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ORIGINAL ARTICLE

Depressive Primes Stimulate Initial Avoidance of Angry Faces: An Eye-Tracking Study of Paranoid Ideation

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Abstract Cognitive models of paranoia posit the existence of specific information-processing biases, such as attentional biases, that are related to persecutory beliefs. The nature of these biases remains unclear. Some models propose depression to be at the core of paranoid ideation, while other models propose anxiety. In this study we tested whether attentional biases towards angry or neutral faces were facilitated by 300-ms presentation of an emotional prime word (positive, depressive, paranoid, neutral) in normal participants high in paranoid beliefs (HPB, N = 52) or low in paranoid beliefs (LPB, N = 43). Analyses of first fixation patterns in visual scanpaths revealed that paranoid words made all participants avoid angry faces, though this tendency reached significance only in the LPB group. In contrast, depressive words triggered significant avoidance of angry faces in the HPB group. These findings suggest that activation of depressive cognitive schemas facilitates attentional biases specifically in participants with subclinical paranoia, which would favor the depression-based model of paranoia. We discuss the importance of priming methodologies and visual scan measures for revealing specific cognitive processes in psychopathology and testing competing etiological models of paranoia.

Keywords Eye-tracking · Selective attention · Paranoia · Depression · Anxiety

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Introduction

Recent theoretical models of persecutory beliefs implicate affective and cognitive processes in the genesis and maintenance of persecutory delusions (Bentall et al. 2001; Freeman et al. 2002). However, elucidating the precise role of these processes has proven to be more difficult than expected.

The information-processing paradigm, very useful in studying depression and anxiety, provides a framework for studying mechanisms underlying persecutory delusions. According to Beck's (1976) cognitive specificity hypothesis, emotional disorders differ mainly in the content of their schemas. For instance, according to this hypothesis, anxious individuals show dysfunctional schemas that contain themes related to personal threat or harm, which bias their cognitive processes related to threats. In contrast, the schemas of depressed individuals contain themes related to loss, failure and rejection, which bias their cognitive processes related to these contents (Beck et al. 1985). However, research suggests that psychological disorders differ not only in schema content but also in the processes involved in each disorder (Mathews and MacLeod 2005). Increasing evidence suggests that anxiety involves biases in early stages of automatic information processing (Bar-Haim et al. 2007; Yoon and Zinbarg 2008), whereas depression involves biases during later stages of information that typically involve more elaborated processes (Matt et al. 1992; Vázquez and Hernangómez 2009).

Research on current cognitive models of persecutory delusions ~~have~~ explored similarities between paranoia and the cognitive processing of information associated with anxiety and depression (e.g., Freeman et al. 2001, 2002; Green and Phillips 2004). Drawing on similarities with depression, some models have proposed that paranoid

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patients exaggerate attempts to maintain a positive self-concept because of the existence of an underlying negative self-schema (Bentall et al. 2001; Lyon et al. 1994; Kinderman 1994). According to this reasoning, persecutory delusions operate as a *self-serving* mechanism, allowing individuals to avoid the activation of negative self-beliefs by attributing negative experiences to external causes (see Bentall et al. 2001). Although initial research on attributional biases in psychosis yielded contradictory results (see Díez-Alegría et al. 2006), recent results support the defensive model. For example, paranoid patients have been found to have positive explicit self-esteem but negative implicit self-esteem (Valiente et al. 2011). In addition, paranoia is associated with highly unstable self-esteem, and decreases in self-esteem are associated with exacerbation of paranoid thinking (Thewissen et al. 2008).

Other models of persecutory thinking have linked paranoid delusions to anxiety (e.g., Garety and Freeman 1999). There is empirical support for cognitive models of anxiety that posit early vigilance/facilitated attention to threat cues, followed by avoidance of the same cues (e.g., Koster et al. 2006; Koster et al. 2005; Mogg et al. 2004; Williams et al. 1997). Indeed, some authors have suggested a role for hypervigilance and worry in the development of psychosis (Freeman and Garety 1999; Freeman et al. 2000). For example, high levels of anxiety have repeatedly been found to occur prior to and during psychotic delusions (e.g., Norman and Malla 1994). More importantly, anxious and paranoid people are similar in their attentional processing of threatening information (Green and Phillips 2004).

