



Contents lists available at ScienceDirect

# Journal of Behavior Therapy and Experimental Psychiatry

journal homepage: [www.elsevier.com/locate/jbtep](http://www.elsevier.com/locate/jbtep)

## Scanning to conclusions? Visual attention to neutral faces under stress in individuals with and without subclinical paranoia.



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### ARTICLE INFO

#### Article history:

Received 9 May 2016

Received in revised form

26 July 2016

Accepted 26 August 2016

Available online 28 August 2016

#### Keywords:

Psychosis

Visual perception

Stress

Vulnerability

Delusions

Data-gathering

### ABSTRACT

**Background and objectives:** A promising candidate for a vulnerability indicator for psychosis is the restricted scanpath. Restricted scanning of social stimuli, such as faces, might also contribute to misinterpretations of facial expressions and thus increase the likelihood of delusional interpretations. Moreover, similar to other vulnerability indicators of psychosis, scanpaths may be susceptible to stress. Thus, we hypothesized that scanpath restriction would increase as a function of delusion-proneness, stress and their interaction.

**Methods:** Participants were asked to look at neutral faces and rate their trustworthiness under a stress and a non-stress condition, while the eye gaze was recorded. The non-clinical sample was classified into low- and high-paranoia scorers using a median split. Eye-tracking parameters of interest were number of fixations, fixations within emotion-relevant facial areas, scanpath length and duration of fixations.

**Results:** In general, high-paranoia scorers had a significantly shorter scanpath compared to low-paranoia scorers ( $F(1, 48) = 2.831, p = 0.05, \eta_p^2 = 0.056$ ) and there was a trend towards a further decrease of scanpath length under stress in high-paranoia scorers relative to low-paranoia scorers (interaction effect:  $F(1, 48) = 2.638, p = 0.056, \eta_p^2 = 0.052$ ). However, no effects were found for the other eye-tracking parameters. Moreover, trustworthiness ratings remained unaffected by group or condition.

**Limitations:** The participants of this study had only slight elevations of delusion-proneness, which might explain the absence of differences in trustworthiness ratings.

**Conclusions:** Restricted scanpaths appear to be partly present in individuals with subclinical levels of paranoia and appear to be susceptible to stress in this group. Nevertheless, further research in high-risk groups is necessary before drawing more definite conclusions.

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### 1. Introduction

The continuity of psychotic experiences, and paranoid delusions in particular, has been extensively researched (Freeman, Pugh, Vorontsova, Antley, & Slater, 2010). It has been used to study indicators of vulnerability that co-occur or may be causal to psychotic experiences (Linscott and van Os, 2013; Freeman, 2016) and to identify people at risk of developing the full clinical picture of psychosis (Mossaheb et al., 2012). In regard to the latter, it has been found, however, that the mere presence of non-clinical psychotic experiences is not a sufficient predictor of psychosis because less than 8% of those with psychotic experiences develop a psychotic

disorder (Linscott and van Os, 2013). Thus, identifying vulnerability indicators and understanding their causal contribution to symptoms in individuals at non-clinical levels of the psychosis continuum is relevant both to our understanding of symptom formation and in regard to identifying individuals at risk of psychosis.

A promising candidate for a specific indicator of vulnerability is a restricted visual scanpath, which has been found to show a near-perfect accuracy of up to 98.3% in correctly discriminating people diagnosed with schizophrenia from controls (Beedie, Benson, & St Clair, 2011; Benson et al., 2012). The characteristics of restricted scanning styles associated with schizophrenia are fewer fixations, increased average fixation durations, and a shorter scanpath length (sum of saccades between points of fixation) (Beedie et al., 2011). Given the continuity of psychotic symptoms, restricted scanpaths are likely to already be detectable in non-clinical individuals with elevated levels of psychotic experiences. Indeed, this has been demonstrated in a study finding individuals with higher delusion-

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proneness to exhibit less fixations in salient areas for both neutral and threatening faces (Hillmann, Kempkensteffen, & Lincoln, 2015).

It is intuitive to expect that restricted visual scanning in salient areas of faces may contribute – at least to some extent - to biases and misattributions associated with delusions, such as mis-attributing fear to anger and anger to neutral facial stimuli (Premkumar et al., 2008). This expectation would also be in line with cognitive accounts of delusions and associated empirical evidence emphasizing the role of limited data-gathering, a liberal acceptance bias, selective attention and confirmatory biases as specific vulnerabilities (Blackwood, Howard, Bentall, & Murray, 2001; Freeman & Garety, 2014; Moritz et al., 2009). Moreover, following both the traditional diathesis-stress postulates of schizophrenia (Nuechterlein & Dawson, 1984) and their more recent cognitive variants (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001), pre-existing perceptual abnormalities and biases can be expected to increase under stress. Accordingly, the effect of stress on data-gathering has been shown in several studies on patients with schizophrenia spectrum disorders, who tended to respond to stressors by a further reduction in data-gathering relative to controls (Keefe & Warman, 2011; Moritz, Köther, Hartmann, & Lincoln, 2015; Moritz et al., 2010). The same pattern of findings emerges on the non-clinical side of the continuum. This is indicated by studies showing that inducing stress further increases both paranoia and reasoning biases in more psychosis prone relative to less psychosis prone healthy individuals (Keefe & Warman, 2011; Kesting, Bredenpohl, Klenke, Westermann, & Lincoln, 2013; Lincoln, Peter, Schäfer, & Moritz, 2009), whereby the association was found to be mediated by reduced data-gathering (Lincoln, Lange, Burau, Exner, & Moritz, 2010). Whether stress exerts a similar influence in the visual information processing domain, in terms of a further restriction of scanpaths, is unknown.

