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Mood-congruent free recall bias in anxious individuals is not a consequence of response bias

Riccardo Russo, **Dora Whittuck**, **Debi Roberson**, **Kevin Dutton**, **George Georgiou**, and **Elaine Fox**
University of Essex, UK

Abstract

The status of mood-congruent free recall bias in anxious individuals was evaluated following incidental encoding of target words. Individuals with high and low levels of trait anxiety completed a modified Stroop task, which revealed an attentional bias for threat-related stimuli in anxious individuals. This group was significantly slower in naming the colour in which threat-related words were displayed compared to neutral words. In a subsequent free recall test for the words used in the modified Stroop task, anxious individuals recalled more threat-related words compared to low-anxious people. This difference was significant even when controlling for the false recall of items that had not been presented during study. These results support the view put forward by Russo, Fox, Bellinger, and Nguyen-Van-Tam (2001) that mood-congruent free recall bias in anxious individuals can be observed if the target material is encoded at a relatively shallow level. Moreover, contrary to Dowens and Calvo (2003), the current results show that the memory advantage for threat-related information in anxious individuals is not a consequence of response bias.

Anxious individuals show selective processing biases for threat-related information. This is evident primarily in interpretative and attentional tasks (Williams, Watts, MacLeod, & Mathews, 1997). To illustrate, clinically anxious patients and people with elevated trait anxiety show increased interference in naming the colour in which threat-related words are presented (Williams, Mathews, & MacLeod, 1996). In contrast, several studies indicate that elevated levels of trait anxiety and the clinical condition of generalised anxiety disorder (GAD) do not seem to be associated with explicit memory bias for threat-related information (Coles & Heimberg, 2002; Williams et al.,1997).[1]

The absence of mood-congruent explicit memory bias in anxiety is predicted by the influential model proposed by Williams et al. (1997). Their model states that *integrative* perceptual processes, which operate on the perceptual/structural characteristics of an event, are biased for mood-congruent stimuli in anxiety but not in depression. Thus, attentional bias for mood-congruent stimuli in anxious individuals but not for depressed individuals is consistent with the Williams et al. model. Conversely, the model posits that *explicit* memory performance is a function of elaborative processing, and therefore depression, but not anxiety, should be associated with a mood-congruent explicit memory bias. The apparent

Correspondence should be addressed to Riccardo Russo, Department of Psychology, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, UK. Email: rrusso@essex.ac.uk.

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[1]This study only focuses on mood-congruent bias in explicit memory. Russo et al. (1999) reviewed the available relevant literature on mood-congruent bias in perceptual implicit memory in anxious individuals and, contrary to the claim of Williams et al. (1997), found no convincing empirical evidence supporting the presence of any mood-congruent memory bias in perceptual implicit memory.

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lack of an explicit memory bias among individuals suffering from GAD or showing elevated trait anxiety, coupled with the presence of an explicit memory bias for depressive-related information among clinically depressed subjects, is consistent with this prediction (see Matt, Vazquez, & Campbell, 1992, for review).

However, Russo et al.(2001) have challenged the view that anxious individuals do not show a mood-congruent recall bias. In reviewing studies on mood-congruent explicit memory bias in high trait anxiety individuals and in GAD patients, they noted that the learning of targets in these studies was generally intentional and followed tasks that promoted deep semantic encoding of target words (e.g., Becker, Roth, Andrich, & Margraf, 1999; Bradley, Mogg, & Williams, 1995). Russo et al. (2001) argued that the detection of mood-congruent memory bias for threat-related information is unlikely under these conditions. This is because intentional learning and semantic analysis of targets promotes a highly efficient encoding of target material, so that there is little scope for emotional factors to further influence the recall of affectively toned material. Therefore, mood-congruent explicit memory biases in anxiety, if present, are more likely to be detected following study conditions that do *not* promote efficient encoding of targets. These conditions should provide a greater opportunity for emotional factors to influence the encoding of mood-congruent information, thus providing a suitable basis for the emergence of a free recall bias in anxiety.

More specifically, Russo et al. (2001) predicted that when items are incidentally learned using relatively shallow orienting tasks (e.g., counting the number of syllables present in each target word), the minimal semantic analysis of threat-related targets should not divert non-anxious participants from focusing only on the orienting task. Conversely, anxious individuals should be diverted by the *meaning* of the threat-related stimuli, leading to a deepening of processing of these stimuli during learning. Such an encoding bias would be congruent with the attentional and interpretative biases shown by anxious individuals and also provides a basis for the mood-congruent recall bias to emerge.

