freeman, 2020). Two putative causal mechanisms in paranoia (compassion for the self and compassion for others) were successfully manipulated, which led to significant changes in paranoia with large effect sizes. The current study used the same causal-interventionist approach, as well as the same sample size, VR social scenarios and measures of paranoia. Thus the methodology employed in this study has previously been shown to

successfully test the use of cognitive techniques to reduce paranoia.

2. Method

2.1. Participants

One-hundred individuals who reported six or more paranoid thoughts in the last month (a score of 22 or above on the Green et al. (2008) Paranoid Thoughts Scale Part B (GPTS-B)) took part. This cut-off score captures the upper quartile of paranoia scores in the general population (Freeman, Evans, & Lister, 2012; Freeman, Lister, & Evans, 2014). Recruitment was via social media and radio advertisements in Oxfordshire, UK. 702 participants were screened using online questionnaires administered through Qualtrics. Exclusion criteria were: aged under 18 years old; a history of severe mental illness; photo-sensitive epilepsy; or any significant visual, auditory, or mobility impairment.

2.2. Design

The study had a between-groups design. Each participant took part in a single 30-minute session. After completing baseline measures, participants were randomised to the power or neutral condition. An independent researcher used an online generator to create the randomization sequence. Separate randomization sequences were created for paranoid and non-paranoid samples. The study was double-blind. Participants were unaware of study hypotheses or that they were being randomised to hold a powerful or neutral pose (they were provided with a cover story as to the reason for standing in a certain way), and the researcher was blind to which pose participants were randomised to hold. Participants held the powerful or neutral pose twice, once before each of two entries to VR social environments. Two different VR environments were used: an underground train and a lift. Fig. 1 summarises the experimental procedure. The study was pre-registered with Open Science Framework and received ethical approval from an Oxford ethics committee.

2.3. Amendment to protocol

After pre-registering the study, we decided to collect data from an additional 50 participants who reported no paranoia at screening (the minimum score of 16 on the GPTS-B). Given power posing has never previously been tested in individuals with paranoia, we wanted to test the possibility that any difference in effect of the power manipulation between this study and previous studies could be due to the population selected i.e. the participants' paranoia, rather than the manipulation itself.

2.4. Procedure

The study replicated procedure from previous studies on power posing. The power pose employed was that used in study one of Yap et al. (2013) and Cuddy et al. (2015). The neutral control pose was adapted from Cuddy et al. (2015) to be neutral rather than low power by uncrossing feet and arms. Fig. 2 shows both the powerful and neutral poses. Participants assumed poses for one minute, given this has previously been shown to be sufficient to elicit an effect (Carney, Cuddy & Yap, 2010). Moreover, each participant in the present study would be posing twice, five minutes apart, leading to a total of two minutes of posing.

There were just two key differences between the current study and previous ones. Firstly, the control condition was designed to be a neutral pose, rather than a low power pose. This was to enable the detection of positive effects of power posing rather than potentially a negative effect of a contractive pose. Secondly, participants did not complete a filler task while posing. Previous studies have used tasks

Fig. 2. Power (left) and neutral (right) poses.

such as forming impressions of faces (Carney et al., 2010) or verbal tasks (Ranehill et al., 2015). We chose not to employ a filler task during poses because the rationale given for using a social filler task is that power posing is most effective in a social context. However, many studies have found power-posing effects using filler tasks without social components (Ranehill et al., 2015, Fischer et al., 2011, studies 2 and 3; Yap et al., 2013, studies 2 and 3), suggesting the filler task does not serve any particular known purpose. Moreover, if power posing were to be used by individuals in their daily lives, for example before doing something challenging, this would presumably be done without a filler task.

To ensure the researcher was blind to randomization group, participants received instructions on how to pose via a video displayed on a computer screen while the researcher was out of the room. Participants were informed that they were following instructions which would allow the VR tracking system to calibrate to their body. To increase the credibility of this, participants were asked to wear VR trackers on their arms and ankles for the duration of the study. Participants were video recorded while posing so that afterwards each participant could be rated on the strength of their power pose, or whether they correctly assumed the neutral pose. Two independent raters watched the videos, rating the power poses as strong, moderate or weak, and the neutral poses as correct or incorrect.

2.5. Assessments

2.5.1. Paranoia

At baseline participants completed the Green et al. Paranoid Thoughts Scale - Part B (GPTS-B; Green et al., 2008). This is a 16-item scale assessing ideas of persecution such as 'I was convinced there was a conspiracy against me' and 'I was sure someone wanted to hurt me' on a 1–5 scale (1 = not at all, 5 = totally). Scores range from 16 to 80, with higher scores reflecting greater paranoia. The scale has been well validated for use in both clinical and non-clinical samples (Statham et al., 2019) and has strong concurrent validity with paranoia severity as

assessed by clinical interviews and by controlled virtual reality tests (Freeman, Antley, et al., 2014; Freeman et al., 2010). The GPTS-B also demonstrates high reliability (a > 0.95) across both the mild and severe ends of the paranoia spectrum (Freeman et al., 2019).

Two visual analogue scales were averaged to form a state measure of paranoia. The scales were: 'Please mark on the line below how vulnerable you felt during the virtual reality scenario' and 'Please mark on the line below how much you felt under threat during the virtual reality scenario'. The scale ranged from 'Not at all' to 'Extremely'. These were completed after being in each VR environment. Cronbach's alpha measure of internal consistency for the scale was 0.82. Visual analogue scales were chosen due to their sensitivity to change. Paranoia measured in VR has been correlated with both GPTS scores (r = 0.34) and interviewer assessment of paranoia (r = 0.54) (Freeman, Antley, et al., 2014).

2.5.2. Power

A visual analogue scale was also used to measure self-reported feelings of power. At baseline and immediately after posing participants were asked 'Please mark on the line below how powerful you feel right now'. After each entry to VR participants were similarly asked 'Please mark on the line below how powerful you felt during the virtual reality scenario'.

2.6. Virtual reality

Participants wore a VR head-mounted display (HMD), an HTC Vive Pro. Two scenarios of approximately three minutes were used: an underground tube train ride and a lift (see Fig. 3). These scenarios were based on those used in Freeman et al. (2016). For the tube train ride, participants began on the platform before entering the carriage when the train arrived and the doors opened. A journey commenced that took them to the next station where they could get off the train. The carriage had a total of either 12–13 people with three people in the central area near the participant in the first exposure and four in the second. For the lift scene, participants entered the lift, the doors closed, and they stayed in the lift as they ascended 27 floors before descending again to the ground floor where they could get off. The lift had either three or four avatars in it, for the first and second exposures respectively. The presence of an additional avatar in each second exposure aimed to increase the intensity of the social situation and prevent participants re-entering an identical scenario. No specific instructions were given to participants about what to do in either scenario, nor were avatars programmed to initiate interaction with participants. The aim was just to provide objectively neutral social environments, given these have previously been shown to induce paranoia in this population (e.g. Atherton et al., 2016; Freeman, Evans et al., 2014).

Fig. 3. Virtual reality scenarios.

2.7. Analysis

The target sample size was 100 individuals reporting paranoia, randomised equally between the experimental (power pose) and control (neutral pose) groups. We wanted to be able to detect moderate to large effect sizes. To detect an effect size of 0.6 using two-tailed t-tests and 80% power a sample size of 45 per group would be required. The use of mixed effects models would also allow greater statistical power and therefore detection of somewhat smaller effect sizes. Data were entered by an independent researcher and primary outcomes were double rated by a second independent researcher blind to both participant condition and study hypotheses. All analysis was repeated separately for the 50 individuals without paranoia.

Analysis was conducted as specified at pre-registration. We used a linear mixed effects regression model for each continuous outcome in order to account for the repeated measures of outcomes at the two time points (after each VR scenario). This addressed hypotheses one and two i.e. whether there was a relationship between condition (powerful vs neutral posture) and feelings of power, and between condition (powerful vs neutral posture) and paranoia. If there were significant effects on both power (the proposed mediator) and paranoia (the outcome) it was planned to conduct a mediation analysis by determining the extent of mediation of paranoia at the final time-point, by feelings of power at the final time point. The approach is similar to that of Baron and Kenny (1986) but uses a linear mixed effects model at each step. Two separate linear mixed effects models show that the intervention is correlated with the outcome, and then also with the mediator. A third model then uses the outcome as the response and both the intervention and mediator as covariates. We would also test for reverse mediation, putting paranoia at the final time point as the mediator and feelings of power at the final time point as the outcome as a check on the direction of the relationship. If no significant effect was seen on power (i.e. no significant total effect) mediation analysis would not be conducted. While it has been suggested that mediation can still be tested in the absence of a significant total effect (Hayes, 2009), there is some debate about the potential for introducing bias by doing so (Loeys, Mooerkereke & Vansteelandt (2015). R studio version 3.6.1 was used for the statistical analysis (R Core Team, 2013).

2.8. Post hoc analysis

After deciding to collect data from an additional 50 participants without paranoia, a moderation analysis was planned. This tested for an interaction of participant group (paranoid or non-paranoid), to see whether this moderated the effect of condition on feelings of power.

3. Results

There were no missing data. Table 1 shows the demographic and baseline characteristic of the participants. Participants were predominantly females and in their mid-thirties. Within the paranoid group, the mean GPTS-B scores of 35.8 and 32.1 in the power and control groups respectively indicated a much higher level of paranoia than in most analogue samples (e.g. 24.2 in Atherton et al., 2016; 25.6

Table 1
Baseline and demographic variables by randomization group.

	Paranoid Group		Non-Paranoid Group	
	Power (n = 50)	Control (n = 50)	Power (n = 25)	Control (n = 25)
Age (years), mean (SD)	31.3 (11.4)	35.1 (12.3)	37 (14.8)	38.4 (14.5)
Men/woman, *n/n*	21/29	22/28	13/12	9/16
Ethnicity, *n*				
White British/Irish	36	37	17	16
Non White British/Irish	14	13	8	9
Employment status, *n*				
Unemployed	3	7	1	2
Full/Part-time employed	32	36	18	19
Student	13	7	4	3
Retired	2	0	2	1
GPTS Part B score at baseline, mean (SD)	35.8 (15.4)	32.1 (16.1)	16.2 (0.6)	16.8 (3.2)
Powerful feelings at baseline, mean (SD)	4.9 (2.2)	5.6 (2.1)	6.6 (1.8)	6.6 (1.7)

Freeman, Evans et al, 2014) and are over the cut-off used for inclusion in a clinical trial for clinical paranoia (Garety et al., 2017). Scores of 35 and 32 fall at the upper end of 'elevated' paranoia and lower end of 'moderately severe' paranoia as categorized in a recent large-scale validation of the GPTS based on data from over 10,000 individuals (Freeman et al., 2019).

