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Effects of State Anxiety on Selective Processing of Threatening Information

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The conceptualisation of Stroop interference as a state versus stable quality was examined in 23 spider-fearful and 23 control subjects. Stroop colour-naming response latencies were examined after an anxiety-provoking (approach) condition and a neutral condition. Spider-fearful subjects showed increased response times to spider versus neutral words across conditions, as well as increased response times to spider words in the approach condition as compared to the neutral condition. These results suggest that increases in state anxiety enhance an existing interference effect for threatening information in highly fearful individuals. Similar results were also found for positive words, suggesting an emotionality effect during heightened state anxiety. Finally, cognitive avoidance was found to influence Stroop interference under state anxiety conditions.

INTRODUCTION

Anxious individuals are thought to possess a bias in encoding that favours threatening information (for reviews, see Dalgleish & Watts, 1990; MacLeod, 1991), and makes relevant threatening stimuli central to their perceptions (Williams, Watts, MacLeod, & Mathews, 1988). This attentional bias has been measured through different techniques, including

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delays in colour-naming for threat words on a modified Stroop (1935) task, and decreased detection latencies for dot-probes following threat words (MacLeod, Mathews, & Tata, 1986).

In contrast to control subjects, anxious individuals demonstrate Stroop interference for threatening information related to individuals' current concerns (Logan & Goetsch, 1993). Stroop interference has been observed across a range of anxiety disorders, including spider phobia (Lavy, van der Hout, & Arntz, 1993; Watts, McKenna, Sharrock, & Trezise, 1986), panic disorder (Ehlers, Margraf, Davies, & Roth, 1988; McNally, Riemann, & Kim, 1990b), generalised anxiety disorder (Mathews & MacLeod, 1985), and post-traumatic stress disorder (McNally, Kaspi, Riemann, & Zeitlin, 1990a).

One conceptualisation of Stroop interference involves network models of emotion. Bower (1981) proposed that activation of emotion nodes leads to information related to anxiety being processed more quickly by anxious individuals. Additionally, the greater the match between information in the environment and the information stored in an individual's fear network, the greater the likelihood of activating the fear network (Lang, 1985, 1979). Thus, a closer match would be expected to produce higher levels of state anxiety and consequently, greater Stroop interference for threatening information.

A second conceptualisation of anxious cognitive processes postulates a danger schemata through which information related to threat is interpreted (Beck & Clark, 1988; Mathews & MacLeod, 1985). A danger schemata results in preferential encoding of threatening, or schema-congruent, information, thus producing Stroop interference effects. According to this theory, then, Stroop interference represents a stable characteristic of anxious individuals, possibly responsible for initiating an anxious state.

Although these theories differ in the relative emphasis given to state anxiety and stable dispositions, both theories acknowledge the possible causal role of each factor in Stroop interference. For example, more extensive and elaborate networks (presumably caused by more pervasive and enduring anxiety) might facilitate the development of state anxiety and interference effects. Also, individuals with a schema biased toward encoding threatening information may be more likely to become state anxious, which may shape further their danger schema, and consequently, interference effects.

Results from several studies that have examined Stroop interference as a stable versus state quality are mixed. Some researchers found stronger correlations between interference for threatening information and trait anxiety (Mogg, Mathews, & Weinman, 1989), whereas others found stronger correlations with state anxiety (Mathews & MacLeod, 1985). Furthermore, MacLeod and Hagan (1992) found no correlation between

state or trait anxiety and interference using a standard (unmasked) paradigm of the Stroop task. Limitations of these studies, however, include measuring the stable quality of Stroop interference through correlations with a trait anxiety measure rather than through repeated measurements across various situations, and correlating Stroop interference with a state anxiety measure rather than examining the effects of an experimental induction of state anxiety.

Experimental methods used to induce state anxiety include mood inductions (Richards, French, Johnson, Naparstek, & Williams, 1992), physical arousal (McNally, Riemann, Louro, Lukach, & Kim, 1992), difficult anagrams (Mogg, Mathews, Bird, & Macgregor-Morris, 1990), and exposure to a snake (Mathews & Sebastian, 1993). Again, mixed findings have emerged. Under stressful conditions, threatening information has been found to have no increased interference effects relative to nonstressful conditions (McNally et al., 1992), decreased interference for fearful subjects (Mathews & Sebastian, 1993), decreased interference for all subjects (Mogg, Kentish, & Bradley, 1993; using the unmasked Stroop paradigm, MacLeod & Rutherford, 1992), increased interference for high trait anxious individuals (Richards et al., 1992), and increased interference for all subjects (Mogg et al., 1990). However, in these studies, the methods of inducing state anxiety often were not selected for their relevance to anxious individuals' primary concerns (e.g. not all high trait anxious individuals become anxious when given difficult anagrams to solve). Consequently, fear networks possibly were not accessed fully. Furthermore, the effects of state anxiety on Stroop interference are best examined using a within-subjects design, where changes in anxiety can be related to changes in interference; some of the past studies, however, employed between-subjects design.

