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Processing bias in anxious subjects and repressors, measured by emotional Stroop interference and attentional allocation

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Abstract

We hypothesized that repressors would show cognitive avoidance of threatening information in an attention deployment task, but an attentional bias for the same information in an emotional interference task, while high anxious subjects would show a threat-related bias on both tasks. A modified Stroop task and a visual probe task (VPT) were used, with physical threat words, social threat words, social positive words and general positive words. The relationship of the response to the two tasks was also investigated. The results showed that high state anxiety was related to greater Stroop interference of physical threat words as well as social words, both threat and positive. No group effects were found for the Stroop, in spite of sufficient power. In contrast, in the VPT high trait anxious subjects shifted attention only towards social threat words, especially when these words were presented outside their attentional focus. No difference involving the repressor group was present. There was a small positive inter-task relation for social threat-related bias. It is suggested that the emotional biases measured by the Stroop and the VPT reflect automatic decisions about cognitive resource allocation at subsequent phases in information processing, at which increasingly more specific aspects of the emotional information are deciphered and used. © 1999 Elsevier Science Ltd. All rights reserved.

1. Introduction

There is a growing body of evidence that anxiety is associated with systematic cognitive biases that favour the processing of threatening information (Broadbent and Broadbent, 1988; Williams

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et al., 1988; Mathews et al., 1989; Mineka and Sutton, 1992). In general, these biases are explained by assuming an allocation of attentional resources or processing resources for threat information. However, the nature of these anxiety-related biases is still poorly understood. Moreover, it is questionable whether these biases are simply absent in low anxious individuals or whether these individuals show the opposite pattern, i.e. actively avoiding the processing of threat information. Several studies have produced an inconsistent picture of the pattern of biases in low anxious individuals (e.g. MacLeod et al., 1986; Dawkins and Furnham, 1989; Fox, 1993 1994; Myers and McKenna, 1996) and the clarification of this picture may have consequences for the understanding of cognitive processing in anxiety (de Ruiter and Brosschot, 1994). Two problems seem to be at the heart of the confusion and will be addressed in this study. One is that both low anxious groups and high anxious groups may be far from homogeneous with respect to their reactions to threat information. A second cause for confusion is that the different tasks used to study anxiety-related cognitive bias do not actually measure the same process or measure different aspects of the same process.

First, results from a range of studies show that low anxious individuals are a rather heterogeneous group with respect to their behaviour under stressful conditions. A large subgroup shows physiological and behavioural reactions that are not compatible with their low trait anxiety scores on a paper and pencil test. Such reactions also include performance on tasks that are used to measure cognitive bias for threat information. The subgroup that displays these contradictory responses is defined by low scores on trait anxiety as well as high scores on a measure of “defensiveness” (the Marlowe–Crowne social desirability scale: MC, Crowne and Marlowe, 1960). They are called “repressors” (REP) and are distinguished from so-called “truly low anxious” (TLA), subjects who also score low on defensiveness. High anxious subjects are similarly divided into “high defensive/high anxious” (HD/HA) subjects, who score high on both scales and “high anxious” (HA) subjects, who score high on anxiety and low on defensiveness. This division into subgroups on the basis of defensiveness scores is based on a series of studies inspired by the work of Weinberger et al. (1979). Several of these studies have demonstrated that while subjects with a repressor (REP) coping style seem to be low anxious, they are more like high anxious subjects in their physiological and nonverbal reactions to stressors. The magnitude of their reactions might even exceed those of high anxious subjects (Weinberger et al., 1979; Asendorpf and Scherer, 1983; Jamner et al., 1988; Esterling et al., 1990; Bonanno et al., 1991). In other words, while objective measures among REP subjects indicate the presence of anxiety, subjective measures do not.

In line with these findings, Dawkins and Furnham (1989) showed that REP subjects demonstrated more threat-induced decrement in reaction time for threat words on a modified Stroop task, even more than commonly found among HA subjects. In fact, the interference by threat words was twice as high for REP subjects than for HA subjects, while there was no interference at all in TLA subjects. Fox (1994) repeated this experiment, but she did not find the same interaction between group and word type. An explanation for this non-replication of the Dawkins and Furnham results could be that Fox administered words of different valence randomly and in a trial-by-trial fashion, while Dawkins and Furnham used blocked presentations of similar word types with the traditional format of the Stroop task. In a blocked trial, repeating words of the same category may lead to stronger priming (Broadbent and Gathercole, 1990). Thus, only when blocked trials are used, may the interference effects be robust enough to detect the influences of the REP coping style.