3.1. Inter-rater reliability

Out of the 100 power posing videos in the paranoid participant group (two per participant in the power pose condition) 89 were rated as strong, 11 as moderate, and zero as weak by the first independent researcher, and 92 were rated as strong, 8 as moderate, and zero as weak by the second independent researcher. There was disagreement on the category for only five videos (but no pose was rated as weak). For the control group all 50 individuals were rated by both independent researchers as correctly holding the neutral pose on both occasions.

Of the 50 power posing videos in the non-paranoid participant group 49 were rated as strong, zero as moderate, and one as weak by the first independent researcher, and 47 as strong, two as moderate and one as weak by the second rater. There was disagreement on two videos. All 25 individuals were rated by both independent researchers as correctly holding the neutral pose on both occasions.

3.2. Hypothesis 1: Effect of condition on feelings of power

Table 2 shows the mean scores and effect sizes for the two outcomes at each time point.

3.2.1. Paranoid group

There were no significant differences between the experimental and control groups in self-reported feelings of power in either the middle (group difference = 0.66, C.I. = −0.13; 1.45; $p = 0.102$) or final time point (group difference = 0.67, C.I. = −0.12; 1.46; $p = 0.098$).

3.2.2. Non paranoid group

Immediately after posing there were no significant differences between the power and control group in self-reported feelings of power. A significant difference was seen both at the middle time point (during the first VR scenario), group difference = 1.20, 95% C.I. = 0.30; 2.09, $p = 0.009$, and at the final time point (during the second VR scenario), group difference = 1.13, C.I. = 0.23; 2.02; $p = 0.013$.

3.3. Hypothesis 2: Effect of condition on paranoia

3.3.1. Paranoid group

There were no differences in paranoia between the power and control groups during either the first VR scenario or second VR scenario (group difference at final time point = −0.23, C.I. = −1.17; 0.72; $p = 0.634$).

Table 2
Scores for primary power and paranoia outcomes.

	Power group: mean (SD)	Control group: mean (SD)	Adjusted mean difference (95% CI)	*P*-value	Standardised effect size
Paranoid sample (n = 50): Powerful feelings					
Baseline	4.90 (2.18)	5.60 (2.07)			
Time 1	5.26 (2.34)	5.88 (2.12)	−0.21 (−1.0; 0.58)	0.609	0.1
Time 2	4.91 (2.37)	4.67 (2.50)	0.66 (−0.13; 1.45)	0.102	0.3
Time 3	4.87 (2.61)	4.62 (2.16)	0.67 (−0.12; 1.46)	0.098	0.3
Paranoid sample (n = 50): Paranoia					
Time 2	3.83 (2.31)	4.31 (2.41)	−0.62 (−1.56; 0.32)	0.201	−0.3
Time 3	3.68 (2.82)	3.77 (2.57)	−0.23 (−1.17; 0.72)	0.634	−0.1
Non-paranoid sample (n = 50): Powerful feelings					
Baseline	6.66 (1.78)	6.61 (1.72)			
Time 1	7.20 (1.83)	6.88 (1.63)	0.28 (−0.61; 1.17)	0.539	0.2
Time 2	7.25 (1.77)	6.02 (2.47)	1.20 (0.30; 2.09)	0.009	0.7
Time 3	6.85 (1.85)	5.68 (2.64)	1.13 (0.23; 2.02)	0.013	0.6
Non-paranoid sample (n = 50): Paranoia					
Time 2	2.77 (2.30)	3.52 (3.20)	−0.80 (−2.26; 0.64)	0.278	−0.3
Time 3	2.79 (2.62)	3.45 (2.12)	−0.71 (−2.16; 0.74)	0.338	−0.3

3.4. Non paranoid group

There were no differences in paranoia between the power and control groups during either the first VR scenario or second VR scenario (group difference at final time point = −0.71, C.I. = −2.16; 0.74; $p = 0.338$).

Due to the lack of change in paranoia mediation analysis was not performed.

3.5. Post-hoc analysis

Given a significant effect for power posing was seen in the non-paranoid group but not in the paranoid group we tested for a group interaction, in case paranoia status was a moderator on the results. This was not significant (group difference = −0.48, C.I. = −1.50; 0.55, $p = 0.36$).

A significant overall sample effect testing the effect of condition on feelings of power in all 150 participants in this model was seen (group difference = 0.87, C.I. = 0.04; 1.71, $p = 0.041$).

4. Discussion

This study tested for the first time whether power posing could increase feelings of power and hence reduce paranoia. The study benefited from being pre-registered, using a double-blind design, and measuring in-the-moment paranoia in neutral social situations via virtual reality simulations. Moreover, nearly all participants randomised to take a power pose were rated by independent researchers as doing so very strongly, and 100% of those in the control groups were rated as posing in the correct neutral position. Thus it can safely be concluded that participants in the power groups were indeed power posing, and those in the control group were not. Small increases in feelings of power were seen in those who power posed, though this did not reach significance in the paranoid group. No effect on paranoia was seen in either group, meaning that power posing as administered did not change levels of paranoid ideation. Thus, the hypotheses were not fully supported.

Nearly all aspects of the present study have been used in previous studies of power posing, all of which more conclusively report an effect of power posing on feelings of power. The measures, power stance, and use of deception were taken from Cuddy et al., 2015, the length of pose from Carney, Cuddy and Yap (2010), and the use of a video camera from Ranehill et al., 2015 to allow the study to be double-blind. Perhaps the only difference of note is that we compared power posing to neutral posing, rather than contractive posing. In a recent commentary, Crede (2019) argues that previous reviews and meta-analyses of power posing (e.g. Cuddy, Schulz & Fosse, 2018; Gronau et al., 2017) fail to distinguish between negative effects of contractive posing and positive effects of power posing. The results of the present study, could therefore be taken to support that previous findings of a power pose effect may partly be seeing a negative effect of contractive posing, rather than just a positive effect of power posing.

That no significant effect of power posing was seen before entry to VR in the non-paranoid group could suggest that the effects of power posing are only displayed within a social context, i.e. within the VR social environments in this study. However, Ranehill et al.'s (2015) study had no social element to it, yet they still found an effect on feelings of power. It is therefore not clear why no effect of power posing on feelings of power was seen immediately after posing. It may be that it takes time for the feelings of power to evoke, or perhaps that prior to entering VR participants were preoccupied with thoughts about what the VR scenarios would be like.

That power posing did not significantly increase feelings of power in the paranoid sample suggested that power poses are perhaps less successful in this population, potentially because individuals with paranoia feel more exposed rather than powerful during posing, or that the presence of a video camera was particularly unsettling to these individuals. However, the post-hoc analysis did not support this hypothesis. Paranoia status was not a moderator of the results, meaning the lack of effect in the paranoia group was not due to the nature of the sample. This combined analysis also revealed a significant total sample effect of condition on feelings of power, suggesting that in the total group there was a significant increase in feelings of power in those who power posed. The lack of significant effects in the paranoia group alone could therefore be due to higher variability in this group. The large standard deviations seen in the paranoid group could support this interpretation.

Indeed the sample size of the study can be considered a limitation. The study was powered to detect only moderate to large effect sizes given that this size of effect is desirable for clinical interventions, but it is possible that a larger sample size would have resulted in a statistically significant effect of power posing. A further limitation of the study is that there will be bias present in the recruitment process. Recruitment was primarily achieved through social media advertisements in Oxfordshire, and participants had to be able and willing to travel to the in-person testing session. Additionally, although a cover story was used in order to create a double blind design, we did not assess the extent to which participants believed the cover story. Given participants may have been familiar with the concept of power posing, it is possible that some participants – particularly those in the experimental condition – may have guessed the true aims of the study thus compromising the double blind design. Finally, we only tested one kind of manipulation. Future research could look at adaptations of power posing that may elicit greater change, for example continuing to stand powerfully while in the challenging situation, or making participants aware of the hypothesis in case a cognitive element helps to elicit change in feelings of power. Nonetheless, this study aimed to test the effects of power posing and it seems clear from the results that power posing likely elicits only very small changes in feelings of power. Given paranoia has multiple causes (Freeman, 2016), manipulating just one mechanism to such a small extent would likely only result in very small changes in paranoia, which this study was not able to detect.

CRediT authorship contribution statement

Poppy Brown: Conceptualization, Data curation, Formal analysis, Writing - original draft. **Felicity Waite:** Supervision, Writing - review & editing. **Aitor Rovira:** Software. **Daniel Freeman:** Supervision, Writing - review & editing.

Declaration of competing interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://

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ORIGINAL PAPER

Parenting behaviour and paranoia: a network analysis and results from the National Comorbidity Survey-Adolescents (NCS-A)

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Abstract

Purpose Parenting behaviours—including the extent to which parents are protective, hostile, or caring—likely impacts whether a child develops a sense of vulnerability that carries forward into adulthood. Ideas of vulnerability are a contributory factor to the occurrence of paranoia. Our aim was to assess whether there is an association between specific parenting behaviours and paranoia.

Method We examined cross-sectional associations of parenting and paranoia in an epidemiologically representative cohort of 10,148 adolescents (National Comorbidity Survey-Adolescents; NCS-A) and a second dataset of 1286 adults in Oxfordshire. Further, a network analysis was conducted with paranoia, parenting behaviours, and cognitive-affective variables (compassion, self-esteem, anxiety, and depression). Overprotectiveness, verbal abuse, physical abuse, and amount of care were assessed in mothers and fathers separately.

Results Nearly all parenting variables were significantly associated with paranoia, with parental verbal and physical abuse showing the largest associations. For example, the odds of reporting paranoia was over four times higher for those in the adult sample reporting a lot of paternal verbal abuse, compared to those reporting none (OR = 4.12, $p < 0.001$, CI 2.47–6.85). Network analyses revealed high interconnectivity between paranoia, parenting behaviours, and cognitive-affective variables. Of the parenting variables, paranoia most strongly interacted with paternal abuse and maternal lack of care.