The current study examined the effects of increased state anxiety on Stroop interference for threatening information in relation to a specific fear. Spider-fearful and control subjects completed a Stroop task after a neutral condition and after approaching a spider. If Stroop interference is an enduring quality resulting from a danger schemata in fearful individuals, then fearful subjects should show increased colour-naming latencies for spider words relative to neutral words across both conditions. But if Stroop interference is dependent on elevations in state anxiety, then, spider-fearful subjects should show longer colour-naming response latencies for only spider words in the approach as compared to the neutral condition.

In this study, we distinguish an enduring bias for processing threatening information from trait anxiety. Trait anxiety may not be elevated if phobic stimuli are not encountered frequently (Craske, 1991); however, low trait anxious phobic individuals may maintain a disposition for displaying Stroop interference effects (an enduring bias). Thus we measure interference

effects on two occasions, rather than relying on correlations with trait anxiety.

We tested a competing hypothesis, that longer response times in the approach condition result from distracting effects of the presence of the spider, by including a group of control subjects. If the presence of the spider or the approach condition instructions are distracting, then control subjects should show different response times between the experimental conditions.

Also, we tested a second hypothesis concerning the emotional valence of words. Some researchers have demonstrated interference effects from positive emotional words in anxious individuals (Martin, Williams, & Clark, 1991; Mogg & Marden, 1990). However, Mathews and Klug (1993) suggested that only positive words that are linked to threat concerns because they are opposite to anxiety (e.g. "carefree") cause interference. We tested the emotionality hypothesis by including positive words opposite to anxiety emotions.

Finally, we attempted to examine the issue of cognitive avoidance. Cognitive avoidance is sometimes used as a means of reducing fear and impeding full activation of fear networks (Foa & Kozak, 1986). We hypothesised that spider-fearful subjects who engaged in cognitive avoidance during the spider task would show less fear activation, and thus less interference from the presentation of spider words in a colour-naming task.

METHOD

Subjects

Approximately 300 undergraduates completed a series of 0–8 point visual analogue scales (VAS) assessing fear and avoidance of spiders as part of a brief in-class screening procedure. Students who reported a strong to extreme fear (6–8) of touching a spider were recruited for the spider-fearful group. Students who reported no fear to mild fear (0–2) of touching a spider were recruited to serve as a low-fear control group. Sixty-eight undergraduates were initially recruited. The same screening scales were re-administered at the start of the experiment in order to ensure stable, distinct groups possessing either fear or lack of fear of spiders. Thus, subjects who reported fear levels that no longer met inclusion criteria were excluded from analyses. Eleven of the original fearful group were excluded for this reason. Eleven control subjects were excluded randomly to match group sizes. Each group contained three male and 20 female subjects. Fearful subjects averaged 18.7 years of age (SD = 0.86). Control subjects averaged 19.6 years of age (SD = 1.36). Subjects received course credit for their participation.

Materials

Subjects participated in a modified version of the Stroop colour-naming task (Stroop, 1935). Three categories of words were generated: spider, neutral, and positive. Six spider words were drawn from lists used by Watts et al. (1986) and Lavy et al. (1993): spider, cobweb, crawl, hairy, creepy, and poisonous. Spider words were matched for length and frequency in English usage (Carroll, Davies, & Richman, 1971) with six neutral words (lesson, gates, suntan, leafy, brews, and northwest) and six positive words (safety, serene, cared, relax, genial, and enjoying).[1] Words were presented on a computer screen, one at a time. Each word was presented a total of four times, once in red, yellow, blue, and green, for a total of 72 word presentations (18 words × 4 colours). The original set of 18 words was randomised four times to create the final Stroop list. A voice-activated relay recorded response latencies in milliseconds. This voice-activated relay stopped the computer's clock as soon as subjects initiated a verbal response to the word presentation. To assess the integrity of word categories, subjects were asked to rate the emotionality of each Stroop word, on a scale ranging from −3 (very negative) to +3 (very positive).

Experimental Conditions

The order of the two experimental conditions was counterbalanced across all subjects.

Neutral Condition. Subjects stood and counted silently by sevens for 2 minutes. Next, they participated in the computerised Stroop task.

