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Difficulty in disengaging attention from threatening facial expressions in anxiety: A new approach in terms of benefits

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Background and objectives: Recent work suggests that the ability to disengage attention from threatening information is impaired in anxiety. The present study compared the difficulty to disengage from angry, fearful and neutral faces in Low Trait Anxious individuals (LTA) versus High Trait Anxious individuals (HTA) at two stages of facial expression processing (i.e., initial and later face processing).
Methods: HTA and LTA individuals performed an attentional shifting task to assess attentional disengagement. Participants had to classify a peripheral target letter, appearing 200 or 500 ms after a face was displayed.
Results: LTA individuals were quicker when the letter appears after 500 ms compared to 200 ms regardless of the emotion of the face. An impaired disengagement in HTA individuals was observed for fearful and angry faces (i.e., no reaction differences between 200 and 500 ms) but not for neutral faces. These results suggest that it is particularly difficult for anxious individuals to switch attention from one stimulus to another if the engaged stimulus is a threatening face.
Limitations: Generalisation of our results is restricted to trait anxiety and emotional facial expression processing.
Conclusions: LTA individuals can benefit from the emotional processing (i.e., from 200 to 500 ms) to make a rapid attentional shift and engagement to the target stimuli whereas HTA individuals did not and continue to process the threatening facial expression. These results also point out the role of top down processes on the regulation of disengagement from threatening information in anxiety.

Attentional bias towards threat in anxiety is a relatively robust phenomenon (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007; for a meta-analysis). This attentional bias has been observed in various paradigms (e.g., dot probe task, spatial cueing task, visual search task) and refers to a general tendency to allocate selective attention towards potentially threatening information (e.g., Fox, 2002). However, as suggested by Posner and Petersen (1990), attention comprises different components (i.e., shifting, engagement and disengagement). In order to measure these different components, Koster, Crombez, Verschuere, and De Houwer (2004) adapted the dot probe task. Using this task, Salemink, van den Hout, and Kindt (2007) found that trait anxiety is related to disengagement difficulties and not to quick orienting. Another paradigm measuring whether the bias operates primarily in shifting or disengagement components is the modified cueing paradigm (Fox, Russo, Bowles, & Dutton, 2001). Several studies using this task showed a difficulty in disengaging attention from threat but no facilitated attentional capture by threat in anxious people (e.g., Fox, Russo, & Dutton, 2002; Koster et al., 2004).

To account for this "delayed disengagement hypothesis" in anxiety, Cisler and Koster (2010) proposed a framework describing the interrelations between the attentional components, mediating mechanisms, and stages of information processing. They suggested that the disengagement difficulty might be a combination of automatic and strategic processing. This disengagement difficulty "refers to the degree to which a threat stimulus *captures* attention and impairs switching attention from the threat to another stimulus" (Cisler & Koster, 2010, p. 208). This tendency maintains cognitive resources on the source of threat and may maintain and enhance anxiety states (see also Fox et al., 2002).

In order to measure disengagement from emotional facial expressions, Georgiou et al. (2005) used the Fox et al.'s attentional shifting task (2001, experiment 5). In this task, while the stimulus is

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presented at the centre of the screen, a target letter appears after 600 ms (either X or P) at one of four locations for 50 ms (above, below, to the left or to the right). Georgiou et al. (2005) showed that high trait-anxious individuals took longer to classify peripheral target letters when fearful facial expressions, relative to sad, happy, or neutral expressions, were presented at fixation. Moreover, Moriya and Tanno (2011, experiment 2) only found a difficulty in disengaging from angry faces in socially anxious individuals when the face remained on the screen during the target display, but not when there was a temporal gap between the face and the target (experiment 1). This difficulty to disengage in high socially anxious people was characterized by longer reaction times for angry faces compared to neutral faces after presentation times of 300 ms or longer (i.e., 500, 700 and 1000 ms) but not for shorter presentation times (i.e., 100 and 200 ms). Taken together, these results suggested that (a) the face must remain on the screen during the complete processing in order to evidence a difficulty to disengage in anxious individuals and (b) the difficulty to disengage takes place after presentation time of 200 ms. Besides, Weierich, Treat, and Hollingworth (2008) explained that within orienting processes, one could expect vigilance towards a stimulus at an early stage of presentation (e.g., 100 ms–200 ms) and within disengagement processes, problems to disengage from a stimulus at longer presentation times (e.g., 200 ms–800 ms).