Conclusion There are associations between participants' self-reported experiences of parental behaviours and paranoia. Despite being associated with paranoia, cognitive-affective variables did not appear to mediate the relationship between parenting and paranoia, which is surprising. What might explain the link therefore remains to be determined.

Keywords Paranoia · Delusions · Parental abuse · Parental over-protectiveness · Parental care

Introduction

Paranoia exists on a spectrum of severity in the general population: many people have a few paranoid thoughts and a few people have many [1–3]. It is therefore possible to learn about the clinical disorder by studying milder variants in the general population. A contributory causal factor in the occurrence of paranoia is negative beliefs about the self [4]. Negative views of the self-engender a sense of vulnerability that paranoia builds upon. How do these negative views of the self-develop? The influence of the environment on the occurrence of paranoia has been found to be substantial; with non-shared environmental influences on paranoia estimated to be 0.49 [5]. An obvious potential contributory factor that could affect views of the self is parenting behaviour. This paper investigates for the first time the association between specific aspects of parenting, cognitive-affective processes, and paranoia.

In a theoretical model, it is hypothesised that negative self-beliefs lead to feeling inferior, apart, and vulnerable, and that paranoia builds upon these concerns [4]. Negative beliefs about the self (e.g., that the self is vulnerable) are correlated with both clinical and non-clinical levels of paranoia [6–9]. Experimental studies in non-clinical samples have shown that increasing or decreasing negative self-beliefs affects the occurrence of paranoia [10, 11]. Furthermore, it has been shown that treating negative self-beliefs in

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patients with persecutory delusions can lead to a reduction in paranoia [12]. Negative self-beliefs are also strongly associated with a lack of self-compassion [13]. Experimental manipulations have found that self-compassion interventions can reduce both negative beliefs [14, 15], and paranoia in non-clinical [16, 17] and clinical samples [18]. Compassionate interventions focused on beliefs about others also show promise. Negative beliefs about others (e.g., that others are devious) have been correlated with clinical and non-clinical levels of paranoia [6]. Brown et al. showed that an intervention that trained compassion for others resulted in a reduction in paranoia. The empirical literature shows a tight connection between beliefs about the self and others and the occurrence of paranoia.

How might the beliefs about the self and others form in the first place? Childhood physical abuse, sexual abuse, and other victimisation experiences have been associated with paranoia and may plausibly partly exert influence via beliefs about the self and others [19, 20]. Parenting behaviour is also a plausible contributory factor to the development of negative beliefs. Parental behaviours have been investigated in relation to a number of mental health conditions. For example, over-protectiveness and low parental care have been associated with anxiety [21, 22] and depression [23]. Such parental behaviours have also been associated with schizophrenia. Read et al. review a number of studies investigating 'affectionless control', that is, high perceived over-protectiveness but low care by parents of individuals with schizophrenia [24]. They found evidence for an association between affectionless control and schizophrenia, particularly among fathers. Parker et al. suggest that levels of parental protectiveness can range from excessive contact, intrusion, control, infantilisation, and the prevention of independent behaviour, to allowing of complete autonomy and independence [25]. Similarly, levels of care can range from emotional warmth, affection, closeness, and empathy, to emotional coldness, neglect, and indifference. While it might be argued that the link between this kind of parental behaviour and schizophrenia is predominately genetic, Onstad et al. showed that for both monozygotic (MZ) and dizygotic (DZ) twins, the twin later diagnosed with schizophrenia reported more overprotection than the other twin [26]. Given MZ twins are genetically identical, this suggests the association between parental over-protection and schizophrenia symptoms is not purely a genetic one.

How might parenting behaviours link to paranoia? Perhaps the experience of overprotection could lead a child to develop schemas about the world as dangerous and themselves as vulnerable, to explain the protection. Similarly, experiencing low care from parents could lead a child to develop the kinds of negative self-beliefs that paranoia builds upon, e.g., that they are unworthy of care and therefore inferior to others. Finally, negative beliefs about the self and others are often developed in the context of adverse interpersonal experiences [4]. Experiencing abuse, particularly from a trusted figure such as a parent during childhood, could therefore also result in the development of negative schemeas about the self and others. Indeed Read and Gumley argue that maltreatment by attachment figures can lead to a disorganised attachment style, which reflects a combination of negative beliefs about the self and others [24]. They suggest these beliefs are then carried forward into adulthood and can contribute to the onset of psychosis. While paranoia has been shown to be associated with having an insecure attachment style [27], particularly a disorganised insecure attachment [28], and with experiencing abuse or being taken into institutional care [29], its association with these more specific parental behaviours has not been determined.

In this paper, we examine associations in two samples (a national epidemiological group and a newly recruited sample of adults) between parenting, cognitive affective processes, and paranoia. The aim was to use the first sample as an initial test of the model, with the second sample used to explore the relationships in greater detail with more robust measures included. We also make use of a network analysis to conceptualise the interplay between these variables [30, 31]. Network analysis statistically estimates complex interactions thereby allowing visualisation of the strength of associations between groups of variables, while also giving insight into potential causal processes [32]. The visualisation of such complex interplay enables greater learning from cross-sectional data, and the drawing of potential causal pathways helps to generate hypotheses for future research [33]. More generally, the network approach is increasingly seen as an important method for allowing psychological processes to be analysed as products of complex and dynamic systems [34].

Our hypotheses were as follows. First, that regression analysis would show positive associations between maternal and paternal overprotectiveness and paranoia and between maternal and paternal abuse and paranoia, and negative associations between amount of maternal and paternal care and paranoia in both participant groups. Second, these associations would be apparent when analysing variables as part of a network. Third, within the network, cognitive-affective variables such as levels of anxiety and self-esteem would provide a mediating pathway between paranoia and parenting behaviours.

Method

Associations between parenting behaviour and paranoia were first tested in the National Comorbidity Survey Replication Adolescent Supplement (NCS-A) [35] and then in a new survey conducted to assess the key variables in greater depth. The NCS-A survey was administered using computer

assisted, face-to-face, individual interview by professional interviewers employed by the Survey Research Centre. The interview schedule was based on the World Health Organisation Composite International Diagnostic Interview (WMH-CIDI). Merikangas et al. report further details of the adaptions to measures in the NCS-A [36]. A hard copy of the instrument is posted at www.hcp.med.harvard.edu.ncs. The new survey was administered via Qualtrics, an online questionnaire platform.

Participants

NCS-A

The NCS-A sample included 10,148 adolescents aged 13–17 years old. 9244 adolescent students were selected from a representative sample of 320 schools in the same nationally representative sample as the National Comorbidity Survey-Replication (NCS-R) (response rate 74.7%). The remaining 904 participants were from the same households of those that took part in the National Comorbidity Survey-Replication (response rate 85.9%). The mean age was 15.18 years (SD = 1.51) and 48.9% ($n = 4962$) of the sample were male, 51.1% ($n = 5186$) female.

Oxfordshire participant group

The second participant group consisted of 1231 adults (aged 18 or over). Participants took part in the survey as part of the screening process for an experimental study that was advertised via social media adverts in the region of Oxfordshire, UK**.** The mean age of this survey group was 41.54 years (SD = 15.95). Data on participant gender were not collected for the first 207 participants. Of the remaining 1024 participants, 23.7% ($n = 243$) were male and 76.3% ($n = 781$) female. It is typical for online surveys to receive a considerably higher response rate from women [37, 38]

Measures

NCS-A

Paranoia Participants were asked to respond to the following statement with 'true', 'false', or 'do not know': 'People often make fun of me behind my back'. This item has previously been used as a brief measure of paranoia [39]. A correlation difference test supported the internal validity of the measure by showing that this single-item measure of paranoia ($n = 857$) had a significantly higher correlation with a 16-item measure of paranoia (the Green et al. Paranoid Thoughts Scale-Part B, Green et al., 2008) [40] ($r = 0.56$), than with a measure anxiety ($r = 0.38$), $z = 15.00$, $p < 0.0001$.

Parental behaviour Participants were asked to respond to the following statements with 'a lot', 'some', 'a little', or 'not at all' for both mother and father figures separately: 'How much did he/she really care about you?'; 'How overprotective was he/she?'. Participants were asked to respond to the following lists and statements with 'often', 'sometimes', 'not very often', or 'never' for both mother and father figures separately: 'When you were growing up, how often did he/she do any of these things to you?': 'insulted or swore, shouted, yelled or screamed, threatened to hit' [verbal abuse (List A)]; 'pushed, grabbed or shoved, threw something, slapped or hit' [physical abuse (List B)]; 'kicked, bit or hit with a fist, beat up, choked, burned or scalded, threatened with a knife or gun' [severe physical abuse (List C)].

Oxfordshire participant group

The Oxfordshire participant group completed the same measures of paranoia and parental behaviour described for the NSC-A dataset, as well as the following measures:

Paranoia Participants completed the Green et al. Paranoid Thoughts Scale—Part B (GPTS-B) [40]. This is a 16-item scale assessing ideas of persecution over the past month such as 'I was convinced there was a conspiracy against me' and 'I was sure someone wanted to hurt me' on a 1–5 scale (1 = not at all, 5 = totally). Scores can range from 16 to 80; higher scores reflect greater paranoia. The scale is well validated for use in both clinical and non-clinical samples [41] and has strong concurrent validity with paranoia severity as assessed by clinical interviews and by controlled virtual reality tests [42, 43]. Using item response theory analysis with over 10,000 individuals, the GPTS-B has been shown to demonstrate high reliability ($a > 0.95$) across both mild and severe ends of the paranoia spectrum [44]. Test–retest reliability has also been shown to be good, with an intraclass correlation coefficient of 0.81 [40].

Parenting The Measure of Parenting Style (MOPS) [45] was used. This contains 15 items measuring specific maternal parenting behaviours and the same 15 items measuring paternal parenting behaviours. It was developed to overcome shortcomings of the Parental Bond Instrument [25] and assesses reported parental indifference, abuse, and overcontrol separately for mothers and fathers. Higher scores reflect higher reported levels of each behavior. Alpha coefficients of internal consistency for each of the six subscales range from 0.76 to 0.93 [45].

Although two of the subscales were named differently from the parenting questions included in the NCS-A dataset (indifference vs. amount of care, and over-control vs. overprotection), they were taken in our study to be measuring the same constructs. This was justified upon Parker et al.'s

descriptions of both over-protection and care described above [45]. The abuse items in the MOPS were similar to those in the NCS-A dataset in separately measuring both physical and verbal abuse.

