**Abstract**

**Background and objectives:** When asked to evaluate faces of strangers, people with paranoia show a tendency to rate others as less trustworthy. The present study investigated the impact of arousal on this interpersonal bias, and whether this bias was specific to evaluations of trust or additionally affected other trait judgements. The study also examined the impact of eye gaze direction, as direct eye gaze has been shown to heighten arousal.

**Methods:** In two experiments, non-clinical participants completed face rating tasks before and after either an arousal manipulation or control manipulation. Experiment one examined the effects of heightened arousal on judgements of trustworthiness. Experiment two examined the specificity of the bias, and the impact of gaze direction.

**Results:** Experiment one indicated that the arousal manipulation led to lower trustworthiness ratings. Experiment two showed that heightened arousal reduced trust evaluations of trustworthy faces, particularly trustworthy faces with averted gaze. The control group rated trustworthy faces with direct gaze as more trustworthy post-manipulation. There was some evidence that attractiveness ratings were affected similarly to the trust judgements, whereas judgements of intelligence were not affected by higher arousal.

**Limitations:** In both studies, participants reported low levels of arousal even after the manipulation and the use of a non-clinical sample limits the generalisability to clinical samples.

**Conclusions:** There is a complex interplay between arousal, evaluations of trustworthiness and gaze direction. Heightened arousal influences judgements of trustworthiness, but within the context of face type and gaze direction.

*Keywords:* Paranoia; Trust; Arousal; Gaze

The effect of arousal and eye gaze direction on trust evaluations of stranger’s faces: a potential pathway to paranoid thinking.

Paranoid thinking is characterised by suspicions about the intentions of others (Freeman, 2016). In psychosis, people report paranoid thoughts that are distressing, implausible, and relatively resistant to change (i.e., persecutory delusions; Freeman & Garety, 2000). However, paranoid ideation is not unusual, as around a third of people with no history of mental health problems report being suspicious of those around them (Freeman, 2007).

One bias associated with paranoia may be a tendency to perceive unfamiliar faces as being untrustworthy. Non-clinical participants prone to paranoid thinking evaluated unfamiliar faces as less trustworthy than control participants (Kirk, Gilmour, Dudley, & Riby, 2013). Clinical studies have reported more ambiguous results. People with psychosis rate unfamiliar faces as being less trustworthy (Pinkham, Hopfinger, Pelphrey, Piven, & Penn, 2008), or as no different (Haut & MacDonald, 2010; McIntosh & Park, 2014), or more trustworthy than controls (Baas, Van't Wout, Aleman, & Kahn, 2008). Usually these studies did not specifically identify paranoid symptoms in their clinical groups. Where this has been done, paranoid individuals rate faces as less trustworthy (Pinkham et al., 2008).

Freeman, Garety, Kuipers, Fowler, & Bebbington (2002) describe how there are many routes to suspicion, mistrust and paranoia, but one contributory factor is how people make sense of unusual experiences and sensations. If a person experiences heightened arousal around other people, this experience drives a search for meaning or an explantion of what may account for this. People with psychosis may hold negative beliefs about others trustworthiness (Fowler et al., 2006), and may regard themselves as vulnerable to others actions perhaps owing to past experience of assaults, bullying and interpersonal hostility (Freeman, 2016). These beliefs are usually stable, but the moment to moment appraisals of experiences that are shaped by these beliefs may fluctuate because of dynamic factors such as levels of arousal (Freeman, 2007). Higher levels of negative arousal may predispose individuals towards making negative interpretations of ambiguous events (Freeman et al., 2013). Hence, when experiencing normally occurring variations in arousal people with paranoia may be more prone to attribute the cause of their experience to the actions of others which thereby reinforces and maintains these negative beliefs about the intentions of other people to hurt or harm the indvidual.

Consistent with this claim, Hooker et al. (2011) reported that following a negative affect prime, individuals with schizophrenia rated neutral faces as less trustworthy than following neutral or positive primes. This provides preliminary evidence that heightened levels of arousal elicit (or exacerbate) a mistrust bias (Freeman et al., 2008). However, the induction paradigm employed by Hooker et al. (2011) primed participants to experience positive, neutral, or negative affect on a trial-by-trial basis, which can have different effects to more traditional mood induction paradigms (in which mood is induced and maintained for several minutes, Lench, Flores & Bench, 2011). Thus, it is important to replicate Hooker et al.’s (2011) findings using a different type of negative arousal induction. This is the first aim of two related experiments presented here.

In research on the trustworthiness of others it is important to consider the potential impact of eye gaze direction. Faces are powerful social cues, assisting rapid and automatic judgements about others (Ambady, 2010; Todorov, Pakrashi, & Oosterhof, 2009). Research suggests direct eye gaze elicits greater levels of arousal than averted gaze (Myllyneva, Ranta, & Hietanen, 2015) and that there are complex relationships between gaze direction and trustworthiness. For example, while speakers who communicate with a direct gaze appear more trustworthy than those who use an averted gaze (Kreysa, Kessler, & Schweinberger, 2016), this effect is moderated by the emotional expression of the to-be-rated face (Wyland & Forgas, 2010), and the mood of the rater (Willis, Palermo, & Burke, 2011).