As predicted, Russo et al. (2001) did find that high trait anxiety individuals showed greater recall of threat-related information compared to non-anxious individuals following an incidental lexical orienting task that promoted a minimal semantic encoding of targets. Moreover, when both semantic and lexical incidental orienting tasks were used, a mood-congruent free recall bias emerged only for items studied following the lexical orienting task. Thus, mood-congruent memory bias can be detected in high trait anxiety individuals provided that the information is encoded at a relatively shallow level of processing (Russo et al., 2001). Similar results to those described by Russo et al. (2001) were also obtained by Friedman, Thayer, and Borkovec (2000) with a sample of GAD patients in a free recall task that followed a relatively shallow incidental learning phase (i.e., subjects were asked to read silently words that were displayed soon after colour patches had appeared on a computer screen).

However, the notion that free recall bias in anxiety is process specific has recently been challenged (Dowens & Calvo, 2003). These authors suggested that the increased recall of threat-related information in anxiety does not reflect genuinely improved memory for threat-related information but is simply a consequence of response bias (i.e., a general tendency to report threat-related information). Using an incidental shallow encoding task comparable to that used by Russo et al. (2001), they found that participants high in trait anxiety recalled significantly more threat-related items than low-anxious individuals. However, when Dowens and Calvo adjusted the recall scores by taking into account the number of threat-related items that were recalled even though they had not been presented during learning (i.e., intrusions), the difference in the number of threat-related words recalled between high-

and low-anxious individuals was no longer significant. This supports the view that mood-congruent recall bias in anxious individuals can be attributed to a response bias.

However, a closer scrutiny of Dowens and Calvo's results indicates that a genuine recall bias for threat-related information may actually be present even when taking false alarms into account. When the percentage of intrusions for threat-related information is subtracted from the percentage of correctly recalled items in their data, it appears that, at least in the case of physical-threat items, the difference between the high-and the low-anxiety groups is about 6.5%. Assuming that the variability in the corrected scores is comparable to that of the uncorrected scores, then a *t*-test on the above difference would fall short of significance, i.e., $t(38) = 1.76$, $p < .09$. Given the relatively small number of participants in each anxiety group (20), it is likely that the analyses on corrected free recall scores did not reach significance due to relatively low statistical power. With 20 participants per group, and assuming a medium effect size, $d = 0.5$, the probability of rejecting the null hypothesis of no difference in the corrected recall for physical-threat-related items between low- and high-anxious groups was about .35. Therefore we argue that it is important to assess the extent to which the null finding reported by Dowens and Calvo (2003) is replicable with greater statistical power. Thus, the present experiment was designed to provide further empirical data to determine whether or not free recall bias for threat-related information in anxious individuals is genuine or indicative of a response bias.

To this aim, 40 high and 40 low trait anxious individuals were incidentally exposed to neutral and threat-related words (these last comprised both ego- and physical-threatening words) in a modified Stroop task. Given the nature of the modified Stroop task, (i.e., naming the colour in which a series of words were displayed), this task provided an opportunity to induce a relatively shallow incidental encoding of neutral and threat-related words, as well as an opportunity to assess the presence of any attentional bias for threat-related information in our sample of anxious individuals. Following the Stroop task, participants were unexpectedly asked to recall all the words they could remember from those presented in the colour-naming task. We expected a selective increment in the response time to threat-related information in the Stroop task only in the group of anxious individuals, indicating that threat-related words captured the attention of anxious individuals. We also expected a selective increment in the free recall of threat-related words in anxious individuals compared to non-anxious individuals. By taking into account the proportion of words falsely recalled (i.e., intrusions), and subtracting these from the appropriate category of words (i.e., either neutral or threat-related) we also assessed the extent to which any response bias could offset any genuine free recall advantage for threat-related information in anxious individuals.