Self-compassion The self-compassion scale-short form (SCS-SF) was used [46]. The scale consists of 12 items asking about how respondents typically act towards themselves in difficult times, rated on a Likert scale of one (almost never) to five (almost always), meaning higher scores reflect higher levels of self-compassion. There are six subscales, but use of a total score is recommended when using the short form. The SCS-SF demonstrates good internal consistency (Cronbach's $\alpha > 0.85$ and a near-perfect correlation with the long form of the scale when using total scores ($r > 0.96$) [46].

Compassion for others Participants were given the Compassion Scale [47], a 24-item scale measuring how respondents typically act towards others. As with the SCS-SF, items are rated on a Likert scale of one (almost never) to five (almost always) and there are six subscales, but a total score can also be used. Higher scores reflect higher levels of compassion for others. The scale demonstrates good internal consistency (Cronbach's $\alpha = 0.9$) [47].

Anxiety and depression The Patient Health Questionnaire-4 (PHQ-4) [48] is a brief four-item scale for anxiety and depression that has been well validated for detection of anxiety and depression in clinical samples [49]. Two items measure anxiety over the past two weeks and two measure depression over the past two weeks. Higher scores reflect greater anxiety and depression. Internal consistency for the scale is good (Cronbach's $\alpha = 0.85$) [48]. The two item measure of anxiety used has shown high sensitivity for identifying generalised anxiety (88%), panic (76%), and social anxiety (70%), as well as moderate sensitivity for PTSD (59%) [50].

Self-esteem The Rosenberg Self-Esteem Scale [51] is a highly used ten-item measure of global self-worth that measures positive and negative feelings about the self. Items are answered using a four-point Likert scale ranging from strongly agree to strongly disagree. Scores range from 10 to 30. Five items are reversed scored so that higher total scores indicate higher self-esteem.

Analysis

NCS-A data

The NCS-A data were analysed using the Statistical Package for the Social Sciences [52]. The data were weighted to adjust for within-household differential probabilities of respondent selection. Details of the rationale and process of weighting have previously been reported [35, 53]. Logistic regressions were used to test the associations between the assessments of parental behaviour and paranoia. Standard mediation analyses were not conducted due to the cross-sectional nature of the data [54]. Gender was included as a co-variate in all analyses. All tests were two-tailed. The primary analysis was conducted separately for mother and father figures, given that interactions between them would be based on small amounts of data for key categories.

Oxfordshire data

First, identical logistic regressions as above were conducted using the same measures of parenting and paranoia as were included in the NSC-A dataset. Second, simple regressions were conducted for the more in-depth measures of parenting and paranoia completed by the Oxfordshire participant group.

Network analysis with the measures from the Oxfordshire survey was conducted in R, version 3.6.1 [55]. A network modelling approach was used to estimate the partial correlations between paranoia and the other measures. In network analysis, variables are represented by nodes. Two nodes may be connected by an edge. Edges represent an association between two variables after controlling for all other variables included in the network, i.e., a partial correlation. The absence of an edge between two variables indicates that the partial correlation is zero after controlling for all other variables, known as conditional independence. Associations are visualised in a network where the thickness and saturation of the edge colour corresponds to the strength of the relationship [56].

Using the package qgraph, a Gaussian graphical model was fitted [56]. A regularisation technique with the Least Absolute Shrinkage and Selection Operator (LASSO) was used to overcome any potential sampling variation and limit the estimation of false positives [57]. The LASSO regularisation shrinks estimates by employing a penalty that limits the sum of the partial correlation coefficients [58]. The degree of regularisation is controlled by a tuning parameter, which is selected to optimise the model fit by minimising the Extended Bayesian Information Criterion (EBIC) [59]. The EBIC hyperparameter is set between 0 and 0.5, with a lower parameter resulting in more potential false edges being retained, and a higher parameter potentially omitting true edges from the network [58]. A hyperparameter of 0.3 was therefore chosen. Using the package bootnet, a non-parametric bootstrap with 5000 interactions was conducted, to construct 95% confidence intervals for each edge [30]. Due to the method of regularisation edge weights are biased towards zero. Consequently, reported confidence intervals cannot be interpreted as a significance test against zero [30].

Two separate network models were constructed to show the shortest path between paranoia and every other variable, and between the parenting variable found to have the strongest edge with paranoia and every other variable using Dijkstra's algorithm [60]. The shortest path represents the quickest route for an interaction to occur between two variables, calculated using the strength of edge weights along each potential route. In this way, even though two nodes may share a direct path, an indirect route via an intermediary node may consist of stronger associations and therefore be a quicker route. Redundant edges are then supressed. Such a network is helpful for highlighting likely mediation pathways.

Results

Twenty-three per cent ($n = 2302$) of participants in the NCS-A participant group endorsed the paranoia item "People often make fun of me behind my back". In the Oxfordshire group, 18% (n = 226) endorsed the paranoia item. Table 1 summarises the results of the logistic regressions for both participant groups. Odds ratios of above 1.0 indicate a positive association, whereas odds ratios of below 1.0 indicate a negative association.

In the NCS-A participant group, reporting 'a lot' of maternal or paternal overprotectiveness was significantly associated with having a higher likelihood of reporting paranoia. For example, the odds of reporting paranoia was 1.62 times higher for those who reported 'a lot' of overprotectiveness from their mother figure, compared with those who reported 'none'. Conversely, in the Oxfordshire participant group, the odds ratios were in the opposite direction suggesting a negative association between reporting overprotectiveness and reporting paranoia. However, in only one instance did this reach statistical significance, and the confidence intervals for these results were also wide and mostly crossing 1.0. Patterns for all other variables across the two samples were consistent. Reporting verbal abuse and physical abuse were associated with a higher likelihood of reporting paranoia, and reporting a lot of care was conversely associated with a low likelihood of reporting paranoia.

Oxfordshire sample regressions

Table 2 displays the results of the regressions. The GPTS-B was significantly positively correlated with all subscales of the MOPS indicating that higher levels of parental indifference, control and abuse were associated with greater endorsement of paranoid thoughts. Anxiety and depression were also significantly positively correlated with paranoia, whereas higher levels of self-compassion, compassion for others, and self-esteem were significantly negatively correlated with paranoia.

Network analysis

Figure 1 shows the fully estimated network. Table 3 displays edge weights from paranoia to all other variables and their 95% confidence intervals. The network is highly interconnected within and between the parenting variables, cognitive-affective variables, and paranoia, confirming the presence of the significant associations seen in the regression results. Paranoia was most significantly associated with anxiety, with slightly smaller associations to all of the other cognitive-affective variables. The largest edges between paranoia and parenting behaviours were between paranoia and maternal indifference, and between paranoia and paternal abuse. A slightly smaller edge was present between paranoia and maternal control, with only very weak edges between paranoia and paternal indifference, paternal control, and maternal abuse. The strongest edge between the parenting variables and the cognitive-affective variables was between maternal control and self-compassion.

Figure 2a shows the shortest paths from paranoia to the other variables. The shortest path between paranoia and all parenting variables, except paternal abuse, was through maternal indifference, indicating that a large proportion of the relation between paranoia and the parenting variables is mediated by maternal indifference. Paternal abuse, however, retained its direct relationship with paranoia. Figure 2b shows the shortest paths from maternal indifference to all other variables. Together these figures show that the shortest paths to paranoia are separate for parenting behaviours and cognitive-affective variables.

Discussion

This study presents the first investigation into potential links between specific parental behaviours—maternal and paternal overprotectiveness, abuse, and care—and paranoia. Associations were first analysed in a large epidemiological adolescent cohort, then replicated in a smaller non-epidemiological adult sample. The limitation of the brief measures used in the adolescent cohort was addressed by replicating associations in the adult participant group using stronger measures of the concepts, as well as adding several important cognitive-affective variables into the analysis. Finally, relationships were visualised in a network, enabling the strength of relationships and potential mediating pathways to be explored. All three levels of analysis revealed positive associations between paranoia and parental overprotection, indifference, and abuse, consistent with our first two hypotheses. It was found that the cognitive-affective variables were

Table 1 The cross-sectional relationship between parental behaviours and paranoia, controlling for gender

	NCS-A Sample				Oxfordshire Sample			
	N (no. who endorsed paranoia item/no. who did not endorse paranoia item/% who endorsed paranoia item)	Odds ratio	*p* value	95% CI	*N* (no. who endorsed paranoia item / no. who did not endorse paranoia item / % who endorsed paranoia item)	Odds ratio	*p* value	95% CI
Overprotectiveness								
Mother figure								
A lot	2962 (852, 2110, 28.8)	1.62	< 0.001**	1.31–1.99	229 (39, 190, 17.0)	0.674	0.095	0.43–1.07
Some	2834 (559, 2275, 19.7)	1.12	0.310	0.90–1.38	282 (45, 237, 16.0)	0.626	0.039*	0.40–0.98
A little	2387 (408, 1979, 17.1)	0.95	0.664	0.77–1.18	194 (31, 163, 16.0)	0.615	0.050*	0.38–1.00
Not at all	893 (163, 730, 18.3)				257 (62, 195, 24.1)			
Father figure								
A lot	2512 (720, 1792, 28.7)	1.31	0.002**	1.12–1.55	132 (23, 109, 17.4)	0.872	0.616	0.51–1.49
Some	2362 (456, 1906, 19.3)	0.89	0.180	0.75–1.06	214 (37, 177, 15.3)	0.896	0.629	0.58–1.40
A little	2565 (477, 2088, 18.6)	0.93	0.383	0.79–1.10	228 (38, 190, 16.7)	0.854	0.479	0.55–1.32
Not at all	1637 (329, 1308, 20.1)				388 (79, 309, 20.4)			
Verbal abuse (List A)								
Mother figure								
Often	363 (128, 235, 35.3)	2.17	< 0.001**	1.70–2.78	172 (54, 188, 31.4)	2.57	0.001**	1.51–4.39
Sometimes	1262 (376, 886, 29.8)	1.79	< 0.001**	1.51–2.11	222 (56, 166, 25.2)	1.82	0.026*	1.07–3.08
Not very often	2432 (544, 1888, 22.4)	1.38	< 0.001**	1.19–1.59	310 (38, 272, 12.3)	0.97	0.911	0.57–1.66
Never	5044 (939, 5044, 18.6)				258 (29, 229, 11.2)			
Father figure								
Often	302 (109, 193, 36.1)	1.50	< 0.001**	1.15–1.96	126 (52, 74, 41.3)	4.12	< 0.001**	2.47–6.85
Sometimes	1230 (360, 870, 29.3)	1.19	0.003**	1.01–1.40	198 (45, 153, 22.7)	2.03		1.25–3.30
Not very often	2075 (407, 1668, 19.6)	0.76	0.041*	0.66–0.88	272 (39, 233, 14.3)	1.29	0.004**	0.79–2.09
Never	5494 (1111, 4383, 20.2)				366 (41, 325, 11.2)		0.303	
Physical abuse (List B)								
Mother figure								
Often	99 (44, 55, 44.4)	2.61	< 0.001**	1.72–3.96	87 (23, 64, 26.4)	1.93	0.028*	1.07–3.47
Sometimes	392 (129, 263, 32.9)	1.71	< 0.001**	1.35–2.15	154 (49, 105, 31.8)	2.47	< 0.001**	1.53–3.98
Not very often	877 (236, 641, 26.9)	1.34	0.001**	1.12–1.60	278 (50, 228, 18.0)	1.34	0.183	0..87–2.06
Never	7734 (1578, 6156, 20.4)				443 (55, 388, 12.4)			
Father figure								
Often	97 (41, 56, 42.3)	1.98	0.002**	1.29–3.03	64 (24, 40, 37.5)	2.77	0.001**	1.52–5.02
Sometimes	338 (107, 231, 31.7)	1.36	0.018*	1.05–1.76	137 (39, 98, 28.5)	1.98	0.005**	1.23–3.17
Not very often	632 (163, 469, 25.8)	1.08	0.451	0.88–1.33	223 (42, 181, 18.8)	1.37	0.152	0.89–2.10
Never	8035 (1676, 6359, 20.9)				538 (72, 466, 13.4)			