If the Dawkins and Furnham results are replicated, they will add support to the view that REP subjects are in fact high anxious subjects who claim not to be anxious on self-report measures. An emotional interference effect as shown in their study may then be seen as proof of a cognitive *bias* for threat words in REP subjects, consistent with the usual interpretation of these results in anxious subjects (MacLeod and Mathews, 1991). On the other hand, other similar cognitive experimental studies suggest an alternative interpretation. Myers and McKenna (1996), using socially threatening words and a more extreme selection of repressors, reported the exact opposite of Dawkins and Furnham. In their study, all groups *except* the REP subjects showed higher interference for socially threatening words. Myers and McKenna interpreted these findings suggesting that REP subjects avoid the processing of social-emotional information. In two other studies REP subjects show the opposite of the HA reaction pattern: again, REP subjects seem to avoid and even actively inhibit threat information, when compared with other groups of subjects (Fox, 1993, 1994). In one of these experiments, Fox (1993) used a task for attentional deployment, the visual probe paradigm developed by MacLeod et al. (1986). In this task, two words are presented on a computer screen, while the subject has to name aloud the top word and ignore the bottom word. Following the display of the words, a visual probe (a black dot) may appear on the location of a word and the subject is asked to push a button as soon as this happens. Attentional allocation is believed to be measured by the reaction time (RT) to this visual probe. The rationale is that the faster the subject reacts to a given dot location, the more the subject's attention is drawn by that location. On the other hand, the longer it takes to push the button for a given dot location, the more the subject's attention is drawn by the opposite location. When both these conditions are fulfilled for threat words, attentional bias for threat words is thought to be present. Using this paradigm, MacLeod et al. (1986) and Mogg et al. (1992) found that anxious patients showed an attentional bias for threatening social and physical words, while control subjects showed the reverse pattern. Fox (1993) replicated this finding for high trait anxious subjects (i.e. HA subjects), but only for social threat words. She also showed that low trait anxious subjects, that were also REP subjects, shifted their attention *away* from social threat words, while "truly" low trait anxious TLA individuals did not show a consistent attentional pattern.

In another study, Fox (1994) showed a specific threat-related "negative priming" effect for REP subjects, which was not present in the HA subjects or TLA subjects. In a negative priming paradigm, a reaction to a target stimulus is delayed when the same stimulus or a semantically related stimulus has to be ignored in the previous trial. This delay (negative priming) is interpreted as a measure of cognitive inhibition. By using stimuli of neutral and threat categories, it was demonstrated that the reactions of REP subjects, when compared to the other subjects, were more delayed if the repeated stimulus was a threat word than when it was a neutral word. HA subjects, on the other hand, had slower reactions to all stimuli after a threat stimulus that had to be ignored. Fox concluded that in this task REP subjects seem to inhibit threat information more effectively than either HA or TLA subjects. In contrast, HA subjects seemed to have difficulty inhibiting the threat information — at least until the next trial.

Thus, both Fox's visual probe study and her negative priming study support the notion that REP subjects are characterized by cognitive *avoidance* of threat information. Although this is clearly consistent with the usual interpretation of the repressor coping style, it is not immediately clear how these results can be reconciled with the higher threat-induced *bias* of REP subjects in a Stroop task (Dawkins and Furnham, 1989). This might be explained if one takes into account the

stage of information processing at which these tasks are directed and the spatial properties of the tasks. One of the differences between the Stroop task and the other tasks — the visual probe task and negative priming task — is that the Stroop task measures reactions to simultaneously presented stimuli, while the other two tasks measure reactions to the stimulus presented immediately after the threat stimuli. Considering that in the visual probe task and the negative priming task the critical measures occur 300 to 500 ms after the presentation of the threat stimulus, these tasks are probably measuring different mechanisms than the Stroop task does. Another important difference between the tasks is that in the Stroop task, the critical threatening information is integrated in the attended stimuli, while in the VPT half of the threatening and attended stimuli are spatially separate (but all pairs of threatening and attended stimuli are “separated” in time). Both these differences might explain the contrasting effects found for repressors in the tasks. It may be possible that compared to HA subjects, REP subjects have as much (or even more) difficulty inhibiting threat information *during* reacting to the — integrated — target, reflected in higher threat-related interference in the Stroop task (Dawkins and Furnham, 1989). However, in contrast to HA subjects, they may succeed in cognitive avoidance in a *later* processing stage, especially when the target is spatially separated from threat. This would be reflected in an attentional bias away from threat information in the visual probe task and a better inhibition of threat information in a negative priming task (Fox, 1993, 1994).

In summary, it seems that the presence of a selective bias for threat information in low anxious persons is dependent on their “defensiveness”. Part of the low anxious subjects are characterized by an avoidant or “repressive” style of reacting to stressors. An attentional bias for threat information (resembling the bias found in high trait anxious subjects (Dawkins and Furnham, 1989)) as well as avoidant processing of threat information has been found for these repressors (Fox, 1994). This avoidant style may be detected depending on which task is used to tap it.

The present study serves two main goals. One is to try to replicate the differential findings of processing bias and cognitive avoidance for REP, HA and TLA subjects. This is done with the aid of the two paradigms that are most frequently used in cognitive bias studies in anxiety, the visual probe task (VPT; Fox, 1993) and the modified Stroop task (Dawkins and Furnham, 1989; Fox, 1994). Our other aim was to investigate the degree to which a different cognitive mechanism is tapped by these two tasks. To our knowledge, such a comparison within subjects of the two tasks has not been previously undertaken. For this purpose, we have studied the convergence of the biases measured by both tasks for different emotional words. Such an analysis would show whether or not and to what extent, the two tests measure a similar mechanism.