Research exploring the attentional processing of paranoid individuals has evolved through diverse methodologies. Emotional Stroop and dot-probe methodologies, while helpful for detecting attentional biases in anxiety, have yielded divergent results in paranoia (Bentall and Kaney 1989; Taylor and John 2004). To overcome some limitations of these methods (see Caseras, et al. 2007), research has gradually focused on measuring attention using visual scanning techniques. These techniques allow continuous monitoring of visual attention. Evidence from eye-tracking studies in paranoia has revealed a gaze bias in which the eye gravitates toward threatening stimuli but then later avoids them. This pattern of results has been found in clinical samples with persecutory delusions (Freeman et al. 2000; Green et al. 2003b; Phillips and David 1997; Phillips et al. 2000), non-clinical delusion-prone individuals (Green et al. 2003a), and individuals with a high trait anxiety or generalized anxiety disorder (Mogg and Bradley 2005). Thus, it remains unclear whether this attentional pattern is specific to paranoid individuals.

To our knowledge no research to date has compared the validity of anxiety- and depression-based models of paranoia in the same study using attentional tasks. Furthermore, existing research on cognition and paranoia based on information-processing paradigms has not fully explored the specific role of self-schema in attentional biases.

Present Study

The aim of this study was to explore whether the activation of negative self-schemas through cognitive priming could affect selective attentional biases towards threatening information in people with paranoid ideation. Previous research with anxiety has shown that activation of threat-related schemas may bias subsequent information processing. For instance, Helfinstein et al. (2008) primed a group of individuals with social anxiety with a social threat word, and then showed them a pair of faces (one neutral, one angry) in a dot-probe task. Under this condition, participants did not show an attention bias to angry faces but a suppression of bias. Specifically, the authors suggested that the emotional prime activated the anxiety system which provoked an initial increase of alertness and, when the dot probe was presented (i.e., 300 ms later), a bias away from angry faces. Following a similar approach, we examined selective attention of participants using an eye-tracking paradigm. To activate specific cognitive schemas, we used four types of prime words: neutral, happy, depressive and paranoid. To assess selective attention we used pairs of neutral and angry faces. Neutral and positive priming conditions allowed us to explore natural vigilance bias toward angry faces. Depressive and paranoid prime conditions allowed us to explore whether activating a depressive or threat-related self-schema could affect attentional biases to emotional stimuli, in this case angry faces.

Previous research on anxiety and paranoid attentional processes suggest initial preference for threatening stimuli, followed by avoidance from them (see Green and Phillips 2004). However, based on the results of Helfinstein et al. (2008), we hypothesized that negative emotional primes would alter this attentional pattern. More specifically, our first hypothesis was that, in individuals high in paranoid ideation, paranoid primes would increase the probability that subjects would initially avoid angry faces. Our second hypothesis was that, if depressive schemas play a role in paranoia (Kinderman 1994), then depressive primes would also elicit an initial avoidance bias in individuals high in paranoia. This would show that these participants are more likely to interpret depressive information as threatening compared to those with lower paranoia scores. If confirmed, this finding would contribute to an integration of the anxiety and depression models of paranoia.

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Method

Participants

Participants were 95 undergraduate students (10 men and 85 women) who volunteered for participation in the experiment in exchange for partial course credit. Mean age was 22.82 years ($SD = 2.90$). All the participants reported having normal vision. Based on the median Paranoia Scale score ($M = 32$), participants were classified for further analyses into two groups: low on persecutory beliefs (LPB) ($n = 43$) or high on persecutory beliefs (HPB) ($n = 52$). In order to validate the method of group assignment used in this study, we administered other measure of paranoia (the Persecution and Deservedness Scale, PaDS; Melo et al. 2009), described in the next section). The HPB group showed significantly higher scores on the PaDS than the LPB group [$t(93) = -6.45$, $P < .001$]. The procedure of dividing the groups based on the median in the PS has been used to explore differences in cognitive processing between groups (e.g., Fenigstein 1997; Linney et al. 1998). Using similar scales, like the PDI (Peters et al. 1996 Delusion Inventory), and also using a median split procedure, Green et al. (2003a, b) explored group differences on visual scan and facial affect recognition.

