An informational pathway to the development of a contamination-related memory bias

Short Report

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Abstract

Background and Objectives: Following from previous work in which post-encoding suggestions of threat led to the development of a memory bias (in the presumed absence of an attentional bias; Senn & Radomsky, 2012), we sought to examine whether the development of a similar threat-relevant memory bias could be fostered via a purely informational pathway.

Methods: A vignette about a classroom interaction was read aloud to (n = 96) undergraduate participants who then completed a post-encoding recall test. Participants were then told that the experimenter forgot to read the last sentence of the vignette, and were then randomly assigned either to the Threat condition, in which the additional statement indicated that a character in the vignette had a highly contagious flu, or to the No-Threat condition, in which the additional statement indicated that a character in the vignette had been accepted to graduate school. A second recall test was then administered.

Results: Participants in the Threat condition (but not those in the No-Threat condition) demonstrated a proportional memory bias in favour of threatening information. This bias was not evident at the initial recall test.

Limitations: Time spent engaging in active recall was not assessed. Also, although the study was designed to minimize demand characteristics, it is possible that these played a role.

Conclusions: An explicit memory bias for threat can be created through informational means alone, even when no threat was present at encoding. Results are discussed in terms of pathways to fear and of cognitive approaches to understanding and treating anxiety disorders.

Keywords: Memory bias; contamination fear; pathways; onset; OCD.

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Theories involving emotion and cognition posit that attention, interpretation and memory are biased toward emotionally-relevant content, particularly when such content is personally significant or meaningful (Bower, 1981; Kovacs & Beck, 1978; Radomsky & Rachman, 2004). Research on memorial biases in association with anxious arousal and/or anxious psychopathology is inconclusive (see Coles & Heimberg, 2002, and Mitte, 2008 for reviews). Most studies failing to detect a memory bias employed methods based in traditional cognitive science research (e.g., learn, and then later recall lists of words) and/or stimuli which were low in ecological validity (e.g., word list learning). The failure to detect explicit memory biases in association with anxiety led to other theories which attempted to explain this in the context of well-demonstrated attentional biases, by highlighting differences between the activation of cognitive structures and their recollection (e.g., Mogg, Mathews & Weinman, 1987).

A number of researchers took a more ecologically valid approach to studying memory in association with anxious arousal employing contaminated objects (Radomsky & Rachman, 1999), threatening objects (Tolin et al., 2001), objects which were the subject of extant repeated checking by study participants (Radomsky, Rachman & Hammond, 2001), internal physiological sensations among those concerned about social evaluation/social performance (Ashbaugh & Radomsky, 2009, 2011; Mansell & Clark, 1999) and on the whole, were better able to detect the memory biases proposed by earlier theorists. A number of reviews of the literature have concluded that explicit memory biases for threat/in association with anxious arousal are present under ecologically valid conditions (e.g., Coles & Heimberg, 2002; Mitte, 2008; Muller & Roberts, 2005).

In virtually all of these studies, stimuli designed to convey threat (contrasted against those designed to be neutral) were encoded during an early part of the study, and participants were later asked to recall, recognize and/or otherwise remember these stimuli. This approach is entirely consistent with attempts to understand the role(s) that cognition (including memory) might play in the maintenance of anxious psychopathology; unfortunately, it lends itself to a rather important limitation. Namely, it is impossible to determine whether any observed bias in recall or recollection is simply the result of biases in attention. That is, if participants are known to allocate preferential attentional resources to threatening stimuli (during encoding, for example), it would not be surprising if such stimuli were better remembered (during retrieval). Indeed, recent work in depression has shown that attentional biases can cause memory biases (Blaut, et al., 2013). Further, although consistent with approaches to understanding the *maintenance* of anxiety-related problems, this methodology does not lend itself well to questions and constructs related to the development or onset of anxiety-related problems.