The stimuli that have been widely used to study attentional bias are emotional facial expressions (EFE). In fact, these stimuli act as important social cues and can be used to examine how emotionally relevant information is prioritized. As suggested by Cisler and Koster's (2010) framework, research on attentional disengagement has to clearly specify which stage of processing is at stake. Unfortunately, previous studies varied the EFE duration presentation without clearly taking into account the various stages of facial expression processing. In the following paragraphs, we will review data on the time course of EFE processing.

Magnetoencephalography (MEG) recordings indicate that, as early as 100 ms after presentation, stimuli can be categorized as "faces" (Lui, Harris, & Kanwisher, 2002). Moreover, the perceptual analysis of facial features has been associated with a specific Event Related Potential (ERP), the N170, which peaks 150–200 ms post stimulus. According to Ashley, Vuilleumier, and Swick (2004), the emotional effects on N170 do not appear selective for any specific expression, suggesting a non specific role of configural and attentional effects associated with encoding of structural facial cues, rather than with emotional significance per se. Then, posterior ERPs components around 250 ms after face onset might index the discrimination between emotional and neutral expressions (Krolak-Salmon, Fischer, Vighetto, & Mauguiere, 2001). Two other ERPs components may be involved in the processing of EFE. The first component, named N300, is supposed to reflect an affective processing (Rossignol, Philippot, Douilliez, Crommelinck, & Campanella, 2005) — for example, this component reacts more to affective features of stimuli rather than to physical characteristics (Carretié & Iglesias, 1995). The second component, the P3b, peaking at parietal sites around 450 ms, arises when an attended stimulus is detected. It is believed to reflect decision making and premotor response-related stages (Rossignol et al., 2005). Recently, Toffanin, de Jong, and Johnson (2011) have proposed an electrophysiological marker of attentional disengagement, the P4pc (Positivity 400 ms post-target posterior contralateral). Whereas attentional engagement can be studied by means of the N2pc (Negativity 200 ms post-target posterior contralateral) component of ERP, they showed, using a rapid serial visual presentation paradigm and spatial-cuing paradigm, that the P4pc occurs only in contexts where there is a need to disengage.

Taking into account these electrophysiological data, we assume that the capacity to switch attention from a face to another stimulus could take place in the initial stage of face processing (i.e., around 170 ms) and continue in the later stage of information processing (i.e., from 200 to 500 ms). Bar-Haim, Lamy, and Glickman (2005) investigated attentional disengagement using both ERP and behavioural data in an attentional shifting task. They showed that high-anxious people were slower to respond to targets. Moreover, the ERP waveforms suggested that slower reaction times in high-anxious people might reflect attentional dwelling on the faces' cues. The lack of emotion effect in this study could be attributed to the moment when the target appears (i.e., 600 ms). Indeed, at this stage, the EFE processing is mostly achieved. Furthermore, Moriya and Tanno's (2011, experiment 2) results presented above showed that socially anxious individuals demonstrated difficulty disengaging from angry faces displayed for 300 ms, which in fact corresponds to duration of affective processing (indexed by the N300).

Finally, research suggested a differential attentional processing of fearful facial expressions and angry facial expressions. According to Davis and Whalen (2001), individual differences in anxiety may be attributable to a neural system for threat processing, involving the amygdala, which modulates attentional vigilance, and which is more sensitive to fearful than angry faces. Indeed, fearful faces tend to be ambiguous and therefore require higher attention from the threat processing system. However, Mogg, Garner, and Bradley (2007), using a dot probe task with eye-movement recordings, showed that fearful and angry faces elicited similar biases and that high anxious individuals were more likely to gaze directly at intense negative facial expressions. These results could be explained by considering the different component processes of attention, namely, *shifting* versus *maintenance*. According to Mogg et al. (2007), "the amygdala may indeed modulate attention to threat, but its level of activation may be a function of both initial orienting and maintained attention" (p. 167). Initially, angry and fearful faces may attract attention to the same extent but differ in their capacity to hold attention. Mogg et al.'s (2007) lack of difference in biases between angry and fearful faces may be due to their dot probe task that is not appropriate for investigating maintained attention (i.e., the component in which angry and fearful faces processing should differ).

