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Worrying Facilitates Correct and False Memories about Negative Information

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Abstract

Despite the clinical relevance of worrying, its underlying cognitive mechanisms remain poorly understood. Eysenck postulates that high-worriers' long term memory is characterized by tightly organized clusters with negatively valenced worry-related information, causing this information to be more readily accessible. Based on this premise, we expect (1) that high-worriers will more easily store negative worry-related information, but (2) that they are also more prone to produce false memories about negatively valenced worry-related information. We tested these hypotheses in a healthy student population using the Deese-Roediger-McDermott (DRM) paradigm. The results of our study indicate that worrying is positively correlated (1) with the correct recognition of negative words, and (2) with the production of false recognitions of negative words. These results were unrelated to themes participants often worry about. As expected, there was no correlation between worrying and (false) recognition of positive or neutral words. In conclusion, these findings indicate that worrying is associated with memory biases for negative information. This supports the existence of negatively valenced clustered long term memory structures. However, no support was found for the idea that clusters are concentrated on specific worry themes high worriers frequently worry about.

Keywords: Worrying; Recall; Recognition; False memory; DRM paradigm; Anxiety

Introduction

Worry can be described as uncontrollable thought activity, typically involving concerns about future events with a possible negative outcome [1]. High-worriers are characterized by a higher uncontrollability of negative thought intrusions as opposed to low-worriers [2]. Eysenck [3,4] hypothesizes that these uncontrollable negative thought intrusions are due to tightly organized worry-clusters in high-worriers' long term memory (LTM). These worry-clusters are 'nodes' of negative information, related to themes or domains a person frequently worries about. According to this theory each worry-cluster thus represents a specific worry-domain. In analogy to Bower's [5] network theory, Eysenck postulated that the strong connections between cluster elements in LTM would facilitate the activation of the entire cluster. Confronted with information associated to a worry-cluster, high-worriers are thus more likely to automatically start worrying about this particular worry-cluster, leaving little control over this process once instigated.

In order to test the worry-cluster theory, Pratt et al. [6] investigated whether high-worriers experience more difficulties to make categorically based decisions on their worry domains using a word allocation task. Results showed that high-worriers were slower to reject negative words when these words were associated to a domain they often worry about. This effect was not found for positive words. The authors attributed these results to elaborated negative worry-related clusters in high-worriers' LTM, the idea being that it takes them longer to get through all of the information and make a decision. Because of the increased accessibility of worry-specific information with a negative valence in high-worriers' memory structures, we wish to investigate whether high-worriers will more easily link new related information to the existing worry-clusters and consequently store negative worry-related information more efficiently.

There is little other research on the connection between worrying and memory. However, research shows that worrying is closely related to anxiety. There is a strong correlation between trait-worry and trait-anxiety [7], trait-worry being the pure cognitive component of a wider (also physiologically) tendency to react anxiously or not (trait-anxiety) [4,8]. Chronic excessive and uncontrollable worry has been shown to play an important role in different anxiety disorders, and it is even the defining characteristic of generalized anxiety disorder [9]. Because of the tight relationship between worry and anxiety, we believe it is indispensable to further unravel the connection between worry and memory, to ultimately gain more insight into the relationship between anxiety and memory.

Research has shown that anxious persons exhibit a strong tendency to selectively process threatening stimuli. More precisely, there is strong empirical evidence for an attentional bias in anxiety: high-anxious persons and patients with an anxiety disorder automatically direct their attention toward threatening information [10]. As selective attention improves memory performance [11] one might expect anxiety to be associated with a memory bias for threatening stimuli as well. Thus, this memory bias could be a consequence of the attention bias. Alternatively, an independent mechanism might cause threatening stimuli to be selectively processed. However, in contrast to findings on attentional bias, there is no consensus on the relationship between anxiety and memory bias. Some studies show that participants with a high score on trait-anxiety have a better memory for threat-related information [12,13], but others have failed to demonstrate a connection between memory bias and trait-anxiety [14,15]. The relationship between different types of anxiety disorders and memory biases is currently also unclear [16,17].

