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An experimental investigation of hypervigilance for threat in children and adolescents with post-traumatic stress disorder

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ABSTRACT

Background. The present study examined biases in visual attention for emotional material in children and adolescents with post-traumatic stress disorder (PTSD) and healthy controls.

Methods. The participants carried out an attentional deployment task in which probe detection latency data were used to determine the distribution of visual attention for threat-related and depression-related material.

Results. The results showed that children and adolescents with PTSD, relative to controls, selectively allocated processing resources towards socially threatening stimuli and away from depression-related stimuli. This attentional avoidance of depression-related information in the PTSD participants declined with age.

Conclusions. The results of the study are interpreted as a consolidation and extension of previous research on attentional bias and emotional disorder in younger participants.

INTRODUCTION

Beck *et al*. (1985) have described clinical anxiety in terms of a biased information-processing system, including a bias in attention. According to this theory, anxious individuals are characterized by cognitive structures ('threat schemata') specifically related to the processing of threat-related stimuli, which may have been established during the person's early life. The structures are conceptualized as being over-activated during the development of an anxiety disorder such that they act as guides to information intake in favour of schema-congruent, threat-related elements of the environment. This process is especially significant in post-traumatic stress disorder (PTSD) where attentional hypervigilance for threat is a symptom of the syndrome (American Psychiatric Association, 1994). Such heightened perception of danger and subsequent appraisal of one's capability in dealing with that danger has obvious survival value. However, the suggestion is that individuals with PTSD exhibit excessive attentional hypervigilance to an excessive range of threat and danger cues within their environment, such that this process becomes maladaptive.

PTSD theorists (e.g. Brewin *et al*. 1996) have suggested that such attentional biases are a non-trivial component of the traumatic response. They are seen not as mere epiphenomena of being in an anxious state but as important factors in the aetiology and maintenance of the disorder. In this analysis, anxiety leads to increased hypervigilance for threat, a greater level of threat detection leads to increased anxiety which, in turn, leads to increased hypervigilance, and so on in a vicious circle. For this reason,

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understanding more about the nature of attentional processing in PTSD is important in developing theoretical explanations of the disorder.

The nature and extent of attentional bias effects for emotional information is reasonably well established in adult populations with PTSD (see Thrasher & Dalgleish, 1999, for a review). However, work investigating attentional processing in younger populations with PTSD is at an earlier stage, numbering only one published study (Moradi *et al.* 1999) that we are aware of. As there is currently considerable uncertainty about the degree of symptom overlap between adult and child/adolescent presentations of PTSD, it is important to investigate empirically the underlying nature of basic symptoms such as hypervigilance in younger populations. In the one study published to date, Moradi *et al.* (1999) examined the performance of children and adolescents with PTSD on the emotional Stroop task. This task requires participants to name the colours that sets of emotional and non-emotional words are written in, while ignoring the actual word-content. Slower colour-naming is interpreted as an index of how much the content of the word interferes with task performance. Moradi *et al.* (1999) found that children and adolescents with PTSD were slower to name the colours of threat-related words relative to both their performance on neutral words and to the performance of healthy controls. This was taken as evidence that the processing of threat-related information recruits greater attentional resources in children with PTSD compared to controls.

One problem with the emotional Stroop task, however, is that there is some debate as to how good a measure of attentional bias it is (see Williams *et al.* 1996). One reason for this debate is that the design of the task does not rule out response biases in that participants are responding to an emotional stimulus. So, for example, it may be that the initial allocation of attentional resources to both emotional and non-emotional words is equivalent on the task but that at the later response stage in processing, when the participant has to generate the colour-name, greater cognitive resources are needed in the case of threat-related words to suppress the response of reading the word, thus selectively slowing the colour-naming of threat material. In this explanation then, the Stroop task is a response bias measure not an attentional bias measure.