We had several expectations. Firstly, in line with Dawkins and Furnham (1989), we expected that interference by threat words would be higher in REP subjects than in HA subjects and higher in the latter than in TLA subjects. Secondly, we expected that REP subjects would shift their attention away from social threat words in the VPT, in comparison to physical threat words (Fox, 1993) and, additionally, to positive words, while HA subjects were expected to shift their attention toward social threat words. Thirdly, we thought TLA subjects would show no selective bias in either task. Fourthly and exploratively, we correlated response latencies for the emotional Stroop trials with the VPT indexes that are used to express emotional bias in the VPT.

As an additional check, we also used positively valenced social words in both tasks, in addition to general positive words, in order to investigate whether the expected biases for social words pertain to the semantic category of general social information, instead of to the specific threatening

content (see also Mathews and Klug, 1993). Furthermore, unlike Dawkins and Furnham (1989) and Fox (1993), we took care to include the HD/HA group. Most studies using Weinberger et al. (1979) repressor operationalization were performed without this group, mainly because it is difficult to find enough HD/HA subjects. It is obvious, however, that without this category no final conclusions can be drawn with regard to the independent contributions of defensiveness and trait anxiety. Finally, we included *state anxiety* in the analyses, since attentional bias for threat is most often found when trait as well as state anxiety is high (Broadbent and Broadbent, 1988; MacLeod and Mathews, 1988).

2. Method

2.1. Subjects

Sixty-nine first-year students, recruited from a large pool of psychology students, served as subjects in the experiment, participating for either course credit or a small amount of money. Their age ranged from 18 to 42 yr (mean = 22.2 yr), 50 subjects were female, 19 were male. The subjects were divided according to their scores on defensiveness on the Marlowe–Crowne scale (MC; Crowne and Marlowe, 1960; Hermans, 1967) and their trait anxiety scores on the Spielberger trait anxiety inventory (STAI; van der Ploeg et al., 1979). We used a shortened version of the MC (Hermans, 1967) and like Weinberger et al. (1979), the medians of both scales were chosen to split the subjects into four groups: 15 REP subjects (high MC/low STAI), 15 HD/HA (high MC/high STAI), 11 TLA (low MC/low STAI) and 10 HA (low MC/High STAI). Eighteen subjects scored on a median and were therefore left out. Fifteen subjects is sufficient to find a similar effect size as was found by Dawkins and Furnham (1989). State anxiety was measured before the tasks, using the state version of the STAI (van der Ploeg et al., 1979).

2.2. Materials

Five different stimulus categories of 36 words were used. There were two threat categories: social threat (e.g. lonely, stupid etc.) and physical threat (e.g. infection, cancer). We used social positive (e.g. respect, intelligent) and general positive (e.g. funny, optimist), respectively, as “emotional counterparts”. Finally, a neutral category of words was employed (e.g. wallpaper, automatic). This category was used to control for inter-group differences in reaction times. The words were chosen from Asmundson et al. (1992), Phaf et al. (1992), Fox (1993) and Mathews and Klug (1993). The words in the different categories were matched on lexical frequency, number of syllables and on the extent to which they were representative of their respective categories. There was no information available on emotionality of the words. In both the Stroop task and the VPT, words in the five categories were administered in corresponding blocks. These blocks were randomized per subject and words within the blocks were also randomized.

For the Stroop task, 12 words of each category were chosen at random from each of the five categories. The Stroop words were matched between the categories on word frequency and number of syllables. Each word block was presented three times, resulting in $(12 \times 5 \times 3 =)$ 180 trials in

($5 \times 3 =$) 15 blocks. At the start of the Stroop task, 15 non-experimental neutral words were introduced for practice trials.

The remaining 24 words for each of the five categories were applied in the VPT. Each category word and neutral word pair was matched with respect to word frequency and number of syllables. For this task, another 240 matched extra neutral words were employed to create 120 filler pairs. Five blocks were presented to each subject, consisting of 24 critical word pairs (category word and neutral word) and the 120 filler word pairs. In total, ($5 \times (24 + 120) =$) 720 word pairs were used in the VPT.

2.3. Apparatus

2.3.1. Stroop task

The Stroop words were presented to the subject via an IBM-compatible Laser microcomputer and a Sanyo 12-inch (30.5 cm) colour monitor. Before the presentation of each word, a fixation square appeared on the centre of the screen for 500 ms. After that, each word was shown at the same location in one of four colours (red, yellow, blue and green). The words were displayed in lower case and were 6 mm high. In each trial, the word remained on the screen until the subject had started to name its color aloud. Using a voice key, the reaction time (time between onset of word presentation and the detection of the vocal response) was registered per word with 1-ms accuracy. When there was no reaction within 3000 ms, the trial was considered to have failed and registered as an error. The experimenter marked errors due to vocalizations and other sounds and marked the color that the subjects named with a separate keyboard.

