Journal of Affective Disorders 152-154 (2014) 91–96

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research report

State anxiety modulates the impact of peripherally presented affective stimuli on foveal processing

Fabien D'Hondt [a,b,c,*,1], Jacques Honoré [a,b,d], Alexandre Williot [a,b,e], Henrique Sequeira [a,b,c]

[a] Université Lille Nord de France, Lille, France
[b] LNFP, UDSL, Lille, France
[c] Neurosciences, Université de Lille 1, Villeneuve d'Ascq, France
[d] Centre National de la Recherche Scientifique (CNRS), Paris, France
[e] Psychologie, UDL3, Villeneuve d'Ascq, France

ARTICLE INFO

Article history:
Received 23 April 2013
Accepted 17 May 2013
Available online 12 June 2013

Keywords:
Emotion
State-anxiety
Trait-anxiety
Depression
Peripheral vision
Attention

ABSTRACT

Background: The priority processing of peripherally presented affective stimuli was recently shown in healthy individuals to divert attentional resources dedicated to foveal processing. Here we investigated the influence of sub-clinical levels of anxiety and depression on this bias.
Methods: Eighty-four participants were submitted to psychological tests that evaluate anxiety and depression levels. Then, they had to make speeded responses to the direction of left- or right-oriented arrows that were presented foveally at fixation. Each arrow was preceded by a peripherally presented pair of pictures, one neutral and one emotional, unpleasant or pleasant. Thus, the direction of the foveal arrow was either congruent or not with the peripheral location of the previously presented emotional picture. Data analysis focused on the differences of reaction times between congruent and incongruent conditions, which assess the spatial response bias in the task.
Results: A main effect of state-anxiety was observed suggesting that the higher the level of state-anxiety, the greater the congruence effect.
Limitations: Since the obtained result relates to subclinical anxiety levels, its generalization to anxiety disorders remains tentative.
Conclusions: State-anxiety appears to modulate the propensity to be influenced by emotionally salient information occurring in peripheral vision, independently of its relevance to the ongoing behavior. The long-term persistence of a high level of alertness for emotional cues in visual periphery could contribute to the causation and the maintenance of anxiety disorders.

1. Introduction

Cognitive models posit that biases in the processing of emotional information contribute to the development and maintenance of anxiety disorders (e.g., Beck and Clark, 1997; Mathews and Mackintosh, 1998; Mathews and MacLeod, 1994; Mogg and Bradley, 1998). In particular, there is now substantial evidence of attentional biases to threatening images in high anxious individuals and in patients with anxiety disorders (e.g., Bar-Haim et al., 2007). However, one underestimated factor in studies investigating emotional processing in anxiety is the impact of affective stimuli occurring in peripheral vision.

Based on the fact that the main part of visual information appears outside the central vision, recent studies have investigated how emotional information appearing at eccentric locations is processed (e.g., Bayle et al., 2009, 2011; Calvo et al., 2008; Hung et al., 2010; Rigoulot et al., 2008, 2011, 2012). These studies have shown that the prioritized coding of emotion, as previously highlighted for stimulations projected to the center of the visual field, still persists in peripheral vision despite impoverished visual conditions. In this context, peripheral vision may serve as a warning system favoring particularly salient signals of high adaptive relevance and may contribute to their attentional or foveal capture. In agreement with this, we recently reported evidence showing that emotional salience in peripheral vision induces a spatial response bias during the subsequent processing of foveal information (D'Hondt et al., in press): human individuals respond faster to the direction of foveal arrows that is congruent with the

* Corresponding author at: Université Lille Nord de France, UDSL, Laboratoire de Neurosciences Fonctionnelles et Pathologies, Service EFV, Hôpital Roger Salengro, CHRU de Lille, 59037 Lille, France. Tel.: +33 3 20446281; fax: +33 3 20446732.
E-mail address: fabien.dhondt@gmail.com (F. D'Hondt).
[1] Current address: Université de Montréal, Département de psychologie, Centre de Recherche du Centre Hospitalier Universitaire Sainte-Justine, 3175 Chemin de la Côte Sainte-Catherine, Montréal, QC, Canada H3T 1C5.

0165-0327/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jad.2013.05.051

location of a previously presented affective stimulus in peripheral vision.

In the current study, using the same paradigm, we aimed at assessing the influence of anxiety in the propensity to covertly pay attention to emotional stimuli in peripheral vision independently of the current attentional goals. Indeed, anxiety is associated with an impaired goal-directed attentional system and an increased influence of the stimulus-driven attentional system, and this imbalance leads to a selective attentional bias to threat (Eysenck and Derakshan, 2011; Eysenck et al., 2007). In particular, evidence shows a covert (i.e., without foveal capture) attention bias toward threat stimuli in anxiety (Calvo and Eysenck, 2008; Gutiérrez and Calvo, 2011), suggesting that anxious individuals would maintain a broad distribution of attention across the visual field to facilitate detection of threat from all visual locations (Eysenck, 1992; Eysenck et al., 2007; Richards et al., 2011, 2012). Therefore, one could predict that the spatial response bias induced by peripherally presented affective stimuli on the subsequent processing of foveal information may be influenced by anxiety.