According to Reidy and Richards [12] divergent results can be

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explained by the type of stimuli used in research to investigate the connection between anxiety and memory. They postulate that anxiety biases are only found when stimuli were specific to the type of anxiety under investigation. For example, McNally et al. [18] used panic-related words when testing panic patients. Their results showed that panic patients have a better memory for panic-related information only. In other words, anxious patients have a better memory for subjects they frequently worry about. However, persons with a high trait-anxiety score have a wide range of concerns, which may vary from individual to individual. Therefore it was suggested by Reidy and Richards [12] that the most appropriate stimuli to test anxious patients and persons with a high trait-anxiety score would be stimuli related to each individual's concerns, i.e., personally relevant worry-related information. A more recent study of Reidy [19] indeed shows that high trait-anxiety is associated with improved memory for worry-related information.

Since repeated worrying about specific information enhances memorization, we conjecture that the association between trait-anxiety and enhanced memory for worry-related information [19] might be mediated by trait-worry. Borkovec [1] suggested that worrying leads to a strengthening of worry-related information in LTM: Higher frequency of thinking about certain domains enhances their retrievability as a result of an increased number of retrieval cues. A study by Mellings and Alden [20] supports this view by indicating that rumination (persistent negative thought described in the context of depression, closely resembling worrying) after a social interaction enhances the long term storage of negative information related to this social interaction in a later test phase.

Apart from memory retrieval of correct memories, the current study also investigates false memories in high-worriers. If worrying is indeed associated with an increased accessibility and activation of negative worry-specific information, as suggested by the worry-cluster theory [6], high-worriers will probably not only have enhanced memory retrieval of negative worry-related information, but also produce more false memories of negative worry-related information.

In order to test this hypothesis, we used the Deese [21], Roediger and McDermott [22] (DRM) paradigm. In the DRM task participants are presented with lists of semantically related words (e.g. red, ice cream, summer, sweet, fruit, raspberry, etc.). Within each list, every word is strongly associated with a single central word which does not appear in the list itself. This central word is the list's critical lure (e.g. strawberry). Quite often, participants report that the critical lure appeared in the word list when performing a free-recall task or a recognition task. In other words, they have created a false memory about the critical lure.

Recall of the critical lures has been found to be equal to recall of words that were actually presented during the task [23]. According to Roediger et al. [24] this phenomenon can be from presented associated words to the not-presented associated critical lure. The false recall of the critical lure is thus a consequence of residual activation in the associative network. For the aim of the current study, this suggests that persons with a strong tendency to worry are more likely to create false memories of worry-related information, because the strong connection between each element of a worry-cluster increases the likelihood of residual activation.

In the current study, we used a classic DRM paradigm but added four self-composed lists, containing negative words associated with themes our target group frequently worries about ((1) fear of failure, (2) relations, (3) health and (4) loss/dead). We analyzed correct and false recall and recognition separately for lists that were associated with positive, neutral and negative lures. The negative lures could either reflect personally relevant worry-themes, or non-personally relevant worry-themes. This enabled us to not only investigate whether high-worriers had more correct and false memories of words from the negative lists, but also to determine whether this memory bias was more pronounced when the negative word lists reflected personally relevant worry-themes.

To recapitulate, the purpose of the present study was to investigate whether worrying is positively correlated with (1) correct recall and recognition of negative words, and (2) false recall and recognition of negative lures. In addition, we determined whether the expected correlation between worrying and (false) memory of negative words is stronger when the words reflect personally relevant worry-themes. Finally, we investigated whether the expected memory bias also correlates with trait-anxiety.

Method

Participants

Seventy four undergraduates (62 females), with an age ranging from 18 to 46 years (M=20.3, SD=6.3) participated in the experiment. They participated in the context of a course (experimental clinical psychology) at the Vrije Universiteit Brussel (VUB). There was no correlation between the amount of worry as determined by the Penn-State Worry Questionnaire (PSWQ) scores (see below) and age (r=-0.09, p=0.44), or female/male ratio (r=0.08, p=0.50). As expected, there was a significant correlation between PSWQ scores and trait-anxiety scores, measured with the State-Trait Anxiety Inventory (STAI), (r=0.47, p<0.001).[1]

Materials

Self-report questionnaires:

The Penn-State Worry questionnaire (PSWQ): The PSWQ [25,26] is a 16-item questionnaire that assesses the tendency to worry. Items are rated on a 5-point scale for the degree to which they characterize the participant. The Dutch version of the PSWQ has an adequate reliability and high internal consistency [27].

