



MAJOR RESEARCH PROJECT:

The causal role of attentional control within depressive rumination

LITERATURE REVIEW: Do deficits or biases in attentional control contribute causally to depressive rumination? A systematic review

EMPIRICAL PAPER: Using Working Memory Training to Reduce Depressive Rumination: A Multiple Baseline Single Case Experimental Design

Submitted by **Rebecca Pepper**, to the University of Exeter
as a thesis for the degree of **Doctor of Clinical Psychology**, April 2017

This thesis is available for Library use on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature:

Author's Declaration

The literature review was completed independently by the author, with the exception of where papers were also independently checked by a second researcher for reliability purposes. All elements of the empirical paper were completed independently by the author.

Contents

List of Tables	iv
List of Figures	v
LITERATURE REVIEW	1
Abstract.....	2
Introduction	4
Rumination and AC: Theoretical Accounts	4
Rumination and AC: Correlational Evidence.....	6
Rumination and AC: Experimental Evidence	7
Method	8
Eligibility Criteria	8
Information Sources	10
Search Terms	10
Study Selection	12
Data Extraction and Items.....	12
Risk of Bias	13
Results	13
Discussion.....	39
Critical Appraisal of Studies	39
Critical Appraisal of Review.....	43
Current Implications and Future Research.....	44
Conclusion	46
References.....	47
Appendices.....	55
Appendix A: Journal Guidelines – Journal of Experimental Psychopathology	55
Appendix B: Quality Assessment Tool for Quantitative Studies – Items and Dictionary	59
EMPIRICAL PAPER	69
Acknowledgements.....	70
Abstract.....	71
Introduction	72
Cognitive Processing and Rumination: The Role of Attentional Control	72
Attentional Control and Rumination: Empirical Evidence.....	73
Rationale for Current Study	76

Method	79
Design	79
Participants	80
Measures	82
Procedure	88
Analysis	89
Results	93
Training Compliance	93
Training Effects	94
Transfer Effects	94
Daily Ratings	97
Discussion	105
Conclusion	110
References	111
Appendices	121
Appendix A – Author Guidelines – Journal of Experimental Psychopathology	121
Appendix B – mST Trials	125
Appendix C – Ethical Approval	126
Appendix D – Graphical Data for P9	127
Appendix E – Participant Data	128
Appendix F – Questionnaires	131
Appendix G – Dissemination Statement	136

List of Tables

Literature Review

- Table 1. Search Terms Entered in Databases. p11
- Table 2. Studies included in the review, including study characteristics, relevant main findings, critical evaluation, and QATQS rating. p15
- Table 3. Experimental paradigms used to assess each sub-type of attentional control. p36

Empirical Paper

- Table 1. Example Affective Shift Task trial types. p85
- Table 2. Negative Intrusion Scores Demonstrating the Impact of Daily Training p95
- Table 3. Scores within the Affective Shift Task p96
- Table 4. PHQ-9 Scores, Score Improvements and Reliable Change Indices p98

List of Figures

Literature Review

- Figure 1. Search strategy and process of identification, screening, eligibility and inclusion for review. p14

Empirical Paper

- Figure 1. Example Affective Shift Task trial p84
- Figure 2. Example modified Sternberg Task trial. p87
- Figure 3. Sequence of A and B phases completed for each participant. p93
- Figure 4. Multiple baseline design across eight participants for daily IRBS scores. p99
- Figure 5. Multiple baseline design across eight participants for daily PANAS positive affect scores. p100
- Figure 6. Multiple baseline design across eight participants for daily PANAS negative affect scores. p101
- Figure 7. Multiple baseline design across eight participants for daily PANAS sadness scores. p102



SCHOOL OF PSYCHOLOGY
DOCTORATE IN CLINICAL PSYCHOLOGY

LITERATURE REVIEW

Do deficits or biases in attentional control contribute causally to depressive rumination? A systematic review

Trainee Name: **Rebecca Pepper**

Primary Research Supervisor: **Professor EDWARD WATKINS**
Professor of Experimental and Applied Clinical Psychology

Secondary Research Supervisor: **Dr Jennifer Limond**
Senior Lecturer

Target Journal: **Journal of Experimental Psychopathology** (see Appendix A for author guidelines)

Word Count: **3961 words** (excluding abstract, tables, figures, references, footnotes, appendices).

**Submitted in partial fulfilment of requirements for the Doctorate Degree in
Clinical Psychology, University of Exeter**

Abstract

Background: Rumination is a known determinant of the onset, prognosis, and recurrence of depression. Several cognitive models hypothesise that rumination is the result of deficits and/or biases in exerting appropriate attentional control (AC) over the contents of working memory. Recent research has used Cognitive Control Training (CCT) to experimentally manipulate AC and examine whether AC causally influences rumination.

Objectives: To systematically review the evidence that levels of AC contribute causally to depressive rumination, and determine whether this relationship depends on the use of negative material within CCT procedures.

Method: During January 2017, a systematic search of the CENTRAL, EMBASE, MEDLINE, PsychINFO, Scopus, and Web of Knowledge databases was conducted using terms describing depression, rumination and AC.

Results: Of the 2,490 titles and abstracts screened, 24 articles were read in full and 17 experimental studies considered eligible for inclusion.

Conclusions: Overall, the current review found only equivocal evidence that AC casually influences levels of rumination. There was also limited evidence that significant effects depended upon the use of negatively-valenced training material. Importantly, however, studies were more likely to report a significant causal effect when they demonstrated strong methodological rigour and exposed participants to a sufficiently intensive training schedule, highlighting some important recommendations for future research seeking to examine this relationship further. In addition, the review highlighted how, unless ongoing concerns regarding conceptual

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

clarity and methodological standardisation within CCT studies are addressed, it will remain difficult to draw confident conclusions regarding the role of AC in rumination.

Key words: Attentional Control, Cognitive Control Training, Depression, Rumination

Introduction

Depressive rumination is a repetitive style of self-thought, defined as “behaviours and thoughts that focus one’s attention on one’s depressive symptoms and on the implications of these symptoms” (Nolen-Hoeksema, 1991, p.569) and known to predict the onset, course, and recurrence of depressive episodes (Ciesla & Roberts, 2002; Nolen-Hoeksema, 2000; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Watkins, 2008). Rumination may, therefore, represent a viable treatment target for those seeking to reduce the incidence and impact of depression (De Raedt, Koster, & Joorman, 2010). Yet, questions remain as to why some people ruminate more than others and what drives these individual differences.

Rumination and AC: Theoretical Accounts

The perseverative nature of rumination suggests it may be related to deficits and/or biases in attentional control (AC), defined as “the ability to selectively attend to task-relevant information and to inhibit distraction by task-irrelevant material” (Koster, De Lissnyder, Derakshan, & De Raedt, 2011, p. 139).¹ Linville (1996) was among the first to suggest that deficits in AC might contribute to the emergence and maintenance of rumination. Within this global, deficit-based model, stress and/or low mood lead to lowered levels of inhibition (the cognitive mechanism responsible for gatekeeping access to conscious thought and a subtype of AC), allowing task-irrelevant thoughts to dominate cognitive resources and perpetuate rumination

¹ As a subset of cognitive abilities within the broader umbrella term of cognitive control, AC can be seen to overlap with other related yet distinct concepts, including executive control (Banich, 2009), attentional scope (Whitmer & Gotlib, 2013), and verbal processing mode (Watkins, 2008). For the sake of clarity, the current review focuses solely on abilities that fall within the definition provided by Koster and colleagues (2011) and abilities that fall outside this definition are considered beyond the current scope (for a recent review of these alternative accounts, please see Mor & Daches, 2015).

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

(Linville, 1996). Others have suggested that, rather than experiencing a global deficit in AC, people with a higher ruminative disposition instead experience valence-specific biases in how they use AC to influence the contents of their working memory (e.g., Joormann, Yoon, & Zetsche, 2007). Specifically, these authors predict that difficulties blocking and/or removing irrelevant negative content from working memory lead to a maladaptive focus on negative rather than neutral or positive sources of information, thus increasing the propensity to ruminate.

Koster et al. (2011) further developed these ideas to propose a more comprehensive, reciprocal account of the interplay between rumination and AC (the Impaired Disengagement Hypothesis [IDH]). Within this model, AC is conceptualised as a multi-faceted construct, involving attentional biases towards negative material, as well as the ability to shift between various mental sets (set-shifting), monitor/update the contents of working memory (WM), and inhibit the entry of irrelevant content to WM. Previous factor analyses have demonstrated that inhibition is, in itself, multi-faceted (Friedman & Miyake, 2004); whereas prepotent response inhibition describes the ability to “deliberately suppress dominant, automatic, or prepotent responses” (p. 104), resistance to distractor interference relates to the ability to “resist or resolve interference from the external environment that is irrelevant to the task at hand” (p. 104), and resistance to proactive interference describes the ability to “resist memory intrusions from information that was previously relevant to the task but has since become irrelevant” (p. 105). Within the IDH, deficits/biases in any of these related yet distinct abilities are hypothesised to result in the prolonged processing of negative self-thoughts (rumination), leading to impaired emotion regulation and sustained negative affect (Gotlib & Joormann, 2010). Crucially, persistent rumination results in the further depletion and/or biasing

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

of attentional resources (Watkins & Brown, 2002), resulting in a vicious cycle that perpetuates the experience of depressive symptomology (Koster et al., 2011) and hinders treatment progress (Baert, Koster, & De Raedt, 2011).

Rumination and AC: Correlational Evidence

To date, a number of correlational and prospective studies have sought to investigate the relationship between impaired AC and rumination within depression. During a recent systematic review, Roberts, Watkins and Wills (2015) concluded that convergent evidence across a number of experimental paradigms indicated that levels of rumination are related to individual differences in AC, but that issues with appropriately defining and indexing such abilities undermine the conclusions that can be drawn regarding the precise nature of this relationship. Another recent narrative review suggested there was stronger evidence for this relationship when tasks include negatively-valenced material, supporting bias- rather than deficit-based accounts of AC (Mor & Daches, 2015). In addition, during a recent meta-analysis, Yang, Cao, Shields, Teng and Liu (2016) found evidence of a significant inverse relationship between levels of rumination and indices of inhibition and set-shifting, but no significant relationship between rumination and measures of updating WM. Interestingly, task valence did not emerge as a significant moderator of these associations, challenging models that hypothesise a bias rather than general deficit in AC among ruminators (i.e., Joormann et al., 2007; Koster et al., 2011). Thus, the role of stimulus valence in the relationship between AC and rumination remains unclear, at present. Yet, such information is crucial to distinguishing between deficit- and bias-based accounts of the relationship between AC and rumination.

Whilst useful in demonstrating that rumination and AC are indeed related, the cross-sectional nature of correlational research prevents conclusions regarding the

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

direction of causality, as it cannot rule out the possibility of a reverse relationship (i.e., rumination causes deficits/biases in attentional control; e.g., Ellis & Ashbrook, 1988; Hertel, 1998) or the influence of other third-variables that might more parsimoniously account for the observed relationship (such as depressed mood itself; Hartlage, Alloy, Vazquez, & Dykman, 1993). Indeed, several experimental studies have demonstrated a reverse causal relationship between rumination and various aspects of AC, such that induced rumination led to reduced performance across a range of tasks related to AC (for a review, see Roberts et al. 2015). Whilst such findings are not entirely against the predictions of the IDH (which acknowledges a reciprocal relationship between depressed mood, rumination, and AC; Koster et al., 2011), they, nonetheless, demonstrate the importance of experimental research to better understand the direction of causality within these relationships.

Rumination and AC: Experimental Evidence

As such, researchers have begun to utilise experimental designs to examine whether deficits/biases in AC causally influence levels of rumination. Many of these studies have used forms of Cognitive Control Training (CCT), designed to strengthen deficient AC abilities through repeated task exposure (Koster et al., 2017). To date, the novelty of this approach has precluded a systematic review of the evidence regarding the causal role of AC deficits/biases in rumination. Roberts et al. (2015) attempted to conduct such a review, but no eligible studies were identified during their search (dated August 2013). Also, whilst there has been a recent narrative review of the early contributions to this literature (Mor & Daches, 2015), systematic reviews offer several additional advantages, including the use of specific, explicit methods of identifying, critically analysing, and synthesising data that are replicable, potentially more reliable, and can be updated as the literature continues to develop

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

(Cipriani & Geddes, 2003). Thus, the aim of the current review was to enhance current knowledge about the relationship between AC and rumination by systematically and critically reviewing existing experimental studies to answer the following questions:

- Do deficits and/or biases in AC contribute causally to depressive rumination?
- Does the ability to demonstrate a causal relationship depend on the use of negative material within CCT procedures?

Method

To aid standardisation, the current review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

Eligibility Criteria

Study factors. To investigate causality, eligible studies must have used an experimental design with AC as the independent variable and rumination as the dependent variable. Eligible studies must have been written/translated into English. To reduce the risk of publication bias, in addition to peer-reviewed journals, studies may also have appeared within published conference proceedings or online dissertation repositories, or remain currently unpublished (grey literature).

Participants. Given the emerging nature of this area of research, studies involving both adult (18-65 years) and child/adolescent (0-18 years) samples were considered for inclusion, as were studies using both clinical and non-clinical samples.

Intervention/Manipulation. Only studies that manipulated valid forms of AC were eligible for inclusion. Following Koster et al. (2011), the current review adopted

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

a broad conceptualisation of deficient AC, including negative attentional biases (AB), deficits or biases in each form of inhibition (resisting distraction [RD], resisting proactive interference [PI], prepotent response inhibition [PR]; Friedman & Miyake, 2004), set-shifting (SS), and monitoring/updating the contents of WM (MU). Based on this specific operationalisation and prior categorisations of existing experimental paradigms (Friedman & Miyake, 2004; Roberts et al., 2015), studies utilising any of the following cognitive training tasks were eligible for inclusion: Anti-Saccade (AB), Controlled Retrieval (PI), Directed Forgetting (PI), Dot-Probe (AB), Flanker (RD), Internal/Affective Shift (SS), *n*-back (MU), Negative Affective Priming (PI), PASAT (MU), spatial-cueing (AB), or Sternberg tasks (PI), along with any other unnamed tasks of AC that also met the current operationalisation. Eligible studies could either use these tasks as independent or adjunctive interventions. **Comparator.** Eligible experimental designs could compare reparative AC training with either placebo training (active control) or wait-list/treatment-as-usual (passive control).

