Journal of Anxiety Disorders 23 (2009) 374–380

Contents lists available at ScienceDirect

Journal of Anxiety Disorders

Is preattentive bias predictive of autonomic reactivity in response to a stressor?

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ARTICLE INFO

Article history:
Received 17 June 2008
Received in revised form 9 November 2008
Accepted 3 December 2008

Keywords:
Preattentive bias
Emotional vulnerability

ABSTRACT

Biased processing of threatening information may play a casual role in the development of anxiety disorders. Even though empirical evidence points to the fact that preattentive bias can predict subjectively experienced distress in response to a stressor, it is still unknown whether it could be useful in predicting the physiological reactivity in response to a stressor. In the present study, the emotional Stroop task was used to measure preattentive bias. Whereas Stroop interference for masked threat words (i.e., preattentive bias) was found to be positively associated with emotional distress (self-reported) in response to a laboratory stressor, this association was reversed when the autonomic reactivity (electrodermal activity) was used as a measure of emotional response to the very same stressor. Also, neither of these effects were a function of pre-existing anxiety levels. The negative association between preattentive bias and autonomic reactivity corresponds to the autonomic inflexibility seen in clinical anxiety (or very high scores of trait anxiety) when exposed to stressful events. Results were discussed in terms of an inability to automatically inhibit the processing of threatening cues that seems to be a vulnerability marker for anxiety.

Research focusing on the link between cognitive biases and anxiety disorders has generated a considerable interest during the last decade (e.g., Eysenck, 1997; Williams, Mathews, & MacLeod, 1996, for reviews). In particular, selective attention favoring threatening information has received increased attention because recent cognitive formulations have placed much emphasis on its role as a key cognitive factor underlying vulnerability to and the maintenance of anxiety disorders (e.g., Eysenck, 1997; Mogg & Bradley, 1998; Williams, Watts, MacLeod, & Mathews, 1997). Others, on the other hand, have suggested that various trait factors, such as negative affectivity (e.g., Clark, Watson, & Mineka, 1994) and anxiety sensitivity (McNally, 1990), may play a key role in the development of clinical anxiety. However, it is important to note that selective attention and trait factors are by no means independent of each other. Indeed, a number of studies using non-clinical samples have provided evidence that high levels of trait anxiety are associated with selective attention for threatening information in conditions when the information can be consciously perceived (e.g., Dalgleish, 1995), and in conditions where the information cannot be consciously perceived (e.g., MacLeod & Rutherford, 1992; Rutherford, MacLeod, & Campbell, 2004). Consequently, it seems reasonable to argue that if attention is being paid to the joint contribution of selective attention and trait factors, it will not only increase our understanding of the development and maintenance of anxiety disorders, but also to identify vulnerable individuals with regard to the development of anxiety.

Studies on selective attention have typically been of two types: one based on measurement of spatial attentional allocation towards specific information appearing at different locations, while the second is based on the competition of attentional resources between two different types of information that are co-occurring in the exact location of space. The former is referred to as the "attentional probe task", wherein two stimuli (e.g., threat-related and neutral) are typically presented simultaneously on a computer screen. The participant's task is to respond to a probe stimulus that appears in one of the stimulus positions shortly after the two stimuli have disappeared. A fast reaction time suggests that attention has been directed at the stimulus in the position of the probe, whereas a slow reaction time suggests that attention has been drawn away from the stimulus in the position of the probe. The latter attentional task is referred to as the "emotional Stroop task". In this task participants are presented with a series of words of differing emotional valence, printed in a variety of colors. They are instructed to name the color as quickly as possible, while ignoring the meaning of the word. It has been proposed (Mathews, 1990) that all words are automatically processed for meaning, but when the word has a meaning that is closely related to an individual's current concern, the individual will have difficulties in ignoring the meaning of the words and will therefore be slower to

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doi:10.1016/j.janxdis.2008.12.001

name the color of these words compared to neutral words (Stroop interference). In particular, these effects appear to be strongest when the words match their particular fear.

With regard to the emotional Stroop task, one concern that has been put forward (e.g., Phaf & Kan, 2007) is the relative absence of Stroop interference on the masked version of this task (i.e., subliminal presentation). In response that, one notable feature of the research using emotional Stroop task the are findings (e.g., Jansson & Lundh, 2006; Rutherford et al., 2004) indicating that some participants are in fact measurably faster to color-name unconsciously perceived threat words relative to neutral control words (the Stroop facilitation effect). In the case of relatively harmless threats such as, the functional significance of selective attention away from unconsciously perceived negative information would be that it assists us in focusing on current goal-relevant activities as well as in maintaining a positive state of mood. Prolonged attention directed towards the very same threat, on the other hand, have the exact opposite effects and, hence, would be highly dysfunctional.