In order to circumvent the potential problem of response bias inherent in the emotional Stroop task, MacLeod *et al.* (1986) developed the attentional deployment or attentional dot probe paradigm. In this task, on each trial, a word pair appears on a computer screen for a fixed time (500 ms in the original paper), one word above and the other below the centre of the screen. In the critical trials, one of the words is threatening and the other is neutral. Some word pairs where both words are neutral act as fillers. Participants are required to read the top word on each trial. The words then disappear from the screen. On critical trials, a dot probe appears in a place previously occupied by one of the two words. Participants have to press a button as soon as they see the probe. The rationale is that participants are generating a neutral response (the button press) to a neutral stimulus (the dot probe), thus minimizing the potential for response biases to effect the data. Consequently, the reaction time (RT) to the dot probe is a reasonably pure measure of visual attention to the word that the dot replaced because individuals will be faster to respond to the dot if they are already attending to that spatial location. Studies with generally anxious children and adolescents using this paradigm (e.g. Vasey *et al.* 1995; Taghavi *et al.* 1999) have indicated that anxiety is associated with a visual attentional bias for threat-related material. In contrast, there is no evidence supporting such biases in children and adolescents with depression or mixed anxiety depression (Taghavi *et al.* 1999; Neshat-Doost *et al.* 2000). This pattern of findings broadly mirrors those in the adult literature (Williams *et al.* 1997).

The present study therefore sought to extend the research on biases in visual attention in children and adolescents with PTSD by using the attentional deployment task. This has the advantage of potentially validating the phenomenon reported by Moradi *et al.* (1999) using an alternative methodology and also of minimizing the influence of response biases, thus providing a measure of visual attention that is closer to the symptom of hypervigilance in PTSD that is of primary clinical interest (American Psychiatric Association, 1994). Children and adolescents

with PTSD and healthy controls were therefore administered the attentional deployment task with social-threat, physical threat- and depression-related words. The hypothesis was that the clinical group, relative to the controls, would show attentional bias for threat-related material but not for depression-related material.

METHOD

Participants

The clinical group comprised 24 children and adolescents (12 boys and 12 girls), aged 9 to 17, who met Diagnostic and Statistical Manual of Mental Disorders, 4th edn (DSM-IV; APA, 1994) criteria for a primary diagnosis of PTSD. All of the participants with PTSD were involved in either road traffic or personal violence events (not including abuse or domestic violence) in the 2 years prior to the study and were recruited through clinicians of the Psychology Department of the Institute of Psychiatry, London. Diagnostic status was determined in a clinical assessment by mental health teams, including psychiatrists and psychologists in a separate assessment session. Consensual diagnosis by all members of the team was a requirement for selection. Diagnosticians were blind to the hypotheses of the study.

The control group consisted of 24 children and adolescents (17 boys and seven girls), aged 9–17 years. The control group was recruited from primary and secondary schools from different parts of London. Control participants had no known history of emotional disorder or trauma according to parents and teachers. The control and PTSD groups were comparable on age, verbal IQ and reading ability (see Results section).

Apparatus and Materials

Measures

Participants were given the following self-report measures of mood and tests of vocabulary and reading ability:

1 The Revised Children's Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1978) – a measure of trait anxiety;

2 The Depression Self-Rating Scale (DSRS; Birleson, 1981) – a measure of depressed mood;

3 The Revised Impact of Event Scale (IES; Horowitz *et al*. 1979; administered to the PTSD participants only) – a measure of the frequency of the intrusion and avoidance symptoms of PTSD;

4 The British Picture Vocabulary Scale (BPVS, short form; Dunn *et al*. 1981) – a measure of receptive vocabulary;

5 Basic Reading Subtest of the Wechsler Objective Reading Dimensions Test (WORD; Rust *et al*. 1993) – a measure of reading ability.

The attentional deployment task

Forty-eight emotional words were used in this study: 16 words related to physical threat (e.g. explosion), 16 words related to social threat (e.g. rejected) and another 16 depression-related words (e.g. sad). Words relevant to the participants' individual traumas were not used for three reasons: (*a*) although trauma-related words would have allowed the threat content to be titrated to individuals' concerns, the imbalance across materials on dimensions such as word frequency would have made the data uninterpretable; (*b*) the clinical and theoretical analysis of hypervigilance for threat in PTSD suggests that it pathologically extends beyond trauma-related information; and, (*c*) the use of general threat material enables comparison with other studies on younger populations (e.g. Vasey *et al*. 1995).