2.3.2. Visual probe task

The VPT words were presented via the same computer configuration as the Stroop words. The program presented each of the word pairs briefly (500 ms), with the words separated on the vertical axis of the screen by a distance of 1.2 inch (3 cm) (visual angle less than 2 degrees). In each of the five blocks (four emotional blocks and one neutral block), dot probes occurred on 24 randomly chosen neutral word pairs and on all critical word pairs. In addition, half of the probes replaced the upper word, while the other half replaced the lower word, with equal probability of locations for each emotional category. A small fixed interval of 25 ms was introduced between the termination of the word display and presentation of the dot probe. In trials without probes, the next pair of words followed after 1 s; on probe trials, the dot remained until the subjects responded. Word position and probe position gave rise to four different conditions and the categories were evenly distributed over these conditions (6 words in each) for each subject. The program balanced the word pairs over the conditions and subjects in such a way that every word pair had appeared once in each of the 4 conditions after each group of 4 subjects. Every session started with 6 practice trials. RTs to dot probes in the VPT are thought to reflect the extent to which the subject's attention is drawn (or moved away) from the location where a word of certain emotional valence has just been displayed. RTs to dot probes at the position of the critical emotional word are assumed to be smaller when attention is drawn to the word ("congruent" condition). In contrast, RTs to dot probes that appear on the other location are assumed to be larger when attention is drawn to the critical word ("incongruent" condition).

2.4. Procedure

Subjects were told that the experiment was about reaction time and attention. Each subject was presented a Stroop task and a VPT. The order of tasks was randomized. There was a 30 min interval between the tasks in which the above-mentioned questionnaires (see “subjects”) and some other questionnaires were filled in by the subjects, that did not pertain to the current research questions.

In the Stroop session, the subjects were asked to name aloud as fast as possible the color of each word presented on the screen. In the VPT, they were asked to read aloud the top word as soon as it appeared and press a button (under the fingers of their right hand) as soon as a dot appeared (see also MacLeod et al., 1986).

2.5. Analysis

For the two tasks, analyses of variance (ANOVA's) for repeated measures were performed on the RTs for the 4 emotional word categories. The between-subjects factors were group (REP vs. HD/HA vs. TLA vs. HA), state anxiety (median split) and order of presentation of the tasks. For the Stroop task, there was one within subject factor: Category (social negative vs. social positive vs. physical negative vs. general negative). For the VPT, there were three within subject factors: category, emotional word position (under vs. up) and dot position (*idem*). If visual attention was allocated differently for the 4 categories and the four groups, then this should be indicated by a 4 way interaction group \times category \times emotional word position \times dot position. To explore the VPT findings further, an index of attentional bias was used that is proposed by several authors to facilitate the understanding of the otherwise complex interactions in this task (MacLeod et al., 1986; Mogg et al., 1992; Fox, 1993). This index is calculated for each of the emotional word types as follows: [(word up and dot under) – (word under and dot under)] + [(word under and dot up) – (word up and dot up)] divided by two. The rationale underlying this index is that the presence of an anxiety-related attentional bias requires two differences between anxious subjects and controls: (1) *faster* RTs for trials that are *congruent* with respect to emotional word position and dot position (both emotional word and dot in same location); and (2) *slower* RTs for *incongruent* trials (emotional word and dot in different locations). A relatively high *positive* index value for trials from an emotional category is interpreted as meaning that the subject's attention is allocated to the location where a word belonging to this category appeared. In contrast, a relatively high *negative* index value indicates that the subject shifted attention away from these words. The neutral category was not used in the analysis of the VPT, for the obvious reason that “incongruent” and “congruent” trials do not exist for neutral words against the background of other neutral words. The neutral category was also not used in the Stroop analysis, for the following reasons. Preliminary analysis showed that there was no group difference for neutral words (see results section). Adding these words to the analyses would decrease power. Additional analyses with neutral words included did not change any of the results, except for slightly enhancing *p*-values. The main interest of the current study is, like in Fox' studies, the difference between groups in their reactions to emotional words.

Finally, to compare the responses on the Stroop and the VPT, hierarchical regression analysis was used for each of the word categories. In each of the analyses, RTs to neutral trials were entered

Table 1
Mean trait anxiety scores and defensiveness scores for the experimental groups

	Repressors	High def./high trait anxious	Truly low trait anxious	High trait anxious
Trait anxiety	31.5 (3.7)	45.4 (5.4)	31.5 (2.8)	43.0 (4.1)
Defensiveness	7.5 (1.3)	7.3 (1.2)	3.5 (0.7)	3.4 (1.1)

Standard deviations are in brackets.

as a first predictor, to control for the expected high correlation of general reaction speed on both tasks.

3. Results

3.1. Defensiveness and anxiety scores

Mean scores of the Spielberger trait anxiety scale and the MC scale are shown in Table 1. The 4 groups differed in trait anxiety ($F(3,47) = 41.6$; $P < 0.001$) and MC-defensiveness ($F(3,47) = 52.5$; $P < 0.001$). Student–Newman–Keuls (SNK) tests for multiple comparisons revealed that HA and HD/HA subjects had higher trait anxiety scores than REP and TLA subjects and that REP and HD/HA subjects had higher defensiveness scores than HA and TLA subjects. These scores are very much like those in, for example, the studies of Fox (1993, 1994), corrected, of course, for the fact that we used a shortened version of the MC.