Approach Condition. Subjects were asked to approach a tarantula in a glass tank and to observe the experimenter touch the spider with a Q-tip for 2 minutes. Subjects were informed that following the 2-minute observation period, they would complete a computer task and then be asked to touch the spider themselves. These instructions were intended to maintain anxiety throughout the Stroop task. After subjects completed the computerised Stroop task, they were informed that they would not be required to touch

[1] We decided to match positive, neutral, and spider words by length and frequency rather than create categorised neutral words to complement the categorised spider and positive words for two reasons. First, this method more closely matches Watts et al.'s (1986) study, and secondly, Mogg et al. (1993) found no difference in response times to categorised versus uncategorised neutral words. Additionally, we used positive words related to anxiety emotions rather than generating opposites to spider words because most of the spider words did not have opposites (e.g. they were nouns).

the spider. They then completed the Cognitive Avoidance Scale. To assess the credibility of the approach condition, subjects rated the believability of the instructions on a 0–8 point VAS.

Self-report Instruments. Fear of spiders was assessed through: (1) a series of five 0 to 8 point VAS measuring fear and avoidance of spiders (screening scales); (2) the fear rating of harmless spiders (0 to 4 points) from the Fear Survey Schedule-III (FSS-III; Wolpe & Lang, 1964), a 108-item survey of fears of a variety of situations and stimuli; and (3) Subjective Units of Distress Scale (SUDS) rating of current anxiety, assessed on a 0 to 8 point VAS.

Trait anxiety was measured using the Trait scale of the State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983).

Cognitive avoidance was measured using a Cognitive Avoidance Scale (CAS); a 12-item scale devised for this study to measure the degree to which subjects avoided processing information about the spider, rated on a 7-point scale. Two ratings were calculated: an Avoidant score, or sum of avoidant cognition items (e.g. "I pretended that the spider did not exist or blurred my vision of the spider"), and a Monitoring score, or sum of items regarding focusing on the spider or one's reactions to the spider (e.g. "I thought about the way my body would react—e.g. my heart would start racing—if I touched the spider").

Physiological Measures. Heart rate was measured to provide a second, independent index of fear. Heart rate was monitored continuously using a UNIQ Heart Rate Watch, consisting of an electrode belt placed around the subject's chest, and a wrist watch that received heart-rate data. Heart rate was monitored throughout the two experimental conditions, and for a 2-minute post-baseline period, and recorded over 15-second sampling intervals.

Procedure

On arrival at the laboratory, subjects completed the screening scales, FSS-III, and Trait Anxiety Inventory, and the heart-rate watch was attached. Subjects participated in either the neutral or approach condition as their first condition. SUDS ratings were recorded at 0sec, 10sec, 1min, and 2min throughout each condition. Heart rate was monitored continuously throughout each condition. Then the Stroop task was administered, with the spider outside the subjects' view although still present in the room. Subjects were instructed to ignore the meaning and name the colour of the words out loud as quickly as possible. After eight practice trials, subjects colour-named the 72 experimental words. The experimenter monitored subjects' responses,

and marked any incorrect colour-naming responses, as well as any words which subjects had to repeat in order to be registered by the voice relay.

A 10-minute filler task between conditions was designed as a resting period to allow heart rate and anxiety to return to baseline levels. The filler task consisted of nonanxiety questionnaires. Then, subjects participated in the second condition.

Following the two conditions, subjects completed the emotionality and believability ratings. Heart rate was recorded for a final 2-minute period to obtain a post-baseline, uncontaminated by anticipatory anxiety.

RESULTS

Integrity of Groups

Fearful subjects reported significantly higher fear of touching a spider on the VAS screening scale ($M = 6.4$, SD = 1.2) than did control subjects {($M = 0.7$, SD = 0.8), $t(44) = 18.61$, $P < 0.001$}. Fearful subjects reported significantly more fear of harmless spiders on the FSS-III ($M = 3.2$, SD = 0.8) than control subjects {($M = 0.4$, SD = 0.6), $t(44) = 13.11$, $P < 0.001$}.

The two groups did not differ significantly, however, on the Trait Anxiety Inventory (fearful subjects $M = 44.00$, SD = 9.9, control subjects $M = 39.77$, SD = 10.5).

Integrity of Experimental Manipulations

Overall, subjects rated the approach condition instructions as very believable {$M = 7.02$ (SD = 1.8)}. Fearful and control subjects did not differ in their believability ratings.