Psychological and Clinical Measures

- Paranoia Scale (PS; Fenigstein and Vanable 1992). This 20-item instrument was designed to assess self-reported paranoid ideation in the general population. It is the most widely used dimensional measure of paranoia. Each item is rated on a five-point Likert scale (1, not at all applicable; 5, extremely applicable). Scores can range from 20 to 100, with higher scores indicating greater paranoid ideation. It measures participant agreement with statements such as, "I sometimes feel as if I'm being followed", or "I have often found people jealous of my good ideas just because they had not thought of them first". In our study, the range of PS scores was 20–65, and the instrument showed good internal consistency ($\alpha = .87$).
- Beck Depression Inventory (BDI-II; Beck et al. 1988). This is a 21-item self-report questionnaire to assess the severity of symptoms of depression. Each item is rated on a four-point scale (0–3), with higher scores reflecting greater severity of symptoms (e.g., "I feel sad most of the time"). The Spanish version (Sanz et al. 2003) has shown good inter-item reliability and construct validity. Participants rated the occurrence of each symptom using a 4-point scale. In our study, the Cronbach's α was .90.
- The Brief Core Schema Scales (BCSS; Fowler et al. 2006). This is an instrument specifically designed to assess self-evaluations and evaluations of others in psychosis. The BCSS contain 24 items related to beliefs about the self and others; the items are assessed on a 5-point scale (0–4). The scale contains four subscales: negative self (BCSS-NS; e.g., "I am worthless"), positive self (BCSS-PS; e.g., "I am successful"), negative others (BCSS-NO; e.g., "Other people are bad") and positive others (BCSS-PO; e.g., "Other people are accepting"). Each subscale contains six statements. In our study, the BCSS showed good internal consistency: BCSS-NS, $\alpha = .68$; BCSS-PS, $\alpha = .81$; BCSS-NO, $\alpha = .75$; BCSS-PO, $\alpha = .88$.
- Brief Fear of Negative Evaluation Scale (FNES; Leary 1983). The FNES is a 12-item scale that measures social anxiety, fear of criticism, and fear of negative evaluation in social settings. The FNES is scored on a Likert scale ranging from 1 ("not at all") to 5 ("extremely"). The scale consists of items such as, "The opinions of others about me do not bother me". Total scores can range from 12 to 60, with higher scores reflecting greater social anxiety. In this study, the internal consistency was .90.
- Rosenberg Self-Esteem Questionnaire (RSQ; Rosenberg 1965). RSQ is a widely used measure of global self-esteem. It has 10 items and participants are required to indicate their agreement with the statements on a four-point Likert scale (e.g., "I think I am a valuable person, at least the same level as others"). The range of possible scores is 10–40, with higher scores indicating higher self-esteem. In our study, the Cronbach's α was .85.
- The Persecution and Deservedness Scale (PaDS; Melo et al. 2009). This is a brief measure to assess both the severity of paranoid thinking and the perceived deservedness of persecution, and is suitable for clinical and non-clinical populations. In this study we used only the 10-item persecution subscale, which measures beliefs of being the target of others' malevolence (e.g., "There are times when I worry that others might be plotting against me"). Participants were asked to rate each statement on a 5-point scale ranging from 0 (*certainly false*) to 4 (*certainly true*). Melo et al. (2009) have reported good internal reliability and a high correlation with the Paranoia Scale. In our study, internal consistency was $\alpha = .72$ for the persecution ideation subscale.

Eye-Tracking Paradigm

In this task, pairs of faces of the same actor (one neutral and one angry) were simultaneously presented to the participant. Immediately before each presentation of faces,