Recently, we demonstrated that a memory bias could be detected following a combination of direct experience and information in the absence of attentional bias at encoding (Senn & Radomsky, 2012). Undergraduate participants were asked to interact with a series of 30 neutral objects displayed in two boxes. Following a baseline recall test, participants were randomly assigned to the threat condition (in which they were told that one box was used to hold a tarantula while its terrarium was cleaned; the live tarantula was shown to participants during this manipulation), or the control condition (in which they were told that one box was used to hold the laboratory's printer paper; the paper was shown to participants during this manipulation). Importantly, the other (unmanipulated) box was described across both conditions as in use for the study only. A second free recall test was then administered. Results showed a

significantly greater proportion of spider box to unmanipulated box items recalled compared to the proportion of paper box to unmanipulated box items recalled. This difference was not evident at baseline. To our knowledge, this was the first study to demonstrate a memory bias for threat in the presumed absence of an attentional bias (indeed, although attention was not assessed, all objects were neutral at encoding, as no threatening information – or spiders were introduced until after encoding). Further, the experiment demonstrated how such biases might form, in this case through a combination of direct experience (with a live tarantula) and information (connecting the tarantula to some of the objects with which participants had previously interacted). (These results are also consistent with false memory research, where information provided at a later time is integrated with old information to create a new comprehensive memory (e.g., McCloskey & Zaragoza, 1985)).

We propose that consistent with pathways to the development of fear in humans (i.e., direct conditioning, vicarious conditioning, information, and prepared) described by Rachman (1977), there should be similar pathways to the development of memory bias in association with threat/anxiety. The goal of the present study was to assess a purely informational pathway (i.e., without direct experience) to a contamination-related memory bias via a vignette-based experiment. We hypothesized that when provided with threatening information about some of the previously encoded material, participants would display a proportionate memory bias compared to those provided with neutral information about previously encoded material.

Method

Participants

Participants were (n = 96) undergraduate students who participated either for course credit or entry in a cash draw. Participants were on average 21.73 (SD = 5.63) years of age and

the majority (81.2%) were female. There were no age ($t(94) = 0.99$, $p = .33$) or sex ($\chi^2(1) = 0.01$, $p = .92$) differences between the two conditions (see below).

Measures

Beck Anxiety Inventory (BAI; Beck & Steer, 1990) and *Beck Depression Inventory-2* (BDI-II; Beck, Steer, & Brown, 1996). The BAI and BDI-II are both well used 21-item questionnaires that assess symptoms of anxiety and depression respectively. In the current study, internal consistencies of these scales were α's= .91 and .90, respectively.

Vancouver Obsessional Compulsive Inventory (VOCI; Thordarson et al., 2004). The VOCI is a 55-item questionnaire assessing a range of obsessive-compulsive symptoms, including a contamination subscale. The scale has high test-retest reliability (0.91), and internal consistency (α = 0.96; Radomsky et al., 2006). Convergent and divergent validity are excellent (Thordarson et al., 2004; Radomsky et al., 2006). Internal consistency in the current sample was α = .95.

Memory Recall Test. Both prior to and following the manipulation (see below) participants were asked to write down everything they could recall from a vignette that was dictated earlier in the study. They were given five minutes to complete this task.

Manipulation Check Questions. Both prior to and following the manipulation (see below) participants rated their anxiety, urge to neutralize their anxiety, and urge to wash their hands on a scale from 0 ('not at all') to 100 ('extremely').

Materials

A short vignette was created describing the experience of an individual completing a group project with two other students. Some of the information mentioned in the vignette relates to physical contact or exchange of items that have been touched (e.g., borrowing pens, shaking

hands), while other information is about the person's life or appearance (e.g., number of siblings, type of shoes). The vignette includes details about these and other aspects for both students (e.g., the type of pen each student was using). The vignette is available upon request from the first author.

Procedure

Participants were asked to close their eyes and imagine themselves as the individual in the vignette as the experimenter read the vignette aloud. Participants then responded to emotion state questions (see *Measures*), completed a distractor task, and finally a recall memory test. Participants were then informed that the experimenter had accidentally read an old version of the vignette and had thus forgotten to read the last sentence, at which time this sentence was provided. The content of this additional sentence depended on the condition to which the participant was randomly assigned (Threat or No-Threat). In the Threat condition participants were told that one of the students has a highly contagious flu. In the No-Threat condition participants were told that one of the students was just accepted to graduate school. For each participant one of the students in the vignette had additional information reported about them (the 'manipulated' individual), and no new information was provided about the other student (the 'un-manipulated' individual). Which student became the manipulated individual was counterbalanced across participants.

Following the manipulation, participants were asked to repeat the previously completed tasks (emotion state questions, distractor task, and a recall memory test). Finally, they completed the self-report questionnaires (see *Measures*).