Table 1 (continued)

	NCS-A Sample				Oxfordshire Sample			
	N (no. who endorsed paranoia item/no. who did not endorse paranoia item/% who endorsed paranoia item)	Odds ratio	*p* value	95% CI	*N* (no. who endorsed paranoia item / no. who did not endorse paranoia item / % who endorsed paranoia item)	Odds ratio	*p* value	95% CI
Severe physical abuse (List C)								
Mother figure								
Often	23 (11, 12, 47.8)	3.18	0.006**	1.39–7.30	14 (5, 9, 35.7)	1.89	0.293	0.58–6.18
Sometimes	39 (12, 27, 30.8)	1.56	0.212	0.78–3.12	19 (4, 15, 21.1)	0.80	0.705	0.244–2.60
Not very often	108 (39, 69, 36.1)	1.91	0.002**	1.27–2.89	42 (16, 26, 38.1)	2.35	0.014*	1.19–4.64
Never	8933 (1926, 7007, 21.6)				887 (152, 735, 17.1)			
Father figure								
Often	27 (8, 19, 29.6)	1.13	0.779	0.48–2.67	15 (5, 10, 33.3)	2.20	0.178	0.70–6.93
Sometimes	58 (15, 43, 25.9)	1.04	0.904	0.57–1.91	34 (15, 19, 44.1)	3.97	<0.001**	1.92–8.19
Not very often	100 (32, 68, 32.0)	1.41	0.124	0.91–2.19	55 (23, 32, 41.8)	3.69		2.08–6.55
Never	8918 (1933, 6985, 21.7)				858 (134, 724, 15.6)		<0.001**	
How much care								
Mother figure								
A lot	8757 (1879, 6878, 21.5)	0.52	0.190	0.20–1.38	635 (81, 554, 12.8)	0.25	0.001**	0.12–0.56
Some	192 (58, 134, 30.2)	0.69	0.471	0.25–1.90	200 (51, 149, 25.5)	0.54	0.126	0.24–1.19
A little	51 (14, 37, 27.5)	0.56	0.313	0.18–1.74	95 (31, 64, 32.6)	0.64	0.304	0.28–1.49
Not at all	18 (7, 11, 38.9)				32 (14, 18, 43.8)			
Father figure								
A lot	8217 (1719, 6498, 20.9)	0.47	0.001**	0.30–0.72	574 (82, 492, 14.3)	0.39	0.002**	0.22–0.70
Some	531 (149, 382, 28.1)	0.67	0.094	0.42–1.07	216 (40, 176, 18.5)	0.41	0.005**	0.22–0.77
A little	177 (55, 122, 31.1)	0.77	0.324	0.45–1.30	102 (25, 77, 24.5)	0.51	0.044*	0.26–0.98
Not at all	93 (35, 58, 37.6)				70 (30, 40, 42.9)			

Dependent variable: 'People often make fun of me behind my back'

Reference group: 'Not at all'/'Never'

*Significant at $p < 0.05$

**Significant at $p < 0.01$

interacting with the parental behaviours and paranoia, but that within the network, cognitive-affective variables were not likely to be mediating the pathway between paranoia and parenting behaviour. Instead mediation is most likely to occur via maternal indifference, given the shortest path from paranoia to all parenting variables except paternal abuse was through maternal indifference.

Regressions using the single item measures of parenting and paranoia revealed consistent patterns across both participant groups. Increased levels of paranoia were associated with an increased likelihood of reporting parental verbal and physical abuse and lack of care. In the NSC-A group, there were also clear associations between the single item measure of increased parental over-protectiveness and paranoia, which was not replicated in the Oxfordshire participant group. It is not clear why this was the case. Analysis of the more extensive measures still showed a positive association between mother and father over-control and paranoia in this group. It is possible that the brief measure of over-protection did not satisfactorily capture the experiences of control measured in the MOPS. Correlations between the GPTS and MOPS showed similar levels of association with paranoia for all six subscales (maternal and paternal indifference, abuse, and control). Despite previous research finding stronger associations between reported paternal behaviour and schizophrenia, than maternal behaviour and schizophrenia [61],

Table 2 Correlations between GPTS-B and all other measured variables

	n	Correlation with GPTS-B (Pearson)	*p* value
Mother indifference	1252	0.298	< 0.001
Mother control	1252	0.302	< 0.001
Mother abuse	1252	0.270	< 0.001
Father indifference	1174	0.280	< 0.001
Father control	1174	0.287	< 0.001
Father abuse	1174	0.264	< 0.001
Self-compassion	867	− 0.407	< 0.001
Compassion for others	867	− 0.226	< 0.001
Self-esteem	866	− 0.435	< 0.001
Anxiety	867	0.473	< 0.001
Depression	867	0.482	< 0.001

this was not found to be the case in our analysis regarding parenting and paranoia.

The network analysis revealed a highly interconnected network, though with the parenting and cognitive-affective variables clearly clustering separately. After controlling for all other variables, the strongest associations between reported parenting behaviours and paranoia were between maternal indifference and paranoia, and between paternal abuse and paranoia. Janssen et al. [20] suggest that adverse childhood experiences such as trauma or abuse may create cognitive vulnerability characterized by negative schemas about the self and the world, which then facilitates external attributions and the occurrence of paranoia. In line with this, we had hypothesised that cognitive-affective variables would provide a mediating pathway between parenting behaviour and paranoia. The associations between parenting behaviour and cognitive affective variables such as self-esteem, and between these variables and paranoia support this to an extent. However, the parenting variables and cognitive-affective variables had separate shortest paths to paranoia, suggesting that the variable clusters also have their own direct associations with paranoia. It is possible that other constructs not measured are mediators. For example, we did not measure attachment style because there are conceptual problems with the reliance on self-reported attachment style [24] and the interest was in more specific parenting behaviours. However, a measure of attachment style may have helped illuminate mediating pathways, by providing a measure of how individuals represent, internalize, and respond to their parents' behaviours. Future research could examine where variables such as attachment style lie in the causal chain, along with other potentially relevant developmental variables such as family structure or sibling relationships.

There are a number of limitations to the study. First, demographic confounds such as socio-economic status and cognitive variables such as IQ were not tested. Previous studies assessing the relationship between early-life adversities and symptoms of psychosis have found that these variables are associated with paranoia [29]. True associations between parental behaviours and paranoia may be smaller once accounting for these factors. Second, although well validated, the measure of anxiety and depression was very brief. This was to minimise participant burden, particularly considering neither variable was of primary interest for this analysis. Nonetheless, edge strengths and mediating pathways concerning these variables may have been slightly

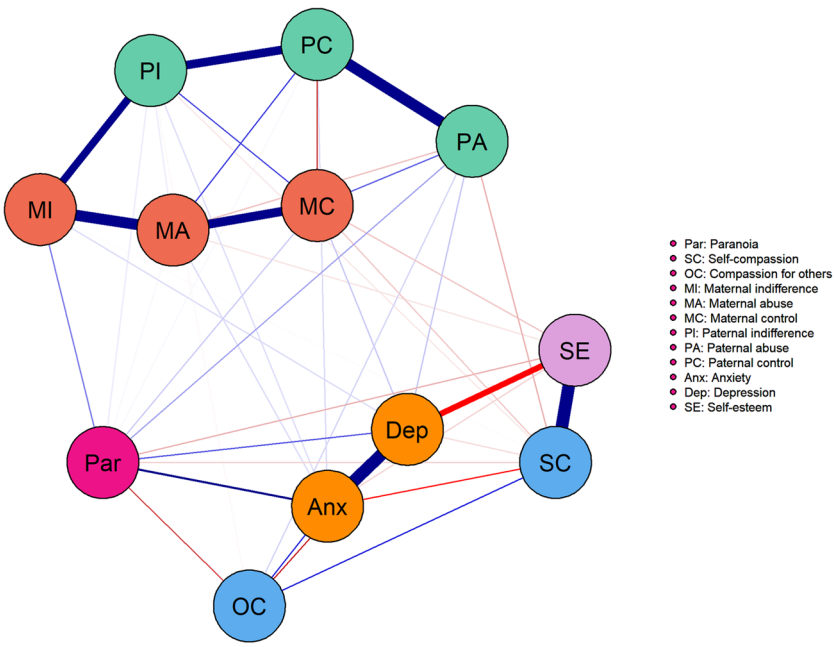

Fig. 1 Fully estimated network. Blue lines indicate positive associations; red indicates negative association. Line thickness and colour saturation correspond to strength of relationship

Table 3 Edge weights and confidence intervals between paranoia and all other variables

	Edge weight to paranoia (*r*)	95% confidence interval
Mother indifference	0.08	0.01; 0.15
Mother control	0.03	− 0.03; 0.09
Mother abuse	0.00	− 0.04; 0.05
Father indifference	0.01	− 0.03; 0.05
Father control	0.00	− 0.04; 0.05
Father abuse	0.06	− 0.01; 0.12
Self-compassion	− 0.03	− 0.08; 0.03
Compassion for others	− 0.11	− 0.19; − 0.03
Self-esteem	− 0.05	− 0.11; 0.01
Anxiety	0.19	0.11; 0.26
Depression	0.10	0.03; 0.17

altered had a more extensive measure been used. Third, there will be bias in the recruitment process for the adult Oxfordshire sample. Recruitment was achieved primarily through social media advertisements. Participants in this group were also predominantly female.

