T1 Title: A Novel Approach to Investigating the Effect of Anxiety on Working Memory Recall using an Adapted Brown-Peterson Task

T2 Contributors, Affiliations, and Persistent IDs (recommend ORCID iD)

Chris Jarrold

University of Bristol

ORCID iD: https://orcid.org/0000-0001-8662-0937

Study lead.

Meg Attwood

University of Bristol

ORCID iD: https://orcid.org/0000-0003-2576-1861

Co-investigator. Contributor to study design and advisor on analysis.

Rose Hammal

University of Bristol

ORCID iD: https://orcid.org/0000-0002-8003-5881

Lead on study design, data collection, and analysis.

T3 Date of Preregistration

07/04/2021 12:46:19

T4 Versioning information

1

T5 Identifier

Rose_1

T6 Estimated duration of project

6 months

T7 IRB Status

Ethical approval has been secured from the University of Bristol's School of Psychological Science Human Research Ethics Committee (ethics approval code: 181220115227).

T8 Conflict of Interest Statement
None

T9 Keywords
Working Memory; Anxiety; Distraction; Intrusions

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
We don't plan to use a predefined standard lab practice

Abstract

A1 Background

Working memory may provide a means of holding information in mind that reduces susceptibility to distraction. In contrast anxiety might make individuals' more prone to 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, and the nature of distractors that might intrude into memory.

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 words is followed by a period of distraction, and then a recall test. The amount of information to be remembered will be varied across trials. Distractors will vary in whether they are negatively valenced or not, and attended to or not. Participants' short-term memory capacity and state and trait levels of anxiety will also be measured.

Introduction

I1 Theoretical background

Research has demonstrated that anxiety can decrease working memory recall, but what is less clear is whether this reflects the effects of anxiety at encoding, on reduced storage capacity, or on the extent to which individuals are subject to distraction. It is important to understand the nature of the underlying relationships between working memory and anxiety so that therapies can be developed that effectively target the negative effects of anxiety.

I2 Objectives and Research question(s)

This project examines the extent to which intrusions into a to-be-remembered memory list are affected by general levels of anxiety and by the nature of the distracting information. It also explores the extent to which working memory protects against such intrusions by looking at whether the extent of any intrusions depends on the working memory load of a given trial, relative to the participant's working memory capacity.

I3 Hypothesis (H1, H2, …)

H1 - the extent of intrusions from the processing (distraction) phase of the main task will depend on the number of to-be-remembered items in the presentation list, and the characteristics of the distractor items. Specifically we predict greater intrusions with longer list lengths (H1a), for attended than unattended distractors (H1b), and for negative-valenced as opposed to neutral distractors (H1c). We make no a-priori prediction about whether level of attention to a distractor will interact with its valence in determining its likelihood of intruding.

H2 - Trait anxiety will be related to the extent of distractor intrusions across both the neutral and negatively-valenced distractors, but this will be particularly pronounced for negatively-valenced items (H2a) and for distractors that are not attended to during the processing phase (H2b). Note, H2b does not predict higher absolute levels of intrusions for unattended distractors (see H1), but rather that - to the extent that such intrusions do occur - they will be more common among individuals with high trait anxiety.

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 resistant

to distractor intrusions when the list lengths of presented memory items is within their capacity.

E2 - We will test the possibility that higher perceived cognitive load is associated with reduced rates of distractor intrusions 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 examine the extent to which the predictions for H2 and E2 are met when correlational analyses are conducted with different questionnaire measures of anxiety.

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 0.4. 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 be recruited through the lead researcher's school's 'experimental hours scheme' for undergraduate participants and via Prolific. Participants recruited via Prolific will be paid at the standard rate for an hour's participation.
Participants will all be aged between 18 and 30, and will be required to be 'fluent' English speakers. 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 individual (i.e., the median and MAD will be calculated across all trials 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 questionnaires. 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 per questionnaire. Any individual who has more than 2 missing responses on any questionnaire 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 three questionnaires.

The main experimental 'Brown-Peterson' task has a 3-factor design, with three within-participant factors of list length (3 levels), emotional valence of distractors (2 levels), and whether distractors are attended to or not (2 levels).

Cognitive and somatic state and trait anxiety scores, levels of rumination, and levels of worry and working are potential covariates. Working memory capacity is a further potential covariate.

M11 Randomization of participants and/or experimental materials

Participants will proceed through the components of the study in the same set order. Trials within the Brown-Peterson task are presented in a fixed, but pseudorandom order.

M12 Measured variables, manipulated variables, covariates
The main dependent variable of interest is the frequency of distractor intrusions.

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. Any such analysis of processing reaction times will employ only those associated with correct processing responses.

Recall performance on the Brown-Peterson task will also be measured, and will be scored in terms of partial credit scores (Conway et al., 2005) at each different list length.

Performance on the word span task will also be coded in terms of (overall) partial credit score. However, in any analysis that seeks to match an individual's memory span to their performance on the Brown-Peterson task we will code word 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 using the frequency of intrusions.
H2 will be tested by relating scores on the various questionnaires to the frequency of intrusions. A secondary analysis will examine the effects of the various measures of anxiety on errors and RTs for judgements to the different types of distractors in the processing phase of the Brown-Peterson task.
E1 will be examined by relating performance on the word span task to the frequency of intrusions.
E2 will be examined by comparing the effect of list length within the Brown-Peterson task on the frequency of intrusions made by subsets of individuals with high and low anxiety scores and high and low memory spans.
E3 will be examined using the derived component scores from the different questionnaire measures.