Data analyses

Information recalled from the vignette was coded as belonging to one of two categories: touched items (e.g., pens, Kleenex), or untouched items (e.g., program of study, number of siblings). Furthermore, information was categorized as being related to the individual who had added information about them provided (manipulated) or the individual for whom no new information was provided (un-manipulated).

The dependent variable of interest was calculated by dividing the number of items recalled at time 2 that were both touched and manipulated, by the total number of items recalled at time 2 (i.e., following the manipulation). This proportionate memory variable was selected because it provides valuable information about the variable of interest (items that were both touched and manipulated) while taking into account the limited capacity of memory (Miller, 1956).

Results

Participants. There were no significant condition differences on obsessive-compulsive symptomatology, general anxiety, or depressive symptomatology. There were also no condition differences in overall memory performance at time 1 or time 2, or total memory recall. There was a significant decrease in memory over time across participants, $t(95) = 2.47$, $p = .02$, $d = 0.25$. However, when changes in memory over time were investigated by condition, this decrease was significant in the Threat condition ($t(48) = 2.65$, $p = .01$, $d = 0.38$) but not in the No-Threat condition ($t(46) = 0.72$, $p = .47$, $d = 0.11$).

Manipulation Check. Participants who were provided new threatening information about one of the individuals in the vignette were more anxious ($t(94) = 4.24$, $p < .001$, $d = 0.86$) and had stronger urges to neutralize their anxiety ($t(94) = 3.32$, $p = .001$, $d = 0.68$) and wash their

hands ($t(94) = 9.88$, $p < .001$, $d = 2.03$) than those who were provided with new neutral information. These condition differences were not evident prior to the manipulation (p's > .05).

Overall Analyses. An ANCOVA was conducted to assess the effects of condition on memory. The independent variable was condition, and the dependent variable was the proportion of items recalled at time 2 that were both manipulated and touched to the total number of items recalled at time 2. The covariate was this same proportionate memory variable calculated at time 1 (proportion of items recalled at time 1 that were manipulated and touched to the total number of items recalled at time 1), to account for initial memory performance. Results showed a significant difference between conditions, $F(1, 93) = 7.12$, $p = .01$, adjusted $r^2 = .61$, with individuals in the Threat condition showing a higher proportionate memory for items that were both manipulated and touched compared to all items recalled than those in the No-Threat condition (see Figure 1). At time 1 there was no difference between conditions on this proportionate memory variable, $F(1, 94) = 0.00$, $p = .99$, adjusted $r^2 = -.01$.

Discussion

This study was designed to assess whether or not a memory bias could be created via informational means alone, thus assessing the distinct contribution of information in the absence of direct experience. Indeed, results showed that although no such bias was evident at encoding (when all of the to-be-recalled information was neutral in valence), following the manipulation, participants in the Threat condition showed a significant proportional memory bias in favour of threatening information (i.e., information relating to touched objects belonging to the individual described as having a highly contagious flu) compared to those in the No-Threat condition. These results are consistent with Senn and Radomsky (2012) who found a similar memory bias, although in the current study, a solely informational pathway was used rather than the

combination of both direct and informational pathways used in Senn and Radomsky (in which participants were shown a live tarantula which was described as having walked all over the to-be-remembered objects). Given that the current results support an informational pathway in the development of memory bias, it is difficult to discern the potential unique importance of direct experience.

The above findings are noteworthy for a number of reasons. First, the bias reflects an explicit memory bias. Although explicit memory biases for threat are arguably more commonly demonstrated under conditions high in ecological validity (Coles & Heimberg, 2002), there are many studies which have failed to show the presence of preferential recall (or recognition) of threat-relevant information. In addition, in the current study the observed memory bias presumably occurred in the absence of an attentional bias. (Although attention was not assessed, one assumes that participants could not have shown an attentional bias at encoding because none of the presented information was threatening in nature). This is also consistent with Senn and Radomsky (2012), and appears to show that the preferential allocation of attentional resources may not be necessary to foster better later memory. Future researchers may wish to confirm this via attentional assessment during a similar protocol.

The memory bias demonstrated in the current study is also notable because there was no direct contact with any threatening stimulus (only new information about a character described in a previously listened-to vignette). Although the majority of studies have assessed memory for stimuli which were either threatening or non-threatening at encoding (e.g., Coles, Turk, & Heimberg, 2007; Radomsky & Rachman, 1999), only one other (to the best of our knowledge) has assessed memory for previously neutral information, later made threatening during the study (Senn & Radomsky, 2012). In this earlier study, the manipulation was effected using a live

tarantula, more in line with learning by direct experience. The current protocol employed stimuli (and a manipulation) which was/were informational only. As such, it establishes a more specific pathway toward the development of memory biases for threat (see Rachman, 1977).