Outcomes. Eligible studies must have administered a validated measure of depressive rumination before and after the AC intervention, and directly analysed the impact of this intervention on these pre-post ratings. Relevant, validated measures of trait rumination within the context of depression include the Ruminative Response Scale of the Response Styles Questionnaire (RRS; Nolen-Hoeksema & Morrow, 1991), the Rumination on Sadness Scale (RSS; Conway, Csank, Holm, & Blake, 2000), the Stress Reactive Rumination Scale (SRRS; Alloy et al., 2000), the Ruminative Thinking Questionnaire (RTQ-10; McEvoy, Mahoney, & Moulds, 2010), and the Perseverative Thought Questionnaire (Ehring et al., 2011). Relevant, validated measures of state rumination include the Momentary Ruminative Self-

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Focus Inventory (MRSI; Mor, Marchetti, & Koster, 2013) and frequency-based measures of rumination (i.e., thought diary/listing).

Information Sources

Following guidelines provided by the gold-standard for systematic reviews (Higgins & Green, 2011), the reference lists of recent review papers were used to identify relevant publications.² In addition, during January 2017, electronic searches were conducted using the CENTRAL, MEDLINE, and EMBASE bibliographic databases, supplemented by further searches within the subject-specific database PsycINFO and citation indexes Web of Science and Scopus. Conference abstracts and other grey literature were identified using the Conference Proceedings Citation Index. Databases were searched from their start point through to January 2017. Through an iterative process, the reference lists of all identified papers were also screened for further publications of relevance. Finally, additional author searches were conducted for each key author (defined as having authored >2 eligible papers within the initial screening; Koster, E.H.W., Mor, N., and Vanderhasselt, M.A.), who were also contacted directly to enquire about any additional or upcoming research.

Search Terms

Table 1 contains the search terms entered into each electronic information source. Search terms for AC were based upon descriptions provided within several seminal reviews (Koster et al., 2011; Mor & Daches, 2015; Roberts et al., 2015), as were search terms for rumination (Smith & Alloy, 2009; Watkins, 2008). Search

² Koster & Hoorelbeke, 2015; Mogoşe, David, & Koster, 2014; Mor & Daches, 2015

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Table 1

Search Terms Entered in Databases

Attentional Control	Rumination	Depression
<p>“Anti-saccade task”, “Controlled retrieval task”, “Directed forgetting task”, “Dot-probe task”, “Flanker task”, “Internal shift task”, “Affective shift task”, “<i>n</i>-back task”, “Negative affective priming task”, PASAT, “spatial-cueing task”, “Sternberg task”, Attention* ADJ2 bias, Attention* ADJ2 control, Cognitive ADJ2 bias, Cognitive ADJ2 control, Effortful ADJ control, Executive ADJ2 control, Executive ADJ2 function, Information ADJ2 processing, Interference, Prepotent, Selective ADJ2 attention, Sustained ADJ2 attention,</p> <p>Disengag*, Inhibit*, Switch*, Shift*, Updat*, Monitor*, Remov*, Replac* } AND “working memory”</p>	<p>Brood*, “Counterfactual th*”, “Defensive pessimism”, “Habitual negative self-th*”, Intrus*, “Mental simulation”, “Perseverative cognition”, Preoccup*, “Repeated cognitive representations”, “Repetitive th*”, Ruminat*, Self-focus</p>	<p>Depress*, “Affective disorder”, Dysthymi*</p>

Note: * = truncation used to identify multiple variations of key terms, ADJ2 = searches for key words adjacent within two words. Syntax modified according to database search guide.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

terms for depression were taken from the Cochrane Common Mental Disorders Group's Conditions List (The Cochrane Collaboration, 2016a). Within each search set, all terms were adapted to each database's use of Boolean operators and separated using the "OR" command. Each search set was then combined using the "AND" command to collate the final list of studies.

Study Selection

During initial screening, the title and abstracts of all identified studies were screened for reporting the outcomes of an experimental design regarding the influence of AC upon rumination. The remaining studies were then read in full and assessed against the aforementioned PICO eligibility criteria. To determine the reliability of study selection, 20% of studies ($n=7$) were assessed by an independent researcher³ and 86% agreement was obtained.⁴

Data Extraction and Items

To determine study eligibility and aid evaluation, the author used a data extraction template provided by the Cochrane Consumers and Communication Review Group (The Cochrane Collaboration, 2016b). Data items included information regarding participants (number, demographics, recruitment/attrition), the AC intervention used, and outcomes (change on primary/secondary measures, conclusions made).

³ Dr Kate Williams, Clinical Psychologist

⁴ The one study where an initial agreement was not reached by the first two reviewers was also reviewed by Prof Edward Watkins, who provided the deciding vote to include the study in question.

Risk of Bias

All eligible studies were evaluated for quality/risk of bias using the Quality Assessment Tool for Quantitative Studies (Thomas, Ciliska, Dobbins, & Micucci, 2004, see Appendix B). To determine the reliability of this evaluation, 20% of studies ($n=4$) were re-assessed by an independent researcher⁵ and 100% agreement was obtained.

Results

A total of 2,490 citations were identified across the databases searched. Following the removal of duplicates and screening of titles/abstracts, 24 full-text papers were read to determine their eligibility. Seven additional full-text papers were identified from reviewing the reference lists of included studies and seminal papers. Following full-text review, 16 papers were excluded based on violations of PICO criteria, resulting in 15 papers containing a total of 17 studies eligible for qualitative review (see Figure 1).⁶

⁵ Dr Kate Williams, Clinical Psychologist

⁶ Two papers contained two separate eligible empirical studies (Baert et al., 2010; Onraedt & Koster, 2014).

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

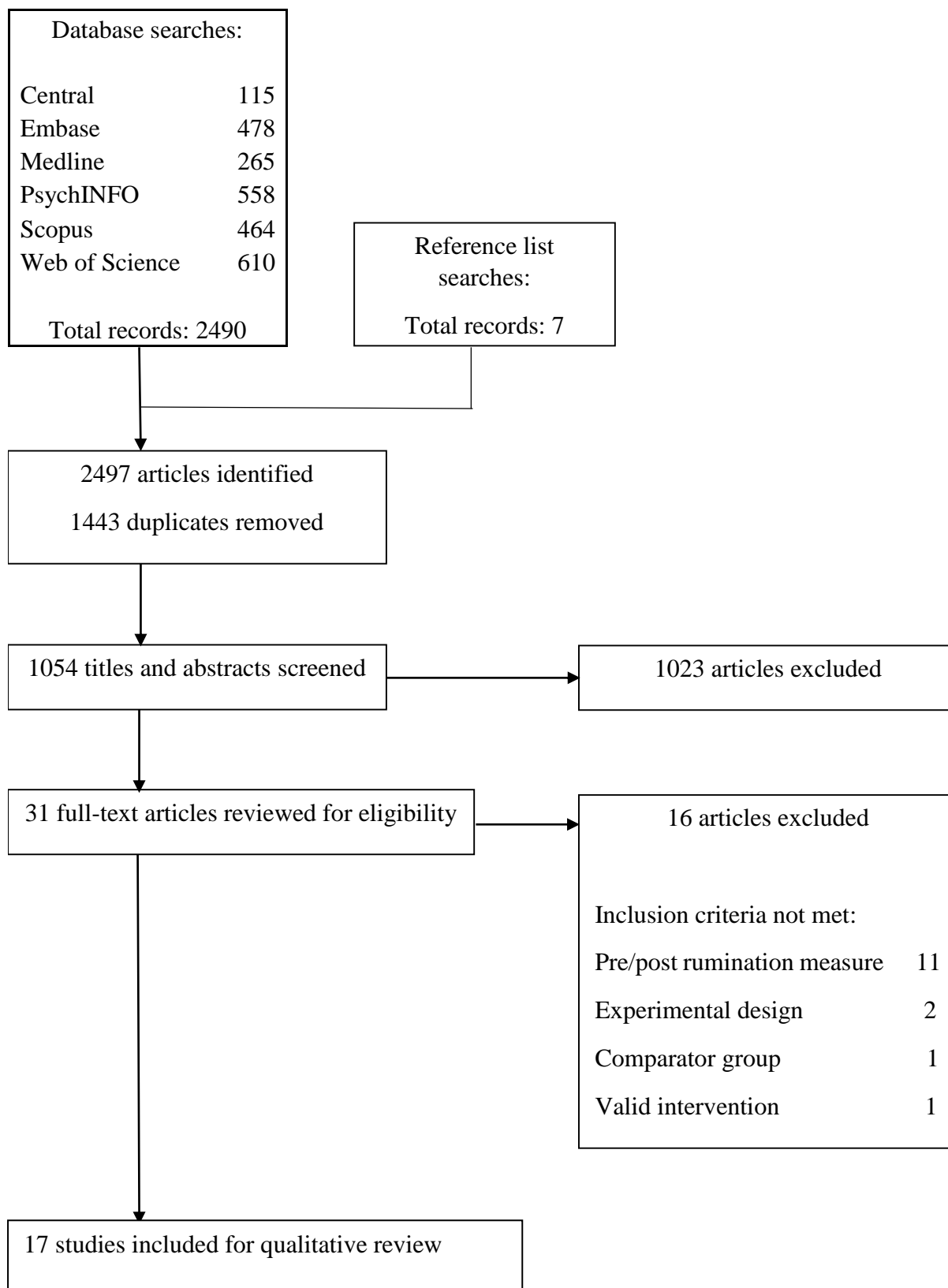


Figure 1. Search strategy and process of identification, screening, eligibility and inclusion for review.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating
			Task	Valence	Measure	Results	
						experimental condition did not change attentional bias or rumination scores in the predicted directions.	
	2	Patients with primary diagnosis of Major Depressive Disorder and scoring > 13 on HDRS ($n = 44$, 16 male; $M_{age} = 42.43$ [$SD = 10.85$])	Spatial cueing task - train attention away from negative stimuli ($n = 15$) <u>Training length/frequency:</u> Daily for 10 days (unknown task duration)	Negative	Active control: Spatial cueing placebo ($n = 20$)	RRS <u>Manipulation check:</u> No evidence of a training effect upon attentional bias scores. <u>Key findings:</u> No significant differences in pre-post RRS scores for either group. Effect sizes unavailable. <u>Conclusions:</u> Training within the experimental condition did not change attentional bias or rumination	<u>Strengths:</u> Training optimised for characteristics of attentional bias in depression. <u>Limitations:</u> Absence of attentional bias at baseline. Lack of training effect on attentional bias scores suggests task insensitivity/unreliability. Participants also exposed to therapy and/or medication alongside training. Drop-outs had significantly higher A-moderate B-strong C-strong D-moderate E-strong F-moderate Overall - strong

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating		
			Task	Valence	Measure	Results			
						scores in the predicted directions.	distress scores than completers. No follow-up to assess long-term effects of training. Low statistical power. Experimenter not blind to condition allocation		
de Voogd et al. (2016)	3	Unselected adolescents ($n = 340$, 144 male; $M_{age} = 14.41$ [$SD = 1.20$])	Dot-probe ($n = 128$) or Visual search ($n = 126$)	Negative	Active control: Dot-probe placebo ($n = 50$). Visual search placebo ($n = 41$).	PTQ	<p><u>Manipulation check:</u> Training on the visual search paradigm resulted in the expected decreases in attentional bias ($d = -2.25$), but training within the dot-probe paradigm did not ($d = 0.04$).</p> <p><u>Key findings:</u> Both groups demonstrated reductions in rumination over time, but no significant between group</p>	<p><u>Strengths:</u> Use of double-blind randomised design. Use of 12-month follow-up.</p> <p><u>Limitations:</u> Relatively low number of training sessions (8). Validity of both training paradigms under question. Only 24% participants completed all training sessions.</p>	<p>A-weak B-strong C-strong D-strong E-strong F-strong Overall – moderate</p>

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating
			Task	Valence	Measure	Results	
						<p>differences or timeXgroup interactions.</p> <p>Effect sizes unavailable.</p> <p><u>Conclusion:</u> No beneficial effects of either training over and above placebo conditions.</p>	<p>Use of unbalanced randomisation. Small control group.</p>
Yang, Ding, Dai, Peng & Zhang (2015)	4	Students scoring > 14 on BDI-II (n = 77, 22 male)	Dot-probe task - train away from negative material <u>Training length/frequency:</u> (n = 27)	Negative	Active control: Dot-probe placebo - neutral cueing location (n = 27). Passive control: Assessments only	RRS <u>Manipulation check:</u> Participants within the dot-probe training group showed a significant reduction in pre-post training attentional bias (d = 1.66), whereas those in the active (d = 0.22) and passive control groups did not (d = 0.14). <u>Key findings:</u> Significant timeXgroup	<p><u>Strengths:</u> Use of multiple follow-up points. Use of randomised double-blind design. Training optimised for depressive symptomology.</p> <p><u>Limitations:</u> None identified</p> <p>A-moderate B-strong C-strong D-strong E- strong F-strong Overall - strong</p>

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating
			Task	Valence	Measure	Results	
			12 mins 4x per week for 2 weeks		(<i>n</i> = 23).	interaction (<i>d</i> = 0.33), such that participants in the dot-probe training group demonstrated a significant reduction in pre-post rumination scores (<i>d</i> = 0.49) but participants in the active (<i>d</i> = -0.05) and passive control groups did not (<i>d</i> = 0.12). Mediation analyses revealed that change in rumination score was directly mediated by change in attentional bias score.	
						<p><u>Conclusions:</u> Attentional bias training may be helpful in the treatment and prevention of depression</p>	