Thus, in the first of two experiments, we investigated the impact of increased negative arousal on participants’ evaluations of the trustworthiness of unfamiliar faces, hypothesising that a state of increased negative arousal and paranoia would result in participants rating faces as less trustworthy than controls. In the second experiment we investigated again whether increased arousal led to lower trustworthiness ratings with particular consideration of whether this bias was specific to the assessment of trust and if gaze direction further influenced these trust evaluations.

**Experiment One**

**Method**

**Participants**

 Participants were 40 university students (33 females) aged 18-25 years (*M* = 21.13, *SD* = 2.13).

**Design**

A 2 (Time) x 2 (Group) x 3 (Face) mixed experimental design was utilised. Participants rated faces selected to be Untrustworthy, Neutral or Trustworthy before and after either an arousal or control induction. These two groups were compared on baseline levels of paranoia and completed Visual Analogue scales to assess levels of paranoia and arousal during the different stages in the experiment.

**Measures**

 **The Green et al. Paranoid Thoughts Scale (GPTS; Green et al., 2008).** Levels of paranoid thinking were assessed using the GPTS. This scale consists of 32 items that describe thoughts related to suspiciousness. Participants are asked to rate to what extent they have had these feelings over the past month on a 5-point Likert scale (1 = *Not at all;* 5 = *Totally*) with higher scores reflecting higher levels of paranoid thinking. In this sample, the GPTS had good internal reliability (Cronbach’s α = .87).

**Visual Analogue Scales (VAS).** Levels of negative arousal and levels of paranoid ideationwere assessed using two set of VAS. To assess levels of arousal, participants were asked to rate how nervous, jittery, tense, and scared they were on a scale of 0 (*not at all*)to 10 (*very much so*). To assess levels of paranoia, participants were asked to rate to what extent they felt that others were hostile, held bad intentions, would cause them harm, and wanted them to feel threatened on a scale of 0 (*not at all*)to 10 (*very much so*). Scores on both sets of VAS could range from 0-40, with higher scores reflecting higher levels of arousal or paranoia. In this sample, the scales had acceptable internal reliability (arousal Cronbach’s α = .86; paranoia Cronbach’s α = .91). Reliability of a scale of all the items combined was acceptable (Cronbach’s α = .71).

**Experimental Inductions**

**Arousal Induction.** A negative arousal induction procedure used in a previous study (Dudley et al., 2014) to increase arousal and perceived threat from others was employed. It involved watching a seven-minute film clip set at night amongst woods, and it implies interpersonal threat from unidentified others leading the characters to become increasingly distressed and afraid. The scene was originally chosen because it does not depict scenes of gore or physical violence but rather emphasises a state of nervousness, fear and concern about the presence of others.

**Control Induction.** A neutral induction procedure that has been shown to maintain or lower levels of arousal (see Dudley et al., 2014) was also employed. This involved watching a seven-minute film of interchanging flowers with a relaxing sound track.

**Face Evaluation Task**

 Sixty computer generated faces were selected from the Todorov face data set (Oosterhof & Todorov, 2008, see Figure 1), which provides computer manipulated variations of faces along a 7-point Likert scale of trustworthiness, from -3 (very untrustworthy) to +3 (very trustworthy). The faces were used to create two PowerPoint presentations (A and B) of 30 faces, consisting of 10 faces rated as untrustworthy, 10 rated as neutral, and 10 rated as trustworthy.

Participants were tested individually in a quiet room. Faces were presented using Microsoft PowerPoint, displayed on individual slides for 3 seconds, with a one second fixation cross presented between each face, in a fixed randomised order. Participants were asked to rate the trustworthiness of each face on a seven-point scale (1 = *very untrustworthy*; 7 = *very trustworthy*) that was presented on-screen throughout the task. The researcher recorded the participant’s spoken ratings for each face. Participants received a small payment for their time.

Figure one about here please

**Procedure**

 Both studies were approved by a departmental ethics committee. After providing informed consent, participants completed the GPTS, and the first set of VAS (Time 1). They then completed the first face evaluation task (either A or B), followed by a second set of VAS (Time 2). Participants completed their allocated (randomly) induction and a third set of VAS (Time 3), and then a second face evaluation task (B or A). Participants completed a fourth set of VAS (Time 4) and were then debriefed. The order in which participants completed the two versions of the face evaluation task was counterbalanced.

**Sample Size Considerations**

Although the full model is a 2 x 2 x 3 Time X Group X Face type ANOVA, for the key test of the within-between Time x Group interaction collapsed across Face Type, to detect a conventionally defined medium effect size (f = .25), alpha = 0.05; power = 0.80, the required sample size for the 1 df interaction is 34 (G\*Power-3, Faul, Erdfelder, Lang, & Buchner, 2007).  This is based on an assumed correlation between pre- and post-induction measures of .5, which seems reasonable given the short time frame.    However, if r were as low as .2, then required f would be .31, and if it were as high as .7, then required f would be .19, both within the medium range.  Therefore N = 34 was retained as the required sample size for a medium ES and for a range of values for the T1 to T2 correlation. This assumption was based on the moderate to large effect sizes demonstrated by previous research (Kirk et al., 2013).