3.2. Stroop task

In the Stroop task, the number of errors in color naming and other errors never exceeded 6% of the total number of trials per category/subject (mean error percentage was 1.4%, with a standard deviation of 0.86%). There were neither differences in number of errors between the groups nor between the word categories. There were no effects or interaction effects involving group or any of the others factors on the RTs to neutral trials. Therefore, there was no need to use neutral RTs as a covariate in the analyses of the emotional trials. The ANOVA for repeated measures of the RTs scores (see Table 2) showed no order of presentation effect. Further analyses were performed

Table 2
Mean reaction times (ms) and standard deviations in the Stroop task for each category and each experimental group

	Repressors	high def./high trait anxious	Truly low trait anxious	High trait anxious
Physical Threat	644 (65)	652 (88)	643 (87)	657 (89)
Social Threat	637 (75)	640 (85)	620 (90)	639 (100)
General Positive	632 (75)	623 (60)	632 (99)	631 (93)
Social Positive	626 (73)	630 (68)	627 (101)	627 (72)

Table 3
Mean reaction times (ms) and standard deviations in the Stroop task for each category and low versus high state anxiety

	Low state anxiety	High state anxiety
Physical threat	630 (70)	656 (87)
Social threat	620 (81)	642 (87)
General positive	618 (70)	629 (83)
Social positive	610 (66)	643 (82)

without this factor. There was a main effect of category ($F(3,41)=6.1$, $P<0.01$). Post hoc t -tests showed that this effect was due to the fact that RT for physical threat words (641 ms) was longer than for the other 3 categories: social threat words (629 ms; $t(67)=2.4$, $P<0.05$), general positive words (622 ms; $t(67)=4.1$, $P<0.001$) and social positive words (624 ms; $t(67)=3.5$, $P<0.001$). There was no effect or interaction effect involving group, but there was a trend ($P<0.10$) toward an interaction between state anxiety and category. When the group factor was removed from the analysis, this interaction was significant ($F(3,63)=2.9$, $P<0.05$). This was further explored by ANOVAs over the four categories, separately for low and high state anxiety groups (divided on the median). The mean RTs for each anxiety group are displayed in Table 3. The effect of Category was stronger for high state anxiety ($F(3,27)=8.1$, $P=0.001$), than for low state anxiety ($F(3,34)=3.44$, $P<0.05$). Student's t -tests for paired samples within the groups showed that RTs of low anxious subjects were *higher* on physical threat trials (630 ms) than on the three other emotional types of trials: general positive trials (618 ms; $t(36)=2.1$, $P<0.05$), social positive trials (610 ms; $t(36)=3.29$, $P<0.01$) and — marginally significant — on social threat trials (620 ms; $t(36)=1.8$, $P<0.10$). For high anxious subjects, the effects were quite different, in that RTs on the general positive trials, rather than on the physical threat trials, differed significantly from other trials: RTs on general positive trials (629 ms) were *lower* than on physical threat trials (656 ms; $t(29)=3.8$, $P<0.001$), on the social positive trials (643 ms; $t(29)=3.4$, $P<0.01$) and, marginally, the social threat trials (642 ms; $t(29)=1.8$, $P<0.10$). Thus, it appeared that, while low state anxious subjects react slower to physical threat words than to all other word types, high state anxious subjects react slower to physical threat words *and* both types of social words than to general positive words. From Table 3, it can be seen that the difference between the low and high anxious subjects is higher for physical threat words (26 ms), social threat words (22 ms) and social positive words (33 ms) than for general positive words (11 ms).

3.3. Visual probe task

For the VPT, there was also no effect of Order and no effect or interaction effect involving state anxiety and therefore these factors were removed from further analyses. As might be expected, RTs were faster when the dot replaced the upper word that was to be named aloud (486 ms) than when it replaced the lower word location (517 ms; $t(63)=-2.96$, $P<0.01$). Again, There were no effects or interaction effects on the neutral RTs to neutral trials. Thus, there was no need to use

Table 4

Mean reaction times (ms) and standard deviations in the visual probe task (VPT) for each category and each experimental group, separated by dot position and emotional word position

	Repressors	High def./ high trait anxious	Truly low trait anxious	High trait anxious
Physical Threat				
<i>Congruent:</i>				
dot low/word low	465 (86)	506 (144)	473 (72)	484 (66)
dot high/word high	458 (100)	462 (130)	435 (77)	459 (108)
<i>Incongruent:</i>				
dot low/word high	504 (153)	487 (112)	450 (64)	427 (65)
dot high/word low	471 (86)	486 (98)	464 (74)	456 (70)
Social Threat				
<i>Congruent:</i>				
dot low/word low	465 (104)	468 (125)	475 (105)	493 (170)
dot high/word high	473 (116)	442 (119)	428 (73)	434 (89)
<i>Incongruent:</i>				
dot low/word high	458 (95)	473 (121)	442 (66)	484 (97)
dot high/word low	489 (136)	476 (115)	478 (103)	504 (111)
General Positive				
<i>Congruent:</i>				
dot low/word low	482 (104)	500 (119)	490 (106)	448 (48)
dot high/word high	444 (93)	469 (94)	443 (88)	436 (76)
<i>Incongruent:</i>				
dot low/word high	465 (115)	484 (105)	447 (74)	451 (112)
dot high/word low	470 (87)	495 (121)	458 (78)	445 (75)
Social Positive				
<i>Congruent:</i>				
dot low/word low	490 (132)	465 (72)	439 (68)	440 (89)
dot high/word high	465 (109)	445 (80)	441 (77)	509 (149)
<i>Incongruent:</i>				
dot low/word high	455 (107)	465 (89)	455 (72)	411 (62)
dot high/word low	486 (99)	487 (83)	471 (101)	438 (72)

