

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

Poppy Brown^{1*}, Felicity Waite^{1,2}, Aitor Rovira^{1,2} and Daniel Freeman^{1,2}.

¹Department of Psychiatry, University of Oxford, Warneford hospital, Warneford Lane, Oxford, OX3
7JX

²Oxford Health NHS Foundation Trust

*Address for correspondence: Poppy Brown, University Department of Psychiatry, University of Oxford,
Warneford hospital, Warneford Lane, Oxford, OX3 7JX

Tel: +44 1685 618262, E-mail: poppy.brown@psych.ox.ac.uk

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.

Key words: power posing; paranoia; delusions; virtual reality

Introduction

Low levels of beliefs about control, power, and social rank may be important in the occurrence of many mental health conditions (e.g. Watson, 1967; Radloff & Monroe, 1978; Benassi, Dufour & Sweeney, 1988, Allan & Gilbert, 1997). 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.

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, 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 methodological quality of studies vary (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 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.

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 this informs treatment development. This is an interventionist-causal model approach (Kendler and 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, Waite & Freeman, 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 (low self-esteem), (Tiernan, Tracey & Shannon, 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. Lincoln, Hoenhaus & Hartmann, 2013; Freeman, Pugh et al, 2014; Atherton et al, 2016).

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, Evans, Waite, Loe & Freeman, 2018; Freeman et al, 2005; Wong, Freeman & Hughes, 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 take a powerful pose would report feeling more powerful than those who took 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 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 et al., 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.

Method

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, 2011; 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.

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 randomisation sequence. Separate randomisation 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. Figure 1 summarises the experimental procedure. The study was pre-registered with [Open Science Framework](#) and received ethical approval from an Oxford ethics committee.

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.

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. 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 & 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 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.

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 range from 16-80, with higher scores reflecting greater paranoia. The scale has been 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). The GPTS-B also demonstrates high reliability ($\alpha > 0.95$) 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).

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'.

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 Figure 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 et al., 2014).

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, Moerkereke & Vansteelandt (2015). R studio version 3.6.1 was used for the statistical analysis (R Core Team, 2013).

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.

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 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).

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.

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.

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; $p=0.098$).

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; $p=0.013$

Hypothesis 2: Effect of condition on paranoia.

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; $p=0.634$).

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.

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, $p=0.041$).

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, use of 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 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 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. 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 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.

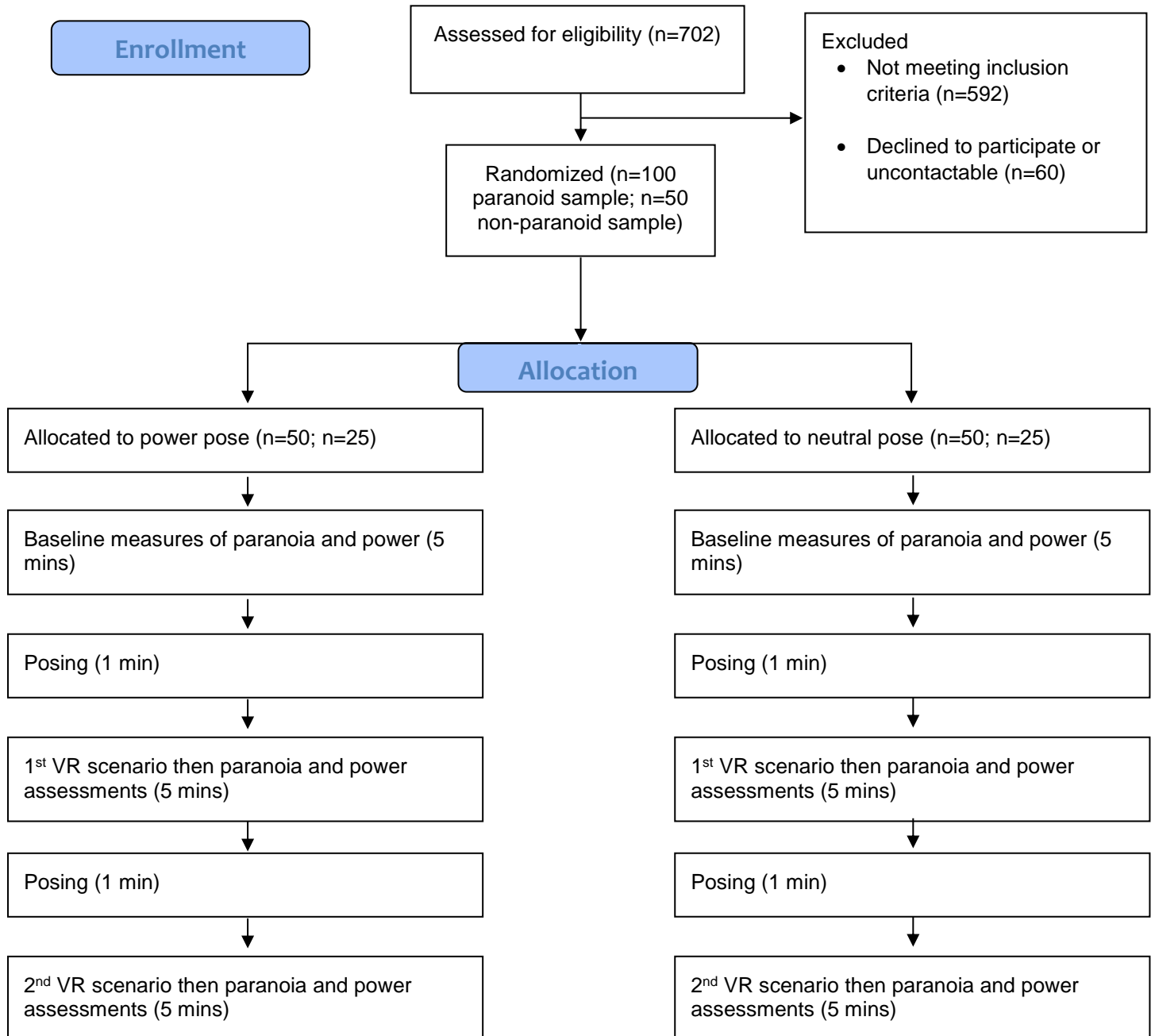


Figure 1. Experimental procedure.



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



Figure 3. Virtual reality scenarios.

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, <i>n/n</i>	21/29	22/28	13/12	9/16
Ethnicity, <i>n</i>				
White British/Irish	36	37	17	16
Non White British/Irish	14	13	8	9
Employment status, <i>n</i>				
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)

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

Author Contributions

The study was conceived by PB, FW and DF. AR created the VR environments. PB completed recruitment, testing and analysis. PB wrote a first draft of the manuscript. DF and FW supervised the research project and contributed to the manuscript. All authors approved the final version of the manuscript.

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