Finally, the biggest limitation is that the studies were cross-sectional, limiting causal inference. It cannot be determined whether these parental behaviours contribute to the development of paranoia, whether paranoia impacts parental relationships and thus parental behaviours, whether paranoia biases report of parental behaviours, or whether a confounding variable can explain the associations. However, regarding the possibility that paranoia biases the report of parental behaviours, it has been shown that patient reports of early experiences do tend to be unaffected by current symptoms, accurate when judged against reports of siblings, and stable over long periods, including times of acute illness versus remission [62–64]. Moreover, regarding the possibility that a confounding variable explains the relationship, a number of potentially confounding cognitive-affective variables were included in the analysis, yet were not mediating variables. On the other hand, there are a number of other variables that were not measured. For example, attachment style, bullying, and other victimisation experiences could be mediators. Additionally, although the two-item measure of anxiety included has shown sensitivity to identifying multiple anxiety disorders [50], other more in-depth or specific measures of may have revealed a mediating link that our measure did not capture.

Bradford Hill [65] argues that when judging whether effects might be causal, the strength and consistency of associations, temporal sequence of events, and the existence of plausible mechanisms should be considered. Upon these criteria, we argue a causal relationship between parenting and paranoia is certainly a possible explanation of the data, whereby parental abuse, indifference, and over-control could act as contributory causal factors in the development of paranoia. Further work testing this hypothesis is needed. For example, studies on longitudinal datasets would allow a greater degree of inference as to whether or not these links go beyond correlation, and studies in clinical populations would allow investigation of any association present in more severe cases of paranoia. This area is complex to research; there is reliance on retrospective reports and it is difficult to disentangle environmental and genetic contributions. However, there is a plausible mechanistic route that may be in action here.

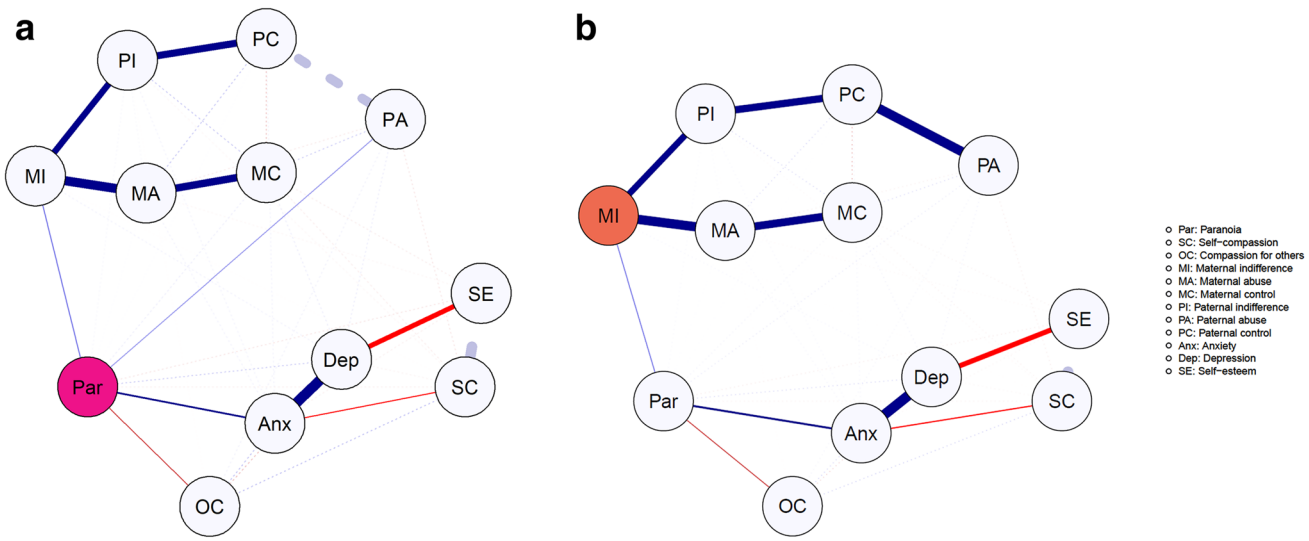

Fig. 2 **a**, **b** Shortest path analysis

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Availability of data The NCS-A data can be accessed at https://www.hcp.med.harvard.edu/ncs/ncs_data.php. The Oxfordshire data can be made available upon appropriate request.

Compliance with ethical standards

Conflicts of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Code availability R code from the network analysis can be made available upon appropriate request.

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Original Paper

Virtual Reality Cognitive Therapy in Inpatient Psychiatric Wards: Protocol for a Qualitative Investigation of Staff and Patient Views Across Multiple National Health Service Sites

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Abstract

Background: Patients in psychiatric wards typically have very limited access to individual psychological therapy. Inpatients often have significant time available, and an important transition back to everyday life to prepare for—but historically, there have been few trained therapists available on wards for the delivery of evidence-based therapy. Automated virtual reality (VR) therapy may be one route to increase the provision of powerful psychological treatments in psychiatric hospitals. The gameChange automated VR cognitive therapy is targeted at helping patients overcome anxious avoidance and re-engage in everyday situations (such as walking down the street, taking a bus, or going to a shop). This treatment target may fit well for many patients preparing for discharge. However, little is known about how VR therapy may be viewed in this setting.

Objective: The objectives of the study are to explore psychiatric hospital staff and patients' initial expectations of VR therapy, to gather patient and staff views of an automated VR cognitive therapy (gameChange) after briefly experiencing it, and to identify potential differences across National Health Service (NHS) mental health trusts for implementation. Guided by an implementation framework, the knowledge gained from this study will be used to assess the feasibility of VR treatment adoption into psychiatric hospitals.

Methods: Focus groups will be conducted with NHS staff and patients in acute psychiatric wards at 5 NHS mental health trusts across England. Staff and patients will be interviewed in separate groups. Individual interviews will also be conducted when preferred by a participant. Within each of the 5 trusts, 1 to 2 wards will be visited. A total of 8-15 staff and patients per ward will be recruited, with a minimum total of 50 staff and patients recruited across all sites. Focus group questions have been derived from the nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability (NASSS) framework. Focus groups will discuss expectations of VR therapy before participants are given the opportunity to briefly try the gameChange VR therapy. Questions will then focus on opinions about the therapy and investigate feasibility of adoption, with particular consideration given to site specific issues. A thematic analysis will be conducted.

Results: As of May 15, 2020, 1 patient focus group has been conducted.

Conclusions: The study will provide unique insight from patients and staff into the potential for implementing automated VR therapy in psychiatric wards. Perspectives will be captured both on the use of immersive technology hardware and therapy-specific issues in such settings.

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KEYWORDS

virtual reality; therapy; inpatient psychiatric care; implementation

Introduction

The Implications of Digital Technologies to Mental Health

There is a clear rise in the use of digital technologies, especially online apps, to deliver mental health treatments [1]. A second wave of digital treatments that use virtual reality (VR), increasingly being tested and shown to be effective in clinical trials, are likely to be implemented in services in the future [2]. VR therapy may be a particularly valuable tool in psychiatric wards. VR provides a safe and controlled setting for patients to practice entering, and coping with, challenging situations they may face at discharge. Therefore, it is important to assess the feasibility of implementing VR therapy in inpatient ward settings, and identify likely barriers and facilitators.

Psychiatric Wards

Over the past 60 years, there has been an increasing move away from inpatient care toward the provision of care in the community whenever possible [3]. However, inpatient admission remains an important part of the care pathway when a person's illness cannot be sufficiently managed in the community [4]. Qualitative investigations suggest that inpatient admission is needed to provide safety and protection from difficult environments, with many patients coming from places that they found to be too stressful and where they felt at risk of hurting themselves or others [5].

The shift in strategy toward community care has led to a reduction in the provision of inpatient beds. Bed numbers in England fell by 62% between 1987 and 2010, from almost 70,000 to fewer than 35,000 [4]. For adults in England, there are now just 18,000 beds, despite increases in the number of people in contact with mental health services [6]. The number of admissions to psychiatric wards has fallen accordingly, with a 19% reduction since 2012. However, bed occupancy remains high, at 95% in 2019 [6]. Average length of stay and numbers of involuntary admissions (ie, individuals detained under the mental health act) are also increasing [7]. Currently in the UK, the average length of stay in psychiatric wards is approximately 46 days. First admissions tend to be briefer, with an average length of 35 days. Length of stay is longer, with an average of 60 days, for those admitted involuntarily, compared to 37 days for those voluntarily admitted [8]. In 2019, 40% of admissions were involuntary, and the majority (62%) of all occupied bed days were by patients with psychosis [6], with these individuals also being the most likely to be detained [9]. It is clear that the need for inpatient admission remains, but with reduced capacity, the severity of illness required for admission has increased.

Inpatient wards are the most expensive form of care, with each acute adult bed costing up to GBP £180,000 (US $236,277.84) per year, the equivalent cost of supporting 44 people through a community mental health team over a year [10]. The lack of available beds and pressures to meet targets for lower bed occupancy rates [11] means ward staff are often forced to focus on achieving acute symptom reduction in patients rather than improvement in social functioning or coping ability [8]. Pressures are compounded by the limited availability of trained staff [12], a reliance on agency staff, and high levels of staff burnout [13]. Therefore, opportunities for staff-patient engagement in therapeutic relationships and collaborative care focused on recovery are limited [9,14]. Delivery of one-to-one or group psychological therapy is infrequent [15], with wards having very limited input from qualified psychologists [16] and treatment being predominantly pharmacological [12].