In this study we sought to extend the line of existing research on scanpath abnormalities as a vulnerability indicator of psychosis by investigating the impact of stress on visual scanning behavior in individuals with varying levels of delusion-proneness. Participants with higher versus lower levels of delusion-proneness were exposed to neutral faces and instructed to rate the trustworthiness of the presented faces. This was done under a stress versus a non-stress condition while we tracked the participants' eye movements. A first aim was to replicate our previous findings, by showing that, independent of the experimental condition, the more delusion-prone individuals would show a more restricted scanpath (fewer fixations, fewer fixations in emotion-relevant areas, increased average fixation durations and a shorter scanpath length) compared to less delusion-prone individuals. Furthermore, we expected the individuals with a higher level of delusion-proneness to show a more restricted scanpath in the stress versus the non-stress condition relative to the controls (interaction effect). Finally, we sought to explore the effects of group and stress on the perceived trustworthiness of the facial stimuli. We expected that individuals with higher levels of delusion-proneness would exhibit lower trustworthiness ratings than the group with lower levels of delusion-proneness and that this difference would be more pronounced in the stress compared to the non-stress condition.

## 2. Method

### 2.1. Participants

Participants were recruited via notices, flyers and oral advertising in lectures at the University of Hamburg. Participants volunteered to take part for partial fulfillment of a curriculum requirement. Inclusion criteria were age 18–65 years, sufficient German language skills to complete the assessments, normal or

corrected to normal vision and no hearing impairment. Exclusion criteria were daily alcohol/drug consumption, medication with known influence on the oculomotor system, a diagnosis of schizophrenia, a diagnosis of schizophrenia in first-degree relatives or a neurological disorder. Additionally, based on evidence for abnormal scanning behavior in social phobia (Horley, Williams, Gonsalvez, & Gordon, 2004), participants with extreme values in social anxiety as indicated by a score outside a 99% norm on the German version of the Fear of Negative Evaluation Scale (Vormbrock & Neuser, 1983; Watson & Friend, 1969) were excluded. Therefore, the cut-off was  $\geq 71$  for female participants and  $\geq 65$  for male participants.

### 2.2. Assessments

To assess delusion-proneness we used the Paranoia Checklist (Freeman et al., 2005), an 18-item self-report scale that measures paranoid ideation in a non-clinical population. Respondents are asked to rate the frequency of statements, such as “I need to be on my guard against others” or “People are laughing at me” on a 5-point Likert Scale. The original version of the Paranoia Checklist has excellent internal consistency (Cronbach  $\alpha > 0.90$ ) and good convergent validity (Freeman et al., 2005). The German version has good internal consistency (Cronbach  $\alpha = 0.86$ ). Convergent validity has been shown with the German version of the Community Assessment of Psychic Experiences ( $r = 0.63, p < 0.001$ ) and with the German version of the Paranoid Ideation subscale of the Symptom Checklist-90-R ( $r = 0.56, p < 0.001$ ) (Lincoln et al., 2009). The sample was categorized into high-paranoia scorers and low-paranoia scorers using the median split of the total score.

### 2.3. Eye tracking task

For the eye tracking task, we used facial stimuli from the well-validated Radboud Faces Database (Langner et al., 2010). For our purposes we selected 14 male and 14 female stimuli with a neutral facial expression and gaze direction as well as head orientation to the front. Selection of stimuli was guided by the criterion of highest inter-rater agreement concerning neutrality of the facial expressions reported in the validation study by Langner et al. (2010). For the later analysis, we defined t-shaped areas of interest around the salient facial features of the eyes, nose and mouth.

To provide the participants with a common task that requires focusing attention to the displayed faces and to assess an indirect indicator of paranoid appraisals for the exploratory analyses, participants were asked to rate the trustworthiness of each face on a 5-point Likert Scale.

Eye movements were recorded using an RED500 infrared remote eye tracking system and the included software iViewX 2.7 (SensoMotoric Instruments, Teltow, Germany) with a high speed sampling rate of 500 Hz, an accuracy of  $0.4^\circ$  visual angle and a spatial resolution of  $0.03^\circ$  visual angle. The system uses a dark pupil tracking method and allows free head movements within a range of 16 in x 8 in x 16 in at a 28 in distance. The stimuli were presented with Experiment Center 3.1 (SensoMotoric Instruments, 2014) on a widescreen stimulus monitor with a resolution of  $1680 \times 1050$  pixels.

Participants sat on a chair in a windowless room illuminated with fluorescent light. The height of the chair was adjusted so that the eye gaze was central to the stimulus screen and the distance between participant and stimulus monitor was approximately 28 in. A nine-point calibration procedure was started by the participants with manually acceptance of the calibration points by pressing the space bar. Then the operator validated the calibration results. If values above  $0.5^\circ$  appeared the calibration procedure was

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