The current study aimed at replicating Moriya and Tanno's (2011) study in trait anxious individuals by using only two critical presentation times. Moreover we extended Moriya and Tanno (2011) and Georgiou et al.'s (2005) studies by comparing the difficulty to disengage from fearful and angry faces. Using an attentional shifting task, we examined whether anxiety would produce a difficulty in disengaging in the first step of perceptual/sensory processing of a face (200 ms), or whether such an effect would only be observable during the affective processing of the face (500 ms). We predicted that LTA individuals would benefit from the emotional processing of the face to make a rapid attentional shift and engagement to the target stimuli (i.e., the reaction times were expected to be lower at 500 ms compared to 200 ms) whereas HTA individuals would continue processing the facial expression. Moreover, for HTA individuals, if anger differs from fear in its ability to maintain attention then we should find greater difficulty in disengaging from angry facial expressions compared to the fearful facial expression.

1. Method

1.1. Participants

Participants were 72 undergraduate students from Lille University (34 women and 38 men; mean age: 21.53 years). All participants had normal or corrected-to-normal vision. The participants were selected into two extreme groups on the basis of their response to the French version of the Spielberger's Trait Anxiety Inventory (STAI; Bruchon-Schweitzer & Paulhan, 1993; Spielberger, Gorsuch, & Lushene, Vagg, & Jacobs, 1983). Following the French norms, 28 participants (T note $\geq$ 56, 70th percentile) were classified in the high trait anxiety group (HTA), and 27 participants (T note $\leq$ 45, 31st percentile) in the low trait anxiety group (LTA).

1.2. Materials and apparatus

Twenty-four face stimuli were selected from the Karolinska Directed Emotional Faces database (Lundqvist, Flykt, & Öhman, 1998). They consisted of angry, fearful and neutral prototypical expressions posed by eight models (four males and four females). Each of the black and white photographs measured 10 cm $\times$ 10 cm in size and was matched for brightness. The target stimuli were the capital letter X or P presented in Geneva font 24. The target letters were presented in one of four locations: 8 cm above, below, to the left, or to the right of the centrally located face. These locations were at a visual angle of about 9° degrees from the centre of fixation when viewed from 50 cm.

1.3. Procedure

On arrival at the laboratory, each participant completed the attentional shifting task. They completed a practice block of 8 trials, followed by two blocks of 96 experimental trials. Each combination of three emotional expressions (fear, anger or neutral), four target locations (above, below, left or right), two target types (X or P) and two durations (200 or 500 ms) were equiprobable. Trials were presented in a different random order to each participant.

Each trial began with an asterisk presented at the centre of the screen for 1000 ms. One of the facial expressions was then presented at the centre of the screen and, after 200 or 500 ms, a target letter (X or P) was presented at one of the four locations for 50 ms. The face remained on the computer screen until the participant responded or until 2000 ms had elapsed (see Fig.1). There was an inter-trial interval of 1650 ms.

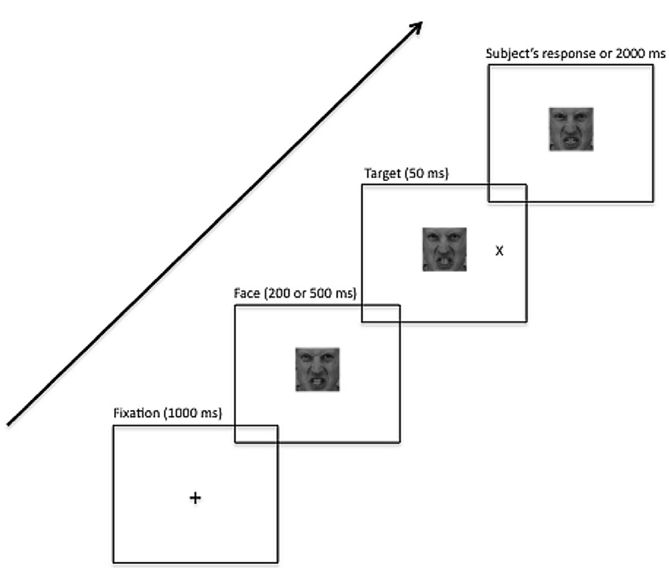

Fig. 1. Sequence of events in the attention shifting task.

