T1 Title: Effects of Working Memory Interference on the Elicitation of Emotional False Memories

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T6 Estimated duration of project

6 months

T7 IRB Status

Ethical approval has be secured from the University of Bristol's School of Psychological Science Human Research Ethics Committee (ethics approval code: 080121114805)

T8 Conflict of Interest Statement

None

T9 Keywords

Working Memory; False Memory; Deese-Roediger-McDermott Task; Anxiety

T10 Data accessibility statement and planned repository

Data access via download; usage of data for all purposes (public use file)

T11 Optional: Code availability

No, we don't plan to make the code available

T12 Optional: Standard lab practices

<<T12 Optional: Standard lab practices>

Abstract

A1 Background

Working memory may provide a means of holding information in mind that reduces susceptibility to false memories. In contrast anxiety might make individuals' more prone to false memory intrusions, particularly those with an emotional content.

A2 Objectives and Research questions

This project explores whether any such protection depends on individuals' working memory capacity, levels of anxiety, the amount of to-be-remembered information, and the nature of intrusion probes.

A3 Participants

At least fifty adult participants will be assessed.

A4 Study method

Participants will complete a version of a working memory task in which a pre-load of semantically-related words is followed by a period of distraction, and then a recognition test. The amount of information to be remembered will be varied across trials, as will whether the memory items prompt a neutral or negatively-valenced false memory. The nature of distraction will be varied between participants. Participants' short-term memory capacity and state and trait levels of anxiety will also be measured.

Introduction

I1 Theoretical background

Working memory refers to the ability to temporarily store information while resisting distraction. This is an important cognitive function that guides long term retention, decision-making and goal-directed behaviour. False memory is a well-established phenomenon in psychology that demonstrates associated information can be erroneously remembered from previously studied material over a long delay. Recently, it has been suggested that the effect of false memory is also observed over the short term, indicating this may be due to interference in working memory mechanisms. Emotional content is further implicated in the production of false memory as negative-valence stimuli, but not arousal, has been shown to elicit higher levels of false memory than either neutral or positive valence.

Research has further highlighted that anxious states, such as excessive worry or rumination, can have an adverse effect on working memory performance leading to less retention over a delay. However, recent evidence suggests conditions which place excessive demands on working memory may act as a buffer against the interfering effects of anxiety, though this effect is contingent on differential verbal or visuospatial working memory mechanisms.

I2 Objectives and Research question(s)

This study will investigate the interplay between working memory capacity and trait-and-state anxiety on the induction of false memory. Specifically, this will address whether differential mechanisms of working memory, such as verbal or visuospatial distraction, contribute to false recognition when there is excessive interference from anxiety and storage load. Interference in working memory has the propensity to alter the quality of decision making and reasoning abilities as mental representations become distorted. Understanding the interaction between individual differences in emotional processing and working memory load may explain how false memories are facilitated.

Anxious individuals demonstrate reduced attentional control in cognitive tasks (even where threat-related stimuli are not present) and experience greater distractibility in everyday life. It is anticipated that higher levels of trait anxiety will be associated with greater incidence of false recognition, irrespective of the valence of semantically-related probes, although error rates will be most pronounced for negative-valence probes. Higher rates of false recognition in anxious individuals (irrespective of valence) can be explained by reduced attentional control and thus, greater interference from processing. False recognition rates are expected to be higher in the verbal distraction as opposed to the visuospatial distraction task, on account of greater interference with the to-be-remembered items; interference which is likely to be greater amongst anxious individuals.

I3 Hypothesis (H1, H2, …)
H1 - the extent of false recognition of a semantically-related probe will depend on the number of to-be-remembered items in the presentation list, the nature of distraction, and the nature of the probe. Specifically we predict greater rates of false memories with longer list lengths (H1a), with verbal rather than visual distraction (H1b), and for negative-valenced as opposed to neutral probes (H1c).

H2 - Trait anxiety will be related to the extent of false memories across both the neutral and negatively-valenced words, but this will be particularly pronounced for negatively-valenced lists (H2a) and on trials involving verbal processing (H2b).

I4 Exploratory research questions (if applicable; E1, E2, ...)
E1 - we will explore the extent to which the predictions outlined in H1 are moderated by individual's working memory capacity. Specifically, we expect individuals to be resitant to false memories when list lengths presented with visual (but not verbal) distraction are within their capacity.

E2 - We will test the possibility that higher perceived cognitive load is associated with reduced rates of false recognition in anxious individuals. Higher perceived task demands may induce more cognitive effort and focussed attentional control, and greater resistance to distraction, in anxious individuals. However, it is anticipated that this will only be observed when higher list lengths are within an individual's capacity.

E3 - We will supplement standard measures of recognition with simultaneously collected confidence ratings. This will allow us to test our hypotheses with a range of more novel statistical methods.