To assess the effectiveness of the manipulation, SUDS fear ratings, averaged over 0sec, 10sec, 1min, and 2min, were analysed through a 2 (Group) × 2 (Condition) repeated measures ANOVA. Analyses revealed a significant interaction effect for SUDS ratings {$F(1,44) = 68.84$, $P < 0.001$}, with fearful subjects reporting significantly higher SUDS ratings in the approach versus neutral condition {$F(1,22) = 122.60$, $P < 0.001$}, whereas control subjects showed no difference in SUDS ratings across conditions (see Table 1). Also, SUDS ratings in the approach condition remained higher after the Stroop task for fearful subjects than for control subjects {$t(32) = 5.64$, $P < 0.001$}.

We conducted similar analyses with our second independent measure of fear, heart rate. A 2 (Group) × 3 (Condition: Neutral, Approach, and Baseline) repeated measures ANOVA revealed a main effect of Condition {$F(2,43) = 6.77$, $P < 0.005$}. Heart rate was significantly higher in the approach than baseline condition {$F(1,45) = 7.41$, $P < 0.01$}, as was heart

rate in neutral condition {$F(1,45) = 12.90$, $P < 0.005$}. However, heart rate did not differ between the approach and neutral condition. No group differences were found for heart rate (see Table 1).

Emotionality Ratings

A 2 (Group) × 3 (Word Type) repeated measures ANOVA was conducted for absolute emotionality ratings of each Stroop word. A significant interaction effect was found {$F(2,88) = 5.06$, $P < 0.05$}. Fearful subjects rated both spider {$F(1,44) = 9.51$, $P < 0.01$}, and positive words {$F(1,44) = 9.46$, $P < 0.01$} as more emotional than neutral words. Fearful subjects' ratings of positive and spider words were not significantly different. On the other hand, control subjects rated positive words as significantly more emotional than spider words {$F(1,44) = 13.66$, $P < 0.001$}, but did not differ in their ratings of spider and positive as compared to neutral words (see Table 2).

TABLE 1
Mean Score on State Anxiety Measures

		Spider-fearful Group (n = 23)		*Control Group* (n = 23)	
	Condition	*M*	*SD*	*M*	*SD*
SUDS (0–8)	Neutral	2.7	1.9	1.2	1.1
	Approach	6.7	1.0	1.3	1.1
Heart rate (bpm)	Neutral	84.8	7.8	84.6	12.6
	Approach	85.2	11.5	84.0	12.5
	Baseline	82.1	8.7	80.8	10.5

Note: bpm, beats per minute.

TABLE 2
Mean Absolute Emotionality Ratings

	Spider-fearful Group (n = 23)		*Control Group* (n = 23)	
Word Type	*M*	*SD*	*M*	*SD*
Spider	1.5	1.4	0.8	0.7
Positive	1.4	0.9	1.9	0.7
Neutral	0.2	0.9	1.1	3.1

Note: Scores range from 0 (no emotional value) to 3 (very emotional).

Analyses of Stroop interference

Incorrect or unregistered responses, based on experimenter observations, were omitted from analyses. On average, 1.6% of subjects' responses were omitted for these reasons. Errors did not differ by group or condition.

To test for practice effects, Order was included in preliminary analyses. Because no main effects or two-, three-, or four-way interactions (Group × Condition × Word Type × Order) emerged with the Order variable, it was excluded from further analyses.

Response times for control subjects were analysed first to evaluate the distraction hypothesis. If the approach condition distracted subjects, then control subjects should show a main effect of Condition, with longer response times in the approach relative to the neutral condition. A repeated measures ANOVA, however, revealed no significant difference in response times across all word types between the approach and neutral condition for control subjects (see Table 3).

TABLE 3
Mean Stroop Response Times (msec)

		Spider-fearful Group (n = 23)		*Control Group* (n = 23)	
Condition	*Word Type*	*M*	*SD*	*M*	*SD*
Neutral	Spider	703	121	669	88
	Positive	688	117	673	89
	Neutral	693	112	680	92
Approach	Spider	740	137	687	96
	Positive	729	145	685	95
	Neutral	720	129	695	101

The remaining analyses were limited to the fearful group because the experimental hypotheses involved predictions about fearful individuals. Specific planned comparisons were conducted because a-priori directional hypotheses had been specified. According to Keppel (1982), planned comparisons of a-priori directional hypotheses can be conducted without testing the omnibus (interaction) effect.[2] Family-wise Bonferroni corrections were applied to planned comparisons for each set of hypotheses.