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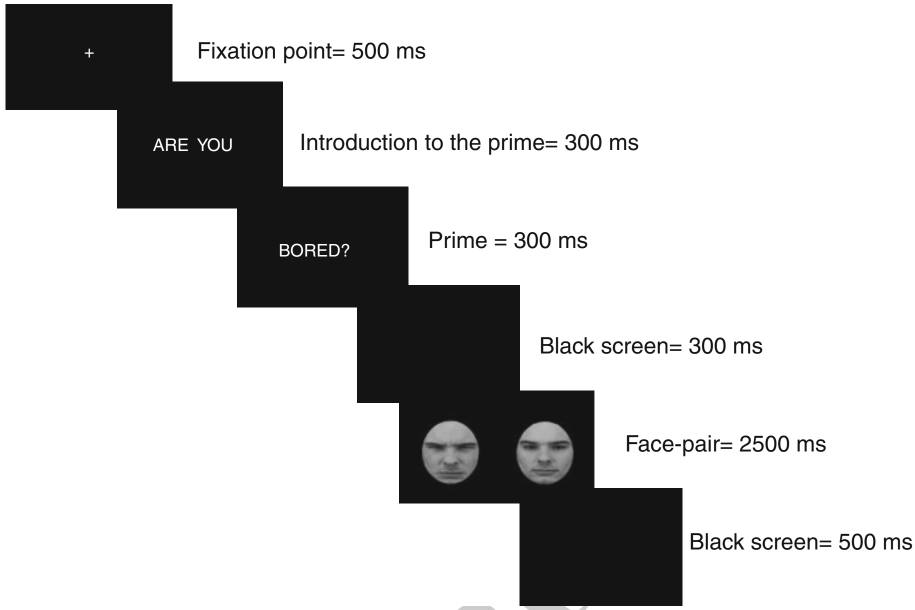

Fig. 1 Time sequence of events in the attentional task. *Note*: In Spanish, the phrase “are you…” consists of only one word: “eres...”

participants were presented with a prime word using a self-referent paradigm (Fig. 1).

Prime Word Selection

Self-referent adjectives were selected for use as prime words. Adjectives belonged to four different categories: neutral, positive, depressive and paranoid. Depression and positive adjectives were selected from the lexical database of Jiménez et al. (1998). Depression words basically covered symptoms of depression (e.g., “loser”, “stupid”, “boring”) and positive words reflected the opposite emotional concepts (e.g., “admirable”, “winner”, “lucky”). Paranoid-related adjectives (e.g., “spied”, “controlled”, “cheated”) were selected from the database of Nieto et al. (2006), which presents norms for paranoia-related words. Neutral self-referent adjectives (e.g., “large”, “scholar”, “single”) were chosen from the LEXESP database (Sebastián et al. 2000). The four lists of adjectives showed no significant differences in frequency of use [F $(3, 92) = .932$, $P = .43$]. The three categories of emotional words (depressive, positive and paranoid) did not show significant differences in their established norms for emotionality [F $(2, 69) = .126$, $P = .88$].

Emotional Faces

We used 24 photographs (12 male and 12 female) depicting threatening (angry) and neutral emotions. Images were selected from the standardized Karolinska A-series [Karolinska Directed Emotional Faces Database (KDEF); Lundqvist et al. 1998]. Each face was edited and cropped to fit within an oval window, and non-informative aspects of emotional expression were removed, i.e., hair, neck, and peripheral areas surrounding the face (Sánchez and Vázquez 2011). The display of faces consisted of two photographs of the same individual, one to the left and the other to the right of the central fixation point. One photograph depicted a neutral expression and the other a angry expression (Fig. 1). Each face was 9.53 cm tall by 6.99 cm wide. Emotional and neutral faces were balanced so that each appeared the same number of times on the left or right side of the screen.

A total of 96 trials were conducted using female and male faces and four prime categories. According to Sánchez and Vázquez (2011) norms, there were no significant differences between male and female angry faces on arousal [$t(24) = .18$, $P = .85$] or affective content [$t(24) = -.69$, $P = .50$].

Apparatus

All stimuli were presented on a 21-inch computer monitor placed 90 cm away from the participant. Eye movements were tracked with a Tobii X120 apparatus situated below the monitor at a distance of 60 cm from the participant. Gaze location was sampled every 16.7 ms (60 Hz). Visual fixations were defined as eye movements that were confined to a diameter of 35 pixels for more than 100 ms (ms) within a visual angle of 1° in areas of interest (AOIs; Bradley et al. 2000). Data reduction and initial statistical analyses were conducted using Tobii Studio™ 1.5.6.0.