Method

M1 Time point of registration
Registration prior to creation of data

M2 Proposal: Use of pre-existing data (re-analysis or secondary data analysis)
No

Sampling Procedure and Data Collection.

M3 Sample size, power and precision
This project aims to obtain a sample size of at least N=50. This would give us 80% power to detect a between group effect size (d) of 0.81. Given the need to test for interactions of an as yet unknown size we will aim to recruit more participants if possible, and will not analyse our data in any way prior to stopping data collection.

M4 Participant recruitment, selection, and compensation
Participants will primarily be recruited through the lead researcher's school's 'experimental hours scheme' for undergraduate participants. If it is not possible to recruit the full sample in this way then Prolific will be used to recruit further participants, who will be payed at the standard Prolific rate for an hour's participation.
Participants will all be aged between 18 and 30. Other demographic factors will not be considered a barrier to inclusion or be balanced across the sample.

M5 How will participant drop-out be handled?
The experiment will take place in a single online session. Therefore we anticipate no drop-outs between sessions. If a participant fails to complete any of the experimental tasks their data will be excluded from all analyses. We will seek to replace such an individual with an additional participant.

M6 Masking of participants and researchers
No masking will take place.

M7 Data cleaning and screening
Reaction times from the processing phase of the Brown-Peterson recognition task will be trimmed using the Median Absolute Deviation (MAD) method described by Leys, Ley, Klein, Bernard & Licata (2013), using a criterion of +/- 3 MAD. This trimming will take place at the level of the task (i.e., the median and MAD will be calculated across all trials of the task for each participant separately). Any identified outliers within an individuals' RTs will be removed.

M8 How will missing data be handled?
Missing data are only anticipated on the STICSA questionnaire. In such cases we will impute the mean value for that individual across all remaining responses. However, this will only be done for individuals with 1 or 2 missing responses. Any individual who has more than 2 missing responses will be excluded from all data analyses.

M9 Other information (optional)

Conditions and design.

M10 Type of study and study design
This is an experimental study with the addition of a questionnaire.

The main experimental 'Brown-Peterson' task has a 4-factor design, with:
a between-participant factor of processing type (distraction: Study 1a vs. Study 1b)
three within-participant factors of list length (2 levels), emotional valence (2 levels), and probe type (3 levels).

Cognitive and somatic state and trait anxiety scores, and working memory capacity, are potential covariates.

M11 Randomization of participants and/or experimental materials
Study 1a and Study 1b will not be conducted in parallel. Consequently, participants will be recruited to Study 1a first (up to n=25) followed by recruitment to Study 1b (up to n=25). Any further participants will be added to each group on an alternating basis.
Within each study participants will proceed through the components of the study in the same set order.
Trials within the Brown-Peterson task are pseudo-randomised where the first 5 trials are fixed to ensure no participants receive an 'unusual' randomisation at the outset, and the remaining 91 trials randomised.

M12 Measured variables, manipulated variables, covariates
The main dependent variable is accuracy on the Brown-Peterson recognition task which will be defined primarily in terms of d'. d' values will be calculated separately for non-related distractors [z(hits) - z(false alarms for non-related probes)] and for semantically-related distractors [z(hits) - z(false alarms for related probes)].
Because the most relevant previous work in this area has used an alternative dependent variable for accuracy, we may also replicate analyses using this 'discriminability index' (see Abadie & Camos, 2019). This is the difference in false recognition rates for semantically-related and semantically-unrelated distractor items.

Reaction times and accuracy for responses to the processing decisions within the distraction phase of the Brown-Peterson recognition task will be recorded. Both will form dependent variables for any supplementary analysis of these processing data and to compare the performance of the two Study groups. Any such analysis of processing reaction times will employ only those associated with correct processing responses.

Performance on the word span task will be scored primarily in terms of partial credit scores (Conway et al., 2005). This variable will be used to compare the performance of the two Study groups. However, in any analysis that seeks to match an individual's memory span to their performance on the Brown-Peterson recognition task we will code memory span in terms of the highest list length on the word span task on which the participant successfully recalled all items (in order) on at least one trial.

H1 will be tested using the d' measures of accuracy described above.
H2 will be tested by relating scores on the STICSA questionnaire to d' scores.
E1 will be examined by relating performance on the word span task to d' scores.
E2 will be examined by comparing the effect of list length (within the Brown-Peterson recognition task) on d' values across subsets of individuals with high and low anxiety scores and high and low memory spans.
E3 will be examined by plotting ROC curves for d' values, and via a calibration analysis that makes use of the confidence data. This will plot accuracy as a function of confidence for both hit rate relative to unrelated probes [hits/(hits+false alarms for non-related probes)] and hit rate relative to semantically-related probes [hits/(hits+false alarms for related probes)].

M13 Study Materials

The State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA; Ree, MacLeod, French and Locke, 2000) is the questionnaire used in the study.