The words used in the present study were chosen from previous research (Neshat-Doost *et al*. 1999) in which a large sample of children generated words to particular category cues (e.g. sad, scary). The words in the present study were identical to those used in other studies of attentional bias in younger participants (Taghavi *et al*. 1999; Neshat-Doost *et al*. 2000). Each emotional word was matched with a neutral word for both length and frequency to make 48 critical word pairs (Neshat-Doost *et al*. 1999). In order to divide the threatening words into those that were physically threatening and those that were socially threatening, a two-stage procedure was used. First, 10 experienced child psychologists and psychiatrists categorized and numerically rated the 129 threatening words that had been produced by a normative sample (Neshat-Doost *et al*. 1999). Only words on which all of the raters agreed were used, with the added proviso that the mean threat rating across threat type was comparable. Secondly, the words were matched with neutral words for length and

Table 1. *Means and standard deviations of participant characteristics of the PTSD and control groups*

	PTSD ($N = 24$)		Controls ($N = 24$)	
	Mean	(S.D.)	Mean	(S.D.)
Sex (M:F)	12:12		17:7	
Age (years)	12·83	(2·88)	12·83	(1·84)
WORD	100·58	(12·35)	103·96	(17·27)
BPVS	98·17	(15·16)	97·21	(15·30)
DSRS***	13·63	(7·20)	8·38	(3·15)
RCMAS***	14·63	(8·07)	10·49	(4·24)
IES	33·25	(19·03)	—	—

IES, Revised Impact of Event Scale; RCMAS, Revised Children's Manifest Anxiety Scale; DSRS, Depression Self-Rating Scale; BPVS, British Picture Vocabulary Scale; WORD (basic reading), Wechsler Objective Reading Dimensions.
*** Groups differ at level $P < 0{\cdot}001$, one-tailed, using independent sample t tests for data with unequal variances.

frequency according to published norms (Carroll *et al*. 1971). Another 148 neutral word pairs were chosen from a normative set (Neshat-Doost *et al*. 1999), with each pair matched for word length, to act as filler items. The practice trials consisted of 12 pairs of neutral words.

Each word-pair was presented for 1500 ms (this duration was determined during piloting and is consistent with previous studies on younger populations, see Vasey *et al*. 1995) with one word above the other and separated on the vertical axis by a distance of 3 cm (visual angle less than 4 °). The word-pairs were presented in random order. The words were presented in black capital letters, 8 mm high. On the 48 critical trials (threat-neutral and depression-neutral word pairs) and on 48 of the filler trials, a dot probe replaced either of the two displayed words (after 1500 ms) and remained on the screen until the participant's response. On the other 100 filler trials there was no probe and the next word pair followed after a delay of 1000 ms following the offset of the previous word pair. On each critical trial, the threat- or depression-related word could appear with equal probability in either the upper or lower screen position. The probe could follow in either position with equal probability, yielding two independent factors: 'emotion position' and the position of the subsequent visual probe ('probe position'). The combination of these two factors gives rise to four possible conditions, two probe positions (upper and lower) and two emotion positions (upper and lower). For each participant, 12 of the 48 critical trials were allocated to each condition.