The trait-anxiety scale of the state-trait anxiety inventory (STAI): The STAI [28,29] is a 40-item self-report scale designed to measure state and trait-anxiety. The respondents in our experiment only completed the trait-anxiety scale, which measures a person's general tendency to be anxious. Respondents are presented with a number of statements, and are asked to indicate the degree to which they apply to them, ranging from (1) almost never to (4) almost always. High construct validity and test-retest reliability (Cronbach's α=0.91) are reported for the Dutch version of the STAI [29].

DRM task:

We presented 18 lists, each consisting of 15 words. All the word lists have one critical lure, i.e., a word that was associated with all of the words in the list, but that did not appear in the list. Twelve (6 negative and 6 neutral) of these 18 lists were taken from the original lists developed by McDermott and Watson [30]. To this we added the 'happy- list' and the 'sad-list' developed by Storbeck and Clore [31], and we created 4 (negative) lists ourselves, with students' important worry themes as critical lures. Based on a pilot with 310 undergraduates, we

[1] Because of non-normality of the data distribution, we used a Spearman correlation coefficient (2-tailed) to calculate the correlations between these variables.

identified 4 principal worry-themes in students. From most to less frequent: (1) fear of failure, (2) relationships, (3) health, and (4) loss/death. We then created the lists of words by asking 126 students to write down 10 words they associated strongly to these 4 critical lures. We assembled all the responses and retained the 15 most frequent words for every critical lure. Subsequently, we composed word lists in which these words were ordered from most to least associated with the critical lure. Out of 18 critical lures, 11 (6 lists from McDermott and Watson [30]; 1 list from Storbeck and Clore [31]; 4 self-created lists) were identified as being negative, 1 (list from Storbeck and Clore [31]) as being positive and 6 (lists from McDermott and Watson [30]) as being neutral. This categorization was based on the valence ratings of the critical lures of each list in the affective word list, which lists valence (1=very negative, 7=very positive) ratings for 740 Dutch nouns and personality traits. Words were centrally presented on a computer screen against a white background written in black font. The DRM task was conducted on IBM-compatible Pentium 4 personal computers with a 17-in. screen, using E-prime Psychology Software Tools Inc. version 2.0 software [32].

Recognition task:

The recognition task consisted of a sheet of paper with 108 printed words, 54 of which effectively appeared in the computer experiment. The other words were the 18 critical lures, as well as 36 unrelated words that did not appear in the computer experiment. The words were printed in black font on a white sheet of paper and presented in random order, organized in 4 columns of 27 words.

Procedure

After completing the informed consent form, participants were asked to fill out the PSWQ and the trait-anxiety scale of the STAI. They were subsequently asked to indicate which themes they frequently worry about, choosing from: (1) fear of failure, (2) relations, (3) health, (4) death, and (5) other themes. They then performed the computer task in individual testing cubicles of the psychology lab of the VUB. They were presented with 18 lists of 15 words each, and given the instruction to memorize as many words as possible. The sequence of the word lists was randomized for each participant. The order of words within each list was, however, fixed: the first word being most strongly associated with the critical lure, with diminishing associative power as the list preceded. Words appeared on the computer screen one at a time for 250 ms, with an inter-stimulus-interval of 32 ms. A free-recall task was presented after each individual list, in which respondents were asked to type as many remembered words as possible. They were explicitly instructed not to guess. At the beginning of the free-recall task, they were informed that they were given 60 s to respond. To announce the next list of words, respondents saw the message: 'Attention, the next list of words will start in 5 s.' This procedure was repeated for all 18 lists. After completing all 18 lists and corresponding recall tasks, respondents performed the pen-and-paper recognition task. They had to stand up, exit their individual testing cubicles and walk through a corridor (100 square feet) to get a sheet with 108 words for the recognition task. They then walked back and filled in this sheet in individual testing cubicles. They were asked to circle those words that they believed were presented during the experiment. Again, instructions stressed not to guess. After the experiment, participants were fully debriefed and given the occasion to ask questions.

Results

We investigated whether PSWQ scores were correlated with (1) immediate correct recall of the words of each word list presented during the free-recall tasks (free-recall), and (2) with correct recognition of the words presented during the final recognition task at the end of the experiment (recognition). The same was done for false recall and false recognition. We distinguish between words from negative, neutral, and positive lists. Within the negative lists, we differentiate between lists containing words related to personally relevant worry-themes versus non-personally relevant worry-themes.

Table 1 shows the obtained results. Because the data distribution was not normal, a non-parametric Spearman correlation coefficient (2-tailed) was used to determine the correlation between PSWQ scores and the correct and false (critical lure) recall and recognition scores. To determine whether the hypothesized memory bias in worriers is associated with trait-anxiety, we also calculated correlations with trait-anxiety scores, see Table 1.