M13 Study Materials

The three questionnaires used in this study are i) the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA; Ree, MacLeod, French and Locke, 2000), ii) the Ruminative Response Scale (Treynor, Gonzalez, and Nolen-Hoeksema, 2003), and iii) the Penn-State Worry Questionnaire (Meyer, Miller, Metzger & Borkovec, 1990)

The words employed as storage items in the Brown-Peterson task were selected from a combination of the MRC psycholinguistics database: https://websites.psychology.uwa.edu.au/school/MRCDatabase/uwa_mrc.htm and the Subtlex-UK database (Van Heuven et al., 2014) to ensure a comparable number of adjectives and nouns in the whole stimulus set across a range of syllable lengths between 1 and 4.

Items for the processing judgements in the distraction phase of the Brown-Peterson task were words selected for valence ratings taken from the Affective Norms for English Words (ANEW) database (Bradley & Lang,1999) and the Norms of Valence, Arousal and Dominance English Lemmas database (Warriner, Kuperman & Brysbaert, 2013). 'Negative' words had a valence of 3 or below while 'neutral' words had valence values of between 4 and 6. Consideration was also given to the number of words selected with the same first letter. The arousal value of each word was also extracted from the databases.

The memoranda in the word span task were selected for syllable length (2), valence (neutral) and arousal (neutral) from the Norms of Valence, Arousal and Dominance English Lemmas database (Warriner et al., 2013).

M14 Study Procedures
Participants begin the study by completing online versions of the Rumminative Response Scale, the Penn-State Worry Questionnaire, and the STICSA Trait 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. Recall involves re-presentation of all of the words in the just-presented list, with the participant selecting each in it's appropriate 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.

They then complete the STICSA State questionnaire.

The final experimental task is the Brown-Peterson task. On any trial a list of to-be-remembered words is visually presented at a rate of 1 word every 2 seconds. This is followed by a distraction period in which the participant is required to complete 4 processing judgements. Each judgement involves the presentation of a side-by-side (left and right) pair of words. One of the two words is surrounded by an outline to indicate that the judgement must be made on that (attended) word and not on the other (unattended) word. The participant must decide whether the attended word is a noun or an adjective and respond by making the appropriate key-press.
Across the 36 trials of the task the list length of the set of to-be-remembered items varies, with 12 trials containing either 5, 6, or 7 items. The 4 processing pairs presented in the distraction phase of any trial always consist of two pairs that contain one emotional and one neutral word. The emotional word is the attended target in one of these pairs and the neutral word is the attended target in the other pair. The position (left or right) and serial position (1st, 2nd, 3rd, 4th) of these pairs is counterbalanced across the trials of a given list length. The remaining two pairs contain two neutral words. Across trials of a given list length there are an equal number of attended words that are adjectives and nouns. Recall is then required and involves re-presentation of all of the words that were used as either storage items on the to-be-remembered list (5, 6, or 7 depending on list length) plus all the words presented in the distraction phase whether attended to or not (8). The participant selects the to-be-remembered items in their correct order from this pool.

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 task will be excluded from data analysis.

In addition, an attention check question will be built into each questionnaire (with one such question in the STICSA state measure and one in the STICSA trait measure), 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 questions on any questionnaire 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 list length (5,6, or 7), emotional valence of distractors (negative vs neutral), and whether a distractor was attended or not. 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 questionnaire measures and performance in the Brown-Peterson task, specifically examining correlations with frequency of intrusion of negatively-valenced vs. neutral distractors (H2a) and with distractors that are or aren't attended (H2b).

E1 will be explored initially explored by dividing the sample into two groups of participants: those with a word span of below 6 those with a word span above 6. 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 (in the first instance; divisions on the basis of the other two questionnaires may also be explored). The effect of each experimental factor within the Brown-Peterson task on these subgroups' pattern of intrusions will then be examined.

E3 will be explored by comparing the correlations obtained in our analysis of H2 seen across the different outcome measures of each questionnaire.

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 will be examined using exploratory analyses.

We may also use a multiple regression or multi-level modelling approach to determine the factors that make individual distractor items more or less likely to be intruded.

AP9 Other information (optional)

Other information, optional

O1 Other information (optional)
This project is a undergraduate student project conducted as part of Ms Rose Hammal's undergraduate degree.

References

Conway, A. R. A., Kane, M. J., Bunting, M. F., Hambrick, D. Z., Wilhelm, O., & Engle, R. W. (2005). Working memory span tasks: A methodological review and user's guide. Psychonomic Bulletin and Review, 12, 769-786. doi:10.3758/BF03196772

Leys, C., Ley, C., Klein, O., Bernard, P., & Licata, L. (2013). Detecting outliers: Do not use standard deviation around the mean, use absolute deviation around the median. Journal of Experimental Social Psychology, 49, 764-766. doi:10.1016/j.jesp.2013.03.013

Meyer, T. J., Miller, M. L., Metzger, R. L., Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. Behaviour Reseach and Therapy, 28, 487-495. doi:10.1016/0005-7967(90)90135-6

Raftery, A. E. (1995). Bayesian model selection in social research. In P. V. Marsden (Ed.), Sociological methodology 1995 (pp. 111–196). Cambridge, MA: Blackwell.

Ree, M. J., MacLeod, C., French, D., & Locke, V. (2000). The State–Trait Inventory for Cognitive and Somatic Anxiety: Development and validation. Poster session presented at the annual meeting of the Association for the Advancement of Behavior Therapy, New Orleans, LA.

Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination reconsidered: A psychometric analysis. Cognitive Therapy and Research 27, 247–259. doi:10.1023/A:1023910315561

Van Heuven, W.J.B., Mandera, P., Keuleers, E., & Brysbaert, M. (2014). Subtlex-UK: A new and improved word frequency database for British English. Quarterly Journal of Experimental Psychology, 67, 1176-1190. doi:10.1080/17470218.2013.850521

License