neutral RTs as a covariate in the analyses of the emotional trials. The RTs for the four emotional categories are displayed in Table 4. Only the interactions involving emotional word \times dot position were considered. There was a significant group \times category \times emotional word position \times dot position ($(F(9,120)=2.5; P<0.05)$) interaction and there were no other significant effects. To facilitate comprehension of this 4-way interaction, we explored it further using the indexes mentioned in Section 2 and used by others (MacLeod et al., 1986; Mogg et al., 1992; Fox, 1993). As explained, a high positive value on these indexes indicates attentional bias, while a high negative index indicates an attentional shift away from the location of the emotional word. These indexes are calculated as [(word up and dot under) + (word under and dot up)] – [(word up and dot up) + (word

Table 5

Indices for attentional bias in the visual probe task (VPT) for each emotional word set and each experimental group: $(\text{incongruent} - \text{congruent})/2$

	Repressors	High def./ high trait anxious	Truly low trait anxious	High trait anxious
Physical threat	26 (61)	-2 (55)	-5 (49)	-30 (43)
Social threat	4 (31)	21 (90)	8 (76)	31 (86)
General positive	5 (21)	5 (65)	-14 (39)	8 (44)
Social positive	-7 (46)	23 (44)	23 (44)	-50 (81)

under and dot under)] divided by two, or $[(\text{incongruent} - \text{congruent})/2]$. Separate ANOVAs for these indexes for each group (see Table 5) revealed that the interaction category \times emotional word position \times dot position was significant only for HA subjects ($F(3,24) = 3.3$; $P < 0.05$). Student's t -tests showed that in this group, the social threat index (31 ms) differed from the physical threat index (-30 ms) and the social positive index (-50 ms) and also — but not significantly — from the general positive index (8 ms).

An effect of index does not tell whether both the expected incongruent effects and congruent effects are present, or only one of them. Therefore, the VPT results were further explored by performing ANOVAs separately for “congruent” and “incongruent” trials. According to the rationale underlying the VPT, an attentional bias should be reflected in both a faster response to congruent trials and a slower response to incongruent trials. The ANOVAs showed that RTs in congruent social threat trials were only a little bit smaller — and nonsignificant — than in physical threat trials (-7) and social positive trials (-11). In contrast, RTs in incongruent social threat trials were much higher than in physical threat trials (+55; $t(8) = 2.5$; $P < 0.05$) and in social positive trials (+71; $t(8) = 3.9$; $P < 0.01$).

3.4. Correlations between the Stroop and VPT

The RTs in the neutral trials of the Stroop and VPT were modestly correlated ($r = 0.36$; $P < 0.01$), for all VPT trials. The correlation was somewhat slighter when the dot position in the VPT was low ($r = 0.28$; $P < 0.05$) than when it was high ($r = 0.38$; $P < 0.01$). This is not surprising considering that the VPT trials with upper dot positions resemble Stroop trials somewhat more than those with lower dot positions, the similarity being the greater spatial integration of the stimuli (word and respectively color and dot).

RTs to the four emotional word categories on the Stroop test were regressed on the corresponding VPT indexes, after partializing out the effect of neutral Stroop trials. Of the four tests, the partial correlation for social threat words was — marginally — significant and negative (part $r = -0.21$; $P < 0.10$). Separate regression analysis were performed for the congruent and incongruent VPT trials. These showed that for social threat words, Stroop RTs were significantly related to congruent trials (part $r = 0.18$; $P < 0.05$), but less so and insignificantly to incongruent trials (part $r = 0.07$, NS).

4. Discussion

In the present study, we did not find confirmation of Dawkins and Furnham (1989) and Fox (1993) findings for repressors concerning attentional bias on the emotional Stroop task and the visual probe task. In the following, we will discuss the Stroop and VPT results, their relationship and what the results might possibly tell about different processes underlying the biases found with the two tasks.

4.1. Stroop interference

With respect to the Stroop, there was no evidence of interference by threat words in repressors (REP subjects) and also not in high anxious (HA) subjects. Instead, we found that all subjects showed greater interference by physical threat words. Although no group differences involving trait anxiety and defensiveness were found, there were several effects of *state* anxiety. High state anxious subjects showed higher interference by physical threat words *and* social threat words *and* social positive words than by general positive words. It seems that while low state anxious subjects are only retarded in their color naming of physical threat words, high state anxious subjects are even more retarded by physical threat words, but also by all words from the social category, irrespective of their valence.