Another concern that has been expressed (e.g., Mogg & Bradley, 1998) is that, in the emotional Stroop task, single word presentation is typically used. Words have fairly limited threat value, whereas pictorial stimuli have high threat value and should therefore be more useful for the purpose of assessing biased processing of threat. With regard to the usage of pictorial stimulus material, it is assumed that unconscious processing of threat is mediated by evolutionary-driven mechanisms that, in turn, are more likely to be triggered by pictorial representations of biologically relevant threats (e.g., Öhman, 1996). Nonetheless, what remains to be explained is why (1) individuals with elevated levels of anxiety are more likely than low anxious individuals to show preattentive bias to threatening information, and (2) why the same kind of bias is associated with emotional responses to stressful events when word stimuli are used (i.e., mild threat value). This is of paramount importance because, as will be discussed below, even if threat words could be viewed as not being "potent" threat cues, the individual differences in which threat words are processed are still a potential marker for the development of anxiety disorders.

In answer to the question with reference to the functional significance of selective attention away from negative information, selective attention towards threatening information may indeed have some negative consequences for the human. To date, there are a few studies that have examined the contribution of selective attention and trait factors on emotional vulnerability. The emotional Stroop task has exclusively been used to examine the predictive value of attentional (conscious) and preattentive (unconscious) bias in emotional responding to a stressful event. Some of these studies involved emotional responding to stressful real-life situations (e.g., MacLeod & Hagan, 1992; Pury, 2002), whereas others involve emotional responding to somewhat more artificially stressful events (e.g., van den Hout, Tenney, Huygens, Merckelbach, & Kindt, 1995). In an early study by MacLeod and Hagan (1992), using a non-clinical sample of women awaiting colpescopy after a positive cervical test, these authors found that Stroop interference for masked threat words (i.e., words presented outside conscious awareness) was a significant predictor of emotional distress in response to diagnoses. Recently, this effect was replicated in a sample consisting of women undergoing fertility treatment (Verhaak, Smeenk, van Minnen, & Kraaimaat, 2004), wherein Stroop interference for masked stressor-specific words (but not general threat words) was a significant predictor of emotional distress in response to failed treatment. Effects in the same direction have been found in high academic stress (Pury, 2002), in hypothetical stressful situations (van den Hout et al., 1995), and in laboratory-induced stress caused by inhalation of carbon dioxide-enriched air (Nay, Thorpe, Roberson-Nay, Hecker, & Sigmon, 2004). Noteable is that all studies above shared one common feature; selective attention favoring threatening information *unavailable for conscious processing* remained as a significant predictor of emotional response to a stressor *after* various personality variables (e.g., trait anxiety, anxiety sensitivity, neuroticism) and state anxiety had been accounted for. Also, while the absence of significant effects for Stroop interference for unmasked words (i.e., words available for conscious processing) appeared consistently across studies, the Nay et al. study (2004) departed from the other studies in the sense that Stroop interference for unmasked words was an even stronger predictor of emotional response than Stroop interference for masked words. It is also interesting to note that one does not necessarily need a cognitive measure of preferential preattentive processing of threat in order to predict emotional distress in response to stressful events. Specifically, emotional responses to stressful life events can be predicted by using skin conductance reactivity to index preferential preattentive processing (Najström & Jansson, 2007).

There is now direct evidence that attentional bias to threat can be altered using an information-processing approach. In a series of experiments, MacLeod, Rutherford, Campbell, Ebsworthy, and Holker (2002) found that non-anxious participants who were trained to develop biased attentional processing of threat cues responded with a more negative mood state when exposed to a stressful task than did those who did not receive such training. This implicates that biased attentional processing can have causal effects on the experience of anxiety and other negative mood states.

The present study was carried out to investigate the relative contributions of trait anxiety and Stroop interference to emotional responses following the exposure of a laboratory stressor. There was one novel feature in the present study apart from a subjective measure of emotional response, as been exclusively used in previous research on this topic, the participants' skin conductance activation (an index of activation of the sympathetic branch of the autonomic nervous system) was measured during a stressful task in order to obtain a measure of physiological reactivity to a stressor, as stressful events are typically accompanied with physiological responses. As earlier noted, biased processing of threatening information, such in this case, preattentive, has received much attention because (1) anxiety patients have a markedly more pronounced bias than controls (e.g., Lundh, Wikström, Westerlund, & Öst, 1999) and (2) this bias appear to be eliminated after successful therapy among anxiety patients (e.g., Mogg, Bradley, Millar, & White, 1995), but also (3) because it has been found to be useful in predicting subjective emotional responses following the exposure of stressful events (e.g., MacLeod & Hagan, 1992). Consequently, it seems reasonable to assume that biased processing of threatening information is a prominent feature in anxiety disorders.

Another prominent feature in most anxiety disorders is heightened physiological arousal in response to stimuli that match their particular fear. Of relevance to this study, evidence from studies by Hoehn-Saric and McLeod (2000, for a review) suggests that when anxiety patients are exposed to moderately stressful tasks, the changes in skin conductance responses (compared to baseline) are smaller than those of the non-anxious controls. These authors argued that this "autonomic inflexibility" seen in anxiety patients reflects a less adaptive response to stress (see also Friedman & Thayer, 1998; Thayer, Friedman, & Borkovec, 1996, for similar conclusions). There is also evidence from non-clinical samples that is consistent with the substantial number of studies (Hoehn-Saric & McLeod, 2000, for a review) that have employed skin conductance as an outcome measure. For example, results from a study (Jezova, Makatsori, Duncko, Moncek, & Jakubek, 2004)