[2] When specific hypotheses are stated, a test of interaction can provide less information (e.g. about the direction of a difference) than a planned comparison, so that it is more meaningful to calculate the significance of planned comparisons. Furthermore, a planned comparison is considerably more powerful than an interaction test. That is, a truly significant difference may not be detected in an interaction test because of insufficient power, whereas a planned comparison based on a theoretical framework may be able to detect such a

According to the first hypothesis of interference effects as an enduring characteristic of fearful individuals, fearful subjects should show longer response times to threatening relative to neutral words across conditions (alpha = 0.05). Fearful subjects showed longer response times to spider relative to neutral words across the two conditions {$F = 6.54$, $P < 0.05$}.

According to the second hypothesis of interference effects as a function of state anxiety, fearful subjects should show increased response times to threatening, but not neutral words in the approach relative to neutral condition (alpha = 0.025). Fearful subjects showed increased response latency for spider words in the approach as compared to neutral condition {$F(1,44) = 5.53$, $P < 0.025$}. Response latency for neutral words, however, did not change across approach and neutral conditions for fearful subjects {$F(1,44) = 3.30$, $P > 0.07$} (see Table 3 and Figs 1 and 2).

As a second test of the hypothesis that interference effects are a function of state anxiety, a two-way interaction (Condition × Word) was performed for spider-fearful subjects only. Contrary to the previous results, this interaction was not significant {$F(2,88) = 1.47$, $P > 0.1$}.

Finally, to test the emotionality hypothesis, we conducted planned comparisons similar to the ones described earlier for positive and neutral words. Contrary to hypotheses, no significant differences emerged between positive and neutral words for fearful subjects across conditions. However, fearful subjects showed significantly increased latency for positive words in the approach as compared to neutral condition {$F(1,44) = 6.44$, $P < 0.025$}, but not for neutral words (see Table 3 and Figs 1 and 2).

SUDS and Heart-rate Analyses

As a secondary test of the relationship between state anxiety and Stroop interference, we conducted regression analyses to examine the degree to which increased fear predicted increased Stroop latencies for spider words. Differences in SUDS ratings between the approach and neutral conditions significantly predicted the difference in Stroop response latency between spider and neutral words in the approach condition ($R^2 = 0.13$, beta = 0.35, $P < 0.05$).

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difference. For example, with the 23 subjects in each group in the present study, the power to detect a 1 SD difference between repeated measures means (assuming moderate correlation) is 0.98 for one planned comparison versus 0.53 for the three-way interaction effect.

Results of the omnibus F-test in our study revealed a nonsignificant three-way interaction (Group × Condition × Word Type); however, there was a significant two-way interaction (Group × Word Type), {$F(2,88) = 4.75$, $P < 0.05$}, indicating that fearful subjects showed longer response times to spider versus neutral words, whereas control subjects showed no differences among word types.

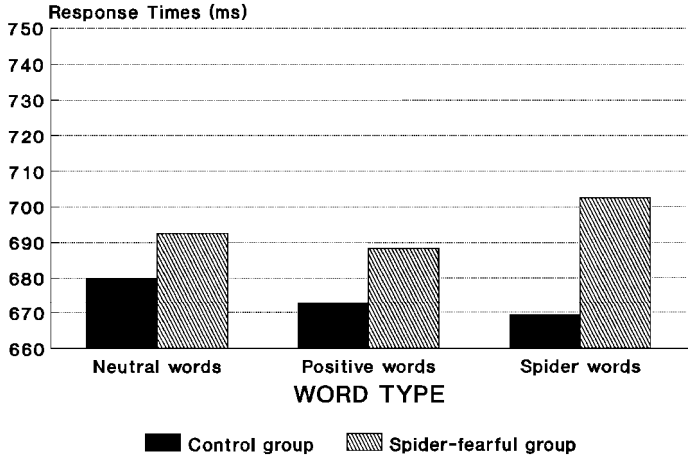

FIG. 1. Stroop response times as a function of group and word type in the neutral condition.

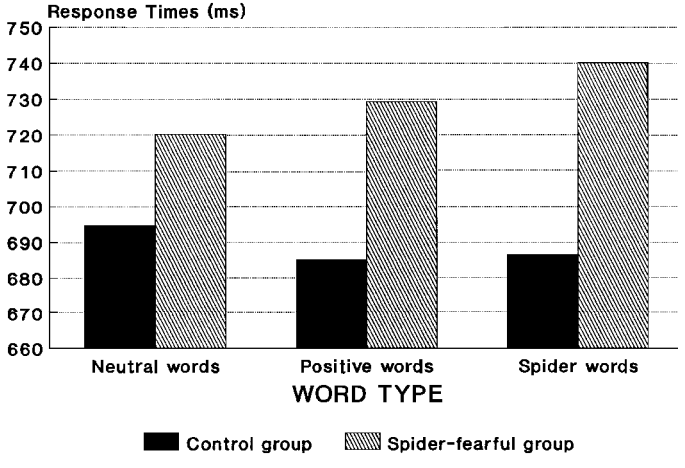

FIG. 2. Stroop response times as a function of group and word type in the approach condition.