These results likely support prioritization of threat-relevant information in memory. Specifically, memory does not increase over time, but rather threat-relevant information is prioritized and thus preferentially recalled. False memory research also informs us that the original memory is not likely lost, but instead the new information has led to an integrated memory (McCloskey & Zaragoza, 1985) in which threat information is more salient. Importantly, the results of the current study support enhanced memory for threat-relevant stimuli; however, this could also be due to the arousing nature of the information rather than the threat value itself. Indeed, it has been shown that arousing information (compared to non-arousing information) is better remembered, regardless of its valence (Mather & Sutherland, 2009). It is therefore possible that a similar effect would have been found if the information provided had been highly positive.

The study is not without limitations. First, the actual time participants spent completing the memory task was not measured, so it is difficult to ascertain whether declarative memory was exhausted in the five-minute period provided. Additionally, demand characteristics may be a concern if participants realized the manipulation was part of the study. Although this was not formally evaluated, even if participants had predicted the exact nature of the study the effects would perhaps be balanced, as individuals in both conditions were provided with new information (that differed primarily in threat level). Moving forward, it would be fascinating to assess whether there is an observational (i.e., vicarious learning) pathway (see Mineka,

Davidson, Cook, & Keir, 1984; Rachman, 1977) to explicit memory bias, in addition to the direct and informational pathways now demonstrated.

We hope that these results will influence the psychoeducation provided to patients/clients who complain of problems whose onset cannot be traced to a particularly difficult episode, but which could be related to the receipt of new threatening information about a previous neutral event. Similarly, clients may benefit from knowing that their memories may be skewed towards threat-related material, and this can help to explain why anxious individuals seem to have excellent and numerous memories of stressful and/or threat-related experiences.

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References

Ashbaugh, A. R., & Radomsky, A. S. (2009). Interpretations of and memory for bodily sensations during public speaking. *Journal of Behavior Therapy and Experimental Psychiatry, 40*, 399-411.

Ashbaugh, A. R., & Radomsky, A. S. (2011). Memory for physiological feedback in social anxiety disorder: The role of fear of bodily sensations. *Cognitive Therapy and Research, 35*, 304-316.

Beck, A. T., & Steer, R. A. (1990). *Beck anxiety inventory manual*. Toronto: Psychological Corporation.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory-II.* San Antonio, TX: Psychological Corporation.

Blaut, A., Paulewicz, B., Szastok, M., Prochwicz, K., & Koster, E. (2013). Are attentional bias and memory bias for negative words causally related? *Journal of Behavior Therapy and Experimental Psychiatry, 44,* 293-299.

Bower, G. H. (1981). Mood and memory. *American Psychologist, 36,* 129-148.

Coles, M. E., & Heimberg, R. G. (2002). Memory biases in the anxiety disorders: Current status. *Clinical Psychology Review, 22,* 587-627.

Coles, M. E., Turk, C. L., & Heimberg, R. G. (2007). Memory bias for threat in generalized anxiety disorder: The potential importance of stimulus relevance. *Cognitive Behaviour Therapy, 36,* 65-73.

Kovacs, M., & Beck, A. T. (1978). Maladaptive cognitive structures in depression. *The American Journal of Psychiatry, 135,* 525-533.

Mansell, W., & Clark, D. M. (1999). How do I appear to others? Social anxiety and processing

of the observable self. *Behaviour Research and Therapy, 37,* 419-434.

Mather, M., & Sutherland, M (2009). Disentangling the effects of arousal and valence on memory for intrinsic details. *Emotion Review, 1,* 118-119.

McCloskey, M., & Zaragoza, M. (1985). Misleading postevent information and memory for events: Arguments and evidence against memory impairment hypotheses. *Journal of Experimental Psychology, 114*, 1-16.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity to process information. *Psychological Review, 6,* 81-97.

Mineka, S., Davidson, M., Cook, M., & Keir, R. (1984). Observational conditioning of snake fear in rhesus monkeys. *Journal of Abnormal Psychology, 93,* 355-372.