To minimize the influence of outlying data points, probe detection latencies less than 100 ms and more than 3 s were omitted, in line with previous research (Mogg *et al*. 1992). To facilitate interpretation of the data, MacLeod & Mathews (1988) provided a formula in which the relationship between emotion position and probe position was simplified in order to provide a single index of attentional bias by substituting the appropriate detection latencies into an equation:

$$\text{Attentional bias score} = [(\text{UP/LE} - \text{UP/UE}) + (\text{LP/UE} - \text{LP/LE})]/2.$$

In this formula UP/LE corresponds to detection times when the upper area is probed but the emotional word is in the lower area, and so on. This algorithm calculates the mean speed of detection latencies to probes in the same area as the emotional stimuli by subtracting them from equivalent probe detection times when the emotional stimulus is in a different location. A value of zero indicates that the emotional stimulus exerts no differential influence upon the detection latencies for probes in either area. To the extent that any participants attended selectively to the area where the emotional stimulus appeared, thus detecting probes disproportionately rapidly in this area, the equation will result in a correspondingly large positive value. To the extent that participants moved attention away from the area where this emotional stimulus appeared, it will result in an appropriately large negative value. Appropriate attentional bias scores were derived for depression-, social- and physical-threat-related words in the present study.

The attentional dot probe task was presented using: an IBM-PC (Thinkpad 755C TF1) with a 26·4 cm active-matrix thin film transistor colour, LCD blue-screen monitor; and a key device consisting of one button for responding to the dot probes.

Procedure

Each participant was tested individually. The participants sat in front of the computer screen at a distance of 50 cm in a quiet room to perform the task. Participants were instructed to

read aloud the top word of each word pair that appeared on the screen. They were informed that some word pairs would be followed by a small dot and were instructed to respond as quickly as possible to this dot with a button press. There was a short practice session of 12 trials that included four probe trials but no emotional words. Afterwards, participants were asked if they would like to have more practice. If so, the practice trials were readministered. Participants then began the main experiment that lasted approximately 15 min. Participants received a break in the middle of the task for 3 min. Finally, the participants were asked to fill in anxiety, depression, post-traumatic stress, vocabulary, and reading scales as mentioned above. Participants were debriefed at the end of the testing session.

RESULTS

Participant characteristics

Means and standard deviations are shown separately for age, reading, vocabulary and the various measures of psychopathology for the patient group and the control group (see Table 1). There were no significant differences between the groups for age, verbal IQ, or reading ability, but the PTSD group, as expected, scored significantly higher on the measures of depression and anxiety. The groups were comparable in terms of sex ratio, $\chi^2 = 2{\cdot}18$, $P > 0{\cdot}1$. PTSD participants' scores on the IES were comparable with studies of child survivors of shipping disasters (Yule, 1992)

Performance of the attention deployment task

Indices of attentional bias to social threat words, physical threat words and depression-related words were computed (see Apparatus and Materials section) and are shown in Fig. 1. Directional statistics were used for the planned analyses; namely, those investigating attentional bias in favour of threat in the PTSD participants, relative to controls. All other analyses were two-tailed.

The indices of attentional bias were entered into a repeated-measures ANOVA with Group (2: PTSD and Controls) as the between-participants variable and Bias Type (2: Social Threat Bias, Physical Threat Bias and Depression Bias) as the within-participants variable. The assumption of sphericity was violated and so Greenhouse–Geisser corrected output is presented. The results revealed a significant interaction of Group × Bias Type, $F(1{\cdot}36, 62{\cdot}53) = 4{\cdot}42$, $P < 0{\cdot}03$, (see Fig. 1). However, there was neither a significant main effect of Bias Type or Group, Fs < 1. Subsequent analyses using independent samples t tests for the three bias indices but utilizing the pooled error variance revealed that the groups were significantly different on the index of depression-related bias, $t(46) = 2{\cdot}02$, $P < 0{\cdot}05$, with the PTSD group showing greater attentional avoidance of depression-related material relative to the controls. There was also a difference between the two groups for social-threat words, $t(46) = 1{\cdot}89$, $P < 0{\cdot}05$, with the PTSD group this time showing greater attentional bias towards the threat-related information relative to the controls. There was no difference between groups for physical threat words, $t(46) < 1$.