A brief digression is required at this point. Previous studies have already tested memory for items presented in a modified Stroop task in high- and low-anxiety subjects, but instead of free recall they used an unexpected *recognition* memory test for the word previously presented and found no mood-congruent memory bias (e.g., MacLeod & McLaughlin, 1995; Mogg, Mathews, & Weinman, 1989). Moreover, previous studies using recognition memory, either with shallow or deeper encoding conditions, have also not provided evidence in favour of mood-congruent memory bias in anxiety (e.g., Dowens & Calvo, 2003 – Exp. 2; Nugent & Mineka, 1994). We argue, however, that recognition memory tasks are not suitable to assess the presence of subtle memory biases induced by mood traits and/or states. As shown by Eich (1980), recognition memory is unlikely to be affected by subtle manipulations like changes of either internal moods or environmental context between study and test (see also Russo, Ward, Geurts, & Scheres, 1999). Hence, the lack of a mood-congruent bias is not surprising in a recognition memory task. Because free recall provides a more sensitive method to assess potential memory biases induced by subtle manipulations of

either internal or external states, we opted to administer only a free recall test for the items incidentally learned during the modified Stroop task.

Before describing the experiment in more detail, it is important to provide clear criteria for an unequivocal assessment of memory bias in anxiety. We have previously argued that evidence indicative of memory bias for threat-related information should comply with the criteria that (a) there should be a significant interaction between anxiety status and word type on the percentage of words recalled; and (b) anxiety should be associated with the recall of more threat words. This should be coupled with low-anxious people showing better or equal recall of neutral words than high-anxious individuals; alternatively, high-anxious people may recall more neutral words than low-anxious people, provided this difference is smaller than the one detected for threat words (Russo et al., 1999; Russo, Fox, & Bowles, 2001; see also Eysenck & Byrne, 1995).

METHOD

Participants

The Spielberger trait anxiety inventory (Spielberger, Gorusch, Lushene, Vagg, & Jacobs, 1983) was administered to a sample of graduate and undergraduate students at the University of Essex. On the basis of the trait anxiety scores, 40 low-anxious participants who scored below 37 in the trait anxiety inventory (mean =32; range, 24–36), and 40 high-anxious participants who scored above 43 in the inventory (mean = 52.4; range, 44–75) were selected. The mean age of the low-anxiety group was 22.07 (SD = 3.09) years; the mean age of the high-anxiety group was 21.05 (SD = 2.46). In each anxiety group 20 males and 20 females were tested. The mean state anxiety score in the high trait anxiety group was 52.7 (range 43–72) and in the low trait anxiety group this was 32.4 (range 22–40). Hence, the two anxiety groups were clearly differentiated in terms of both trait and state anxiety.

Materials

The stimuli used in the Stroop task consisted of 24 neutral and 24 threat-related words (see Appendix). These words were divided into two lists (list 1 and list 2). Each list comprised 12 neutral and 12 threat-related words (2 ego-threatening and 10 physical-threatening). Half of the participants in each anxiety group were tested using the items in list 1, while, for the remaining ones, the items in list 2 were used. The four sets of items differed in neither their frequency of occurrence according to the Kucera and Francis (1967) norms, $F(3, 44) < 1.15$, nor in their length, $F < 1$ (the mean word length of the four lists ranged from 6.25 to 6.75 letters per word).

Stimulus cards (A4 size) were used to display the stimuli in the Stroop task. Two cards contained the 12 neutral words. These were printed five times using five different colours (red, blue, black, pink, and green), so that each card displayed 60 items in two columns. Two different random orders were chosen to arrange the stimuli on each of the two cards. The same procedure was used to display threat-related words. In summary, each participant received two cards containing the same 12 neutral words arranged in different ways and two cards containing the same 12 threat-related words arranged in different ways. To facilitate testing, the Stroop stimuli were presented on cards instead of on a computer screen. Card presentation does not allow the measurement precision that can be obtained with a computer-controlled presentation. Nevertheless, from the data reported in Williams et al.'s (1996) review, the way in which Stroop stimuli are presented does not affect the presence of attentional bias in anxiety. Moreover, as shown by Salo, Henik, and Robertson (2001), the response times to incongruent stimuli in a standard Stroop task are comparable when response times are obtained either from the overall set of stimuli (i.e., a condition

comparable to the card version), or when response times are collected for individual items under computer-controlled presentation conditions.

Design and procedure

We used a 2 ×2 mixed-subjects design, with anxiety (high trait vs low trait) as a between-sub-jects factor and word type (threat-related vs neutral words) as a within-subjects factor. The dependent variable for the Stroop task was the time taken, in seconds, to read out the colour in which threat-related and neutral words were printed, while for the free recall task this was the proportion of threat-related and neutral words recalled.