Mitte, K. (2008). Memory bias for threatening information in anxiety and anxiety disorders: A meta-analytic review. *Psychological Bulletin, 134,* 886-911.

Mogg, K., Mathews, A., & Weinman, J. (1987). Memory bias in clinical anxiety. *Journal of Abnormal Psychology, 96,* 94-98.

Muller, J., & Roberts, J. E. (2005). Memory and attention in obsessive-compulsive disorder: A review. *Journal of Anxiety Disorders, 19,* 1-28.

Rachman, S. (1977). The conditioning theory of fear-acquisition: A critical examination. *Behaviour Research and Therapy, 15,* 375-387.

Radomsky, A. S., Ouimet, A. J., Ashbaugh, A. R., Lavoie, S. L., Parrish, C. L., & O'Connor, K. P. (2006). Psychometric properties of the French and English versions of the Vancouver Obsessional Compulsive Inventory and the Symmetry Ordering and Arranging Questionnaire. *Cognitive Behaviour Therapy, 35,* 164-173.

Radomsky, A. S., & Rachman, S. (1999). Memory bias in obsessive-compulsive disorder (OCD). *Behaviour Research and Therapy, 37,* 605-618.

Radomsky, A. S., & Rachman, S. (2004). The importance of importance in OCD memory research. *Journal of Behavior Therapy and Experimental Psychiatry, 35,* 137-151.

Radomsky, A. S., Rachman, S., & Hammond, D. (2001). Memory bias, confidence and responsibility in compulsive checking. *Behaviour Research and Therapy, 39,* 813-822.

Senn, J. M., & Radomsky, A. S. (2012). Well that changes everything! The genesis of memory bias for threat with implications for delayed onset in anxiety disorders. *Journal of Behavior Therapy and Experimental Psychiatry, 43,* 1019-1025.

Thordardson, D. S., Radomsky, A. S., Rachman, S., Shafran, R., Sawchuk, C. N., & Hakstian, A. R. (2004). The Vancouver Obsessional Compulsive Inventory (VOCI). *Behaviour Research and Therapy, 42,* 1289-1314.

Tolin, D. F., Abramowitz, J. S., Brigidi, B. D., Amir, N., Street, G. P., & Foa, E. B. (2001). Memory and memory confidence in obsessive-compulsive disorder. *Behaviour Research and Therapy, 39,* 913-927.

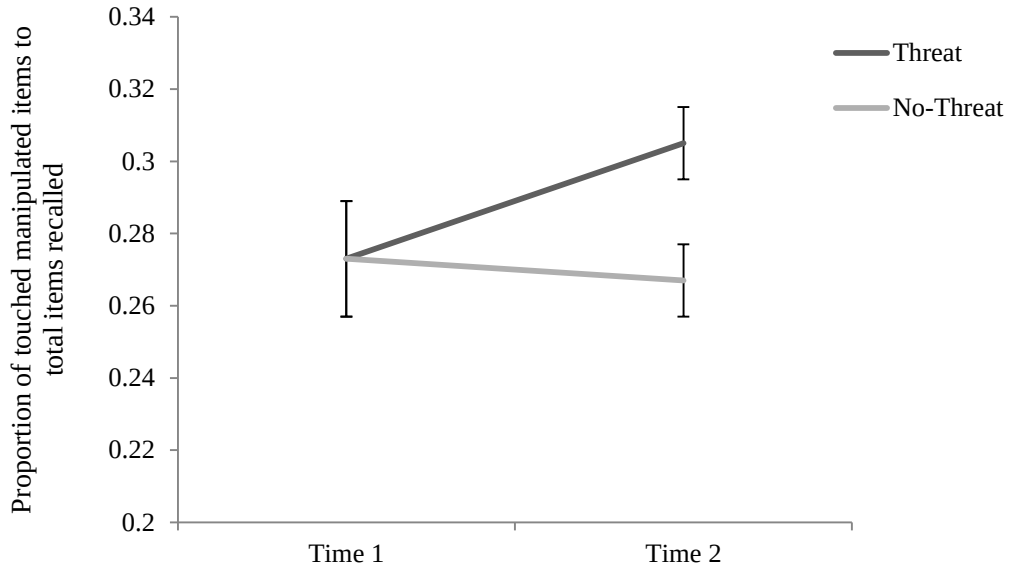

Figure 1. Proportion of recalled items that were both manipulated and touched to total items recalled by time and condition.