 **Results**

**Group Differences in Baseline Characteristics**

There were no differences (all *p*-values > .33) between participants allocated to the two conditions in terms of age (control group *M* = 20.80, *SD* = 2.14, arousal group *M* = 21.45, *SD* = 2.11), gender (80% female and 85% female respectively), or levels of paranoid thinking, (control group *M* = 45.70, *SD* = 8.83; arousal group *M* = 47.95, *SD* = 12.56). These variables were not considered in subsequent analyses.

**Manipulation Check**

 The impact of the arousal manipulation based on the participants’ mean VAS arousal and paranoia scores are presented in Figure 2. A 2 × 4 ANOVA revealed a main effect of Time, *F*(3, 114) = 3.68, *p* = .004, partial η2 = .088, a main effect of Group (arousal or control induction), *F*(1, 38) = 5.61, *p* = .023, partial η2 = .129, and a Time × Group interaction effect, *F*(3, 114) = 12.21, *p* < .001, partial η2 = 24. The interaction effect was investigated using four between-groups *t*-tests reported in Figure two. Group differences in VAS scores were not significant at Time 1, or at Time 2, however, VAS scores at Time 3 revealed higher levels of arousal in the arousal induction group than participants in the neutral induction group. This was also evident at Time 4. The induction appears to have been effective at increasing arousal that endured whilst the participants completed the second face evaluation task.

Figure two about here please

**Trustworthiness Evaluations**

 Descriptive statistics for participants’ trust evaluations are presented in Table 1.

Table 1 about here please

A 2 (Time) × 2 (Group) × 3 (Face Type) ANOVA revealed a main effect of Time, *F*(1, 38) = 9.84, *p* = .003, partial η2 = .21, (qualified by a 2-way interaction, see below), no main effect of Group, *F*(1, 38) = 1.77, *p* = .19, partial η2 = .04, and a main effect of Face Type, *F*(2, 76) = 260.59, *p* < .001, partial η2 = .87. Bonferroni post hoc tests were used to investigate the main effect of Face Type. They revealed that untrustworthy faces were rated as less trustworthy than neutral faces (*p* < .001, *d* = 2.51), that untrustworthy faces were rated as less trustworthy than trustworthy faces (*p* < .001, *d* = 3.74), and that neutral faces were rated as less trustworthy than trustworthy faces (*p* < .001, *d* = 1.50). On the scale used, 1 is very untrustworthy, 4 is neutral and 7 is very trustworthy. Hence, neutral faces are rated exactly as neutral, untrustworthy are below this and trustworthy faces comfortably above this neutral value. Thus, as expected, participants’ ratings of the trustworthiness varied according to the stimuli employed (Kirk et al., 2013).

In terms of interactions, the Face Type × Group interaction effect was not significant, *F*(2, 76) = 1.12, *p* = .33, partial η2 = .03. Similarly, the Face Type × Time interaction effect was not significant, *F*(2, 76) = 0.15, *p* = .86, partial η2 = .00. In contrast, as hypothesised the Time × Group interaction effect was significant, *F*(1, 38) = 7.59, *p* = .009, partial η2 = .17. However, the three-way Face Type × Group × Time interaction was not significant, *F*(2, 76) = 0.17, *p* = .85, partial η2 = .00.

 The Time × Group interaction effect was investigated using two between-groups *t*-tests. Group differences in trustworthiness ratings made during the first completion of the task were not significant, *t*(38) = 0.38, *p* = .70, *d* = 0.12. However, there were group differences in trustworthiness ratings made during the second run of the task. Participants who had completed the arousal induction rated faces as less trustworthy than participants who had completed the neutral induction, *t*(38) = 2.81, *p* = .008, *d* = 0.89.

**Discussion**

This experiment showed that heightened arousal led to unfamiliar faces being perceived as significantly less trustworthy by participants when compared to those participants who were in a control condition. The results support the findings of Hooker et al. (2011) suggesting that individuals in a heightened state of arousal perceive unfamiliar individuals as less trustworthy.

A limitation of this experiment is that the baseline levels of arousal were very low and increased only slightly following the manipulation. This level of arousal is probably well below that reported by a clinical group experiencing paranoia. Given the importance of testing the mechanism of arousal on judgements of trust, future research should consider excluding participants who report little or no change following the arousal manipulation as an increase in arousal is a necessary precondition to allow fair testing of the theory.

A second limitation is that the experiment only investigated the impact of heightened arousal on ratings of trustworthiness. Increased arousal may result in faces being perceived negatively more generally, hence it would be beneficial to incorporate additional trait ratings. Ratings of attractiveness are also automatic (Willis & Todorov, 2006), and draw upon some of the same neural networks as inferences of trust (Bzdok et al., 2012). Experiment two therefore included ratings of attractiveness and intelligence (a dimension with valence but no obvious connection with trust) as well as trustworthiness to assess the impact of arousal more broadly.