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention		Comparator	Outcome		Evaluation	QATQS rating
			Task	Valence		Measure	Results		
Attentional Bias Modification & Monitoring/Updating WM Training									
Moshier & Otto (2017)	5	Patients with current primary diagnosis of Major Depressive Disorder (<i>n</i> = 34, 16 male; <i>M_{age}</i> = 35.60 [<i>SD</i> = 14.60])	Adjunctive CCT (PASAT plus ACI; <i>n</i> = 21) <u>Training length/frequency:</u> 25 mins once a week for 4 weeks	Neutral	Active control: Peripheral Vision Task (<i>n</i> = 13)	RRS total and brooding	<u>Manipulation check:</u> No information provided. <u>Key findings:</u> Significant reduction in rumination scores over time, but no significant time-X group interaction (RRS Total $n_p^2 = .05$; RRS Brooding $n_p^2 = .07$). <u>Conclusions:</u> Weekly CCT does not add to clinical benefit of existing four session BATD treatment.	<u>Strengths:</u> Use of double-blind randomised design. Use of one month follow-up. <u>Limitations:</u> No manipulation check reported. CCT administered only once per week (low dosage intervention). Adjunctive BATD treatment may have overshadowed any impact of CCT. Low power for rumination analyses. Unbalanced drop-out for CCT group. CCT represents combined intervention	A-moderate B-strong C-strong D-strong E-strong F-moderate Overall – strong

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating	
			Task	Valence	Measure	Results		
Siegle, Price, Jones, Ghinassi, Painter & Thase (2014)	6	Outpatients with current diagnosis of Major Depressive Disorder (<i>n</i> = 43, 13 male,)	Adjunctive CCT (PASAT plus ACI; <i>n</i> = 23) <u>Training length/frequency:</u> 35 mins 3x per week for 2 weeks	Neutral	Passive control: Treatment as usual (<i>n</i> = 20)	RRS total and brooding <u>Manipulation check:</u> Post-training participants in CCT group demonstrated significantly faster PASAT performance than control (<i>d</i> = 1.29). <u>Key findings:</u> For RRS total, there was a significant timeXgroup interaction ($\eta_p^2 = .27$), such that participants in the CCT group showed significant pre-post reduction in rumination scores (<i>d</i> = -1.42), but TAU participants did not (<i>d</i> = -0.04). This finding was then replicated for RRS Brooding ($\eta_p^2 = .19$), such that participants in the CCT group showed significant pre-post reduction in rumination scores (<i>d</i>	<u>Strengths:</u> Participants matched across a number of demographic variables. <u>Limitations:</u> Lack of active control group limits ability to rule out contribution of non-specific factors. Participant awareness of interest in changing rumination may have led to demand characteristics. Lack of randomisation at individual level. CCT represents combined intervention with less process specificity.	A-moderate B-strong C-strong D-moderate E-strong F-strong Overall - strong

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention		Comparator	Outcome		Evaluation	QATQS rating
			Task	Valence		Measure	Results		
							<p>= -0.98), but TAU participants did not ($d = -0.04$). Rumination change was positively predicted by performance on a non-adaptive version of the PASAT in the CCT group only ($R^2 = 0.36$).</p> <p><u>Conclusions:</u> CCT was associated with a greater pre-post reduction in rumination than TAU from pre- to post-intervention and these changes were related to gains in non-trained WM performance.</p>		
Monitoring/Updating WM Training									
De Putter, Vanderhasse It, Baeken, De Raedt &	7	Community sample	Dual n -back task + tDCS ($n = 22$)	Neutral	Active control:	MRSI	<p><u>Manipulation check:</u> All participants demonstrated improved pre-post n-</p>	<p><u>Strengths:</u> Naturalistic setting</p>	A-weak B-strong

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating
			Task	Valence	Measure	Results	
Koster (2015)		(<i>n</i> = 66, 13 male; <i>M</i> _{age} = 23.09 [<i>SD</i> = 5.03])	<u>Training length/frequency:</u> 20 min single session	Dual <i>n</i> -back task + sham tDCS (<i>n</i> = 22) Active control: Position or sound 1-back task (<i>n</i> = 22)	back scores, no evidence of an interaction by training group. <u>Key findings:</u> All participants demonstrated reduced pre-post state rumination scores but no significant group differences or timeXgroup interaction. Effect sizes unavailable. <u>Conclusions:</u> WM training with or without tDCS did not influence the incidence of self-reported ruminative thoughts	for the assessment of state rumination. <u>Limitations:</u> Single session training. Use of "healthy" sample may have introduced floor effects for rumination. Lack of sham tDCS + control training group.	C-weak D-moderate E-strong F-weak Overall – moderate

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating	
			Task	Valence	Measure	Results		
Hoorelbeke & Koster (2016)	8	Community participants with remitted depression (> 6 months; n = 68, 23 male)	PASAT (n = 34) <u>Training length/frequency:</u> 15 mins 5x per week for 2 weeks	Neutral	Active control: low cognitive load auditory task (n = 34)	RRS brooding <u>Manipulation check:</u> Both groups improved with practice (PASAT $\eta_p^2 = .90$; control $\eta_p^2 = .65$). <u>Key findings:</u> Significant timeXgroup interaction ($\eta_p^2 = .13$), such that only those in PASAT condition showed immediate reduction in pre-post training brooding scores (PASAT $d = 0.51$; control $d = 0.16$). Whilst both groups showed reductions in rumination from post-treatment to follow-up, PASAT group demonstrated significantly lower brooding scores than controls at both time points (post-training	<u>Strengths:</u> 3-month follow-up. Strong study design. <u>Limitations:</u> High resemblance between training and transfer task.	A-moderate B-strong C-strong D-strong E-strong F-strong Overall – strong

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating	
			Task	Valence	Measure	Results		
						<p>$d = 0.83$; follow-up $d = 0.87$).</p> <p><u>Conclusions:</u> Evidence of immediate and lasting benefits of PASAT training on brooding scores.</p>		
Hoorelbeke, Koster, Vanderhasse It, Callewaert & Demeyer (2015)	9	Students scoring > 42 on RRS ($n = 47$, 4 male)	<p>PASAT ($n = 20$)</p> <p><u>Training length/frequency:</u> 20 mins 5x per week for 2 weeks</p>	Neutral	<p>Active control: Visual search training ($n = 17$)</p> <p>RRS brooding (trait rumination) and frequency count (state rumination)</p>	<p><u>Manipulation check:</u> Both groups improved with practice (PASAT $n^2 = .98$; control $n^2 = .84$).</p> <p><u>Key findings:</u> There was a significant timeXgroup interaction for levels of state rumination following a stress induction procedure ($n^2 = .10$), such that participants in the PASAT group showed less of an increase in negative thoughts ($d = 0.42$)</p>	<p><u>Strengths:</u> 4-week follow-up demonstrates stability of findings. Use of naturalistic stressor increases ecological validity.</p> <p><u>Limitations:</u> Gender imbalance of concern as women more prone to brooding. Reduced follow-up sample size.</p>	<p>A-moderate</p> <p>B-strong</p> <p>C-strong</p> <p>D-moderate</p> <p>E-strong</p> <p>F -moderate</p> <p>Overall – strong</p>

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating
			Task	Valence	Measure	Results	
						<p>than control participants (d = 0.97). A significant timeXgroup interaction was also found for pre-post levels of trait rumination following exposure to a naturalistic stressor ($r^2 = .11$), such that, whilst levels of brooding remained stable within the control group (d = -0.22), the PASAT group showed reduced brooding pre-post exposure showed reduced brooding following exposure to a naturalistic stressor (d = -0.53). In the PASAT group, increased WM performance was a significant negative predictor of post-training brooding, even whilst controlling for</p>	

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention		Comparator	Outcome		Evaluation	QATQS rating
			Task	Valence		Measure	Results		
							showed a small non-significant increase in rumination scores ($d = 0.39$). The difference in change between groups was of medium effect size ($d = 0.64$).	for anxiety within sample.	
							<u>Conclusions:</u> EFMT may have some utility as a treatment for rumination.		
Onraedt & Koster (2014)	11	Students scoring > 46 on RRS ($n = 72$, 9 male)	Dual n -back task ($n = 21$) <u>Training length/frequency:</u> 20 mins daily, for six days	Neutral	Active control: Single 1-back task ($n = 25$) Passive control: No training ($n = 26$)	RRS total and brooding	<u>Manipulation check:</u> Dual n -back group demonstrated significant improvement in performance over the course of training ($d = 1.10$). <u>Key findings:</u> No significant timeXgroup interaction for RRS total score ($n^2 = .008$) or RRS brooding ($n^2 = .028$).	<u>Strengths:</u> Use of two-week follow-up. <u>Limitations:</u> Validity of dual n -back questioned. No evidence of transfer effects means improvement on training task could be simply due to practice. Small number of training sessions (6). Control task also	A-moderate B-strong C-weak D-moderate E-strong F-strong Overall – moderate

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating	
			Task	Valence	Measure	Results		
						<p><u>Conclusions:</u> No effect of training upon rumination scores.</p> <p>involved WM so may have masked any gains.</p>		
	12	Students with "high" RRS scores ($n = 45$)	<p>Dual n-back ($n = 21$)</p> <p><u>Training length/frequency:</u></p> <p>20 mins daily, for six days</p>	Neutral	<p>Active control: Single 1-back task ($n = 24$)</p>	<p>RRS total and brooding</p> <p><u>Manipulation check:</u> Dual n-back group demonstrated significant improvement in performance over the course of training ($d = 1.62$).</p> <p><u>Key findings:</u> No significant $\text{time} \times \text{group}$ interaction for RRS total score ($n^2 = .04$) or RRS brooding score ($n^2 = .009$).</p> <p><u>Conclusion:</u> No effect of training upon rumination scores</p>	<p><u>Strengths:</u> Use of two-week follow-up. Replicated findings of previous study.</p> <p><u>Limitations:</u> Validity of dual n-back questioned. No evidence of transfer effects means improvement on training task could be simply due to practice. Small number of training sessions (6). Control task also involved WM so may have masked any gains.</p>	<p>A-moderate</p> <p>B-strong</p> <p>C-weak</p> <p>D-moderate</p> <p>E-strong</p> <p>F-strong</p> <p>Overall – moderate</p>

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating		
			Task	Valence		Measure	Results		
de Voogd, Wiers, Zwitser & Salemink (2016)	13	Unselected adolescents ($n = 168$, 67 male; $M_{age} = 14.35$ [$SD = 1.16$])	EmoWM ($n = 129$) <u>Training length/frequency:</u> 15 mins 2x per week, for 4 weeks	Negative	Active control: EmoWM placebo - non-adaptive equivalent ($n = 39$)	PTQ	<p><u>Manipulation check:</u> performance on the training task significantly improved pre-post training. Effect size unavailable.</p> <p><u>Key findings:</u> Both groups demonstrated reductions in rumination over time, but no significant differences or timeXgroup interactions. Effect sizes unavailable.</p> <p><u>Conclusion:</u> No beneficial effects of training over and above placebo.</p>	<p><u>Strengths:</u> use of double-blind randomised design. Use of 12-month follow-up.</p> <p><u>Limitations:</u> Relatively low number of training sessions (8). Control training also required inhibition of distracting negative information. High drop-out rates over follow-up periods means reduced power. Use of unbalanced randomisation resulted in small control group.</p>	<p>A-weak</p> <p>B-strong</p> <p>C-strong</p> <p>D-strong</p> <p>E-strong</p> <p>F-strong</p> <p>Overall - moderate</p>

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating	
			Task	Valence	Measure	Results		
Wanmaker, Geraerts & Franken (2015)	14	Patients with current diagnosis of Major Depressive Disorder or Anxiety Disorder (n = 98, 50 male)	Dual n-back + adaptive Symmetry span task (n = 36) <u>Training length/frequency:</u> 25 mins 6x per week, for 4 weeks	Neutral	Active control: 0-back task + placebo Symmetry span task (n = 39)	RRS total and brooding <u>Manipulation check:</u> Participants in the WM training group demonstrated improved performance across both training tasks (Dual n-back $d = 1.73$; Symmetry span $d = 1.32$). <u>Key findings:</u> Whilst RRS total and brooding scores both declined over time, there was no evidence of a significant timeXgroup interaction (RRS total $\eta_p2 = .01$; RRS brooding $\eta_p2 < .01$). <u>Conclusions:</u> Stand-alone WM training may not benefit rumination.	<u>Strengths:</u> Use of double-blind randomised design. Use of adaptive training protocol. <u>Limitations:</u> Large proportion of participants received current or previous therapy. High drop-out rate. More males and active antidepressant users in control group. Combined two WM tasks.	A-moderate B-strong C-weak D-strong E-strong F-weak Overall - weak

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating	
			Task	Valence	Measure	Results		
Resisting Proactive Interference (Inhibition) Training								
Daches & Mor (2014)	15	Students scoring above median on RRS ($n = 94$, 32 male; $M_{age} = 23.20$ [$SD = 2.60$])	NAP – trained to inhibit negative stimuli ($n = 35$) <u>Training length/frequency:</u> 15 mins 2x per week, for 2 weeks	Negative	Active control: NAP - trained to attend to negative stimuli ($n = 26$) Active control: Sham training - valence judgement task ($n = 33$)	RRS brooding <u>Manipulation check:</u> Evidence of training effect in intended direction for each group ($n_p^2 = .086$). <u>Key findings:</u> Participants within the experimental group demonstrated a significant pre-post reduction in RRS brooding scores ($d = 0.39$). Yet there was no significant correlation between difference scores for inhibition bias and brooding among these participants ($r = -.04$). No significant pre-post reductions in brooding found for either control group ($d = -0.15$ and -0.28 , respectively).	<u>Strengths:</u> Use of active comparable control groups. <u>Limitations:</u> Significantly different between-group gender ratio. Low statistical power. Questionable validity of the NAP. Limited number of training sessions (4). Overall - strong	A-moderate B-strong C-strong D-moderate E-strong F-strong