However, heart-rate differences between the approach and baseline conditions did not predict differences in Stroop response times for spider words versus neutral words in regression analyses.

Analyses of Questionnaires

The Trait Anxiety Inventory did not predict significantly the difference in Stroop response latency between spider and neutral words in the approach condition.

Cronbach alpha reliability coefficients were calculated for the Cognitive Avoidance Scale. Coefficient alpha was 0.79 for Avoidant items and 0.85 for Monitoring items. The correlation coefficient between the two scale totals was 0.49. Regression analyses indicated that scores on the Monitoring scale of the CAS significantly predicted the difference in Stroop response latency between spider and neutral words in the approach condition ($R^2 = 0.10$, beta = 0.32, $P < 0.05$). Higher Monitoring scores were associated with greater differences between response times to spider and neutral words. Avoidant scores marginally predicted the difference in response latency between spider and neutral words in the neutral condition ($R^2 = 0.14$, beta = -0.38, $P = 0.07$), but not in the approach condition. Higher Avoidant scores were associated with less difference between response times to spider and neutral words.

DISCUSSION

The aim of this study was to determine the degree to which Stroop interference effects in fearful individuals is a function of an enduring quality and/or of state anxiety. Spider-fearful subjects, relative to control subjects, showed increased response latencies for spider words compared to neutral words overall. These results support past findings of an interference effect for threatening information in spider phobic individuals (Watts et al., 1986; Lavy et al., 1993), and demonstrate that fearful individuals display a pervasive interference effect for relevant threatening information.

Secondly, spider-fearful individuals showed enhanced Stroop interference when anxiety was heightened. That is, spider-fearful subjects showed more interference for threatening, but not neutral information when placed in an anxiety-provoking situation. In addition, changes in anxiety across situations predicted longer response times for spider words, relative to neutral words, in the spider approach condition. These results suggest a mood-state enhancement of Stroop interference. However, these results must be qualified by the nonsignificant interaction between condition and word type for spider-fearful subjects, indicating that the increased response times to spider words did not differ significantly from the change in neutral words. These two sets of results suggest that either the heightened Stroop interference for threatening information during anxiety is a small effect, or that the power to detect the interaction was not sufficiently high.

The presence of an existing interference effect as well as heightened Stroop interference at times of elevated anxiety suggest that neither disposition nor state anxiety alone sufficiently accounts for highly fearful individuals' cognitive processing biases. Rather, phobic individuals may possess a stable tendency to attend more selectively to fear-relevant

threatening information, perhaps rendering them more vulnerable to state anxiety, which in turn magnifies their bias for that threatening information (Eysenck, 1992; MacLeod, 1991; Mathews, 1993).

Finally, the emotionality hypothesis received mixed support. Spider-fearful subjects did not show increased response latencies for positive words, relative to neutral words, overall. However, spider-fearful subjects showed increased response latencies for positive words in the approach condition than the neutral condition.

One explanation for these findings is that although phobic individuals may have a disposition to attend selectively to only threatening information at all times, heightened anxiety may result in fear network activation spreading to related nodes, so that a broader range of information (including positive words related to anxiety) matches the network representations, resulting in greater Stroop interference for a wider range of emotional information.

Our competing hypothesis for the present findings, that subjects were hindered in their Stroop performance by distracting thoughts about touching the spider, was disconfirmed. Control subjects did not show longer response latencies in the approach condition as compared to the neutral condition.

The current study may help to clarify past contradictory findings regarding elevated state anxiety and Stroop interference. First, the present study manipulated state anxiety by targeting a relevant fear. Negative findings from previous studies may be due to the use of generic arousal-induction, such as difficult anagrams, that do not effectively induce state anxiety in all subjects.

Moreover, the present study used a within-subject comparison to detect changes in cognitive processing as a result of increased anxiety. Mathews and Sebastian (1993) conducted a similar experiment with snake-fearful subjects, and reached the conclusion that fear arousal blocks Stroop interference effects for threat words. However, the use of a between-subject comparison of their two conditions renders conclusions about corresponding changes in state anxiety and Stroop interference uncertain. Moreover, verification of the fearfulness of their fearful group, and evaluation of the success with which state anxiety was induced, were not reported. Thus, it is possible that some subjects in the fearful group were not highly fearful of snakes or did not find the manipulation very anxiety-inducing.