Additionally, in examining the task materials it appeared that many more of the untrustworthy items had direct gaze whereas many of those rated as trustworthy had gaze that was averted and was consistently directed upwards. As described previously, direct eye gaze has been shown to heighten arousal levels (Helminen, Kaasinen, & Hietanen, 2011) and to have complex effects on trust-ratings (e.g., Willis et al., 2011). Consequently, it was important to control for gaze direction in a second study which also provided an opportunity to examine whether gaze direction impacted on ratings.

**Experiment Two**

Experiment one demonstrated that an arousal induction led to lower levels of trust evaluations of unfamiliar faces. Experiment two considered whether a) this could be replicated, and b) if this effect was specific to trust-ratings, or whether attractiveness and intelligence ratings would also be affected, and c) explored the influence of direction of eye gaze.

With regards to eye gaze, in some contexts, direct gaze may be perceived as aggressive or threatening (Frischen, Bayliss, & Tipper, 2007), and in others, it is associated with increased trustworthiness (Kreysa et al., 2016). The mood of the rater (Wyland & Forgas, 2010) and the emotion expressed by the to-be-rated face (Willis et al., 2011) appear to be important moderators of the relationship between direct gaze and trust-ratings. Experiment two, therefore, controlled for effects of gaze direction (by having equal numbers of direct and averted gaze for each face type), while also allowing an investigation of whether direct gaze was perceived as more threatening.

In the context of these findings there were four key predictions. The first was that under conditions of increased arousal levels, trust-ratings would be lower (replicating the results of Experiment One). Second, that this impact would be specific to trust-ratings and there would be no effect of arousal on attractiveness-ratings and intelligence-ratings. Third, it was predicted that direct gaze would lead trustworthy faces to be evaluated more positively and untrustworthy faces more negatively in comparison to indirect gaze. Our final prediction was that increased arousal would impact most strongly upon the ratings made by participants to faces with direct eye gaze.

**Method**

**Participants**

Sixty-nine students participated in this experiment. One was excluded from analysis owing to corrupted data. Additional participants were excluded from the analysis if they did not respond to the arousal manipulation. A lack of response was defined as a limited increase (mean increase < 0.5 on the VAS items) following the arousal manipulation (n = 17). Three participants were excluded owing to unexpectedly increasing in arousal following the neutral prime in the control condition. This resulted in a final sample of 48 participants (43 female, mean age = 23.08, *SD* = 5.13).

**Design**

A 2 x 2 x 2 x 2 mixed design was utilised, with the experimental condition (arousal or control) as the between-subjects factor, and gaze direction (direct or averted), face type (untrustworthy or trustworthy; neutral faces were not used in this experiment) and time (pre and post experimental condition) as the within-subjects factors. Faces were rated on three different traits (trustworthiness, attractiveness and intelligence).

**Measures**

As with Experiment one, the GPTS (Green et al., 2008) and VAS to measure state arousal and paranoia were completed. The scales demonstrated good internal reliability (GPTS α = .94; arousal VAS α = .79, paranoia VAS α = .82, overall VAS total α = .74).

**Face Evaluation Task**

Eighty computer generated faces were selected from the Todorov face data set (Oosterhof & Todorov, 2008). Faces were taken from polar ends of the spectrum (i.e., most and least trustworthy versions), with pairs of faces demonstrating matching gaze direction (i.e., both direct or averted). For five pairs of faces, gaze was manipulated using Microsoft Paint, to ensure gaze was clearly direct or averted. Faces were allocated to either PowerPoint A or B so that there were similar numbers of each face type in each presentation. Each face was displayed for 8 seconds, with an 8 second black slide presented between each face, in a fixed randomised order. Participants completed 4-point Likert scales for each face, rating them on perceived levels of attractiveness, trustworthiness and intelligence (e.g., 1 = *untrustworthy*; 4 = *trustworthy*). These 4-point scales were used to simplify the task given the increase in overall number of ratings required.

**Procedure**

The procedure was similar to Experiment one. Participants were randomly allocated to either the arousal or control condition, as well as the order they completed the two presentations (i.e., A then B or B then A). However, as noted 17 participants did not react to the arousal manipulation and therefore there was purposeful recruitment to this condition for the final nine participants to ensure equal group sizes. Consequently allocation to condition was not random for nine of the 69 participants tested.

**Sample Size Considerations**

The full model is a 2 x 2 x 2 x 2 (Time X Group X Face type x eye gaze direction) ANOVA, but once again the key test is the within-between Time x Group interaction. Given the changes to the experiment we estimated a medium effect size (f = .20) for the interaction (the effect size from experiment one was equivalent to f value of 0.45), with alpha = 0.05; power = 0.80, the required sample size for the 1 df interaction is 52.  This is based on an assumed correlation between pre- and post-induction measures of .5 as used in study one.

**Results**

**Sample Characteristics**

Table 2 demonstrates that there were no significant differences between groups in terms of gender. However, there was a significant difference with age, and paranoia scores. These differences were accounted for by older postgraduate participants recruited later in the experiment who were recruited in to the arousal condition to replace excluded participants. Pearson’s correlation identified a negative correlation between GPTS scores and age (*r* = -47*, p* = .001). These differences were controlled for with the addition of the GPTS variable as a covariate using ANCOVA.