Recall

Contrary to our expectations, no correlation was found between PSWQ scores and correct immediate free-recall of negative words (r=-0.10, p=0.38), not even for personally relevant negative words (r=0.07,

Free-recall task after every word list										
	Correct free-recall					**False free-recall of critical lures**				
Word dimensions	***M (SD)***	***r worry***	***p***	***r anxiety***	***p***	***M (SD)***	***r worry***	***p***	***r anxiety***	***p***
Positive	49% (13)	0.00	0.97	0.06	0.63	11% (31)	0.16	0.18	0.11	0.36
Neutral	57% (9)	-0.03	0.79	-0.06	0.60	18% (18)	-0.06	0.62	0.07	0.55
Negative	55% (8)	-0.10	0.38	-0.07	0.53	17% (14)	0.03	0.81	0.08	0.48
Personally relevant	59% (9)	0.07	0.58	-0.08	0.52	5% (16)	0.03	0.79	0.15	0.21
Not personally relevant	59% (10)	-0.00	0.98	0.02	0.85	21% (16)	0.00	0.99	0.11	0.37
Recognition task at the end of the experiment										
	Correct recognition					**False recognitions of critical lures**				
Word dimensions	***M (SD)***	***r worry***	***p***	***r anxiety***	***p***	***M (SD)***	***r worry***	***p***	***r anxiety***	***p***
Positive	75% (27)	0.11	0.37	0.13	0.28	77% (42)	-0.04	0.73	0.14	0.23
Neutral	82% (19)	0.15	0.21	0.06	0.64	45% (30)	0.05	0.71	0.13	0.28
Negative	**68% (10)**	**0.24***	**0.04**	**0.12**	**0.33**	**69% (19)**	**0.24***	**0.04**	**0.19**	**0.21**
Personally relevant	79% (18)	0.02	0.88	0.03	0.79	25% (23)	0.07	0.54	0.17	0.16
Not personally relevant	76% (28)	0.10	0.42	0.20	0.09	57% (23)	0.00	0.99	0.09	0.46

* significant at a 0.05 level

Table 1: Mean scores (%), SDs and correlations with PSWQ scores (*r* worry) and trait-anxiety scale scores (*r* anxiety) for positive, neutral, and negative (personally relevant and not personally relevant) words in the immediate free-recall task and in the final recognition task.

p=0.58). Neither was there a correlation between trait-anxiety scale scores and correct immediate free-recall of negative words (r=-0.07, p=0.53), nor with personal relevant negative words (r=-0.08, p=0.52).

Recognition

In agreement with our hypothesis, the higher the PSWQ score, the more negative words persons correctly recognized at the end of the experiment (r=0.24, p=0.04). Also in line with our expectations, participants with high PSWQ scores were more likely to produce false recognitions about negative information (r=0.24, p=0.04). These effects were unrelated to the personal relevance of negative words (respectively for correct and false recognition: r=0.02, p=0.88, r=0.07, p=0.54). These results seem to indicate that it is unimportant whether the negative information was related to themes participants frequently worry about. As expected, there was no correlation between PSWQ scores and (false) recognition of positive or neutral words. Memory biases associated with worrying were unrelated to trait-anxiety scores (respectively for correct and false recognition of negative words: r=0.12, p=0.33, r=0.19, p=0.21).

Discussion

According to the worry-cluster theory [3,4], people with a strong tendency to worry have tightly organized worry-clusters in their LTM. Therefore, one would expect the tendency to worry to be positively correlated with the recall and recognition of negative worry-related words, as well as with the production of false memories of negative worry-related information. The hypotheses were tested in a DRM paradigm using positive, negative, and neutral words. Negative words were either related or not related to personally relevant worry-themes.

Our hypotheses were partially confirmed as for the recognition of words during the recognition task at the end of the experiment, but not for the free-recall of words during the free-recall task immediately after each word list. In accordance to our expectations, persons with a strong tendency to worry (1) correctly recognized more negative words and (2) falsely recognized more negative words in the final recognition task. These memory biases did not appear to be more pronounced for worry-related information and were unrelated to trait-anxiety. There was no significant link between memory biases in the free-recall and worry scores.