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention		Comparator	Outcome	Evaluation	QATQS rating	
			Task	Valence		Measure	Results		
							<p><u>Conclusion:</u> Training produced a small yet significant reduction in levels of brooding, but correlational analyses did not indicate that increased inhibitory control was related to these reductions in depressive rumination.</p>		
Daches, Mor & Hertel (2015)	16	Students split into high versus low ruminators (<i>n</i> = 174, 52 male; <i>M</i> _{age} = 24.00 [<i>SD</i> = 2.74])	NAP - inhibit negative stimuli (<i>n</i> = 68) <u>Training length/frequency:</u> Single session (unknown task duration)	Negative	Active control: NAP - trained to attend to negative stimuli (<i>n</i> = 72)	MRSI	<p><u>Manipulation check:</u> Evidence of training effect among high (<i>d</i> = 0.72) but not low ruminators (<i>d</i> = 0.07).</p> <p><u>Key findings:</u> No significant effects of training upon pre-post state rumination scores. Effect sizes unavailable</p>	<p><u>Strengths:</u> Manipulation check embedded within training task itself.</p> <p><u>Limitations:</u> Single session of training. Significantly different between-group gender ratio. Extended training duration may have posed an excessive demand that undermined the</p>	<p>A-weak B-strong C-strong D-moderate E-strong F-strong Overall - moderate</p>

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating
			Task	Valence	Measure	Results	
						<p><u>Conclusion:</u> No evidence to support impact of single intensive training session on state rumination. Those vulnerable to depression should be exposed to repeated low-dosage training instead.</p> <p>intended effects of training. No exposure to stressor to test preventative impact of training upon rumination. Embedding manipulation check within training reduced number of trials used and therefore reliability of measure.</p>	
Schreiner, LeMoult & Gotlib (2015)	17	Patients with diagnosis of Major Depressive Disorder ($n = 16$, 0 male; $M_{age} = 32.37$ [$SD = 12.46$])	Affective Sternberg Task ($n = 8$) <u>Training length/frequency:</u> Daily for 1 week (unknown)	Negative	Active control: Lexical decision task ($n = 8$)	RSS <u>Manipulation check:</u> None reported. <u>Key findings:</u> At six-month follow-up, the AST group showed significantly lower rumination scores than the control group ($p < .05$).	<p><u>Strengths:</u> Use of six-month follow-up.</p> <p><u>Limitations:</u> Abstract only provided for review. No manipulation check reported.</p> <p>A-weak B-strong C-weak D-moderate E-strong F-strong Overall - weak (abstract only)</p>

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Publication	Study	Population	Intervention	Comparator	Outcome	Evaluation	QATQS rating
			Task	Valence	Measure	Results	
			task duration)			Effect sizes unavailable. <u>Conclusions:</u> Current training task has the potential to reduce symptoms of depression.	

Note: QATQS ratings: A = Selection Bias, B = Study Design, C = Confounders, D = Blinding, E = Data Collection Method, F = Withdrawals and Dropouts, BDI-II = Beck Depression Inventory – Second Edition, RRS = Ruminative Response Scale, HDRS = Hamilton Depression Rating Scale, PTQ = Perseverative Thought Questionnaire; WM = working memory, CCT = Cognitive Control Training, PASAT = Paced Auditory Serial Addition Test, ACI = Attention Control Intervention, BATD = Behavioural Activation Therapy for Depression, tDCS = transcranial Direct-Current Stimulation, MRSI = Momentary Ruminative Self-Focus Inventory, EFMT = Emotional Faces Memory Task, EmoWM = Emotional Working Memory Training, NAP = Negative Affective Priming task.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Overall, the results of these studies provide equivocal support for the hypothesis that deficits/biases in AC contribute causally to depressive rumination (see Table 2); whilst six experimental studies demonstrated a significant effect of manipulating AC on levels of rumination (#4,6,8,9,15,17), the remaining 11 studies found no such effect. The review found considerable variation in the sub-type of AC being manipulated and the specific training task used (see Table 3). In the interest of clarity, the evidence to support each AC sub-type will be reviewed separately, in turn.

Table 3

Experimental paradigms used to assess each sub-type of attentional control

Attentional Bias (AB)	Monitoring/Updating WM (MU)	Inhibition	Combined AB + MU
Spatial cueing task	Dual n-back	Negative Affective Priming task	Cognitive Control Training
Dot-probe task	Emotional faces memory task	Affective Sternberg task	
Visual search task	Paced Auditory Serial Addition Test Emotion Working Memory task		

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Attentional Bias Studies. Four studies examined the impact of attentional bias training upon rumination. Two of these (both conducted by Baert et al., 2010), used the spatial-cueing task as the training task, whilst de Voogd et al. (2016) and Yang et al. (2015) both used the dot-probe task. All four studies used negative training materials yet whilst Yang et al. (2015) found that training significantly reduced levels of rumination, the other studies found no significant effects. What seemed to differentiate the study by Yang et al. (2015) was their ability to demonstrate a significant reduction in levels of attentional pre-post training (indicating successful manipulation of AC), where others failed to do so. They also received consistently high ratings for study quality, whereas the others received some lower ratings. Despite such strengths, Yang et al. (2015) still demonstrated only a small effect size overall.

Monitoring/Updating WM Studies. Eight studies examined the effect of AC training targeting the ability to monitor/update the contents of WM upon rumination, most of which utilised variants of the dual n -back task as the training task (#7,10,11,12,14). The remaining studies used the Paced Auditory Serial Addition Test (PASAT; Hoorelbeke et al., 2015, 2016) and the Emotional Working Memory task (de Voogd et al., 2016). Only the studies by Iacoviello et al. (2014) and de Voogd et al. (2016) used negative training materials; the remaining six used neutral stimuli throughout training. Whilst each of these studies demonstrated significantly improved inhibition scores over the course of training (successful manipulation of AC), only those using the PASAT demonstrated that AC training designed to improve WM monitoring/updating significantly reduced levels of rumination (Hoorelbeke et al., 2015, 2016). Interestingly, neither Hoorelbeke study used negative training materials, though they do maintain that the frustration of the PASAT constitutes an

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

emotional training *context*. Instead, what differentiated these studies was their consistently high ratings for study quality (whilst other non-significant studies tended to receive lower quality ratings). Again, however, both studies by Hoorelbeke and colleagues yielded only small-moderate effect sizes.

Inhibition Studies. Three studies investigated the impact of inhibition-based AC training upon rumination, two of which used the Negative Affective Priming task (NAP) to improve inhibition (Daches & Mor, 2014; Daches et al., 2015), whilst the other used a modified Sternberg task (Schreiner et al., 2015). All three studies used negative training materials. Daches and Mor (2014) found a significant pre-post training improvement in NAP performance (successful manipulation of AC) and received a “strong” rating for study quality, but the reported effect sizes remained small. Daches et al. (2015) only found significant improvements in training performance among high but not low ruminators (based on pre-training levels of trait rumination), received only a “moderate” rating for study quality and it was not possible to calculate effect sizes from the data provided. The study by Schreiner et al. (2016) did not report any manipulation checks, was rated as “weak” for study design, and did not provide sufficient details to permit the calculation of effect sizes (currently in abstract form only).

Combined Training Studies. Finally, two studies (Moshier & Otto, 2017; Siegle et al., 2014) examined the effect of AC training that combined tasks of attentional bias (Attentional Control Intervention; ACI) and monitoring/updating WM (PASAT). Both used neutral training materials throughout. Whilst Siegle et al. (2014) found such training significantly reduced levels of rumination among participants, Mosher and Otto (2017) failed to replicate such effects. Although both studies received a “strong” rating for the quality of their design, Moshier and Otto

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

(2017) failed to report any manipulation checks and only provided a low-frequency/dosage training schedule that served as an adjunctive to an existing evidence-based treatment for depression (Behavioural Activation). In contrast, Siegle et al. (2014) demonstrated significant pre-post training improvements in the combined AC training task performance (successful manipulation of AC) and exposed participants to training three times per week. Notably, unlike any other study within the current review, using this combined training at a relatively high frequency/dosage Siegle et al. (2014) achieved large effect sizes, suggesting that stronger effects may be achieved by combining multiple aspects of AC within the same training.

Discussion

The Causal Role of AC in Rumination

Overall, the results of the current review indicate that the ability to demonstrate a significant effect of AC training upon rumination does not depend simply on the facet of AC being targeted; a mixture of significant and non-significant effects were found across each AC facet examined to date, including attentional bias, monitoring/updating WM, and inhibition (to date, no experimental studies have investigated the causal impact of set-shifting capabilities on rumination). Thus, to date, there remains only equivocal evidence that various forms of AC are causally related to rumination.

Yet, by using the QATQS Risk of Bias tool, the current review highlighted several areas of methodological weakness, suggesting that such results should be interpreted with caution. Interestingly, all but one of the studies reporting a

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

significant effect received an overall rating of strong⁷, whilst those reporting non-significant effects were more likely to receive a rating of moderate or weak ($n=8$). Common areas of methodological weakness included the use of convenience rather than randomised sampling, failure to control for potentially confounding variables (i.e., pre-existing differences between groups) and, less commonly, lack of adequate blinding and elevated levels of participant drop-out. Such issues could potentially call into question the internal and/or ecological validity of these studies and suggest that well-designed studies may provide stronger evidence for the causal role of AC in rumination. Yet, even among studies that received a strong methodological rating, with the exception of Siegle et al. (2014), effect sizes indicated only a small-moderate effect of AC training upon rumination, suggesting such interventions may have limited clinical utility.

The Impact of Stimulus Valence

The current review found that whilst three of the studies reporting a significant effect used negative training materials (#4,15,17), the other three used neutral materials (#6,8,9) and achieved comparable, if not larger effect sizes than those using negative stimuli. In explaining such results, however, Hoorelbeke et al. (2015, 2016) argue that the frustrating nature of AC training still constitutes an emotional *context*, thus negating the need to use overtly negative stimuli to achieve a significant effect. Also, whilst the remaining six studies that used negative training material reported null effects (#1,2,3,10,13,16), their findings should be interpreted with caution given they all received only “moderate” ratings for study quality. Collectively, such findings suggest that an emotional component (content or context)

⁷ The remaining study (Schreiner et al., 2015) received a weak rating but was judged based on the contents of a conference abstract alone, so may have received a higher rating were further details of the design available.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

may be an important element in demonstrating the causal impact of AC upon rumination, but further high-quality research studies are required to corroborate such claims.

Critical Appraisal of Studies

The impact of training dosage/intensity. Comparing studies that did and did not find a significant effect of manipulating AC on rumination, a pattern emerged based on whether or not the training schedule led to significant improvements in task performance and/or whether participants were exposed to training at a sufficiently intensive frequency. Specifically, within five out of six studies that found a significant effect on rumination, participants also demonstrated significant pre-post improvements within the training task itself⁸ and completed the training task at least every other day (#4,6,8,9,15). In contrast, four of the studies reporting non-significant results failed to find evidence of pre-post change within the training task itself (#1,2,3,16) and a further four non-significant studies gave reason to believe participants were exposed to an insufficient dosage of training (#5,7,10,13). For example, only 24% of participants completed the full training schedule within de Voogd et al. (2016) and training was only administered twice per-week within Moshier and Otto (2017) and Iacoviello et al. (2014).

Failure to demonstrate pre-post change within the training task itself necessarily limits the conclusions that can be drawn about the causal influence of AC upon rumination, as null findings may be simply the result of failing to improve AC in the first place. Similarly, if participants are not exposed to training sessions at a sufficient frequency/intensity, it may fail to adequately activate the neural regions

⁸ The remaining study did not provide information about pre-post training change (Schreiner et al., 2015; conference abstract only).

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

or cognitive processes responsible for evoking change in ruminative thought (Moshier & Otto, 2017). Such findings potentially strengthen the argument for a causal impact of AC upon rumination, as they suggest that consistent significant effects are found when training is found to have a reliable effect on the targeted process (e.g., attentional bias, inhibition, updating etc.). Notably, the studies conducted by Onraedt and Koster (2014) and Wanmaker et al. (2015) failed to find significant effects despite evidence of training task improvement and frequent training exposure. Yet, such null-findings may be accounted for by other concerns regarding study quality and/or task validity (see below).

The issue of task validity. As a relatively novel field of investigation, research examining the impact of AC upon broader psychosocial functioning has also suffered from a lack of conceptual clarity and procedural standardisation (Roberts et al., 2015). Such variation not only makes it difficult to make direct comparisons between studies and pool collective evidence, but, due to concerns around the validity of certain paradigms, may directly undermine attempts to demonstrate and understand the potential causal relationship between AC and rumination (Mor & Daches, 2015).

Many of the paradigms used within the studies currently reviewed represent complex behavioural paradigms that are considered relatively impure indices of AC (i.e., confounding multiple sub-facets of attentional control itself and/or other related, yet distinct, cognitive constructs, such as general WM capacity or other memory-related processes that may also be impacted by depression/rumination; Roberts et al., 2015). For example, variants of the dual *n*-back task were used in the majority of studies used to investigate the impact of monitoring/updating WM on rumination ($n=5/8$), yet this paradigm has been criticised as a relatively impure assessment of

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

such capabilities, as it confounds them with various other aspects of executive functioning and attention (e.g., Lilienthal, Tamez, Shelton, Myerson, & Hale, 2013). Similarly, the NAP task, used to index inhibition within the majority of current studies ($n=2/3$), may rely on memory-related processes rather than AC per se (Mayr & Buchner, 2007).

The use of impure or potentially invalid measures of AC may partially explain why several studies failed to find evidence of deficits/biases in AC causally influencing levels of rumination, as the training simply failed to target the mechanisms of interest. Indeed, provisional research using a variant of the Sternberg task (a well-validated measure of resistance to proactive interference; Roberts et al., 2015) provides more positive support for the causal influence of AC upon rumination (LeMoult et al., 2014; Schreiner et al., 2015). Until valid and reliable measures of AC are developed, it will remain difficult to draw conclusions regarding its causal influence upon rumination.