Table 2 about here please

Analyses revealed no effects of the order of face presentations (order A or B). The order of the presentation of the facial stimuli was not, therefore, considered further.

Manipulation Checks

The impact of the arousal manipulation is shown in Figure 3. The levels of arousal are similar to those reported in Experiment one, in that they are generally low, and show only a modest increase after the arousal manipulation.

Figure three about here please

A 2 x 4 mixed design ANOVA was conducted to determine if participant arousal varied as a function of the experimental manipulation, with a within-subject factor of Time (VAS ratings at times 1 to 4) and a between-subjects factor of Group (arousal versus control). There was a significant main effect of Group, *F*(1,46) = 12.91, *p* = .001, ηp2 = .22, indicating that participants in the experimental condition were on average more aroused (*M* = 1.49, *SD* = 0.17) than those in the control condition (*M* = 0.65, *SD* = 0.17). There was also a significant main effect of Time, *F*(1.98, 90.99) = 15.96, *p <*.001, ηp2 = .26 and these two main effects were qualified by a significant Group × Time interaction, *F*(1.98, 90.99) = 49.21, *p* < .001, ηp2 = .52. Exploration of this interaction showed that groups reported similar levels of arousal pre-manipulation, but differed post-manipulation (Figure 3), with participants reporting higher levels of arousal in the experimental condition, which was maintained for the second face rating task.

Face Evaluation

A 2 x 2 x 2 x 2 mixed design ANCOVA was conducted for each of the three sets of ratings (trust, attractiveness, and intelligence), controlling for differences in GPTS scores. Group (arousal or control) was the between subjects variable, and Face Type (trustworthy or untrustworthy), Gaze Direction (direct or averted) and Time (pre and post) were within subjects variables. A summary of the mean and standard deviations for each face type, for each trait rating are shown in Table 3. A summary of all main effects and interactions is shown in Table 4.

Table 3 about here please

 Table 4 about here please

Trustworthiness ratings. There was a significant main effect of Face Type, *F*(1, 45) = 7.34, *p* = .01, ηp2 = .14, power = .76, with trustworthy faces rated as more trustworthy (*M* = 2.75, *SD* = 0.48) than untrustworthy faces (*M* = 2.08, *SD* = 0.48). There was no significant main effect of Time, *F*(1,45) = 0.08, *p* = .78, ηp2 = .00, power = .06, or Group, *F*(1,45) = 0.19, *p* = .67, ηp2 = .004, power = .07. In contrast to Experiment one, the Time × Group interaction was not significant, *F*(1,45) = 2.71, *p* = .11, ηp2 = .06, power = .36. There was a significant Time x Face Type x Group interaction, *F*(1,45) = 4.18, *p* = .047, ηp2 = .09, power = .52. Ratings for trustworthy faces decreased slightly post-manipulation in the arousal condition (*M* = 2.77, *SD* = 0.46 to *M* = 2.55, *SD* = 0.59), but did not change over time in the control condition (*M* = 2.71, *SD* = 0.47 to *M* = 2.71, *SD* = 0.41). There was no significant change pre- to post‑manipulation in ratings of untrustworthy faces for either group. These effects were modified further by interactions with gaze direction.

There was no main effect of Gaze, *F*(1, 45) = 0.79, *p* = .38, ηp2 = .02, power = .14, nor simple Gaze Direction x Face Type interaction, *F*(1, 45) = 0.38, *p* = .54, ηp2 = .01, power = .09. Trends in the overall means were that trustworthy faces with direct gaze were rated most trustworthy (*M* = 2.98, *SD* = 0.38 cf. *M* = 2.52, *SD* = 0.65 with gaze averted), whereas untrustworthy faces with direct gaze were rated least trustworthy (*M* = 2.01, *SD* = 0.52 cf. *M* = 2.16, *SD* = 0.46 with gaze averted) by participants. Effects of gaze and trustworthiness were demonstrated in a significant Time x Face Type x Gaze Direction interaction, *F*(1,45) = 14.71, *p* < .001, ηp2 = .25, power = .96. Trustworthy faces with direct gaze were rated as most trustworthy post-manipulation (*M* = 3.04, *SD* = 0.45), while trustworthy faces with averted gaze were rated less trustworthy (*M* = 2.47, *SD* = 0.75), but with little effect of condition on the untrustworthy faces.

Finally, there was a significant 4-way interaction of Time x Face Type x Gaze Direction x Group, *F*(1,45) = 7.19, *p* = .010, ηp2 = .14, power = .75. Figure 4 shows that the arousal group demonstrated a decrease in ratings of trustworthiness for the trustworthy faces with averted gaze following the arousal manipulation (*M* = 2.61, *SD* = 0.58 to *M* = 2.37, *SD* = 0.80), while the control group demonstrated a slight increase in ratings (*M* = 2.52, *SD* = 0.63 to *M* = 2.57, *SD* = 0.69). For trustworthy faces with direct gaze, both groups showed a slight increase in ratings, while there was little difference pre- and post-manipulation ratings for untrustworthy faces by either group.