While it has been suggested that threat-related attentional bias is associated with trait-anxiety (i.e., the general tendency to experience anxiety; Bar-Haim et al., 2007; Cisler and Koster, 2010), Quigley et al. (2012) recently found that state-anxiety (i.e., transient experience of anxiety) is associated with increased attention to threatening stimuli, regardless of trait-anxiety, as previously proposed by several studies (e.g., Bradley et al., 2000; Fox et al., 2001; Mathews and MacLeod, 1985; Mogg et al., 1997). Moreover, using a paradigm in which participants had to detect central and peripheral targets presented either alone or simultaneously, Shapiro and Lim (1989) observed that participants placed in a non-anxiety context attended primarily to the central visual stimulus, whereas participants placed in an anxiety context attended predominantly to the peripheral stimulus. Taken altogether, these results suggest that state-anxiety would be associated with an attentional bias for affective stimuli in peripheral vision.

Here, we thus aimed at determining the relative contributions of state- and trait-anxiety in the spatial response bias to foveal information induced by arousing emotional stimuli in peripheral vision. Our goal was also to investigate whether the putative influence of anxiety is specific to negative valence or exists for any arousing stimuli. In fact, some studies have found that anxiety is also associated with biased attention toward positive stimuli (Mogg and Marden, 1990; Riemann and McNally, 1995), and interestingly, that state-anxiety increases attention to all emotional stimuli, regardless of trait anxiety (Rutherford et al., 2004). Furthermore, since evidence also supports the existence of biased attention to negative information in depression (e.g., Peckham et al., 2010), the specific impact of depression needs to be assessed and distinguished from that of state- and trait-anxiety. To this purpose, every participant tested in our study was submitted to psychological tests measuring state-and trait-anxiety but also depression levels. The individual scores were used as co-variables in the analysis of foveal response bias induced by peripherally presented affective stimuli.

2. Methods

2.1. Participants

Eighty-four individuals (mean age of 20 ± 2 years; 8 males) provided informed consent before participating in the present study which has been approved by the local ethics committee and was conducted in accordance with the Declaration of Helsinki. All of them had normal or corrected to normal vision and lacked any history of neurological or psychiatric disorders, or drug consumption. Eighty participants were right-handed and four were left-handed (Hécaen, 1984). Each participant was submitted to psychological tests that evaluated anxiety (State-Trait Anxiety Inventory, A and B; Spielberger et al., 1983) and depression (BDI-II, Beck et al., 1996).

2.2. Materials

Given the differences usually observed between men and women in processing of emotional stimuli (Bradley et al., 2001; Collignon et al., 2010), emotional and neutral pictures from the International Affective Picture System (IAPS, Lang et al., 2008) were selected according to gender. Each gender-based set comprised two subsets of emotional stimuli, 25 unpleasant (U) and 25 pleasant (P), as well as two subsets of 25 neutral stimuli (N1 and N2). To control the emotional parameters of the selected pictures, we compared standardized IAPS ratings for valence (scale of 0–9 in which 0 indicated a very unpleasant picture and 9 indicated very pleasant picture) and for arousal (scale of 0–9 in which 0 indicated very calm and 9 indicated very arousing). Linear and quadratic contrasts were used to assess valence and arousal ratings (D'Hondt et al., 2010). The valences of U, N and P pictures differed (means valence ratings were $U = 2.5$, $N1 = 5.1$, $N2 = 5.1$, $P = 7.4$ for women, and $U = 2.5$, $N1 = 5.0$, $N2 = 5.0$, $P = 7.4$ for men; $ps < 0.05$). U and P subsets were equally arousing (mean arousal ratings were $U = 5.9$, $P = 5.9$ for women, and $U = 6.1$, $P = 6.1$ for men; $ps > 0.05$) and were more arousing than N pictures ($N1 = 2.9$, $N2 = 3.0$ for women, and $N1 = 2.8$, $N2 = 2.9$ for men, $ps < 0.05$). No significant difference in either the arousal or valence ratings of the pictures was observed between N1 and N2 subsets ($ps > 0.05$). Moreover, no significant gender-based difference in either the arousal or valence ratings was observed ($ps > 0.05$). The numbers of pictures depicting faces, animals, objects, landscapes, and human beings were counterbalanced across U, N1, N2, and P subsets. These subsets were homogenized (Image J Software) in terms of their major physical characteristics, which included the mean luminance values, the standard deviation (SD) of the luminance (i.e., contrast index), spatial frequencies, and color saturation levels (red, green, blue). Analyses of variance (ANOVAs) that were performed on these characteristics did not reveal any differences between U, N1, N2, and P scenes that were shown to men or to women ($ps > 0.05$). The pictures were further tested for complexity, which was indexed in terms of the number of bytes, and the percentage of surface occupied by human faces (Calvo and Lang, 2005) and no difference was observed between U, N1, N2, and P subsets that were shown to men or to women ($ps > 0.05$).

From these pictures, we built four kinds of "prime" pairs: 50 pairs with a U picture in the left visual field and an N picture in the right visual field ("U+N1" and "U+N2"), 50 pairs with an N picture in the left visual field and a U picture in the right visual field ("N1+U" and "N2+U"; Fig. 1A). Two other sets of 50 pairs were obtained by combining P and N pictures in the same way. Of note, one same N picture from N1 subset or N2 subset was therefore presented with a given U picture as many times than with a given P picture. Importantly, each picture that appeared on one side of the screen in a given "prime" pair was the mirror picture of the same picture that was presented on the opposite side of the screen in a different "prime" pair. Thus, the various elements of any given picture were equidistant from the fixation point when it was projected in either the left or the right visual hemifield (IrfanView Software; see Bryson et al., 1991). We computed differences between the emotional and neutral pictures of prime pairs for each emotional value and physical parameter that has been mentioned above. No significant difference was observed between the "U+N", "N+U", "P+N", and "N+P" conditions ($ps > 0.05$).