A further challenge to recovery is the lack of meaningful activities on wards, with patients often feeling bored and lonely [5]. Qualitative reports suggest that time is filled primarily with meals, smoking, and trying to look for someone to talk to [17], and that for some patients, the feeling of constant waiting is stressful and overwhelming [18]. One patient from a qualitative study described, "All you did was just sitting around, and there was nothing for you to do…no program to keep you busy…it's not good…I stagnate" [19]. Both staff and patients recognize that the provision of meaningful occupation is central to recovery and wellness [20,21], but pressures on staff time often prevent it.

The lack of both therapy provision and engagement in meaningful activities means that patients are often unprepared for discharge. Patients can access escorted (and eventually, unescorted) leave from the ward [22]; however, it is unclear how frequently this forms part of the therapeutic preparation for discharge, in which leave, for example, is used to practice coping with some of the difficult situations that may have led to a patient's admission in the first place. Consequently, although symptoms may be reduced upon discharge, patients can be ill-equipped with the skills needed to continue their recovery.

Leaving hospital often leads to the re-emergence of the pre-existing stressors that contributed to admission [23,24]. This may explain why the risk of relapse and rehospitalization immediately postdischarge is high [25]. Rates of suicide among patients in their first 3 months after discharge are also high, estimated at 100 times the global suicide rate, with a particular risk in the first week after discharge [23]. Significant anxiety about leaving hospital, sometimes known as "discharge grief," is common [17]. There is a clear need for greater focus on safe transition and discharge preparation. To accomplish this, it is argued that wards must shift from a predominant focus on observation and monitoring of patients for acute symptom reduction, to one of active encouragement of patients to engage in activities and their own care management [5,10].

Virtual Reality Therapy

Immersive virtual reality (VR) technology may provide a way of facilitating preparation for discharge. Difficulties interacting with the social world lie at the heart of most mental health problems [2], and it is clear that patients on wards require greater support to re-enter the external social world, which they previously found challenging [5]. In VR, it is possible to enter

computerized simulations of scenarios that an individual finds difficult, while practicing powerful psychological techniques. This enables individuals to change the way they think, react, and behave in such scenarios. Automating VR therapy means individuals can make use of the therapy even when there is a lack of highly trained staff. The potential for using VR in therapy has been well recognized over the past 25 years, but the development of consumer kits—and with it, the possibility of scaling VR therapy—has occurred only recently [2]. The hardware consists of a computer that generates an image, a display system that presents sensory information, and a tracker that feeds back the user's position and orientation to update the image.

VR has several key advantages over traditional face-to-face therapy. Patients are more willing to enter VR simulations of the situations they find anxiety-provoking because they know the simulations are not real. At the same time, individuals respond the same in VR, psychologically, emotionally, and physiologically, as they do in corresponding real-world environments [26]. Therefore, any learning that has occurred in VR transfers to the real world [27]. Consequently, VR provides a way of immersing individuals in the very environments in which they require practice when they are too fearful or, as is the case in inpatient wards, unable to do so in the real world.

The gameChange VR therapy utilizes this very concept to treat anxious social withdrawal [28]. Many individuals with mental health disorders (particularly, serious mental disorders such as psychosis) withdraw from everyday social activities due to anxiety. Two-thirds of patients with schizophrenia have levels of anxious avoidance equivalent to agoraphobia [29]. The key mechanism utilized by the gameChange therapy concerns safety-seeking behaviors, also known as defenses. Defenses are behaviors that individuals employ to help them feel safer. However, these behaviors actually serve to maintain thoughts and feelings of fear by preventing the learning of disconfirmatory evidence. Dropping defense behaviors during difficult situations allows patients to relearn concepts of safety [30]. Therefore, the gameChange therapy identifies patients' defenses and encourages them to try dropping their defenses in virtual social situations, thus helping to achieve new learning of feelings of safety and confidence. The current gameChange therapy includes 6 virtual scenarios: a street, café, pub, GP surgery, corner shop, and bus, with 5 levels of difficulty within each scenario. The user-centered design process for this therapy has been described in a recent paper [31].

Notably, the gameChange therapy is automated. A virtual coach, Nic, guides patients through each situation and suggests new behaviors to test out. Therefore, the therapy does not require a trained cognitive behavioral therapist to deliver it. While there is still someone in the room with the patient, this individual can be a peer supporter, psychology assistant, social worker, or health care assistant. This individual's role is to set up the equipment and provide support and encouragement. As such, VR delivery staff require only brief initial training and then ongoing supervision with a psychologist. The gameChange therapy is currently being tested in a multi-site randomized controlled trial [28]. Within the trial, patients are offered 6-8 weekly therapy sessions supported by a member of staff, typically an assistant psychologist, peer support worker, or clinical psychologist. Sessions take place either in the participant's home or local mental health base.

Many studies have shown the effectiveness of VR therapy for patients with a range of mental health problems [32-34]. Using these therapies on wards could provide a unique opportunity for helping patients prepare for discharge through the experiential practice of a range of everyday situations. The delivery of an automated VR therapy can be facilitated by a wider range of professionals on the ward and is not constrained to a therapist trained in one-to-one psychological therapies. Higher doses, perhaps daily, would be feasible.

If VR headsets were accessible on wards, additional, freely available VR programs such as physical activity games, relaxation, and meditation exercises could also be used by patients as therapeutic activities that lessen boredom and enhance recovery. The feasibility of this has increased greatly due to continuous hardware improvements and a reduction in costs. This means VR equipment now requires less space, is less technical, and is more user-friendly than it was previously.

Implementation Framework

Implementation frameworks provide an overview of the factors that typically shape and influence the implementation process [35]. We used the nonadoption, abandonment, and challenges to the scale-up, spread, and sustainability (NASSS) framework for health care technologies [36] to inform the study's design. The NASSS draws together a number of implementation models and theories, and covers 7 domains relating to health care technology implementation: the condition or illness, the technology, the value proposition, the adopter system, the organization, the wider context, and embedding and adaptation over time. Challenges regarding each domain are classified as simple (straightforward, predictable, few components), complicated (multiple interacting components or issues), or complex (dynamic, unpredictable, not easily disaggregated into constituent components). Staff and patients are in a position to inform 3 of these domains with regard to implementation of VR therapy: the condition and illness that the therapy is designed for, the intended adopters of VR therapy, and the organization. Other frameworks were also considered, such as the normalization process theory (NPT) [37]. However, the NASSS framework covers a wider range of potential barriers and facilitators to implementation that may be relevant at any point from design through to continued implementation, whereas NPT is more retrospective in nature.

Objectives

The study objectives are threefold: (1) to obtain initial expectations of staff and patients about VR and VR psychological therapy; (2) to gain staff and patient views of an automated VR therapy (gameChange) after trying it; (3) and to identify potential differences and requirements for implementation across health care sites.

Methods

To increase the methodological quality and reporting, the presentation of the study will follow the guidance of the 32-item consolidated criteria for reporting qualitative research (COREQ) [38].

Ethical Review

The gameChange trial received Health Research Authority (HRA) approval and Health and Care Research Wales approval (IRAS 256895, The gameChange Trial). The trial received ethical approval from the NHS South Central - Oxford B Research Ethics Committee (19/SC/0075). The trial has been registered (ISRCTN17308399) and the protocol published [28]. The present study received ethical approval as part of a substantial amendment.

Patient and Public Involvement

In line with the guidance for reporting involvement of patients and the public (short form; GRIPP2-SF [39]) we report the aims, methods, results, and reflections on patient and public involvement (PPI).

There has been considerable PPI in the development of the gameChange therapy and the running of the trial. Within this study, the aim is to ensure all study documentation (topic guide, information sheet, and consent form) is engaging and understandable, and to involve service users in the design of the study. PPI will also be used to discuss the analysis and interpretation of results. A lived experience advisory panel (LEAP), facilitated by the McPin Foundation, contributed to the development of the study. The LEAP comprises 10 individuals from across the 5 study sites. All study documentation was sent electronically to the LEAP for feedback, and an in-person discussion about the study design took place. An additional in-person session will take place to discuss the analysis and results. Many areas of the study documentation were rephrased to make them more inclusive and comprehensible, and many suggestions for how to maximize engagement in focus groups were given. These included key times on the ward to avoid (eg, visiting hours, meal and medication times), reducing the power dynamic in focus groups (eg, by emphasizing that the researchers are here to learn from participants, not the other way round), ensuring the researchers state that the focus group ground rules also apply to themselves, and asking certain questions without making people uncomfortable (eg, by offering post-it notes or asking a question before a break).

Therefore, PPI has been a helpful influence on the study. As the LEAP had been involved with the gameChange trial, they were familiar with the VR that would be demonstrated, and the LEAP was thus well placed to reflect on how this would work in the focus groups. Several members had also been inpatients themselves, allowing them to give important advice about how focus groups could best be conducted on the wards.

PPI was considerable; however, involvement could also have been further strengthened. For example, not all 10 LEAP members were able to attend the in-person meeting. If time had allowed, another in-person meeting may have enabled the incorporation of a greater number of viewpoints.

Context of Data Collection

There are likely to be a number of challenges affecting the data collection process. Wards can be chaotic environments, with unpredictable events and many patients experiencing high levels of distress, making the facilitation of focus groups difficult [16]. The staff pressures and shortages typically seen on wards may mean it is difficult for staff to schedule time for a focus group or interview in advance. For those who are able to take part, time may be limited, preventing the discussion of all relevant topics. In addition, some wards may not always have a suitable room available for conducting focus groups and interviews, so the researchers expect time constraints for when they can conduct focus groups or interviews. This will be compounded by the need to avoid key times on the ward, such as during ward rounds, medication dispensary, visiting hours, meal times, and any structured activities offered on the ward. To minimize these issues, the researchers will aim to be as flexible as possible in their approach, but challenges and disruptions to data collection are nonetheless expected.

Participants

Staff working in either the delivery or management of clinical care on the wards will be invited to take part in focus groups or individual interviews. National Health Service (NHS) patients staying on wards will be recruited according to the following inclusion criteria: (1) participants are willing and able to give informed consent for participation in the study; (2) participants are 18 years old or older; (3) participants are willing to consent to being audio-recorded; (4) participants have sufficient English language skills to participate in the focus group or interview. The exclusion criteria will include high levels of associated risk to self or others through participation in the study (eg, actively suicidal), and photosensitive epilepsy (for which use of VR is not recommended). Researchers will assess a participant's capacity to consent after the participant has read the information sheet and before they sign the consent form. Patients will receive a small payment for taking part.