Figure 4 about here please

 Intelligence ratings. There was a significant main effect of Face Type, *F*(1,45) = 11.03, *p* = .002, η2 = .20, power = .90, with trustworthy faces rated as more intelligent (*M* = 2.55, *SD* = 0.42) than untrustworthy faces (*M* = 2.20, *SD* = 0.39). There was also a significant Time x Face Type x Group interaction, *F*(1,45) = 4.53, *p* = .039, η2 = .09, power = .55. This interaction differed from the pattern found for trustworthiness ratings, as the control group demonstrated an increase in intelligence ratings for trustworthy faces, while the arousal group showed little change. There was again no difference between intelligence ratings of untrustworthy faces pre or post-manipulation for either group.

Attractiveness ratings. There was a Time x Group interaction, *F*(1,45) = 5.79, *p* = .02, η2 = .11, power = .65, with attractiveness ratings decreasing post‑manipulation in the arousal group (*M* = 1.88, *SD* = 0.42 to *M* = 1.79, *SD* = 0.42) and increasing in the control group (*M* = 1.79, *SD* = 0.28 to *M* = 1.81, *SD* = 0.29). There was no significant 3-way interaction of Time x Face Type x Group, *F*(1,45) = 1.12, *p* =.29, η2 = .03, power = .18. For attractiveness, there was a Face Type x Gaze Direction interaction, *F*(1,45) = 12.36, *p* = .001, η2 = .22, power = .93, with attractiveness ratings following a similar pattern as trustworthiness ratings, i.e. untrustworthy faces with direct gaze were rated as least attractive, and trustworthy faces with direct gaze were rated as most attractive. However, there was no significant Time x Face Type x Gaze Direction interaction

Discussion

Experiment two only found partial support for its hypotheses. In terms of the attempted replication of Experiment one, heightened arousal resulted in only trustworthy faces being seen as less trustworthy, but there was no difference in ratings of untrustworthy faces. Additionally, the arousal manipulation resulted in faces being rated as less attractive overall, regardless of face type. Arousal therefore did not only affect trust-ratings. However, given the strong correlation between trustworthiness ratings and attractiveness ratings (r = .79; Oosterhof & Todorov, 2008) and the possibility that they reflect the same underlying dimension of trustworthiness (at least when a relatively narrow age-range of faces are employed; Sutherland et al., 2013), this is perhaps unsurprising.

 The arousal manipulation did not affect ratings of intelligence in the same manner. Intelligence seemed to be unaffected by arousal manipulations, with the exception of the control group rating faces as appearing more intelligent. With regards to the third hypothesis, the impact of direct eye gaze was dependent on the face type, with untrustworthy faces with direct gaze seen as particularly untrustworthy, while trustworthy faces with direct gaze were rated most trustworthy. The same pattern was shown for attractiveness ratings but not intelligence. These effects echo those reported by Willis et al. (2011) who showed that evaluative judgements were more positive for happy faces with direct gaze and more negative to angry faces with direct gaze, compared with averted gaze.

Finally, with regards hypothesis four, the participants rated trustworthy faces with averted gaze as less trustworthy following arousal manipulation, whilst the control group rated trustworthy faces with direct gaze as significantly more trustworthy. There was no meaningful difference in ratings for untrustworthy faces with direct or averted gaze post arousal manipulation.

This experiment addressed some of the limitations of the first experiment, by including additional trait ratings, and both controlling for and exploring how gaze direction impacted on the trustworthiness ratings. This experiment also excluded participants who demonstrated no increase in arousal following the manipulation. This was necessary to provide an adequate test of the hypothesis. This process was successful as evidenced by the larger effect size reported in experiment two after the manipulation. However, an important limitation is that it was a very mild arousal manipulation. In addition, the baseline levels of paranoia were low, and were lowest in the arousal group, which whilst controlled for may have acted against the experiment’s ability to detect differences in trust before and after an arousal manipulation.

General Discussion

The two studies investigated the relationship between arousal, paranoia, direction of eye gaze and judgements of trustworthiness. The first experiment showed that following the arousal manipulation participants rated unfamiliar faces as less trustworthy. This finding was partially replicated in experiment two, as induced levels of arousal decreased trustworthiness ratings of trustworthy faces, and in particular reduced ratings of trustworthy faces with averted eye gaze. Furthermore, it was found that increased arousal reduced ratings of attractiveness, whereas being more calm and relaxed increased ratings of intelligence. Trust and attractiveness appear to share common processes, which intelligence estimations do not (Bzdok et al., 2012). Overall, the findings indicate that evaluations of faces can be influenced by our internal state, specifically heightened negative arousal and replicate the findings of Hooker et al. (2011) but using a different method of arousal induction.

These findings add to our understanding of the evaluation of others. In experiment two, ratings of untrustworthy faces did not differ from pre- to post-manipulation, regardless of gaze direction. This suggests that untrustworthy faces are perceived as inherently untrustworthy, regardless of an individual’s internal state. In contrast, trustworthy faces were viewed as less trustworthy with heightened arousal, particularly faces with an averted gaze. In normal, everyday interactions, therefore, a person experiencing high levels of arousal may feel mistrusting of others, even in contexts where another’s appearance or actions do not warrant suspicion. Thus, everyday social interactions may compound negative beliefs about others in people vulnerable to high levels of arousal. This reveals the complex interplay between arousal, evaluations of trustworthiness and gaze direction, and suggests positive stimuli may also be judged negatively as part of a search for meaning consistent with the individual’s internal state (Freeman et al., 2002).