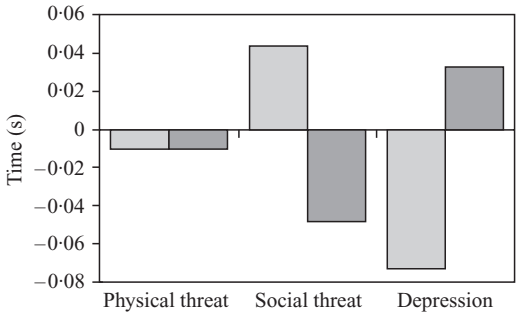

FIG. 1. Mean social threat, physical threat and depression bias indices (in seconds) for the two groups (□, PTSD; ■, Controls). Positive scores indicate attentional vigilance. Negative scores indicate avoidance.

DISCUSSION

The results of the present study showed that children and adolescents with PTSD exhibited visual attentional bias in favour of social-threat-related information, though not physical-threat-related information, and attentional avoidance of depression-related information, relative to healthy controls. The magnitude of this attentional avoidance of depression-related material decreased with age.

These data partially replicate the previous finding of a greater Stroop interference effect for

threat-related material in children and adolescents with PTSD, relative to controls (Moradi *et al*. 1999), this time using a methodology where the data are less susceptible to a response-bias explanation. The findings are consistent with the results of other studies revealing visual attentional biases for threat associated with anxiety in younger populations (Vasey *et al*. 1995, 1996; Taghavi *et al*. 1999).

Taken together these data suggest that childhood anxiety disorders are associated with attentional bias for some types of threat-related information in the same way as adult disorders (see Williams *et al*. 1997, for a review). This suggests that in cognitive processing terms, there is a degree of continuity between anxiety-related psychopathology including PTSD in children and adults. This is an important finding as attentional hypervigilance for threat is a key component of clinical anxiety, in particular PTSD, and is conceptualized as an important factor in the aetiology and maintenance of anxiety disorders (Wells & Matthews, 1994).

There are a number of aspects of the present data that merit discussion however. The first is the fact that the bias for threat-related information in the PTSD participants was restricted to the domain of social-threat. This pattern of data differs from other studies with younger populations (Vasey *et al*. 1995, 1996; Taghavi *et al*. 1999), which found no differences as a function of threat type. However, data from research with adult samples using the dot probe task reveals that attentional bias can be specific to threat content that matches the individual's personal concerns (Asmundsen *et al*. 1992; Mogg *et al*. 1992; Westra & Kuiper, 1997). It is therefore possible that the specificity of the bias in the present study to social threat material reflects the fact that social-threat reflects more closely the main concerns of the children and adolescents with PTSD who took part. This may be because many of them were victims of interpersonal violence; however, given the degree of physical threat involved in such a trauma this explanation lacks immediate intuitive appeal. Unfortunately, there is not enough power to divide the clinical sample by trauma type; however, future studies in this area would benefit from examining this issue.

The second aspect of the present data that merits some discussion is the relative attentional avoidance in the PTSD group of depression-related information. Although the two previous studies that have looked at attentional performance with respect to depression-related information in younger participants have found no evidence for a bias in favour of that material, even in depressed individuals (Taghavi *et al*. 1999; Neshat-Doost *et al*. 2000), neither of those studies has revealed attentional avoidance of depression-related information. Attentional avoidance using the same experimental task has however been reported in the adult literature (e.g. MacLeod *et al*. 1986; Mansell *et al*. 1999). It is not clear what processes underlie such avoidance. The adult data have been interpreted as representing a temporal snapshot of attentional processing of threat, such that an initial phase of vigilance is rapidly surpassed by a more enduring phase of avoidance, which is then picked up by the task. However, it is not clear under what conditions avoidance occurs at a particular time delay. It seems likely that research systematically altering the experimental delay with younger participants would clarify this issue further (cf. Bradley *et al*. 1998).

In summary, the present study extends and partly replicates previous research in clinically anxious children and adults by revealing an attentional bias for social threat material in children with PTSD, relative to controls. However, the absence of such an effect with physical threat material along with evidence for relative attentional avoidance of depression-related material in the PTSD group suggest that further detailed research on the parameters of attentional bias in childhood anxiety is merited.

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