Since the present study is the first to investigate the association between a tendency to worry and both free-recall and recognition, further research is needed to clarify why worriers show recognition biases, but no recall biases. One possible explanation could be that memory biases only occur when information has been sufficiently consolidated. In our experiment, the recognition task came at the very end of the experiment (after a short pause, see procedure) whereas the recall measure was conducted directly after each list of words, possibly not leaving enough time for proper consolidation of memories. We can say that the free recall task mainly appeals to working memory while the recognition task also relies on long-term memory. In this case, our findings are in line with recent findings from another study [33] indicating that there is no difference in updating efficiency (also appealing to working memory) between participants scoring high versus low on trait worry.

In order to determine the role of the degree of consolidation in the memorization of negative words, we could try to investigate whether high-worriers show primacy, but no recency effects for these words. If worriers would recall more negative words from the first part of the word list (primacy), this would indicate that a certain degree of consolidation is needed for memory biases to occur. Unfortunately, primacy and recency effects cannot be reliably determined for a DRM task, given that each word in a list is differentially associated to the critical lure, associations being the strongest for the first words and weakest for the last words. We feel that this is too much of a confounding variable. Moreover, a much longer time course than the one for the recall tasks in our experiment is needed to properly study mechanisms of consolidation.

A second possible explanation is that memory biases occur on the basis of familiarity, since recognition relies strongly on familiarity. Presenting certain specific words in the recognition task could trigger overdeveloped negative networks in persons with a tendency to worry, thereby producing more correct but also more false recognitions of the negative words. This supports the existence of negatively valenced clustered long term memory structures in worriers.

However, these clusters seem not to be concentrated on specific personally relevant worry themes as suggested by Eysenck [3,4]. Because contrary to our expectations, the memory biases found in our study were not more pronounced for personally relevant worry-related information. We feel a methodological remark is at place here. It remains to be determined to which degree the words we encoded as being personally relevant indeed reflected personally relevant worry-themes for our respondents. Respondent were asked to choose from 4 preselected worry-themes those that were relevant for themselves. This procedure inevitably excludes other possible worry-themes. Moreover, the pilot study showed that all 4 themes are very common worry-themes in our studied population. It is thus unsure whether themes that respondents did not mark as relevant to them were indeed totally irrelevant to them.

Ideally, respondents should be asked to compose lists of words themselves, containing personally relevant versus non-personally relevant words. The problem here is that we should be obliged to ask respondents to rank the words from most to least associated to their self-chosen critical lure. Doing so would inevitably reveal the aim of the task, rendering the chance of obtaining false memories practically zero. Furthermore, it is important that all participants conducted the same task with the same word lists, because it is useless to compare lists of words with different familiarities and word lengths.

Since worrying and rumination are very similar cognitive processes [34] it is interesting to compare our results with a study by Joormann et al. [35] who investigated the relationship between false memory and rumination (measured with the Ruminative Response Scale) in participants with major depressive disorder. In analogy to our study the authors used a DRM paradigm and found no relationship between rumination and false free recall for negative material. However, the authors only investigated free recall. It would be interesting to investigate whether the recognition biases we found are exclusively related to worrying or also to rumination.

Our results are in line with other studies that failed to find a connection between memory biases for negative information and trait-anxiety [14,15], whilst other studies, on the contrary, did find evidence for such a connection [12,13]. Because worrying is closely related to anxiety, one would expect information that a person often worries about to end up being better memorized (hence, to evoke more false memories). Perhaps worrying merits a central place in anxiety-memory research. Further research on this topic is needed.

Considering the crucial role worrying plays in the development and

maintenance of affective disorders [36], it seems relevant to discuss our results in a clinical context. Our results indicate that worriers appear to have more correct as well as false recognition for negative information, whereas no memory bias exists for free-recall. It seems important to keep this in mind when exploring negative information in patients with affective disorders e.g. in a therapeutic context. It would e.g. be advisable to favor open questions over closed questions, as offered answer possibilities could be falsely recognized.

It seems also interesting to us to further investigate this matter in a clinical sample as patients will likely score higher on questionnaires measuring (trait) anxiety and worrying, and because the connection between memory and worrying could be investigated for several different kinds of anxiety disorders.

In conclusion, we found that the tendency to worry is positively correlated with both correct and false recognition of negative information. This supports the existence of negatively valenced clustered long term memory structures in high-worriers. Memory biases were however not more pronounced for personally relevant information, and they were not correlated to trait-anxiety scores.

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