A number of limitations need to be considered, and differences between the studies mean direct comparison is limited. For instance, the rating scale used to rate each trait dimension was changed between the studies from a seven point to a four point scale (owing to the additional trait ratings in experiment two, a briefer scale was needed for feasibility). Hence, the lack of replication of the effect of arousal on trustworthy and untrustworthy faces may owe something to changes in methods. Moreover, the second experiment asked people to rate faces for attractiveness and intelligence that were chosen on the basis of trust properties alone. Additionally, the majority of the sample was female while the facial stimuli were all male, which may have affected how trustworthy or threatening the faces appeared. Sampling bias may also explain the low levels of paranoia and arousal in both studies, as students experiencing high levels of paranoia may not have felt comfortable volunteering for research at that point in time..

Future research could address these methodological issues and additionally use more realistic faces to further explore the influence of gaze on perceived trustworthiness of faces in clinical and non-clinical populations with a greater representation of male participants. Given the mixed findings of trust evaluations in clinical participants future research with clinical participants would need to measure state levels of negative arousal as well measures of paranoid ideation.

While the current research has no direct clinical implications it does contribute to the understanding of cognitive biases associated with paranoia and arousal that could be targeted as part of a broader treatment package (MacLeod, Koster, & Fox, 2009). Recent approaches to understanding and treating paranoia have understood that at its heart paranoia is characterised by people feeling unsafe, and as feeling particularly at threat from other people (Freeman, 2016). Hence, the goal of therapy is to help the person recognise that they are safer than they feel. To help them in this process, rather than purely challenge the evidence about their safety, recent treatments have tried to address the factors that lead people to develop their ideas such as their utilising a cognitive style of jumping to conclusions (Dudley, Taylor, Whickham & Hutton, 2015) and novel treatments have helped people notice and overcome this style (Garety, Waller, Emsley, Jolley, Kuipers, Bebbington, et al. 2015). Whilst not tested here, treatments could focus on helping individuals to identify and understand their varying internal states and the impact this has on their perception of others. Helping people to understand that heightened arousal may be increasing the chance of mistakenly attributing this to the actions of others may help people understand that they are actually safer than they feel. Similarly, recent developments in the use of virtual reality technologies (Freeman, Reeve, Robinson, Ehlers, Clark, Spanlang et al, 2017) show that there is promise in using these approaches to help people approach feared social situations. Such interventions could incorporate the knowledge from the current study and consider having people undertake the treatment under conditions of different levels of naturally varying arousal, and perhaps using avatars who vary in the trustworthiness of their faces, and the extent to which they directly stare at the participant.

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The authors have no interest to declare

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Table 1

*Descriptive Statistics for Trustworthiness Ratings by Face Type, Time and Group*

|  |  |  |
| --- | --- | --- |
|  |  | Mean Trustworthiness Ratings (SD) |
| Untrustworthy Faces  |  | 2.99 (0.38) |
| Neutral Faces |  | 3.97 (0.40) |
| Trustworthy Faces |  | 4.65 (0.50) |
| Control Group  | Pre-manipulation | 3.95 (0.42) |
|  | Post-manipulation | 3.93 (0.39) |
| Arousal Group | Pre-manipulation | 4.01 (0.43) |
|  | Post-manipulation | 3.29 (0.36) |
|  |  |  |

Table 2

*Baseline and Pre-Experimental Condition Group Differences (GPTS = Green Paranoid Thoughts Scale)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total *M* (*SD*)*N*=48 | Arousal *M* (*SD*)*n*=24 | Control *M* (*SD*)*n*=24 | Significance between conditions  |
| Gender (N female)  | 43 | 21 | 22 | *X2* (1) = 0.22 *p* = .64 |
| Age  | 23.08 (5.13) | 25.33 (5.59) | 20.83 (3.46)  | *t*(38.39) = 3.36, *p* = .0021*d* = 1.06 |
| GPTS scores  | 44.02 (13.04) | 40.08 (7.25) | 47.96 (16.20) | *t*(31.87) = -2.17, *p* = .0371*d* = 0.63 |

GPTS: Green Paranoid Thoughts Scale

 Levene’s test indicated unequal variances, therefore degrees of freedom were adjusted from 46 to 38.39 and 31.87.