Initial Orientation Index

Eye fixations were examined for two different AOIs of the face display: ~~threatening~~ face (AIO-~~T~~) and neutral face

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(AOI-N). Eight conditions were tested using the combination of the two AOIs and the four categories of prime words. Based on the initial orientation index we calculated a bias score for each of these conditions. The bias score indicated the relative probability that the participant's first visual fixation was on AOI-T or AOI-N. To calculate the bias score, we first calculated the frequency of trials in which the participant's first gaze fixation was directed at AOI-T (FT) and the frequency of trials in which it was directed at AOI-N (FN). Then, an index score was computed [$\sum$ FT/(FT + FN)] for each of the four prime categories. A value of 0.5 indicates no bias in the first fixation. Scores above 0.5 indicate that the participant tended to gaze first at angry faces, whereas scores below 0.5 indicate a tendency to direct the first gaze at neutral faces and to avoid angry ones.

Procedure

Participants arrived at the eye-tracking lab, where they completed the self-report questionnaires. Then they were invited to sit in an adjustable chair that kept their eyes in line with the middle of the computer monitor. Before starting the experimental task, a 5-point calibration procedure ensured that the eye tracker was recording lines of visual gaze within a visual angle of 1° for each point. After calibration, instructions for the task were presented on the computer screen. The instructions asked participants to rapidly decide, in each trial, whether or not each of the adjectives presented described him or her. Participants were instructed to gaze freely at the photographs that would immediately follow each adjective presented.

Each of the 96 trials in the task involved the following series of images: fixation cross, prime, blank screen, and face display (Fig. 1). The central fixation cross was displayed for 500 ms. Next, to ensure self-referent processing of the displayed primes, the fixation cross was followed by the open question "are you" at the center of the screen for 300 ms. This screen was then replaced by a prime word (e.g., "bored?") for 300 ms. The prime word was followed by a blank screen for 300 ms, after which the face display appeared for 2500 ms. Finally, a blank screen was shown for 300 ms as the inter-trial interval. All text was written in capital letters.

Results

Demographics and Psychological Variables

Statistical analyses revealed no significant differences between groups in age or sex (Table 1).

Table 1 Demographic and psychological characteristics in individuals low in persecutory beliefs (LPB) and high in persecutory beliefs (HPB)

Characteristic[a]	LPB (n = 43)	HPB (n = 52)	X^2	t
Female, n (%)	39 (90.7)	46 (88.5)	.04	
Age, year	23.40 (3.79)	22.35 (1.78)		1.67
PS	26.35 (2.84)	40.98 (8.24)		−11.98**
PaDS	3.33 (2.98)	8.40 (4.39)		−6.45**
FNES	31.84 (7.56)	40.65 (9.15)		−5.05**
BDI-II	4.26 (4.15)	10.50 (8.32)		−4.75**
RSQ	35.12 (3.97)	32.02 (5.96)		3.02**
BCSS-PS	15.40 (4.05)	15.15 (5.20)		.25
BCSS-NS	1.51 (1.91)	3.10 (3.36)		−2.88**
BCSS-PO	13.84 (4.35)	9.67 (4.61)		4.50**
BCSS-NO	1.21 (1.34)	2.96 (3.78)		−3.12**

PS paranoia scale, *PaDS* persecution and deservedness scale, *FNES* brief fear of negative evaluation scale, *BDI-II* beck depression inventory II, *RSQ* rosenberg self-esteem questionnaire, *BCSS-PS* brief core schema scales, positive self, *BCSS-NS* brief core schema scales, negative self, *BCSS-PO* brief core schema scales, positive other, *BCSS-NO* brief core schema scales, negative other

~~*$P < .05$;~~ **$P < .001$

[a] Values for all characteristics, except number of females, are reported as mean (SD)

The subgroup of participants high in paranoid ideation showed significantly more symptoms of paranoia (PS and PaDS), more depression (BDI-II), more fear of negative evaluations (FNES) and lower self-esteem (RSQ) than the subgroup low in paranoid ideation (Table 1). According to the BCSS, the HPB subgroup had a more negative view of themselves (BCSS-NS) and others (BCSS-NO), as well as a less positive view of others (BCSS-PO). However, there was no difference in positive view of oneself (BCSS-PS).