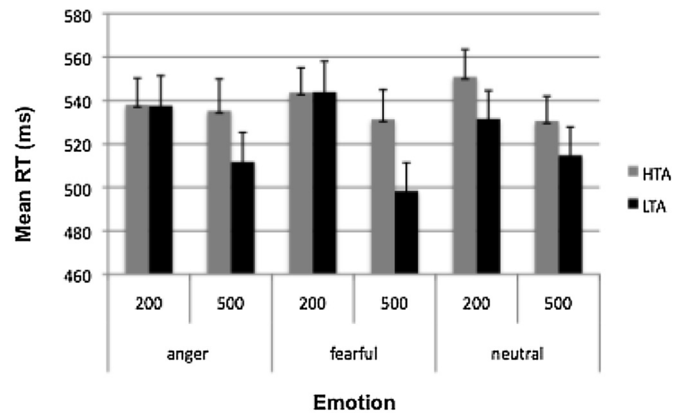

Fig. 2. Mean reaction times in milliseconds as a function of trait anxiety, duration and emotion.

2. Results

Incorrect trials and RTs less than 100 ms and greater than 1500 ms were eliminated from the RT analysis (1.65%). The mean reaction times were entered into an Anxiety Group $\times$ Emotion $\times$ Duration $\times$ Block mixed-factors analysis of variance (ANOVA) with repeated measures on the last three variables. There was a main effect of Block, $F(1,53) = 42.69$, $p < .0001$. Reaction times were faster on the second block (M = 502 ms) relative to the first block (M = 559 ms). Of more theoretical interest, there was a main effect of Duration, $F(1,53) = 25.741$, $p < .0001$, $\eta_p^2 = .33$. Reaction times were faster in the 500 ms condition (M = 520 ms) compared to the 200 ms condition (M = 541 ms). This effect was qualified by a significant Duration $\times$ Anxiety Group interaction, $F(1,53) = 4.73$, $p < .05$, $\eta_p^2 = .08$. In order to explain this interaction, pairwise comparisons were performed between the two groups using the mean reaction times at the 200 ms condition and at the 500 ms condition. There were no differences within each of the two conditions. Then, we compared the 200 and 500 conditions within each group. Pairwise comparisons (Bonferroni correction) showed that LTA individuals were faster in the 500 ms condition (M = 508 ms) than in the 200 ms condition (M = 538 ms) ($p = .007$). In the HTA group, the RTs did not differ between the 200 and 500 ms conditions.

Moreover, there was a significant Anxiety Group $\times$ Duration $\times$ Emotion interaction, $F(2,52) = 3.61$, $p = .034$, $\eta_p^2 = .12$. To examine this 3-way interaction further, given our predictions, we performed a series of planned comparisons focusing on the difference between the 200 ms and 500 ms conditions for each emotion and each group (the planned comparisons focusing on the differences between HTA and LTA groups for each emotion either at 200 or 500 ms were not significant). In the LTA group, RTs for trials in which angry faces were presented were shorter at 500 ms condition (M = 512 ms) than at 200 ms condition (M = 537 ms), $F(1,51) = 6.15$, $p = .016$. In the HTA group, the RTs for the 500 ms condition did not differ from those for the 200 ms condition. For fearful faces, in the LTA group, RTs were shorter at 500 ms condition (M = 498 ms) than at 200 ms condition (M = 544 ms), $F(1,51) = 39.8$, $p < .0001$. In the HTA group, the RTs for the 500 ms condition did not differ from those for 200 ms condition. Finally, regarding the neutral faces, in the LTA and HTA groups, RTs were shorter at 500 ms condition (M_{HTA} = 531 ms; M_{LTA} = 515 ms) than at 200 ms condition (M_{HTA} = 551 ms, M_{LTA} = 532 ms) (for HTA, $F(1,51) = 6.79$, $p = .012$; for LTA, $F(1,51) = 3.93$, $p = .05$). (Fig. 2).