Table 3

*Mean and SDs for Each Trait Rating of Each Face Type for Arousal and Control Groups*

|  |
| --- |
| TRUSTWORTHINESS |
| **Pre manipulation** |
|  |  | Arousal Group (n=24)*M (SD)* | Control group (n=24)*M (SD)* |
| Trustworthy faces | Direct gaze | 2.93 (0.42) |  | 2.91 (0.36) |  |
|  | Averted gaze | 2.61 (0.58) |  | 2.52 (0.63) |  |
| Untrustworthy faces | Direct gaze | 1.96 (0.58) |  | 1.98 (0.69) |  |
|  | Averted gaze | 2.17 (0.50) |  | 2.21 (0.53) |  |
| **Post manipulation** |
|  |  | Arousal Group (n=24)*M (SD)* | Control group (n=24)*M (SD)* |
| Trustworthy faces | Direct gaze | 2.98 (0.53) |  | 3.12 (0.36) |  |
|  | Averted gaze | 2.37 (0.80) |  | 2.57 (0.69) |  |
| Untrustworthy faces | Direct gaze | 2.00 (0.40) |  | 2.10 (0.53) |  |
|  | Averted gaze | 2.14 (0.49) |  | 2.12 (0.51) |  |
|

|  |
| --- |
| INTELLIGENCE |
| **Pre manipulation** |
|  |  | Arousal Group (n=24)*M (SD)* | Control group (n=24)*M (SD)* |
| Trustworthy faces | Direct gaze | 2.59 (0.55) |  | 2.35 (0.38) |  |
|  | Averted gaze | 2.58 (0.55) |  | 2.36 (0.38) |  |
| Untrustworthy faces | Direct gaze | 2.11 (0.50) |  | 2.17 (0.45) |  |
|  | Averted gaze | 2.17 (0.43) |  | 2.25 (0.34) |  |
| **Post manipulation** |
|  |  | Arousal Group (n=24)*M (SD)* | Control group (n=24)*M (SD)* |
| Trustworthy faces | Direct gaze | 2.83 (0.61) |  | 2.74 (0.33) |  |
|  | Averted gaze | 2.52 (0.67) |  | 2.43 (0.34) |  |
| Untrustworthy faces | Direct gaze | 2.24 (0.43) |  | 2.21 (0.36) |  |
|  | Averted gaze | 2.20 (0.46) |  | 2.23 (0.47) |  |

 ATTRACTIVENESS |
| **Pre manipulation** |
|  |  | Arousal Group (n=24)*M (SD)* | Control group (n=24)*M (SD)* |
| Trustworthy faces | Direct gaze | 2.08 (0.59) |  | 2.02 (0.41) |  |
|  | Averted gaze | 2.15 (0.74) |  | 2.00 (0.58) |  |
| Untrustworthy faces | Direct gaze | 1.58 (0.35) |  | 1.52 (0.43) |  |
|  | Averted gaze | 1.72 (0.44) |  | 1.62 (0.29) |  |
| **Post manipulation** |
|  |  | Arousal Group (n=24)*M (SD)* | Control group (n=24)*M (SD)* |
| Trustworthy faces | Direct gaze | 2.11 (0.60) |  | 2.28 (0.44) |  |
|  | Averted gaze | 1.95 (0.74) |  | 1.89 (0.51) |  |
| Untrustworthy faces | Direct gaze | 1.59 (0.36) |  | 1.62 (0.35) |  |
|  | Averted gaze | 1.71 (0.39) |  | 1.63 (0.40) |  |

Table 4

*Summary of the Main Effects and Interactions for the 4-way ANCOVA for Each Trait Rating*

|  |  |  |  |
| --- | --- | --- | --- |
|  | Trustworthiness | Intelligence | Attractiveness |
| Main effects  |  |  |  |
| Time | 0.08 | 1.45 | 1.284 |
| Face | 7.34\*\* | 11.03\*\* | 3.757 |
| Gaze | 0.79 | 0.27 | 0.04 |
| Group | 0.19 | 0.77 | 0.02 |
| 2-way interactions |  |  |  |
| Time x group | 2.71 | 0.44 | 5.79\* |
| Face x group | 0.29 | 0.36 | 0.18 |
| Gaze x group | 0.06 | 0.46 | 1.99 |
| Time x face | 0.68 | 0.13 | 1.00 |
| Time x gaze | 0.00 | 1.99 | 1.64 |
| Face x gaze | 0.38 | 3.68 | 12.36\*\*\* |
| 3-way interactions |  |  |  |
| Time x face x group | 4.18\* | 4.53\* | 1.15 |
| Time x gaze x group | 0.07 | 0.01 | 1.04 |
| Face x gaze x group | 0.75 | 0.42 | 2.99 |
| Time x face x gaze | 14.71\*\*\* | 0.69 | 0.01 |
| 4-way interaction |  |  |  |
| Time x face x gaze x group | 7.19\*\* | 0.02 | 0.10 |

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001



Figure 1

*Means of VAS Scores (Range 0-10) for each group at each stage in Experiment One*

VAS: Visual Analogue Scale

|  |
| --- |
| *VAS time 1 comparison t*(46) = -0.29, *p* = .77, *d* = 0.08 |
| *VAS time 2 comparison t*(46) = 1.34, *p =* .19, *d* = 0.38 |
| *VAS time 3 comparison t*(25.04) = 7.37, *p* <.0012, *d* = 2.12 |
| *VAS time 4 comparison t*(33.65) = 2.58, *p =* .0152, *d* = 0.74 |

Figure 2

*Means of VAS Scores (Range 0-10) for each group at each stage in Experiment Two*

Figure 3.Mean trustworthiness ratings pre and post-manipulation, for each type of face and each group