Heart-rate data did not parallel subjective ratings in the current study. There were no heart-rate differences between groups or experimental conditions. Possibly, our heart-rate measurement was too crude. However, the three response domains of fear (subjective, physiological, and behavioural) are not always hypothesised to be concordant (Lang, 1971). For example, at moderate levels of fear, self-report may not be accompanied by physiological indications of fear (Hodgson & Rachman, 1974). Thus, even within our sample of strongly to extremely fearful subjects,

there might have been too much variability in heart rate to detect differences between conditions.[3]

Additionally, the study findings may be limited in their generalisation to a clinical population due to the use of an analogue sample. However, Borkovec and Rachman (1979) have argued that analogue samples are appropriate when the target and intensity of fear are similar to clinical samples; overall, spider-fearful subjects in this study reported strong to extreme fear during the spider approach condition. Furthermore, Persons (1986) emphasised focusing on psychological phenomena over diagnostic categories when studying the nature of psychological processes. Nevertheless, our sample may differ from a clinical sample in certain aspects of functioning that could alter cognitive processing.

Another limitation involves possible practice effects from two identical Stroop tasks, which other researchers have found (McNally et al., 1990b; Watts et al., 1986). We addressed this issue by counterbalancing the two conditions. Because the effect of Order was not significant, it is likely that response times on the second Stroop task were not affected by the first Stroop task. Our finding regarding practice effects may have differed due to methodology. McNally et al. (1990b) examined response times from the first to the last trial block within one session; Watts et al. (1986) analysed response times to difference scores between spider and neutral words.

Finally, based on the Cognitive Avoidance Scale, higher monitors showed increased Stroop interference for spider words relative to neutral words in the approach condition. This finding is in agreement with studies showing that high monitors report more anxiety in the face of an aversive event (Miller, 1987). In this study, high monitors may have experienced greater fear activation in the anxious condition, which led to increased Stroop interference for threat words.

In summary, spider-fearful individuals showed a bias toward processing threatening information that was enhanced by state anxiety. Furthermore, under conditions of high state anxiety, interference effects for positive emotional information was enhanced. Finally, cognitive styles of monitoring may have moderated the relationship between state anxiety and Stroop interference.

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[3] When we sorted subjects by increases in self-reported fear between conditions, those in the upper quartile (those who showed the greatest increases in subjective fear) had an average increase in heartbeat (approach–baseline conditions) of 6.34bpm, whereas those in the lowest quartile (those who showed the smallest increases in subjective fear) had an average increase in heartbeat of 0.43bpm. This finding supports the idea that synchrony between self-report and physiological responding is most apparent in extremely fearful individuals.

REFERENCES

Beck, A.T., & Clark, D.A. (1986). Anxiety and depression: An information processing perspective. *Anxiety Research*, *1*, 23–36.

Borkovec, T., & Rachman, S. (1979). The utility of analogue research. *Behaviour Research and Therapy*, *17*, 253–261.

Bower, G.H. (1981). Mood and memory. *American Psychologist*, *36*, 129–138.

Carroll, J.B., Davies, P., & Richman, B. (1971). *The American heritage word frequency book*. Boston: Houghton Miflin.

Craske, M.G. (1991). Phobic fear and panic attacks: the same emotional states triggered by different cues? *Clinical Psychology Review*, *11*, 599–620.

Dalgleish, T., & Watts, F. (1990). Biases of attention and memory in disorders of anxiety and depression. *Clinical Psychology Review*, *10*, 589–604.

Ehlers, A., Margraf, J., Davies, S., & Roth, W.T. (1988). Selective processing of threat cues in subjects with panic attacks. *Cognition and Emotion*, *2*, 201–219.

Eysenck, M.W. (1982). *Anxiety: The cognitive perspective*. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Foa, E.B., & Kozak, M.J. (1986). Emotional processing of fear: exposure to corrective information. *Psychological Bulletin*, *99*, 20–35.

Hodgson, R., & Rachman, S. (1974). Desynchrony in measures of fear. *Behaviour Research and Therapy*, *12*, 319–326.

Keppel, G. (1982). *Design and analysis: A researcher's handbook*. New Jersey: Prentice-Hall.

Lang, P.J. (1971). The application of psychophysiological methods to the study of psychotherapy and behavior modification. In A. Bergin & S. Garfield (Eds.), *Handbook of psychotherapy and behavior change*. New York: Wiley.

Lang, P.J. (1979). A bio-informational theory of emotional imagery. *Psychophysiology*, *16*, 495–512.