Critical Appraisal of Review

Whilst adhering to best-practice PRISMA guidelines, the current review still had a number of limitations. Firstly, due to the novelty of the field of interest, the review adopted a broad conceptualisation of AC that encompassed a wide range of potentially overlapping, yet disparate domains. As the field continues to progress, future reviews may wish to adopt a narrower operationalisation of AC to aid detection of clearer patterns within the data available. Also due to the novelty of the field, the current review included several studies where AC modifications represented an adjunctive intervention (combined with treatment-as-usual or some other experimental treatment), rather than a stand-alone intervention. Such allowances also limit the ability to draw clear conclusions about the causal impact of AC on

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

rumination, as it becomes difficult to isolate the true mechanism of effect in instances where significant change was observed. Due to these and other sources of clinical diversity (range of interventions/comparators), further quantitative analysis was considered inappropriate at this time, as the resulting effect sizes would likely be meaningless and/or misleading (Higgins & Green, 2011). In addition, the majority of studies used trait rather than state measures of rumination, which may lack the sensitivity required to detect change over the relatively short duration of most training schedules (Mor & Daches, 2015). Finally, most studies contained a predominately female sample, which may limit the generalisation of the current findings due to known gender differences in the rates and nature of rumination (Hankin, 2009; Johnson & Whisman, 2013).

Current Implications and Future Research

Whilst potentially limited by the aforementioned methodological weaknesses, the results of the current review indicate that, when steps are taken to ensure that training has a reliable effect on the targeted AC process, there is provisional evidence that deficits/biases in AC contribute casually to levels of depressive rumination. Due to variation in the methodological quality of studies currently reviews, it remains difficult to determine whether the ability to demonstrate such a causal relationship depends on the use of negative training materials. Overall, such findings support the validity of cognitive theories purporting a role for impaired AC in the onset and/or maintenance of rumination (i.e., the IDH; Koster et al., 2011). Yet, whilst some have suggested that AC training may be an important adjunct or pre-requisite to enhance the impact of traditional therapies for depression (by ameliorating the negative impact of rumination on the cognitive functions required for successful completion of psychotherapy; Baert et al., 2011), the current findings cast

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

doubt on the potential clinical utility of such approaches; even when significant effects were reported, the accompanying effect sizes often remained small-moderate, suggesting that although statistically significant change may be achieved, the clinical impact of such change may remain modest at best. The provisional findings of Siegle et al. (2014) suggest greater clinical effects may be achieved by combining multiple aspects of AC within training, but require further replication and expansion within future research.

Yet, in order to strengthen such conclusions and implications, the findings of the current review suggest the following recommendations for further research concerning the causal role of AC within rumination. Firstly, in order to increase the internal and ecological validity of findings in this area, future studies must endeavour to recruit representative, well-matched participants, randomly allocated within a double-blind design. Efforts must also be made to devise valid and reliable indices of the various parameters of AC, to ensure the theoretical mechanisms of effect are appropriately targeted during training (Roberts et al., 2015). Similarly, researchers should move towards the development and use of validated measures of state rumination that may be more sensitive to training-induced changes. Such endeavours may benefit from the use of induction or recall procedures designed to stimulate in-vivo rumination (Mor & Daches, 2015). Finally, pilot studies may also be helpful in pre-determining an appropriate training frequency/dosage to ensure significant change within the chosen measure of AC and rule out this alternative explanation for any null-effects. Only when such criteria are met, will reviews be able to conclude confidently about the causal role of AC within rumination.

Conclusion

Based on theoretical accounts suggesting that deficits/biases in AC contribute causally to the development and maintenance of depressive rumination (e.g., Koster et al., 2011), it has been suggested that CCT might represent an alternative/adjunctive treatment for depression (Baert et al., 2011). Due to a number of methodological/conceptual issues, the current systematic review found only inconsistent support for such claims, even when training tasks focused on the manipulation/removal of negative information from WM. Yet, studies that demonstrated high methodological quality, used well-validated training measures, and/or utilised a sufficiently intensive training schedule provided more encouraging results, suggesting that further support for AC-based theories of rumination may be found within future higher quality research.

References

- Alloy, L. B., Abramson, L. Y., Hogan, M. E., Whitehouse, W. G., Rose, D. T., Robinson, M. S., . . . Lapkin, J. B. (2000). The Temple-Wisconsin Cognitive Vulnerability to Depression Project: Lifetime history of axis I psychopathology in individuals at high and low cognitive risk for depression. *Journal of Abnormal Psychology, 109*(3), 403-418. doi:10.1037/0021-843X.109.3.403
- Baert, S., De Raedt, R., Schract, R., & Koster, E. H. W. (2010). Attentional bias training in depression: Therapeutic effects depend on depression severity. *Journal of Behavior Therapy and Experimental Psychiatry, 41*, 265-274. doi: 10.1016/j.jbtep.2010.02.004
- Baert, S., Koster, E. H. W., & De Raedt, R. (2011). Modification of information-processing biases in emotional disorders: Clinically relevant developments in experimental psychopathology. *International Journal of Cognitive Therapy, 4*, 208-222. doi:10.1521/ijct.2011.4.2.208
- Banich, M. T. (2009). Executive function the search for an integrated account. *Current Directions in Psychological Science, 18*(2), 89-94. doi:10.1111/j.1467-8721.2009.01615.x
- Ciesla, J. A., & Roberts, J. E. (2002). Self-directed thought and response to treatment for depression: A preliminary investigation. *Journal of Cognitive Psychotherapy: An International Quarterly, 16*, 435-453. doi:10.1891/jcop.16.4.435.52528
- Cipriani, A., & Geddes, J. (2003). Comparison of systematic and narrative reviews: The example of the atypical antipsychotics. *Epidemiologia e Psichiatria Sociale, 12*(3), 146-154. doi:10.1017/S1121189X00002918

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Conway, M., Csank, P. A. R., Holm, S. L., & Blake, C. K. (2000). On assessing individual differences in rumination on sadness. *Journal of Personality Assessment, 75*, 404–425. doi:10.1207/S15327752JPA7503_04

Daches, S., & Mor, N. (2014). Training Ruminators to Inhibit Negative Information: A Preliminary Report. *Cognitive Therapy and Research, 38*(2), 160-171. doi:10.1007/s10608-013-9585-5

Daches, S., Mor, N., & Hertel, P. (2015). Rumination: Cognitive consequences of training to inhibit the negative. *Journal of Behavior Therapy and Experimental Psychiatry, 49*, 76-83. doi:10.1016/j.jbtep.2015.01.010

De Putter, L. M. S., Vanderhasselt, M. A., Baeken, C., De Raedt, R., & Koster, E. H. W. (2015). Combining tDCS and Working Memory Training to Down Regulate State Rumination: A Single-Session Double Blind Sham-Controlled Trial. *Cognitive Therapy and Research, 39*, 754-765. doi:10.1007/s10608-015-9710-8

De Raedt, R., Koster, E. H. W., & Joorman, J. (2010). Attentional control in depression: A translational affective neuroscience approach. *Cognitive, Affective, & Behavioral Neuroscience, 10*, 1-7. doi:10.3758/CABN.10.1.1

de Voogd, E. L., Wiers, R. W., Prins, P. J. M., de Jong, P. J., Boendermarker, W. J., Zwister, R. J.,... Salemink, E. (2016). Online attentional bias modification training targeting anxiety and depression in unselected adolescents: Short- and long-term effects of a randomized controlled trial. *Behaviour Research and Therapy, 87*, 11-22. doi:10.1016/j.brat.2016.08.018

de Voogd, E. L., Wiers, R. W., Zwitser, R. J., & Salemink, E. (2016). Emotional working memory training as an online intervention for adolescent anxiety and depression: A randomised controlled trial. *Australian Journal of Psychology,*

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

68, 228–238. doi: 10.1111/ajpy.12134

Ehring, T., Zetsche, U., Weidacker, K., Wahl, K., Schönfeld, S., & Ehlers, A. (2011).

The Perseverative Thinking Questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*, 225-232.

doi:10.1016/j.jbtep.2010.12.003

Ellis, H. C., & Ashbrook, P. W. (1988). Resource allocation model of the effects of depressed mood states on memory. In K. Fielder (Ed.), *Affect, cognition, and social behaviour* (pp. 25-43). Göttingen: Hogrefe.

Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General*, *133*, 101-135. doi: 10.1037/0096-3445.133.1.101

Gotlib, I. H., & Joormann, J. (2010). Cognition and depression: Current status and future directions. *Annual Review of Clinical Psychology*, *6*, 285-312. doi: 10.1146/annurev.clinpsy.121208.131305

Hankin, B. L. (2009). Development of sex differences in depressive and co-occurring anxious symptoms during adolescence: Descriptive trajectories and potential explanations in a multiwave prospective study. *Journal of Clinical Child and Adolescent Psychology*, *38*, 460-472. doi:10.1080/15374410902976288

Hartlage, S., Alloy, L. B., Vazquez, C., & Dykman, B. (1993). Automatic and effortful processing in depression. *Psychological Bulletin*, *113*(2), 247-278.

Hertel, P. T. (1998). Relation between rumination and impaired memory in dysphoric moods. *Journal of Abnormal Psychology*, *107*, 166-172.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Higgins, J. P. T., & Green, S. (2011). *Cochrane handbook for systematic reviews of interventions: Version 5.1.0*. Retrieved from <http://handbook.cochrane.org/>

Hoorelbeke, K., & Koster, E. H. W. (2016). Internet-delivered cognitive control training as a preventive intervention for remitted depressed patients: Evidence from a double-blind randomized controlled trial study. *Journal of Consulting and Clinical Psychology*. Advance online publication. Retrieved from <http://dx.doi.org/10.1037/ccp0000128>

Hoorelbeke, K., Koster, E., Vanderhasselt, M.-A., Callewaert, S., & Demeyer, I. (2015). The influence of cognitive control training on stress reactivity and rumination in response to a lab stressor and naturalistic stress. *Behaviour Research and Therapy*, *69*, 1-10. doi:10.1016/j.brat.2015.03.010

Iacoviello, B. M., Wu, G., Alvarez, E., Huryk, K., Collins, K. A., Murrough, J. W., . . . Charney, D. S. (2014). Cognitive-emotional training as an intervention for major depressive disorder. *Depression and Anxiety*, *31*, 699-706. doi:10.1002/da.22266

Johnson, D. P., & Whisman, M. A. (2013). Gender differences in rumination: A meta-analysis. *Personality and Individual Differences*, *55*, 367–374. doi:10.1016/j.paid.2013.03.019

Joormann, J., Yoon, K. L., & Zetsche, U. (2007). Cognitive inhibition in depression. *Applied and Preventive Psychology*, *12*(3), 128-139. doi:10.1016/j.appsy.2007.09.002

Koster, E. H. W., De Lissnyder, E., Derakshan, N., & De Raedt, R. (2011). Understanding depressive rumination from a cognitive science perspective:

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

- The impaired disengagement hypothesis. *Clinical Psychology Review*, 31(1), 138-145. doi:10.1016/j.cpr.2010.08.005
- Koster, E. H. W., & Hoorelbeke, K. (2015). Cognitive bias modification for depression. *Current Opinion in Psychology*, 4, 119-123. doi:10.1016/j.copsyc.2014.11.012
- LeMoult, J., Foland-Ross, L. C., Sorenson, J., Ordaz, S. J., Bergman, S. R., & Gotlib, I. H. (2014). Neural effects of working memory training in major depressive disorder: Facilitating scientific translation. *Biological Psychiatry*, 75, 399S-400S. doi:http://dx.doi.org/10.1016/j.biopsych.2014.03.016
- Lilienthal, L., Tamez, E., Shelton, J. T., Myerson, J., & Hale, S. (2013). Dual n-back training increases the capacity of the focus of attention. *Psychonomic Bulletin & Review*, 20, 135–141. doi:10.3758/s13423-012-0335-6
- Linville, P. (1996). Attention inhibition: Does it underlie ruminative thought? In R. S. Wyer (Ed.), *Ruminative thoughts: Advances in social cognition* (Vol. IX, pp. 121-133). Mahwah, NJ: Erlbaum.
- Mayr, S., & Buchner, A. (2007). Negative priming as a memory phenomenon: A review of 20 years of negative priming research. *Journal of Psychology*, 215, 35-51. doi:10.1027/0044-3409.215.1.35
- McEvoy, P. M., Mahoney, A. E. J., & Moulds, M. L. (2010). Are worry, rumination, and post-event processing one and the same? Development of the repetitive thinking questionnaire. *Journal of Anxiety Disorders*, 24, 509-519. doi:10.1016/j.janxdis.2010.03.008
- Mogoșe, C., David, D., & Koster, E. H. W. (2014). Clinical efficacy of attentional bias modification procedures: An updated meta-analysis. *Journal of Clinical Psychology*, 70, 1133-1157. doi:10.1002/jclp.22081

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group (2009).

Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6, 1-6.

doi:10.1371/journal.pmed.1000097

Mor, N., & Daches, S. (2015). Ruminative thinking: Lessons learned from cognitive training. *Clinical Psychological Science*, 3, 574-592.

doi:10.1177/2167702615578130

Mor, N., Marchetti, I., & Koster, E. H. W. (2013). *The momentary ruminative self-focus inventory (MRSI): Validation and psychometric evaluation*.

Moshier, S. J., & Otto, M. W. (2017). Behavioral activation treatment for major depression: A randomized trial of the efficacy of augmentation with cognitive control training. *Journal of Affective Disorders*, 210, 265-268.

doi:10.1016/j.jad.2017.01.003

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology*, 100, 569-582.

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology*, 109, 504-511.

Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and posttraumatic stress symptoms after a natural disaster: The 1989 Loma Prieta Earthquake. *Journal of Personality and Social Psychology*, 61, 115-121.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science*, 3, 400-424. doi: 10.1111/j.1745-6924.2008.00088.x

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

- Onraedt, T., & Koster, E. H. W. (2014). Training working memory to reduce rumination. *PLoS One*, 9(3). doi:10.1371/journal.pone.0090632
- Roberts, H., Watkins, E., & Wills, A. J. (2015). Does rumination cause “inhibitory” deficits? Retrieved from <http://www.willslab.co.uk/pubs/roberts2015.pdf>
- Schreiner, C., LeMoult, J., & Gotlib, I. (2015). Reducing cortisol reactivity to stress in major depressive disorder: The effects of rumination-reduction training. *Biological psychiatry*, 77(9 suppl. 1), 381s. Retrieved from <http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/797/CN-01099797/frame.html>
- Siegle, G. J., Price, R. B., Jones, N. P., Ghinassi, F., Painter, T., & Thase, M. E. (2014). You gotta work at it: Pupillary indices of task focus are prognostic for response to a neurocognitive intervention for rumination in depression. *Clinical Psychological Science*, 2(4), 455-471. doi:10.1177/2167702614536160
- Smith, J. M., & Alloy, L. B. (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. *Clinical Psychology Review*, 29(2), 116-128. doi:10.1016/j.cpr.2008.10.003
- The Cochrane Collaboration. (2016a). CCDAN Conditions List. Retrieved from http://cmd.cochrane.org/sites/cmd.cochrane.org/files/public/uploads/CCDAN%20topics%20list_CONDITION%20for%20website.pdf
- The Cochrane Collaboration. (2016b). Cochrane Consumers and Communication: Data Extraction Template for Included Studies. Retrieved from http://cccr.org.cochrane.org/sites/cccr.org.cochrane.org/files/public/uploads/DET_2015_REVISIED%20FINAL%20June%2020%202016.doc
- Thomas, B. H., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A process for

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

systematically reviewing the literature: Providing the research evidence for public health nursing interventions. *Worldviews on Evidence-Based Nursing*, 1, 176-184.

Wanmaker, S., Geraerts, E., & Franken, I. (2015). A working memory training to decrease rumination in depressed and anxious individuals: a double-blind randomized controlled trial. *Journal of Affective Disorders*, 175, 310-319. doi: 10.1016/j.jad.2014.12.027

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin*, 134(2), 163-206. doi:10.1037/0033-2909.134.2.163

Watkins, E. R., & Brown, R. G. (2002). Rumination and executive function in depression: An experimental study. *Journal of Neurology Neurosurgery and Psychiatry*, 72, 400-402.

Whitmer, A. J., & Gotlib, I. H. (2013). An attentional scope model of rumination. *Psychological Bulletin*, 139, 1036-1061. doi:10.1037/a0030923

Yang, Y., Cao, S., Shields, G. S., Teng, Z., & Liu, Y. (2016). The relationships between rumination and core executive functions: A meta-analysis. *Depression and Anxiety*, 34, 37-50. doi:10.1002/da.22539

Yang, W., Ding, Z., Dai, T., Peng, F., & Zhang, J. X. (2015). Attention Bias Modification training in individuals with depressive symptoms: A randomized controlled trial. *Journal of Behavior Therapy and Experimental Psychiatry*, 49, 101-111. doi: 10.1016/j.jbtep.2014.08.005

Appendices

Appendix A: Journal Guidelines – Journal of Experimental Psychopathology

Scope of the Journal. The Journal of Experimental Psychopathology is an e-journal created to publish cutting-edge original contributions to scientific knowledge in the general area of psychopathology. Although there will be an emphasis on publishing research which has adopted an experimental approach to describing and understanding psychopathology, the journal will also welcome submissions that make significant contributions to knowledge using other empirical methods such as correlational designs, meta-analyses, epidemiological and prospective approaches, and single-case experiments. Theoretical and review articles addressing significant issues in the description, aetiology, and treatment of psychopathologies are also welcome. The Editors and Associate Editors will make an initial determination of whether or not submissions fall within the scope of the journal and are of sufficient merit and importance to warrant full review.

Submitting Manuscripts. Authors should submit their manuscript electronically via the journal's editorial system (<http://jep.textrum.com/>). Your manuscript will then be allocated to an Associate Editor who will manage the peer review process. You should submit your manuscript in an editable version of WORD or a similar format (not as a pdf). You should also retain a copy of your manuscript because this may be needed for further processing should your manuscript be accepted for publication. DO NOT submit manuscripts or revised manuscripts with tracked changes or tracked comments on them, and do not submit manuscripts with other forms of mark ups on them (e.g. Endnote). This is because your final uncorrected manuscript may be made publicly available in press prior to typesetting in the event of it being accepted for publication. There is no word-limit to articles that may be accepted for publication, but the Editors would expect presentation to be efficient, concise and informative. Most articles accepted for publication would usually be no more than 50 manuscript pages. Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the Editors.

Presentation of the Manuscript. The manuscript should follow American Psychological Association (APA) publication manual guidelines. All pages should be typed double-spaced and numbered (including pages containing the title, authors names and affiliation footnotes, abstract, acknowledgments, references, tables, and figure caption list)

Title Page. A title page should be provided and should include the full title of the article, the authors' names and affiliations, and a suggested running head. The affiliation should include the department, institution, city or town, and country. It should be made clear in which institution(s) the research was carried out. The suggested running head should be no more than 80 characters. The title page should also clearly indicate the name, address, email address, fax number and telephone number of the corresponding author.

Abstract. An abstract following American Psychological Association guidelines should be provided and preferably be no longer than 150 words. The abstract page should also provide a list of 5-10 key words that accurately reflect the content of the article and can be used for indexing and search purposes.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Format of the article. Divide your article into clearly defined sections with the use of headings (non-numbered). The following headings are mandatory: Abstract, Introduction, Method, Participants, Procedure, Results, Discussion and References, but authors may include other headings where appropriate. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Figures & Illustrations. Photographs, drawings, diagrams, graphs and charts should be numbered in one consecutive series of Arabic numerals. Each individual figure or illustration should be accompanied by a clearly-worded caption or figure legend. All figures, tables, photographs, drawings, charts and diagrams should be submitted within the manuscript, preferably on separate pages at the end of the manuscript. If your manuscript is accepted for publication you may then be asked to submit your artwork in an electronic format and supply high-quality printouts in case conversion of the electronic artwork is problematic.

Tables. Tables should be numbered in one consecutive series of Arabic numerals. Each table should be typed on a separate page with the title centred above the table and all explanatory footnotes, etc. printed below. Acknowledgements: Do not include acknowledgements on the title page. Place them on a separate page after the main body of the article and before the reference list.

References. Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications should not be in the reference list, but may be mentioned in the text. Citation of a reference as 'in press' implies that the item has been accepted for publication. Citations in the text should follow the referencing style used by the American Psychological Association. You are referred to the Publication Manual of the American Psychological Association, the latest can be found at <http://www.apastyle.org>. References should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters "a", "b", "c", etc., placed after the year of publication.

Examples reference formats include:

JOURNAL ARTICLES

Davey, G.C.L., Startup H.M., MacDonald C.B., Jenkins D. & Paterson K. (2005) The use of 'as many as can' stop rules during worrying. *Cognitive Therapy & Research*, 29, 155-169.

BOOKS

Davey G.C.L. & Wells A. (Eds) (2006) *Worry and its psychological disorders: Theory, assessment and treatment*. Chichester: John Wiley.

BOOK CHAPTERS

Davey G.C.L. (2006) A mood-as input account of perseverative worrying. In G.C.L. Davey & A. Wells (Eds) *Worry and its psychological disorders: Theory, assessment and treatment*. Chichester: John Wiley. Pp217-237

AUTHORED WEB-PAGE

Lecce S. (2005) Should egalitarians be perfectionists? Retrieved January 30, 2008, from <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1467-9256.2005.00237.x?cookieSet=1&journalCode=ponl>

UN-AUTHORED WEB-PAGE

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

New child vaccine gets funding boost. (2001). Retrieved March 21, 2001, from http://news.ninemsn.com.au/health/story_13178.asp

Supplementary Files. The Editors of the Journal of Experimental Psychopathology are keen to ensure that all published articles come with downloadable supplementary material that will enable readers and researchers to fully appreciate how the research was conducted and analyzed. We believe this will facilitate replication and further research. Depending on the nature of the published article authors will be encouraged to provide supplementary material in a form that can be downloaded and used by students and researchers. These materials might include copies of questionnaires used in the research or developed by the research, instruction sheets, experimental protocols, stimuli and images, audio and visual media clips, computer programs (executables or source code), data analysis macros or scripts if an unusual analysis has been done, scripts for specialist software (e.g., data processing scripts for ERP or EEG data, eprime scripts etc.), photographs of custom-built apparatus, colour images that illustrate data (e.g., fMRI scans, ERP curves) etc. In order to ensure that supplementary material is directly usable, please ensure that data are provided in a file format suitable for downloading. After an article has been accepted for publication, authors will be approached and encouraged to provide what supporting materials they can make available. There will be no transfer of copyright for any of the materials deposited in the Tools & Materials Repository, and this will allow authors to retain copyright of any materials they may have developed themselves or over which they have current copyright ownership. There will be no obligation for authors to provide materials for the repository, and a willingness to provide tools and materials will not be a factor taken into account when deciding whether a manuscript is accepted for publication.

Copyright. Upon acceptance of an article, an e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a link to a Journal Publishing Agreement form. If excerpts from other copyrighted works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article. Proofs: When your manuscript is received by the Publisher it is considered to be in its final form. Proofs are not to be regarded as 'drafts'. One set of page proofs will be sent electronically to the corresponding author, to be checked for typesetting/editing. No changes in, or additions to, the accepted (and subsequently edited) manuscript will be allowed at this stage. Proofreading is solely your responsibility. The Editors reserve the right to proceed with publication if corrections are not communicated.

Blind Review. Authors requesting blind review should explicitly request this when loading their manuscript up to the journal editorial system. The manuscript should also be submitted in a form appropriate to this process (see the APA Publication Manual).

Open Access Option. Many institutions and funding bodies have made funds available to allow authors to publish their research in an open access form. Journal of Experimental Psychopathology offers authors an open access option whereby their article will be freely available to both journal subscribers and nonsubscribers via the journal website. To prevent any conflict of interests, authors can choose to have their article made open access only after the article has formally been accepted for publication. The fee for making an article open access is £1000/US\$1595/€1161 excluding tax, and all authors wishing to take advantage of the open access option should complete and return the open access option form they will receive along with their copyright transfer and publishing forms prior to publication. Authors who wish to take advantage of the open access option will still retain their rights outlined in Textum's Copyright Transfer & Publishing Agreement. Further

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

information about Textrum's Open Access Options can be obtained by emailing openaccess@textrum.com.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION
Appendix B: Quality Assessment Tool for Quantitative Studies – Items

and Dictionary

COMPONENT RATINGS

A) SELECTION BIAS

(Q1) Are the individuals selected to participate in the study likely to be representative of the target population?

Very likely
 Somewhat likely
 Not likely
 Can't tell

(Q2) What percentage of selected individuals agreed to participate?

80 - 100% agreement
 60 – 79% agreement
 less than 60% agreement
 Not applicable
 Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

B) STUDY DESIGN

Indicate the study design

Randomized controlled trial
 Controlled clinical trial
 Cohort analytic (two group pre + post)
 Case-control
 Cohort (one group pre + post (before and after))
 Interrupted time series
 Other specify _____
 Can't tell

Was the study described as randomized? If NO, go to Component C.

No Yes

If Yes, was the method of randomization described? (See dictionary)

No Yes

If Yes, was the method appropriate? (See dictionary)

No Yes

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

C) CONFOUNDERS

(Q1) Were there important differences between groups prior to the intervention?

Yes
No
Can't tell

The following are examples of confounders:

Race
Sex
Marital status/family
Age
SES (income or class)
Education
Health status
Pre-intervention score on outcome measure

(Q2) If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?

80 – 100% (most)
60 – 79% (some)
Less than 60% (few or none)
Can't Tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

D) BLINDING

(Q1) Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?

Yes
No
Can't tell

(Q2) Were the study participants aware of the research question?

Yes
No
Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

E) DATA COLLECTION METHODS

(Q1) Were data collection tools shown to be valid?

Yes
No
Can't tell

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

(Q2) Were data collection tools shown to be reliable?

Yes

No

Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

F) WITHDRAWALS AND DROP-OUTS

(Q1) Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?

Yes

No

Can't tell

Not Applicable (i.e. one time surveys or interviews)

(Q2) Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest).

80 -100%

60 - 79%

less than 60%

Can't tell

Not Applicable (i.e. Retrospective case-control)

RATE THIS SECTION	STRONG	MODERATE	WEAK	
See dictionary	1	2	3	Not Applicable

G) INTERVENTION INTEGRITY

(Q1) What percentage of participants received the allocated intervention or exposure of interest?

80 -100%

60 - 79%

less than 60%

Can't tell

(Q2) Was the consistency of the intervention measured?

Yes

No

Can't tell

(Q3) Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?

Yes

No

Can't tell

H) ANALYSES

(Q1) Are the statistical methods appropriate for the study design?

Yes

No

Can't tell

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION
GLOBAL RATING

COMPONENT RATINGS

Please transcribe the information from the gray boxes on pages 1-4 onto this page. See dictionary on how to rate this section.

A	SELECTION BIAS	STRONG	MODERATE	WEAK
		1	2	3
B	STUDY DESIGN	STRONG	MODERATE	WEAK
		1	2	3
C	CONFOUNDERS	STRONG	MODERATE	WEAK
		1	2	3
D	BLINDING	STRONG	MODERATE	WEAK
		1	2	3
E	DATA COLLECTION METHOD	STRONG	MODERATE	WEAK
		1	2	3
F	WITHDRAWALS AND DROPOUTS	STRONG	MODERATE	WEAK
		1	2	3
				Not Applicable

GLOBAL RATING FOR THIS PAPER (circle one):

- 1 STRONG (no WEAK ratings)
- 2 MODERATE (one WEAK rating)
- 3 WEAK (two or more WEAK ratings)

With both reviewers discussing the ratings:

Is there a discrepancy between the two reviewers with respect to the component (A-F) ratings?