At the start of the experimental session participants were told that they had to perform a series of tasks. The first consisted in naming aloud the colour in which words were displayed on four index cards. Participants were told to perform this task as quickly and as accurately as possible, ignoring (as much as possible) the meaning of the word. A practice trial using six non-target neutral words repeated five times in the colours used in the main Stroop task was given before the main task. The lists used (list 1 and list 2) and the order in which the threat-related and the neutral word cards were presented (i.e., order 1: neutral, threat, neutral, threat; order 2: threat, neutral, threat, neutral) were used equally across the participants in each anxiety group. The time to perform the Stroop task was taken using a digital stopwatch. Time was recorded at the nearest hundredth of a second. While participants appeared to be accurate to the researcher while performing the Stroop task, given the type of administration of the task, as for other studies (e.g., Mathews & MacLeod, 1985) no data on the accuracy of the responses were recorded.

A digit cancellation task, lasting 90 seconds, followed the Stroop task. Immediately after this distractor task, participants were given a surprise free recall task. They were asked to write down, in any order, as many words as they could remember from those presented in the colour-naming task. Finally, participants completed the Spielberger state anxiety inventory to ensure that their mood was relatively comparable to their trait anxiety score, and then they were fully debriefed on the nature of the experiment.

RESULTS

Five participants, three in the low and two in the high trait anxiety groups, did not recall any of the items from the Stroop task, thus they were excluded from statistical analyses.

Stroop task

The mean time taken to read out the colour in which neutral and threat-related words were printed was computed (see Table 1). A two-way mixed ANOVA on these data revealed a critical group by word type interaction, $F(1, 73) = 35.74$, $MSE = 10.4$, $p < .01$, suggesting an attentional bias for threat-related information in high trait anxiety subjects. Planned comparisons indicated that response times to threat-related words were significantly slower than response times to neutral words in the high trait anxiety group, $t(37) = 6.95$, $p < 0.01$, but not in the low trait anxiety group, $t(36) = 1.36$, $p > .10$. Moreover, response times for threat-related stimuli were significantly slower in the high than in the low trait anxiety group, $t(73) = 2.66$, $p < .01$, while the difference between the two groups in the response times to neutral was not significant, $t(73) = 1.37$, $p > .10$.

Free recall

The mean proportion of words correctly recalled was computed (see Table 2). A two-way mixed ANOVA on these data revealed a critical group by word type interaction, $F(1, 73) = 28.50$, $MSE = 0.006$, $p < .01$, suggesting the presence of a mood-congruent free recall bias

for threat-related words in the high trait anxiety group. This was confirmed by a series of planned comparisons. More threat-related words were recalled by the high trait anxiety group, $t(73) = 5.46$, $p < 0.01$, while there was no significant difference between the groups in the proportion of neutral words recalled, $t(73) = 1.47$, $p > .10$ (equivalent results were obtained using the non-parametric Mann-Whitney test in these and in the following contrasts).

The mean proportions of neutral word intrusions during recall for the low and the high trait anxiety groups were .007 and .018, respectively (Mann-Whitney test, $z < 1$). For threat-related words these means were .016 and .029, respectively (Mann-Whitney test, $z = 1.57$, $p < .10$). The corrected mean proportion of neutral words recalled after subtracting the proportion of intrusions is shown in Table 2. A mixed ANOVA on these data confirmed the previous analysis on uncorrected recall scores. The interaction was again significant, $F(1, 73) = 23.87$, $MSE = 0.007$, $p < .01$, and more threat-related words were recalled by the anxious individuals, $t(73) = 3.61$, $p < .01$.