3. Discussion

This experiment was performed to examine the disengagement from angry, fearful and neutral faces in LTA and HTA individuals at two stages of facial expression processing. The first result is that latencies to disengage were shorter when participants were given more time to process the facial expression (500 ms vs. 200 ms). This result suggests that it is easier to disengage when the facial expression processing is mostly achieved. Concerning the effect of anxiety on attentional disengagement, our core result is that LTA but not HTA individuals have shorter reaction times at 500 ms compared to 200. These results suggest that LTA individuals benefit from a longer exposure to the face, as it facilitates a more rapid attentional shift and engagement to the target stimuli whereas HTA individuals do not as they continue to process the facial expression. However this interpretation would be, in future research, strengthened by additional evidence obtained with eye-tracking methodology (e.g., Weierich et al., 2008). This difficulty to disengage from facial expression seems to take place during the emotional processing of the face (i.e., the complex cognitive/and or arousal processes: from 200 ms to 500 ms). Moreover, our study shows that this impaired disengagement in anxious individuals took place especially for fearful and angry faces and not for neutral faces. This data contrasts with the results of Fox, Mathews, Calder, and Yiend (2007) showing that in anxiety, attention is more likely to be held by an expression of anger than fear. Contrary to Fox et al. (2007), we did not manipulate the eye gaze direction of the facial expressions; we kept the eyes staring straight ahead. Therefore the ambiguity of the fearful facial expression (i.e., a fearful face looking directly at you is more ambiguous than a fearful face looking at another location) could be responsible of the disengagement difficulty observed in our study. It seems more interesting in future research to investigate facilitated attention from fearful faces, which has a larger ecological sense insofar as it prevents a danger (Adams & Kleck, 2002).

Our results are in line with the study of Moriya and Tanno (2011) that failed to evidence impaired attentional disengagement in socially anxious people with short presentation times (100 and 200 ms) and showed an attentional disengagement from 300 ms (Moriya & Tanno, 2011). The current results extend Moriya and Tanno's results to trait anxiety and showed that this difficulty also exists for fearful and angry faces. However, contrary to Moriya and Tanno's results, our RTs for threatening faces in anxious individuals were not longer than those for neutral faces. This discrepancy in findings could be explained by a difference in the type of anxiety displayed by participants in both studies (i.e., social anxiety in Moriya and Tanno's study and general anxiety in the present study). Social anxious individuals might be more sensitive to threatening facial expressions than trait anxious individuals (see Staugaard, 2010). Furthermore, this lack of difference between threatening and neutral faces does not mean a lack of disengagement difficulty. We suggest that lower reaction times in the 500 ms condition compared to the 200 ms condition when the facial expression is threatening, could be another indicator of attentional dwelling on facial expression.

Considering that the disengagement was only evident when controlled processes could take place (i.e. from 300 ms), top down processes are likely to play a key role in the capacity to rapidly disengage from threatening information. Indeed, several studies introduce the role of the attentional control in the regulation of attentional biases in anxiety. Using a dot probe task with 500 ms stimulus duration, Derryberry and Reed (2002) showed that anxious participants with good attentional control were better able to shift from the threatening location than those with poor attentional control. According to Eysenck and Derakshan's attentional control theory (2011), anxiety impairs the efficiency of two executive functions (i.e., the inhibition and shifting functions). In this direction, Telzer et al. (2008) showed that high anxious individuals required greater use of the inhibition function than low anxious ones to disengage from the processing of angry faces (evaluated by a dot probe task). The particularity of the dot probe task is that the dot replaces one of the two faces. The participants had to respond to the dot while the face disappeared. It will be interesting to investigate this function with a task in which the threatening information remains on the screen as in an attentional shifting task. This kind of task enables participants to maintain cognitive resources on the source of stress (Moriya & Tanno, 2011). Further research is needed in order to investigate the different functions of attentional control and their influence on the disengagement from threatening information.

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