Initial Orientation Bias

A series of correlation analyses were performed to assess relationships between psychological measures and our measure of selective attention (i.e., initial orientation index) in the four prime conditions. Only two variables were significantly related to selective attention. First, a negative view of oneself (BCSS-NS) was positively related to a selective attention bias in the depressive prime condition ($r = .21$, $P < .05$). Second, a positive view of others (BCSS-PO) was negatively related to selective attention bias in the paranoid prime condition ($r = -.22$, $P < .05$).[1] These two psychological variables were considered as covariates in further analyses.

[1] The correlation between BDI-II scores and the initial orientation index in the depressive prime condition was not significant (r = -.06).

Table 2 Initial orientation index toward angry or neutral faces in LPB and HPB groups under four prime conditions

Prime Condition	LPB (n = 43)	HPB (n = 52)	*F*
Neutral	0.49 (.09)	0.50 (.10)	.07
Positive	0.50 (.10)	0.52 (.09)	1.07
Depressive	0.51 (.09)	0.46 (.08)	6.22*
Paranoia	0.46 (.11)	0.47 (.11)	.30

Indices are reported as mean (SD)

$*P < .05$~~; $**P < .001$~~

A summary of scores of selective attention bias in HPB and LPB groups under different prime conditions is shown in Table 2. As described in the Method, a score of 0.5 indicates no bias to any kind of face (neutral or angry), a score above 0.5 indicates an initial bias toward angry faces and a score below 0.5 indicates an initial bias toward neutral faces.

A 2 × 4 mixed ANOVA with one between-subjects variable of group (2: HPB and LPB) and one within-subjects variable of prime condition (4: neutral, positive, depressive and paranoid) on the initial orientation index yielded a significant interaction effect of group by prime condition [Wilks' Lambda = .90, F (3, 91) = 3.24, $P = .03$, $\eta^2 = .10$; Fig. 2]. To analyze the effect of the two variables significantly correlated with our cognitive index, we included BCSS-NS and BCSS-PO as covariates in additional 2 × 4 ANCOVAs. Our results showed that the interaction remained significant and was unaffected by inclusion of BCSS-NS and BCSS-PO [Wilks' Lambda = .89, F (3, 89) = 3.81, $P = .01$, $\eta^2 = .11$].[2]

To analyze this significant interaction, we conducted tests of the simple ~~tests~~ using the MSerror that we calculated from the overall factorial ANOVA. First, a four one-way ANOVAs on the initial orientation index for each of the four prime conditions, with group (2: HPB and LPB) as the independent variable. The groups of participants differed significantly only in the Depressive Prime Condition (DP) (Table 2). An ANCOVA showed that the differences remained significant (F (1, 91) = 7.77, $P = .01$) after controlling the effects of BCSS-N and BDI scores. As Fig. 2 shows, the HPB and LPB groups significantly differ in the depressive prime condition, the HPB group showing a pattern of avoidance of angry faces.

To test the effect of prime within each group, a within-subject ANOVA on the initial orientation index toward angry faces for each of the four prime conditions (4: neutral, positive, depressive and paranoid) was conducted separately for each group (high and low paranoid ideation). The analyses yielded a no significant effect for the LPB group (Wilks' Lambda = .83, F (3, 40) = 2.22 $P = .10$) and a significant effect for the HPB (Wilks' Lambda = .84, F (3, 49) = 4.22, $P = .01$) group. In the HPB, paired comparisons using a Bonferroni adjusted only revealed a significant difference between positive and depressive primes (see Fig. 2).

Analyses of mean differences in initial orientation indexes do not provide a measure of attentional bias. To further explore the existence of biases in under different prime conditions, a series of contrast tests was performed to assess whether the mean scores of the eight experimental conditions were statistically different from 0.5 (i.e., absence of bias) (Fig. 2). In the paranoid prime condition, the initial orientation index was significantly smaller than 0.5 only in the LPB group [$t(43) = -2{,}049$, $P = .05$]. Consistent with our first hypothesis, the result for the HPB group approached that of the LPB group, though it did not reach statistical significance. In the depressive prime condition, only the HPB group showed an avoidance bias away from the angry face that was significantly different from 0.5 [$t(52) = -2.885$, $P = .01$). This result confirmed our second hypothesis.[3]

Discussion

Our results provide support for the notion that activation of schemas may reveal information-processing biases (Segal and Ingram 1994). Our results suggest that different emotional primes can trigger different patterns of initial attentional biases in individuals depending on their level of persecutory beliefs.