The to-be-remembered items in the Brown-Peterson recognition task have been selected from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999) and the WKB Norms (Warriner, Kuperman, Brysbaert, 2013). The three types of probes employed in the Brown-Peterson recognition task were selected by their mean backward associative strength 'BAS' drawn from Nelson, McEvoy, & Schreiber (2004) norms of word associations.
The processing stimuli employed in the distraction phase of the Brown-Peterson recognition task were selected by pairing letters for matching or not matching symmetry and rhyme (256 total).

The memoranda in the word span task are 168 words selected for syllable length (2), valence (neutral) and arousal (neutral) from the WKB Norms (Warriner et al., 2013).

M14 Study Procedures

Participants begin the study by completing an online version of the STICSA questionnaire.

They then complete a word span task in which lists of to-be-remembered words are visually presented at a rate of 1 item every 2 seconds before being asked to recall these items in correct serial order.
There are 4 trials at each list length, beginning at list length 3 (maximum list length 9). If a participant is able to correctly recall all items in correct order on at least one trial they then progress to 4 trials at the next (one higher) list length. Otherwise the task ends at that point.

The final experimental task is the Brown-Peterson recognition task, which implements a Deese-Roediger-McDermott design. Specifically, a set of semantically related to-be-remembered words are visually presented at a rate of 1 item every 2 seconds. This is followed by a distraction period in which the participant is required to complete 6 processing judgements. Each judgement is a yes/no decision via key press on a visually presented letter pair. In Study 1a (verbal processing) participants judge whether the two letters rhyme. In Study 1b (visual processing) they judge whether the two letter share an axis of symmetry.

Across trials within each study the list length of the set of to-be-remembered items varies, with an equal number of trials containing 4 items and trials containing 7 items. In addition, there is an orthogonal manipulation of the emotional valence of the list with half of lists being semantically related to a negatively-valenced false memory probe, and the other half being semantically related to a neutrally-valenced false memory probe.

Recognition is then probed with either a target word (word included on the original list), a related distractor (false memory that was not on the original list), or an unrelated distractor (unassociated word not on the list). Confidence of recognition is simultaneously measured as an indication of the strength of the false memory. This is done by presenting the participant with a response screen that simultaneously allows them to decide whether an item is old or new while also selecting their confidence in that decision.

At the end of this task participants are questioned about their awareness that lists were semantically related to each other, and whether they recognised the task as a DRM paradigm.

M15 Other information (optional)

Analysis plan

AP1 Criteria for post-data collection exclusion of participants, if any
Any participant who is not significantly above chance ($p < .05$) for their average performance on the processing judgements across the whole of the Brown-Peterson recognition task will be excluded from data analysis.

In addition, an attention check question will be built into each section of the STICSA questionnaire, and any participant who fails to complete all of these questions correctly will have all of their data excluded from the study.

As noted above (M8), any participant who omits answers to more than two of the STICSA questions will have all of their data excluded from the study.

AP2 Criteria for post-data collection exclusions on trial level (if applicable).

AP3 Data preprocessing

AP4 Reliability analysis (if applicable).

AP5 Descriptive statistics
See M12

AP6 Statistical models (provide for each hypothesis if varies).
A Bayesian ANOVA will be used to test H1. This will have the factors of processing type (verbal vs. visual : Study 1a/Study 1b), list length (4 vs 7) and emotional valence (negative vs neutral). We will test the need to include each of the main effects and their interaction in the best fitting model.

H2 will be tested using correlations between STICSA trait scores and performance in the Brown-Peterson recognition task, specifically examining correlations with negatively-valenced vs. neutral semantically related probes (H2a) and with performance among individuals experiencing verbal vs. visual distraction (H2b).

E1 will be explored initially explored by dividing the sample into two groups of participants: those with a word span of 4 and above but below 7 and those with a word span of above 7 (excluding any participants with a word span of below 4). The extent to which the key patterns of performance revealed in the above analyses differ in the two subgroups will then be examined.

E2 will be tested be examining patterns of performance in four subgroups of participants. The two subgroups identified for the analysis of E1 will each be further divided into high anxiety and low anxiety subgroups on the basis of a median split on STICSA trait scores. The effect of list length, and the other experimental factors, on these subgroups' performance on the Brown-Peterson recognition task will then be compared.

E3 will be explored using an analysis of ROC curves for d' values by plotting accuracy (proportion of hits from the total of hits+each type of false alarm) as a function of confidence ratings.

AP7 Inference criteria

Bayes factors of 3 and above will be taken as positive evidence for an effect or difference in models (Raftery, 1995); Bayes factors of 1/3 or less will be taken as positive evidence for a null effect. Where frequentist statistics are used an alpha level of .05 will be employed.

AP8 Exploratory analysis (optional)

See above. E2 and E3 will be examined using exploratory analyses.

AP9 Other information (optional)

Other information, optional

O1 Other information (optional)

References

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