To investigate the possibility that low power prevented a replication of Dawkins and Furnham (1989) findings, we did a power analysis based on the effect size that may be expected on the basis of their study. For interference by threat words in repressors, these authors found an effect size of $d=0.78$. With the p -level for Type I error being 0.05 and the power being 0.80, one needs at least a sample of 11 subjects, which is in fact the number of repressors in Dawkins and Furnham's study. In the present study, we used 15 repressors, which is associated with a power of 0.90 for finding a similar effect size. Thus, our failure to replicate Dawkins and Furnham (1989) finding of higher interference for threat words in repressors was not due to a lack of power. An alternative explanation of the nonreplication is that the words we used might have been less threatening than those used by Dawkins and Furnham. However, this is unlikely, because the same words had a reasonably strong effect for anxious subjects in the VPT in our study. Furthermore, incorrect identification of repressors seems unlikely. Although we did use median splits and not third splits like Myers and McKenna (1996), the average defensiveness and trait anxiety scores were comparable to other studies (Fox, 1993, 1994). Considering that Fox (1994) too was not able to replicate the group differences found by Dawkins and Furnham and Myers and McKenna (1996) but found in fact the opposite, it is now doubtful whether REP subjects differ from HA subjects in their response to threatening Stroop stimuli. Still, it is possible that with really extreme repressors, avoidant effects might be found (Myers and McKenna, 1996). The lack of significant differences between the high and low anxious groups is in line with inconsistencies in the literature of emotional Stroop interference in nonclinical anxiety. Some authors failed to find effects (Martin et al., 1991; Fox, 1994), while others succeeded (Dawkins and Furnham, 1989), particularly in conjunction with high state anxiety (MacLeod and Mathews, 1988; Fox, 1993). Our finding that only state anxiety was related to threat-induced interference is in line with these findings. Together, these results suggest that in non-clinically anxious individuals, threat-related Stroop interference might be far from robust and may be more dependent on current emotional state than in clinically

anxious individuals. Moreover, in the Dawkins and Furnham study, threat-related interference effects were no longer significant when four subjects considered clinically anxious were removed from the analysis. It is also easier to find emotionally relevant stimuli for specific groups of anxiety disorders, which may be responsible for the greater emotional impact of modified Stroop tasks in these groups (e.g. Watts et al., 1986; Ehlers et al., 1988; McNally et al., 1990).

4.2. Attentional allocation

With regard to the VPT, our hypothesis concerning the REP groups was not confirmed, but we partly succeeded in replicating Fox's findings (Fox, 1993). Compared to the other three groups, HA subjects showed an attentional bias for social threat words compared to physical threat and social positive words. Additional analyses revealed that the bias for social threat words was due to slower RTs to dot probes that replaced the words adjacent to the critical social threat word (the "incongruent" trials). For dot probes that replaced the critical words themselves (the "congruent" trials), there was only a very small effect. This finding is not entirely consistent with the rationale underlying the operationalization of attentional bias in the VPT. According to this rationale, attentional bias should be constituted of slower RTs in incongruent trials but also of faster RTs in congruent trials. Thus, at first glance, our results on the congruent trials seem to contradict those of several comparable studies with the VPT (MacLeod et al., 1986; Mogg et al., 1992; Fox, 1993). A more careful look at the RTs in these studies shows that this conclusion is not warranted. For example, closer examination of the table presented by Fox (1993) shows that HA subjects in her study were not faster in the congruent trials in the upper area (that is: half of the congruent trials). Only when both the social threat word and the dot appeared in the lower area were the RTs faster. Moreover, this was still only the case when congruent and incongruent trials were compared *within* the HA group. When the RTs in the incongruent and congruent trials are compared between groups, the following picture emerges. RTs to incongruent social threat probes were — in line with what was expected — slower in HA subjects than in TLA and REP subjects. However, the RTs of HA subjects on the *congruent* social threat trials were *also* slower. Something quite similar seems to be true for the results of MacLeod et al. (1986) and Mogg et al. (1992), using clinically anxious subjects. In their studies, the bias that was concluded to be present for anxious subjects is only apparent when RTs (not the indexes) are compared within this group and not when they are compared between groups. In a comparable investigation Broadbent and Broadbent (1988) performed a similar study, but it is not possible to infer from their results whether congruent and incongruent trials contributed disproportionately to the VPT index. They reported significant correlations between (trait and state) anxiety and the index, but not separately for different combinations of stimulus positions and they found no significant interaction of anxiety, dot position and threat position.

The conclusion that can be drawn from the results of the studies mentioned seems to be that, while anxious individuals react slower to targets somewhere other than where a threat stimulus has appeared, they are often *not faster* in responding to targets in the same position as where the threat stimulus has appeared. Fox (1993) results show that RTs may sometimes even be slower when a target replaces a threat stimulus than when it replaces a neutral stimulus. Although this conclusion may be partly contrary to conclusions from previous studies, it is in line with findings from two negative priming studies in anxious subjects (Fox, 1994; Kindt and Brosschot, 1997a).

In these studies, anxious subjects reacted slower to targets after a threat word had appeared, independent of its position. Moreover, both the VPT and negative priming findings are in fact consistent with Stroop interference for threat words in anxious subjects. In all these cases, reaction speed to a target seems to be hampered by the earlier or simultaneous presentation of a threat stimulus. In short, an explanation based on processing priorities (see MacLeod and Mathews, 1991) seems to fit these results better than one based on an attentional bias. This argument is further substantiated by the significant — albeit weak — positive partial correlation found between the RTs for social threat words on the Stroop and the incongruent VPT trials.