[2] As a parallel statistical strategy, regression analyses were conducted to examine the association between paranoid ideation (PS) and initial orientation bias for each prime condition. To control for the possible effect of depressive symptoms (BDI) and a negative view of oneself (BCSS-NS) on initial orientation, these two variables were also entered into the equation. Our ~~analysis~~ revealed that PS significantly predicted initial orientation bias only in the depressive prime condition (Paranoid ideation, $\beta = -.33$, $P < .05$), which was consistent with the ANOVA approach. Furthermore, following studies with similar samples (Combs et al. 2003), we created two extreme groups using the 70th and the 30th percentiles on the PS, to form the high paranoia group, and the low paranoia group, respectively. As with the median split procedure, a significant interaction was found for the effect of group by prime condition on the initial orientation index (Wilks' $\lambda = .87$, F (3, 60) = 2.87, $P = .04$).

[3] Although the interest of this study focused on analyzing automatic attentional patterns (i.e., bias in the initial orientation of attention), an index of the global preference of attention was also analyzed. This index measures the total time spent on one face (neutral vs. angry) for each prime condition. A 2 × 4 mixed ANOVA with one between-subjects variable of group (2: HPB and LPB) and one within-subjects variable of prime condition (4: neutral, positive, depressive and threatening) on the global preferences index yielded a significant main effect for prime condition (Wilks' Lambda = .85, F (3, 91) = 5.18, $P = .01$) but the interaction was not significant (Wilks' Lambda = .97, F (3, 91) = 0.90, $P = .45$).

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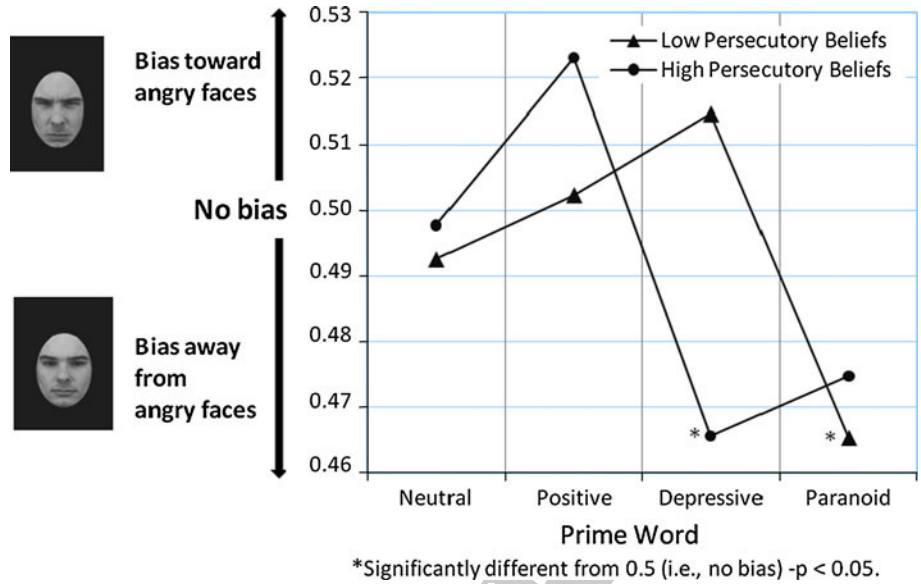
Fig. 2 Initial orientation indices toward angry or neutral faces by LPB and HPB groups under different prime conditions



Our first hypothesis that a paranoid prime would facilitate avoidance bias in the HPB group received only partial support. Although the HPB group showed a tendency in the hypothesized direction, the avoidance bias reached significance only in the LPB group. It is interesting that a paranoid prime can induce an avoidance bias, given that normal people detect angry faces faster than faces showing other emotions (Fox et al. 2000). The gaze pattern observed in the present study may be part of a defensive strategy to neutralize threats (Helfinstein et al. 2008).