No Yes

If yes, indicate the reason for the discrepancy

- 1 Oversight
- 2 Differences in interpretation of criteria
- 3 Differences in interpretation of study

Final decision of both reviewers (circle one):

- 1 STRONG**
- 2 MODERATE**

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION
3 WEAK

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

QATQS Dictionary

The purpose of this dictionary is to describe items in the tool thereby assisting raters to score study quality. Due to under-reporting or lack of clarity in the primary study, raters will need to make judgements about the extent that bias may be present. When making judgements about each component, raters should form their opinion based upon information contained in the study rather than making inferences about what the authors intended.

A) SELECTION BIAS

(Q1) Participants are more likely to be representative of the target population if they are randomly selected from a comprehensive list of individuals in the target population (score very likely). They may not be representative if they are referred from a source (e.g. clinic) in a systematic manner (score somewhat likely) or self-referred (score not likely).

(Q2) Refers to the % of subjects in the control and intervention groups that agreed to participate in the study before they were assigned to intervention or control groups.

B) STUDY DESIGN

In this section, raters assess the likelihood of bias due to the allocation process in an experimental study. For observational studies, raters assess the extent that assessments of exposure and outcome are likely to be independent. Generally, the type of design is a good indicator of the extent of bias. In stronger designs, an equivalent control group is present and the allocation process is such that the investigators are unable to predict the sequence.

Randomized Controlled Trial (RCT)

An experimental design where investigators randomly allocate eligible people to an intervention or control group. A rater should describe a study as an RCT if the randomization sequence allows each study participant to have the same chance of receiving each intervention and the investigators could not predict which intervention was next. If the investigators do not describe the allocation process and only use the words 'random' or 'randomly', the study is described as a controlled clinical trial.

See below for more details.

Was the study described as randomized?

- Score YES, if the authors used words such as random allocation, randomly assigned, and random assignment.
- Score NO, if no mention of randomization is made.

Was the method of randomization described?

- Score YES, if the authors describe any method used to generate a random allocation sequence.
- Score NO, if the authors do not describe the allocation method or describe methods of allocation such as alternation, case record numbers, dates of birth, day of the week, and any allocation procedure that is entirely transparent before assignment, such as an open list of random numbers of assignments.
- If NO is scored, then the study is a controlled clinical trial.

Was the method appropriate?

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

- Score YES, if the randomization sequence allowed each study participant to have the same chance of receiving each intervention and the investigators could not predict which intervention was next. Examples of appropriate approaches include assignment of subjects by a central office unaware of subject characteristics, or sequentially numbered, sealed, opaque envelopes.
- Score NO, if the randomization sequence is open to the individuals responsible for recruiting and allocating participants or providing the intervention, since those individuals can influence the allocation process, either knowingly or unknowingly.
- If NO is scored, then the study is a controlled clinical trial.

Controlled Clinical Trial (CCT)

An experimental study design where the method of allocating study subjects to intervention or control groups is open to individuals responsible for recruiting subjects or providing the intervention. The method of allocation is transparent before assignment, e.g. an open list of random numbers or allocation by date of birth, etc.

Cohort analytic (two group pre and post)

An observational study design where groups are assembled according to whether or not exposure to the intervention has occurred. Exposure to the intervention is not under the control of the investigators. Study groups might be non-equivalent or not comparable on some feature that emotions outcome.

Case control study

A retrospective study design where the investigators gather 'cases' of people who already have the outcome of interest and 'controls' who do not. Both groups are then questioned or their records examined about whether they received the intervention exposure of interest.

Cohort (one group pre + post (before and after))

The same group is pretested, given an intervention, and tested immediately after the intervention. The intervention group, by means of the pretest, act as their own control group.

Interrupted time series

A time series consists of multiple observations over time. Observations can be on the same units (e.g. individuals over time) or on different but similar units (e.g. student achievement scores for particular grade and school). Interrupted time series analysis requires knowing the specific point in the series when an intervention occurred.

C) CONFOUNDERS

By definition, a confounder is a variable that is associated with the intervention or exposure and causally related to the outcome of interest. Even in a robust study design, groups may not be balanced with respect to important variables prior to the intervention. The authors should indicate if confounders were controlled in the design (by stratification or matching) or in the analysis. If the allocation to intervention and control groups is randomized, the authors must report that the groups were balanced at baseline with respect to confounders (either in the text or a table).

D) BLINDING

(Q1) Assessors should be described as blinded to which participants were in the control and intervention groups. The purpose of blinding the outcome assessors (who might also be the care providers) is to protect against detection bias.

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

(Q2) Study participants should not be aware of (i.e. blinded to) the research question. The purpose of blinding the participants is to protect against reporting bias.

E) DATA COLLECTION METHODS

Tools for primary outcome measures must be described as reliable and valid. If 'face' validity or 'content' validity has been demonstrated, this is acceptable. Some sources from which data may be collected are described below:

Self reported data includes data that is collected from participants in the study (e.g. completing a questionnaire, survey, answering questions during an interview, etc.).

Assessment/Screening includes objective data that is retrieved by the researchers. (e.g. observations by investigators).

Medical Records/Vital Statistics refers to the types of formal records used for the extraction of the data.

Reliability and validity can be reported in the study or in a separate study. For example, some standard assessment tools have known reliability and validity.

F) WITHDRAWALS AND DROP-OUTS

- Score YES if the authors describe BOTH the numbers and reasons for withdrawals and drop-outs.
- Score NO if either the numbers or reasons for withdrawals and drop-outs are not reported.

The percentage of participants completing the study refers to the % of subjects remaining in the study at the final data collection period in all groups (i.e. control and intervention groups).

G) INTERVENTION INTEGRITY

The number of participants receiving the intended intervention should be noted (consider both frequency and intensity). For example, the authors may have reported that at least 80 percent of the participants received the complete intervention. The authors should describe a method of measuring if the intervention was provided to all participants the same way. As well, the authors should indicate if subjects received an unintended intervention that may have influenced the outcomes. For example, co-intervention occurs when the study group receives an additional intervention (other than that intended). In this case, it is possible that the effect of the intervention may be over-estimated. Contamination refers to situations where the control group accidentally receives the study intervention. This could result in an under-estimation of the impact of the intervention.

H) ANALYSIS APPROPRIATE TO QUESTION

Was the quantitative analysis appropriate to the research question being asked?

An intention-to-treat analysis is one in which all the participants in a trial are analyzed according to the intervention to which they were allocated, whether they received it or not. Intention-to-treat analyses are favoured in assessments of effectiveness as they mirror the noncompliance and treatment changes that are likely to occur when the intervention is used in practice, and because of the risk of attrition bias when participants are excluded from the analysis.

Component Ratings of Study:

For each of the six components A – F, use the following descriptions as a roadmap.

A) SELECTION BIAS

Strong: The selected individuals are very likely to be representative of the target population (Q1 is 1) and there is greater than 80% participation (Q2 is 1).

Moderate: The selected individuals are at least somewhat likely to be representative of the target population (Q1 is 1 or 2); and there is 60 - 79% participation (Q2 is 2). 'Moderate' may also be assigned if Q1 is 1 or 2 and Q2 is 5 (can't tell).

Weak: The selected individuals are not likely to be representative of the target population (Q1 is 3); or there is less than 60% participation (Q2 is 3) or selection is not described (Q1 is 4); and the level of participation is not described (Q2 is 5).

B) DESIGN

Strong: will be assigned to those articles that described RCTs and CCTs.

Moderate: will be assigned to those that described a cohort analytic study, a case control study, a cohort design, or an interrupted time series.

Weak: will be assigned to those that used any other method or did not state the method used.

C) CONFOUNDERS

Strong: will be assigned to those articles that controlled for at least 80% of relevant confounders (Q1 is 2); or (Q2 is 1).

Moderate: will be given to those studies that controlled for 60 – 79% of relevant confounders (Q1 is 1) and (Q2 is 2).

Weak: will be assigned when less than 60% of relevant confounders were controlled (Q1 is 1) and (Q2 is 3) or control of confounders was not described (Q1 is 3) and (Q2 is 4).

D) BLINDING

Strong: The outcome assessor is not aware of the intervention status of participants (Q1 is 2); and the study participants are not aware of the research question (Q2 is 2).

Moderate: The outcome assessor is not aware of the intervention status of participants (Q1 is 2); or the study participants are not aware of the research question (Q2 is 2); or blinding is not described (Q1 is 3 and Q2 is 3).

Weak: The outcome assessor is aware of the intervention status of participants (Q1 is 1); and the study participants are aware of the research question (Q2 is 1).

E) DATA COLLECTION METHODS

Strong: The data collection tools have been shown to be valid (Q1 is 1); and the data collection tools have been shown to be reliable (Q2 is 1).

Moderate: The data collection tools have been shown to be valid (Q1 is 1); and the data collection tools have not been shown to be reliable (Q2 is 2) or reliability is not described (Q2 is 3).

THESIS: ATTENTIONAL CONTROL AND DEPRESSIVE RUMINATION

Weak: The data collection tools have not been shown to be valid (Q1 is 2) or both reliability and validity are not described (Q1 is 3 and Q2 is 3).

F) WITHDRAWALS AND DROP-OUTS

Strong: will be assigned when the follow-up rate is 80% or greater (Q2 is 1).

Moderate: will be assigned when the follow-up rate is 60 – 79% (Q2 is 2) OR Q2 is 5 (N/A).

Weak: will be assigned when a follow-up rate is less than 60% (Q2 is 3) or if the withdrawals and drop-outs were not described (Q2 is 4).



SCHOOL OF PSYCHOLOGY
DOCTORATE IN CLINICAL PSYCHOLOGY

EMPIRICAL PAPER

**Using Working Memory Training to Reduce Depressive Rumination: A Multiple
Baseline Single Case Experimental Design**

Trainee Name: **Rebecca Pepper**

Primary Research Supervisor: **Professor EDWARD WATKINS**
**Professor of Experimental and Applied Clinical
Psychology**

Secondary Research Supervisor: **Dr Jennifer Limond**
Senior Lecturer

Target Journal: **Journal of Experimental Psychopathology** (see
Appendix A for author guidelines)

Word Count: **7991 words** (excluding abstract, references,
footnotes, appendices).

**Submitted in partial fulfilment of requirements for the Doctorate Degree in
Clinical Psychology, University of Exeter**

Acknowledgements

I would like to sincerely thank all the individuals that gave so much time and energy to contribute to this research project. My thanks also go to Prof. Edward Watkins, Dr. Jennifer Limond, and Dr. Anna Adlam, for all their advice and guidance throughout my thesis, and to James Hooper for his generous support in implementing this project. I am extremely grateful to have been part of two truly wonderful cohorts, who have been a tireless source of support and encouragement, and are true assets to the psychological profession. Finally, this thesis is dedicated to my amazing husband and beautiful, spirited daughter – thank you for giving me the strength and perspective to persevere and for helping me smile through all the ups and downs.

Abstract

Objectives: Due to a number of conceptual and methodological limitations, existing research has provided only equivocal evidence that deficits/biases in attentional control (AC) are causally implicated in depressive rumination and/or that Cognitive Control Training (CCT) can be used to remediate such vulnerabilities. By using a well-validated training task and ensuring adequate training exposure, the current study aimed to examine the hypothesis that daily CCT would reduce rumination and improve mood among participants with elevated ruminative disposition.

Method: Using a multiple baseline design (MBD), eight high-ruminating university participants rated their daily levels of rumination and mood before and after the randomly-determined introduction of daily CCT, designed to enhance their level of AC. Daily ratings were compared before and after the introduction of CCT, using systematic visual analysis and randomisation tests for significance at the group level.

Results: No evidence was found to support the hypothesis that daily CCT reduces rumination and/or improve mood. While participants improved in their performance within the CCT across the training period, there was no evidence of near- or far-transfer, visual analysis revealed no impact of the introduction of daily training, and all group-level analyses were non-significant ($p \geq .05$).

Conclusion: Despite addressing a number of conceptual/methodological concerns, the current study provides no further support for AC theories of rumination or the use of CCT-based treatments for depression. Such conclusions must be interpreted in light of other methodological limitations, however, including the use of a non-clinical sample and the use of MBD to detect delayed treatment effects.

Keywords: *Attentional control, Cognitive Control Training, Rumination*

Introduction

According to the World Health Organisation (2017), depression represents the leading cause of disability worldwide, with between 8-20% of the population estimated to experience at least one episode during their lifetime and the risk of recurrence increasing with each additional episode (Beshai, Dobson, Bockting, & Quigley, 2011). Depressive rumination is a repetitive style of self-thought that is defined as “behaviours and thoughts that focus one’s attention on one’s depressive symptoms and on the implications of these symptoms” (Nolen-Hoeksema, 1991, p.569) and has been identified as a key predictor for the onset, course, and recurrence of depression (Ciesla & Roberts, 2002; Nolen-Hoeksema, 2000; Watkins, 2008). Thus, rumination may represent a viable treatment target for those seeking to reduce the incidence and impact of this disorder (De Raedt, Koster, & Joorman, 2010). Consequently, research has examined the clinical utility of various Cognitive Control Training paradigms (CCT), designed to target deficient forms of cognitive processing typically associated with rumination (Koster, Hoorelbeke, Onraedt, Owens, & Derakshan, 2017).