Lang, P.J. (1985). The cognitive psychophysiology of emotion: fear and anxiety. In A. Tuma & J. Maser (Eds.), *Anxiety and the anxiety disorders*, (pp. 131–170). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Lavy, E., van den Hout, M., & Arntz, A. (1993). Attentional bias and spider phobia: conceptual and clinical issues. *Behaviour Research and Therapy*, *31*, 17–24.

Logan, A.C., & Goetsch, V.L. (1993). Attention to external threat cues in anxiety states. *Clinical Psychology Review*, *13*, 541–559.

MacLeod, C. (1991). Clinical anxiety and the selective encoding of threatening information. *International Review of Psychiatry*, *3*, 279–292.

MacLeod, C., & Hagan, R. (1992). Individual differences in the selective processing of threatening information, and emotional responses to a stressful life event. *Behaviour Research and Therapy*, *30*, 151–161.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology*, *95*, 15–20.

MacLeod, C., & Rutherford, E.M. (1992). Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personal relevance of stimulus materials. *Behaviour Research and Therapy*, *30*, 479–491.

Martin, M., Williams, R.M., & Clark, D.M. (1991). Does anxiety lead to selective processing of threat-related information? *Behaviour Research and Therapy*, *29*, 147–160.

Mathews, A. (1993). Anxiety and the processing of emotional information. *Progress in Experimental Personality and Psychopathology Research*, *16*, 254–280.

Mathews, A., & Klug, F. (1993). Emotionality and interference with color-naming in anxiety. *Behaviour Research and Therapy*, *31*, 57–62.

Mathews, A., & MacLeod, C. (1985). Selective processing of threat cues in anxiety states. *Behaviour Research and Therapy*, *23*, 563–569.

Mathews, A., & Sebastian, S. (1993). Suppression of emotional Stroop effects by fear-arousal. *Cognition and Emotion*, *7*, 517–530.

McNally, R.J., Kaspi, S.P., Riemann, B.C., & Zeitlin, S.B. (1990a). Selective processing of threat cues in posttraumatic stress disorder. *Journal of Abnormal Psychology*, *99*, 398–402.

McNally, R.J., Riemann, B.C., & Kim, E. (1990b). Selective processing of threat cues in panic disorder. *Behaviour Research and Therapy*, *28*, 407–412.

McNally, R.J., Riemann, B.C., Louro, C.E., Lukach, B.M., & Kim, E. (1992). Cognitive processing of emotional information in panic disorder. *Behaviour Research and Therapy*, *30*, 143–149.

Miller, S.M. (1987). Monitoring and blunting: validation of a questionnaire to assess styles of information seeking under threat. *Journal of Personality and Social Psychology*, *52*, 345–353.

Mogg, K., Kentish, J., & Bradley, B.P. (1993). Effects of anxiety and awareness on colour-identification latencies for emotional words. *Behaviour Research and Therapy*, *31*, 559–567.

Mogg, K., & Marden, B. (1990). Processing of emotional information in anxious subjects. *British Journal of Clinical Psychology*, *29*, 227–229.

Mogg, K., Mathews, A., Bird, C., & Macgregor-Morris, R. (1990). Effects of stress and anxiety on, the processing of threat stimuli. *Journal of Personality and Social Psychology*, *59*, 1230–1237.

Mogg, K., Mathews, A., & Weinman, J. (1989). Selective processing of threat cues in anxiety states: A replication. *Behaviour Research and Therapy*, *27*, 317–323.

Persons, J.B. (1986). The advantages of studying pyschological phenomena rather than psychiatric diagnoses. *American Psychologist*, *41*, 1252–1260.

Richards, A., French, C.C., Johnson, W., Naparstek, J., & Williams, J. (1992). Effects of mood manipulation and anxiety on performance of an emotional Stroop task. *British Journal of Psychology*, *83*, 479–491.

Spielberger, C.D., Gorsuch, R.L., Lushene, R., Vagg, P.R., & Jacobs, G.A. (1983). *Manual for the State-Trait Anxiety Inventory (form Y)*. Palo Alto: Consulting Psychologists Press.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643–661.

Watts, F.N., McKenna, F.P., Sharrock, R., & Trezise, L. (1986). Colour naming of phobia-related words. *British Journal of Psychology*, *77*, 97–108.

Williams, J.M.G., Watts, F.N., MacLeod, C., & Mathews, A. (1988). *Cognitive Psychology and Emotional Disorders*. New York: Wiley.

Wolpe, J., & Lang, P.J. (1964). A fear survey schedule for use in behaviour therapy. *Behaviour Research and Therapy*, *2*, 27–30.