DISCUSSION

A standard attentional bias for threat-related information was observed in a sample of 40 high trait anxiety individuals in a modified Stroop task (cf. Williams et al., 1996). Unlike low trait anxiety individuals, anxious subjects were particularly slow in naming the colour of threat-related words. The colour-naming task also acted as a relatively shallow incidental encoding phase for the subsequent unexpected free recall of the neutral and threat-related words. High trait anxiety individuals recalled significantly more threat-related words than low trait anxiety individuals, while the two groups did not differ in the amount of neutral words recalled. These results replicate and extend those obtained by Russo et al. (2001; see also Friedman et al., 2000) using a different type of relatively shallow incidental orienting task. More importantly, the present study showed that, when intrusions were taken into account, free recall of threat-related information was still significantly greater in high-anxious subjects. Given that the sample size used in the present study was almost twice the size used by Dowens and Calvo (2003), we tentatively suggest that their failure to detect a significant recall bias for threat-related information when intrusions were taken into account was a consequence of relatively low statistical power. It should also be noted that, since the majority of the threat-related words used in the present study were of a physical nature, it could be argued that the recall bias we detected is primarily associated to the physical-threatening nature of the target stimuli.

The present study, in conjunction with previous studies, suggests that the memory task used is critical to detect a mood-congruent explicit memory bias. All previous studies assessing an explicit memory bias in anxious individuals for items incidentally learned during a Stroop task have failed to detect such bias (e.g., MacLeod & McLaughlin, 1995). However, these studies used recognition memory rather than recall (as did Dowens & Calvo, 2003 – Exp. 2). The present results confirm that free recall is a more suitable task to detect subtle effects of mood on memory than recognition memory tasks (cf. Eich, 1980). The present results provide support for the view that mood-congruent recall biases in high trait anxiety is a by-product of an attentional processing bias towards threat-relevant information. Provided that threat-related information is presented under conditions that induce a minimal semantic analysis of target stimuli, as in the case of the Stroop task, it is more likely that the threat-related nature of some target stimuli captures the attention of anxious individuals and, as a consequence, these subjects are more likely to further elaborate threat-related words. Hence, more threat-related words are recalled by trait-anxious individuals (Freidman et al., 2000; Russo et al., 2001, present experiments).

The detection of a mood-congruent free recall bias in anxious individuals is at variance with the prediction made by the Williams et al.'s (1997) model that explicit memory bias is a function of elaborative processing. Since depression, but not anxiety, is associated with greater elaborative encoding of mood-congruent stimuli, no mood-congruent recall bias should be observed among anxious individuals. However, since anxiety and depression are highly correlated, it is possible that the current parallel biases in attention and memory were due to high levels of anxiety and depression, respectively. While possible, it is relevant to notice that while attentional biases are common in anxious individuals, they are rarely found for depressed individuals (e.g., Williams et al., 1997). In the present experiment we found *both* attentional and memory biases. On the basis of the above observation, it seems unlikely that the attentional bias was driven by depression. Hence, it also seems unlikely that depression is responsible for the recall bias. Therefore, the Williams et al. (1997) model may need to be modified in order to fully account for the patterns of attentional and memory biases observed in anxious individuals. The current results confirm mood-congruent recall biases in high trait anxiety following relatively shallow incidental learning tasks, and indicate that this effect is genuine and not due to a response bias (cf. Dowens & Calvo, 2003).

APPENDIX

Lists of items used in the experiment with the average frequency of occurrence according to Kucera and Francis (1967)

	Neutral		***Threat-related***	
	List 1	**List 2**	**List 1**	**List 2**
	cupboard	lobster	failure	murder
	whale	capacity	pain	rape
	library	nephew	terrified	despair
	clothing	edition	kill	death
	science	furniture	torture	tragedy
	memory	salon	strangled	destruct
	factory	housed	mutilated	corpse
	tool	length	threaten	cancer
	ankle	window	suffocate	brutal
	board	amount	hurt	disaster
	steamed	wheat	hatred	victim
	kettle	vacuum	agony	crisis
Means	52.5	99.9	26.7	53.2

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TABLE 1

Stroop task

	Neutral	*Threat-related*
High trait	82.6 (3.46)	87.9 (3.84)
Low trait	77.0 (2.09)	76.1 (2.21)

Time taken, in seconds, to read the colour of neutral and threat-related words by high and low trait anxiety subjects. Standard errors are in brackets.

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TABLE 2

Free recall

	Neutral	*Threat-related*
High trait	.088 (.012)	.259 (.017)
Low trait	.113 (.012)	.144 (.012)
After the subtraction of intrusions		
High trait	.070 (.014)	.230 (.021)
Low trait	.106 (.012)	.128 (.012)

Mean proportion of neutral and threat-related words recalled by high and low trait anxiety subjects, before and after subtraction of instrusions. Standard errors are in brackets.