4.3. Relationship of Stroop and VPT bias

Regression analyses showed that only the biases for social threat words on the Stroop and VPT were weakly correlated. The lack of stronger correlations might be explained in different ways. Firstly, meaningful interference by the other word types were absent for the group as a whole. Within the subgroups, such correlations might be present, but these groups are too small to yield interpretable correlation coefficients. Secondly, the relative lack of intertask correlations of biases might indicate that one or both of the mechanisms underlying bias in the two tasks are unstable, due to a fluctuating processing capacity within individuals. A recent experiment by our group (Kindt et al., 1996) revealed that even two techniques to measure emotional *and* standard Stroop interference (i.e. card format and trial-by-trial format) were not correlated, while there was only 30 min between the tasks, just like in the present study. Moreover, emotional Stroop interference within the same format was also not correlated over a 3-week interval in non-clinically anxious subjects (Kindt and Brosschot, 1998). From these studies it was concluded that, although interference is a consistent phenomenon in one test session, the mechanisms underlying it might be too changeable to be used as a reliable characteristic. This instability might also explain the lack of association between bias in the two tasks in the current study, especially when future studies would demonstrate that VPT bias is also highly unstable. A third possible explanation for the lack of intertask correlation in the present study is that different processes underlie the biases in the two tasks. There are other findings that seem to suggest such a conclusion.

4.4. Different processes underlying Stroop and VPT bias?

An interesting point concerns the divergent findings for social positive trials. In the Stroop task, state anxious subjects showed a similar bias for social threat and social positive words, while in the VPT, high anxious subjects demonstrated an attentional shift towards social threat words, but a shift away from social positive words. This might shed some light on the nature of the possible different processes underlying bias in the VPT and emotional Stroop interference. It seems to indicate that the two tasks tap different phases of the information processing chain. It might be argued that the extremely fast decisions required in a Stroop trial only allow for a very rough determination of the category (for example “social”) and not the exact emotional valence. In the VPT, there is some time between the onset of the emotional stimulus and the target, allowing judgment of valence (“social threat” versus “social positive”). This processing phase explanation is in line with our suggestions based upon Stroop studies in phobic subjects, that bias in the Stroop

seems to be triggered in a rather crude and fast on/off fashion and not in a linear way (Kindt and Brosschot, 1997b).

This explanation may elucidate yet another peculiar result of the present study, which is the finding that physical threat words yielded interference in the Stroop task (for all subjects) but not in the VPT. Physical threat might be a more primary type of threat, for which a bias might be present in a very early processing phase — and sometimes even in nonanxious subjects. In a previous study, we found Stroop interference for physical threat (medical-related) words in children irrespective of their anxiety levels (Kindt et al., 1997). In the high state anxiety subjects in the present study, the bias for physical threat words in the Stroop task is higher and a bias for social words also seems to appear. In contrast, information bias in the VPT is tapped at a later phase, in which this type of information might be more easily discarded. Instead, in this phase, anxious subjects still have a bias for social threat words. In spite of the attractiveness of this processing phase interpretation, it remains to be explained why physical threat words and social positive words should yield cognitive avoidance (i.e. a negative index) in the later phase, instead of indices of approximately zero.

4.5. Some considerations about the STAI and MC

It is interesting to note that the bias for threat words found for the anxious subjects in the VPT was highly positive only for social threat words and not for physical threat words. This restriction to social threat was also reported by Dawkins and Furnham (1989) and by Fox (1993) and is probably due to the fact that the tests we used to define the groups, the STAI and the MC, are particularly concerned with social threat and not with physical threat (see also Fox, 1993). In clinical anxiety studies, no difference was found between bias for social threat words and physical threat words (MacLeod et al., 1986; Mogg et al., 1992).

A refinement in our study was that we also studied the group of high defensive/high anxious (HD/HA) individuals, a group that is absent in most other repressor studies, mainly because individuals belonging to this group are relatively scarce. We found the bias for social threat words to be restricted to the HA group. In other words, only those high anxious subjects, who are also nondefensive according to their scores on the MC show a bias for social words. This seems to qualify the VPT results for high trait anxious subjects in the earlier studies in which no HD/HA subjects were included (MacLeod and Mathews, 1988; Fox, 1993).

We conclude from the present study that, with respect to cognitive processing of threat, neither the emotional Stroop task nor the VPT are suitable to discriminate repressors from other individuals. The results with respect to anxiety may be summarized as follows. When words were presented simultaneously and integrated with the target (color), all subjects showed a bias for physical threat words, but when state anxiety was high, both physical and social threat words and social positive words yielded a bias. When a target (dot) appeared some time after a word, high anxious/nondefensive subjects appeared to have difficulty ignoring social threat words at another position than their attentional focus. Bias in a “fast” task like the Stroop seems to be influenced more by state anxiety and seems to reflect a rough analysis of emotional significance and thus pertain to a relatively large category of emotional information (all physical threat words and all socially related words). In contrast, bias in a “slower” task, like the VPT, seemed to be influenced

by trait anxiety and seems to reflect a more refined analysis of emotional significance and may therefore be restricted to a relatively narrow category of social threat words. Thus, the Emotional Stroop and the VPT measure bias for emotionally relevant information, but probably at subsequent phases of information processing, involving increasingly more specified aspects of the emotional information.

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