Our second hypothesis that a depression-related prime would also facilitate an avoidance bias in the HPB group was fully supported by our data. Depressive primes activated significant avoidance of angry faces in HPB participants, whereas it did not alter the initial gaze of LPB subjects. These results are consistent with the self-serving bias model of paranoia (Bentall 1994). They are also convergent with previous research on implicit measures of cognition, which indicates that paranoia involves psychological defence mechanisms (Valiente et al. 2011; McKay et al. 2007; Moritz et al. 2006). Furthermore, the generalized pattern of initial avoidance found in the HPB group under paranoid and depressive prime conditions is consistent with the notion that lower experiential tolerance is associated with worse psychological adjustment (Hayes et al. 2004).

Visual scanning studies can be very useful for analyzing cognitive mechanisms in paranoia. Interestingly, most of the research on information-processing biases related to threat-related information is not entirely consistent with results from eye-tracking studies. For instance, early investigations using the Stroop task found heightened pre-attentive processing of threatening information in people with persecutory delusions (Bentall and Kaney 1989). Using dot-probe tasks, Moritz and Laudan (2007) found that participants with persecutory delusions had shorter reaction times than did healthy controls when processing socially threatening scenes with a stimulus onset asynchrony (SOA) of 400–500 ms. Arguedas et al. (2006), also using a dot-probe task, found a bias of engagement and defective disengagement for threatening facial expressions (anger) in delusion-prone normal individuals.

In contrast to these results from traditional information-processing studies, investigations of visual scan paths have detected avoidance of fixation on angry faces in non-clinical ~~paranoia patients~~ (Green et al. 2003a~~, b~~) as well as in schizophrenia patients with persecutory delusions (Green et al. 2003~~a, ~~b). Similarly, in a socially anxious sample, Helfinstein et al. (2008) detected early avoidance of fixation on angry faces. Visual scan studies allow continuous tracking of gaze patterns, which is an advantage over other visual methodologies such as Stroop tasks.

In the present study, we have detected a tendency among individuals high in paranoid beliefs to initially avoid angry faces after being primed with negative emotional stimuli. Given that this avoidance pattern was significant only in the depressive prime condition, our results support the idea that activation of depressive schemas can in turn activate defensive cognitive responses, in our case avoidance of angry faces. It may be that paranoid individuals protect their self-esteem by biasing attention away from threats, as argued by Bentall et al. (2001). This avoidance mechanism has been observed in subjects trying to regulate anxiety in efforts (Mogg et al. 2004; Williams et al. 1997). Thus, these results call for an integration of anxiety models of paranoia (Freeman 2007; Moritz et al., ~~in press~~) and the defence model of paranoia (Bentall et al. 2001) as depressive primes can activate attentional avoidance biases similar to those found in anxiety. Nevertheless, it should be noted that the results from our study suggest that these biases, in our nonclinical samples, affect only initial attentional processes which is a typical finding in cognitive bases in anxiety (Mogg and Bradley 2005). When using a measure that reflects more effortful processes (i.e., global preference index along the 2500 s trial) we did not find differences in groups' performance.

We should note that there were no differences between both groups in initial orientation to angry faces when using a neutral prime. What this rather unexpected finding could reflect is that, at least in healthy individuals, the use of emotional primes may be highly relevant to the activation of paranoia-related schemas. A second explanation of this finding, although it would deserve further investigation, is that neutral primes could buffer or inhibit the intensity of the response given to a subsequent emotional stimulus. For instance, in the prepulse inhibition (PPI) paradigm (e.g., Braff et al. 1992), the presentation of a brief neutral stimulus (e.g., a 20 mec acoustic tone) reduces the magnitude of the response to a subsequent startling stimulus (e.g., a burst of a 40 ms white noise). This inhibititory effect is observed for intervals up to 500 ms between the prepulse and the pulse. Interestingly, the interval between our prime words and the appearance of emotional faces in our study was 300 ms, which fits within the interval where the PPI takes place.

Although the present study provides several interesting results, it is limited in several ways. First, its cross-sectional nature does not allow a direct inference about the causal relations between paranoid beliefs and cognitive processing mechanisms. Second, our study was conducted in a nonclinical sample, which although helpful for testing new methodologies or procedures (Caseras et al. 2007), does not address translatability to clinical populations (Lincoln and Keller 2008). Despite these limitations, the present results underscore the clinical and theoretical utility of eye-scanning paradigms for studying paranoia and testing competing theories in psychopathology.

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