Sampling and Recruitment

The gameChange trial is recruiting from 5 NHS mental health trusts across the UK: Avon and Wiltshire Mental Health Partnership NHS Trust, Greater Manchester Mental Health NHS Foundation Trust, Cumbria Northumberland Tyne and Wear NHS Foundation Trust, Nottinghamshire Healthcare NHS Foundation Trust, and Oxford Health NHS Foundation Trust. Principal investigators (PIs) and trial coordinators will be at each site. The trial is open to patients from all mental health services, but to date, almost all participants are outpatients. We will work with the PIs and trial coordinators to approach leads of psychiatric wards at each site. Only acute psychiatric wards will be visited rather than rehabilitation wards, given these are the most numerous type. We aim to visit an equal number of male and female wards.

We aim to visit 1-2 wards within each of the 5 trusts, and include 8-15 total participants (staff and patients) from each ward. A minimum total of 50 staff and patients will be recruited across

all sites. Due to the busy nature of wards and frequent lack of room availability, convenience (volunteer) sampling will be used in the first instance. Purposive sampling will then be used to ensure that a range of staff are seen (ie, those who are involved in decision-making as well as those who are more directly involved in day-to-day clinical care).

Procedure

In the weeks leading up to the site visit, staff and patients will be informed of the study and focus group dates will be arranged. Staff and patients will receive participant information sheets and be given time to discuss this with others. The researchers will predominantly rely on members of ward staff to initially introduce the study and go through the information sheet with patients, given staff will be more familiar to patients. Before taking consent, the researchers will be available to take participants through the information sheet again and answer any questions. After consenting, a demographic questionnaire will ask participants their age, gender, and ethnicity. Staff will also be asked about their job roles. Patient diagnosis will not be recorded, given that patients themselves may not be willing or able to disclose this, and we do not wish to add to staff burden by asking them to provide this patient information. The first author (PB) will lead all focus groups. There will be a cofacilitator that is likely to vary by site. A member of staff from the ward may also be present during patient focus groups and interviews. Each of the wards will be visited multiple times to ensure participation is open to as many different patients and members of staff as possible. All data collection will take place on the ward.

Focus groups and interviews will initially ask questions relating to the study's first objective (to obtain the initial expectations of staff and patients about VR and VR psychological therapy) before giving all participants the opportunity to put on a VR headset and try the therapy for a few minutes. They will meet the coach, Nic, and try out 1 level of 1 scenario. Participants will choose which scenario and level they enter, although patients will be encouraged to only try easier levels. Participants will also be observed while they try the VR therapy, and potentially videotaped if they give permission. Observations will be recorded in the researchers' field notes. Further questions will then focus on objectives 2 (to gain staff and patient views of the gameChange automated VR therapy after trying it) and 3 (to identify potential differences and requirements for implementation across health care sites). If any participants leave the focus groups before the end, we do not plan to collect data on the reasons for withdrawal. This is for two reasons: firstly, it is expected to be practically difficult to follow up with a participant who leaves; secondly, participants are told that they may withdraw from the focus groups at any point without the provision of a reason, so as not to make anyone feel obliged to stay. Any data that they have provided prior to leaving will be included in the analysis.

Focus Groups and Interviews

Focus groups were chosen as the primary mode of data collection because they allow individuals to consider ideas together while also highlighting differences in thoughts and ideas between participants [40]. They also allow participants to express ideas spontaneously, in a way that is less structured or influenced by the researchers' prejudices [41]. Given most participants are expected to be unfamiliar with VR, a group setting is likely to be helpful for allowing individuals to consider a range of viewpoints and questions raised by other group members to inform their opinions. The group setting is also likely to be most constructive for generating ideas about potential challenges around the implementation of VR therapy, as well as solutions to challenges, because individuals can build upon each other's suggestions. We aim for each focus group to contain 3-6 participants; however, this will vary depending on staff and patient availability. Wards are a challenging environment for such research, and pragmatism is needed. In particular, it is expected to be difficult to have multiple staff members available at the same time, so a number of single or joint interviews may be necessary. Individual interviews will also be conducted if a participant would prefer. For example, a number of patients might find a group setting difficult, and some members of staff may prefer to express their views privately. Focus groups are expected to last anywhere between 45 minutes to 2 hours. Individual interviews may be shorter. To limit the length of time staff are required to be available at any one time, the possibility of splitting the focus group or interview into 2 sessions will be offered.

Topic Guide

Informed by the NASSS framework, the semistructured topic guide has been created to cover all 3 objectives. PB created a first draft of the topic guide, which was then revised following feedback from FW, DF, the LEAP, 2 experts in qualitative research, and a pilot with colleagues. The topic guide will be reviewed after conducting the first focus groups, and then again at a later stage of data collection and analysis. Changes may be made in response to participant feedback (eg, if focus groups are too long for participants, or if it becomes clear that a certain topic is being under or overexplored). Significant changes to the topic guide will be reported. A copy of the topic guide can be viewed in Multimedia Appendix 1.

Analysis

Focus groups and interviews will be audio-recorded and transcribed verbatim. Field notes from each focus group or interview will also be transcribed. Field notes will record factors such as group dynamics and nonverbal cues to add context to the transcript of the audio recordings. For practical reasons, transcripts will not be returned to participants for comment or correction.

A thematic analysis will be conducted [42]. All data will be entered into NVivo (version 12.0, QSR) [43] in order to provide a transparent audit trail. PB will read and reread transcribed data to ensure familiarity before developing a preliminary coding framework. In line with recommendations [44], there will be team reviews of the coding framework, regular team consultation, and multiple coding for a number of interviews. Details regarding each code will be recorded in memos in Nvivo. Themes will be derived from the data. Data saturation will be discussed as the study progresses. Diverse cases and minor themes will be presented, as we consider breadth as important as frequency. A meeting with the LEAP will be set up in order

to discuss the thematic analysis and consider interpretations of the results.

Reflexivity

Researchers conducting the focus groups and analyzing the results will consider how their own backgrounds may impact data collection and analysis. PB will keep a reflexive log. Details of the research team and reflexivity will be reported in the full manuscript in line with COREQ guidelines [38]. However, reflexivity has also been considered at an early stage, prior to starting recruitment to the study.

All the researchers who will be conducting focus groups have been involved in the design or use of VR therapy for psychosis. Thus, existing knowledge, expectations, and hopes regarding VR therapy may impact how the focus groups are conducted. A number of groups may be cofacilitated by a clinical psychologist, and others may be cofacilitated by an assistant psychologist, which may impact the data in terms of both the cofacilitators' actions (eg, how questions are asked) and how participants respond to the different roles. To try to minimize these potential biases, PB and the cofacilitators will aim to stay close to the interview schedule, as this was created largely from the NASSS implementation framework, not just the experiences and expectations of the authors.

Results

As of May 2020, data collection for 1 patient focus group with 3 participants has been conducted, and coding is underway.

Discussion

Prospects

This protocol describes the plan for a multi-site qualitative study with patients and staff, assessing the feasibility of implementing VR therapy in inpatient psychiatric wards. As part of this process, NHS staff and patients in psychiatric wards will be able to try out and provide their feedback on the gameChange automated VR therapy. The study will provide insight into the degree to which VR therapy might be suitable for inpatient wards, and identify barriers and facilitators to implementation. Studies making use of implementation science should aim to produce generalizable knowledge [45]. As such, this study can also be contextualized as an investigation of the potential implementation of digital psychological therapies more generally in psychiatric wards.

Limitations

There are several limitations to the methodology used in the study. We will only be recruiting from acute psychiatric wards; therefore, results may not generalize to all types of wards (such as rehabilitation wards). Similarly, the wards that agree to take part may be those that are currently not experiencing significant staff shortages, which may also limit the generalizability of findings.

It has been suggested that participants in implementation studies may represent a more highly motivated group of service users who are less representative of the whole population [46]. This may be a limitation of the participant group we recruit. Patient diagnosis will also not be recorded, nor will patients be asked about their specific current experiences and difficulties. Therefore, we will not know what kinds of problems most patients are experiencing unless they discuss them in the groups. In addition, while a focus group environment has a number of benefits, a proportion of participants may not feel entirely comfortable in this setting. This could be due to low self-confidence, conflicts between individuals on the ward, or hierarchical staff roles. Consequently, a number of individuals may not fully share their views. It is hoped that offering individual interviews may help to mitigate this problem, but it is still likely to be present.

Strengths

The study methodology also has several strengths. First, multiple stakeholder involvement is considered important for implementation research [45,47]. Thus, conducting focus groups with staff of varying professional groups and patients is a particular strength of the study; a wide selection of viewpoints is likely to be gained. Second, conducting the study at 5 NHS mental health trusts across the UK will help to increase the generalizability of the results, and allow comparison between different locations. Third, the study methodology and documentation has received feedback from our LEAP, helping to ensure the study will be engaging and acceptable to patients. Fourth, the gameChange VR therapy has been designed to help with the very problem that many patients on wards are struggling with: coping with everyday environments. Therefore, it is likely to fit well with the goals of both staff and patients on wards. Finally, the majority of implementation research is retrospective [47]. This study benefits from prospectively assessing feasibility of implementation in this setting. Prospective assessment of digital interventions allows for optimization prior to implementation, in order to ensure long-term use and the meeting of clinical and scientific standards [48].

It is important to consider how health care technologies can be integrated into existing health services [49]. There have been significant recent advances in digital mental health care. This study will provide valuable insight into how one particular emerging health care technology, VR, might fare in implementation in psychiatric inpatient wards.

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Conflicts of Interest

DF is a founder and nonexecutive board director of Oxford VR, a University of Oxford spin-out company, which programed and commercializes the gameChange treatment. DF holds equity in Oxford VR.

Multimedia Appendix 1

Focus group topic guides.
[DOCX File , 20 KB-Multimedia Appendix 1]

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Abbreviations

GRIPP2-SF: guidance for reporting involvement of patients and the public - short form
LEAP: lived experience advisory panel
NASSS: nonadoption, abandonment, and challenges to scale-up, spread, and sustainability
NPT: normalization process theory
PI: principal investigator
PPI: patient and public involvement
VR: virtual reality

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