Cognitive Processing and Rumination: The Role of Attentional Control

Whilst initially considered a mere side-effect of depression, recent evidence indicates deficits and/or biases in cognitive processing may represent a key vulnerability factor for rumination (Joorman & Vanderlind, 2014). In particular, the perseverative nature of rumination has led to the suggestion that it may be related to deficits and/or biases in attentional control (AC), defined as “the ability to selectively attend to task-relevant information and to inhibit distraction by task-irrelevant material” (Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Several researchers have hypothesised that difficulties exercising appropriate AC over the

contents of working memory (WM) results in the prolonged processing of negative self-relevant material (experienced as rumination), leading to impaired emotion regulation and sustained negative affect (Joormann, Yoon, & Zetsche, 2007; Koster et al., 2011; Linville, 1996). Within such accounts, AC is recognised as a multi-faceted construct, encompassing several forms of inhibition (resisting distraction, resisting proactive interference, and inhibiting propotent responses; Friedman & Miyake, 2004), as well as the ability to shift between and update the contents of WM (Koster et al., 2011). Thus, impaired AC is thought to increase the risk of rumination due to difficulties blocking and/or removing negative material from WM (Joormann et al., 2007). Furthermore, persistent rumination results in the further depletion and/or biasing of cognitive resources (Watkins & Brown, 2002), resulting in a vicious cycle that perpetuates the experience of depressive symptomology (Koster et al., 2011).

Moreover, such deficits and/or biases are conceptualised as mental habits which, if untreated, may lead to relapse when faced with further life stressors (Watkins, 2015). Crucially, recent evidence indicates that existing pharmacological interventions do not impact cognitive impairments within depression (Shilyansky et al., 2016) and that such deficits/biases often remain following traditional forms of treatment (Vanderhasselt & De Raedt, 2009). Through repeated task exposure, CCT provides an opportunity to strengthen previously deficient cognitive abilities, thus representing a viable alternative for treating these previously untargeted impairments (Koster et al., 2017).

Attentional Control and Rumination: Empirical Evidence

Existing evidence consistently demonstrates that rumination is correlated with a range of deficits/biases in AC (for recent reviews see Mor & Daches, 2015; Roberts, Watkins, & Wills, 2015). Consistent with the multi-faceted nature of AC,

however, a recent meta-analysis found evidence of a significant inverse relationship between rumination and levels of inhibition and set-shifting, but not the speed/efficacy of updating WM (Yang, Cao, Shields, Teng, & Liu, 2016). Such findings suggest that, within depression, rumination is particularly associated with deficits in preventing the entry of irrelevant negative information to WM and, switching adaptively between different mental tasks.

Yet, whilst useful in establishing an initial relationship, correlational research cannot rule out the presence of a reverse relationship (i.e., rumination causes deficits/biases in AC; e.g., Ellis & Ashbrook, 1988; Hertel, 1998) or the influence of other unmeasured variables (such as depressed mood itself; Hartlage, Alloy, Vazquez, & Dykman, 1993). Indeed, several experimental studies have demonstrated that inducing a state of rumination can reduce performance across a range of AC tasks (Roberts et al. 2015), highlighting the importance of experimental, causally-informed research to investigate theories implicating AC in the onset and/or maintenance of rumination.

Recently, researchers have utilised CCT procedures to examine the causal impact of AC upon rumination. Typically involving the repeated training of previously deficient cognitive abilities, CCT offers several clinically appealing features, such as its ability to be administered online at relatively low-cost, and its potential to target previously untreated symptoms that may contribute to the duration, severity and/or recurrence of depression (i.e., cognitive processing deficits/biases; Koster et al., 2017). Yet, to date, evidence regarding the impact of CCT upon rumination appears equivocal and has been hindered by various methodological and conceptual concerns (Koster et al., 2017). Briefly, whilst some studies demonstrate a reduction in rumination following exposure to CCT across both at-risk and clinical samples

(e.g., Daches & Mor, 2014; Hoorelbeke, Koster, Vanderhasselt, Callewaert, & Demeyer, 2015; Hoorelbeke, Koster, Demeyer, Loeys, & Vanderhasselt, 2016; Schreiner, LeMoult, & Gotlib, 2015; Siegle et al., 2014), others failed to replicate such findings (e.g., Daches, Mor, & Hertel, 2015; De Putter, Vanderhasselt, Baeken, De Raedt, & Koster, 2015; de Voogd, Wiers, Zwitser, & Salemink, 2016; Iacoviello et al., 2014; Onraedt & Koster, 2014; Wanmaker, Geraerts, & Franken, 2015). There are, however, several possible explanations for this inconsistency.

Firstly, such research has involved a wide variety of training tasks, suggesting ongoing uncertainty regarding the key aspects of AC in depressive rumination and/or how to best train these abilities, and potentially explaining the inconclusive nature of the current evidence-base (Koster et al., 2017). Relatedly, several tasks used to train AC within existing CCT paradigms face ongoing concerns regarding their validity and/or reliability (Roberts et al., 2015). For example, the Negative Affective Priming task (NAP), commonly used to index inhibition, may rely on memory-related processes rather than AC per se (Mayr & Buchner, 2007). Similarly, the dual *n*-back task, commonly used to assess updating, has been criticised as a relatively impure assessment of such capabilities, as it confounds them with various other aspects of executive functioning and attention (e.g., Lilienthal, Tamez, Shelton, Myerson, & Hale, 2013). The use of impure or potentially invalid measures of AC may explain why certain studies failed to find evidence that CCT improves rumination, as the training may have simply failed to target the mechanisms of interest.

Alternatively, the equivocal nature of the existing experimental evidence regarding CCT for rumination may be due to uncertainty regarding the optimal conditions for training. Theoretically, if participants are not exposed to training sessions at a sufficient frequency/intensity, it may fail to adequately activate the

neural regions or cognitive processes responsible for evoking change in ruminative thought (Moshier & Otto, 2017). Indeed, recent reviews indicate that the majority of studies reporting null effects of CCT upon rumination used either single-session or low-dosage CCT procedures, whereas those using more intensive training schedules typically reported significant outcomes (Koster et al., 2017). Similarly, existing studies have varied concerning their use of neutral versus emotional training material and there is some evidence to suggest that greater gains are made when there is an emotional component to the CCT procedure (Koster et al., 2017). Finally, several existing studies suffer from a lack of statistical power due to the use of small sample sizes and/or the use of an insufficiently rigorous experimental design (i.e., no control group, failure to control for pre-existing group differences), issues which could potentially undermine the internal and/or ecological validity of such research (Koster et al., 2017).

Rationale for Current Study

In summary, potentially due to a range of methodological limitations and variation, existing experimental studies have failed to provide consistent evidence that deficits/biases in AC contribute causally to depressive rumination and, therefore, that CCT represents a viable treatment for such symptoms. The current study sought to address these limitations to further examine the utility of CCT in reducing rumination and/or improving mood among participants with elevated ruminative disposition. Issues concerning task validity were addressed by identifying a clear training target and using a well-validated measure to assess/train such abilities. The ability to resist interference from previously but no-longer relevant information (resisting proactive interference [RPI]; Friedman & Miyake, 2004) is a facet of AC with strong links to rumination (Roberts et al., 2015). Furthermore, the modified

Sternberg task is a well-validated measure of RPI that has previously been used to investigate the relationship between AC and rumination within correlational, cohort, and experimental studies (Joorman & Gotlib, 2008; LeMoult et al., 2014; Schreiner et al., 2015). Thus, following the work of LeMoult and colleagues (LeMoult et al., 2014; Schreiner et al., 2015), the modified Sternberg task (mST) was selected as a well-validated measure with which to train RPI using CCT. In addition, following the recommendations of previous CCT reviews, the task involved exposure to emotional stimuli (negative words) and participants were each exposed to eight hours of training (Koster et al., 2017; Shipstead, Redick, & Engle, 2012).

To date, most studies examining the impact of CCT upon rumination have used traditional pre-post designs that only assess the average level of change at a group level (Koster et al., 2017). Whilst useful, such designs are limited in the information they can provide and researchers are becoming increasingly interested in the utility of alternative designs that provide more fine-grained analysis of change. Through the use of regular repeated measurement and detailed visual analysis, single-case experimental designs (SCED) allow closer examination of change for each participant, potentially revealing important information about when change occurs (i.e., potential dosage effects) and whether the intervention is more effective for some participants than others (permitting the identification of potential moderators that warrant further investigation). Such information is not only important for directing further research, but is also potentially more clinically meaningful for practitioners seeking to know whether and when interventions might work for specific individuals, rather than a group, on average (Evans, 1995). Furthermore, tailored non-parametric statistical tests have also been devised to compliment and overcome some of the biases commonly encountered when relying on visual analysis alone

(Edgington & Onghena, 2007; Morley, 2017). SCED also have the advantage of not having to construct a well-matched control sample (as participants act as their own controls prior to treatment), overcoming a limitation common to several previous CCT studies (De Putter et al., 2015; Iacoviello et al., 2014; Onraedt & Koster, 2014; Wanmaker et al., 2015).

Within this design, daily rumination and mood ratings were compared before and after the introduction of daily mST-training, to evaluate the following hypotheses:

H1: Based on AC theories of rumination (Joormann et al., 2007; Koster et al., 2011), it was predicted that participants would demonstrate reductions in rumination following, but not before, the introduction of mST-training.

H2: Given evidence that levels of rumination influence mood (Watkins, 2008), it was predicted that daily mood ratings would improve following, but not before, the introduction of mST-training.

Additional pre-post training comparisons were made to evaluate the following hypotheses:

H3: Based on the premise that CCT produces generalizable gains in levels of inhibition (i.e., near-transfer; Koster et al., 2017), it was predicted that participants would show pre-post training improvements in a non-trained transfer task of inhibition.

H4: Finally, given evidence that rumination is linked to the severity of depressive episodes (Nolen-Hoeksema, 1991, 2000), it was predicted that participants would demonstrate reductions in self-reported depressive symptom severity following, but not before, the introduction of mST-training.

Method

Design

H1 and H2 were examined using a multiple-baseline SCED (MBD), replicating an AB phase design across participants. By staggering the onset of treatment across participants, MBD reduce the likelihood of change being due to extraneous factors or chance alone, thus enhancing the internal validity, generalisation, and selectivity of SCED, and permitting the examination of causal relationships (Koehler & Levin, 1998; Manolov, Losada, Chacón-Moscoso, & Sanduvete-Chaves 2016). Within the current design, the onset of daily mST-training was randomly determined within a set range of start points for each participant, and average levels of daily mood/brooding were compared between baseline (A-phase) and training (B-phase), before being combined to produce an overall estimate of the effect of training upon daily ratings. Neither participants nor researchers were blind to treatment assignment.

Ideally, MBD would include sufficient measurement points to achieve a stable baseline, clear evidence of a treatment effect, and enough points of potential phase shift to examine individual significance (i.e., for each participant separately). Yet, researchers must also balance such requirements with ensuring that the overall duration and task-load of training remains feasible for participants. Given the current uncertainty regarding the time required to obtain a stable baseline across the daily ratings and/or detect an effect of mST-training, length of baseline and training phases was prioritised over the number of potential points of phase shift. As a result, the current study focused on determining significance at the group level, rather than determining individual significance for each participant (which would have

required a much greater number of potential points of phase shift and, thus, considerably extended the study duration).

Consequently, participants spent a minimum of 14 days in the baseline phase (day 1-14), a minimum of 14 days in the treatment phase (day 22-35), and shifted from baseline to treatment between day 15 and 21 (seven potential points of phase shift). The point at which each participant moved from baseline to treatment was randomly determined *a priori*, using the SCRT package for “R” statistical software (Bulté & Onghena, 2008). Use of a randomised phase change means that, should changes in levels of rumination and/or mood be consistently observed following (but not before) the point of transition for each participant, despite differences in individual presentation and/or length of baseline, such changes are less likely to be due to other confounding factors, such as history, maturation, spontaneous remission, or statistical regression (Kazdin, 2003). It also permits the use of non-parametric statistical analysis (randomisation tests; Edgington & Onghena, 2007, see analysis section for further details). Risk of bias analysis using the Single-Case Reporting Guideline in Behavioural Interventions (SCRIBE) checklist (Tate et al., 2016) indicated the current design and methodology were adequate.

Hypotheses 3 and 4 were examined using a repeated-measures design. Measures of depressive symptom severity and non-trained inhibition were administered and compared at three time points for each participant (baseline, pre-training and post-training).

Participants

Recruitment and screening. Participants were recruited using the online participant registration system at the University of Exeter and completed an online screening questionnaire (the Ruminative Response Scale [RRS]; Nolen-Hoeksema

& Morrow, 1991) to determine their initial eligibility as high-brooding individuals (defined as a brooding score $>1SD$ above the mean reported for community adults [cut-off >12.36]; Treynor, Gonzalez, R., & Nolen-Hoeksema, 2003). A total of 26 participants completed the initial RRS screening (total RRS $M = 52.62$ [$SD = 13.45$]; brooding $M = 12.96$ [$SD = 4.18$]). Thirteen participants met the eligibility criteria (brooding score >12.36) and were invited to attend a baseline assessment session (total RRS $M = 61.23$ [$SD = 10.55$]; brooding $M = 16.46$ [$SD = 2.07$]). Eleven participants attended this session and entered the baseline phase (all female, $M_{age} = 25.55$ [$SD = 9.11$]), whilst the two remaining eligible participants chose not to attend. Six participants described themselves as White-British/White-European, whilst the remaining participants described themselves as Chinese ($n = 2$), Afro-Caribbean ($n = 1$), Asian ($n = 1$), and Malaysian ($n = 1$).

Eligibility criteria. Due to all study questionnaires and instructions being written in English and performance within the mST involving judgements regarding the valance of English words, all participants were required to identify themselves as fluent in English. Also, in order to complete the mST-training and daily ratings online, all eligible participants required access to a computer.

During the baseline assessment session, further eligibility criteria were examined using a brief demographic questionnaire concerning any current/historical mental health difficulties. Given the transdiagnostic nature of rumination (Watkins, 2009), clients with comorbid anxiety or Axis II diagnoses were still eligible to participate. Clients with a history of bipolar disorder or psychosis, current drug/alcohol dependence, learning disability, or organic/acquired brain damage were not eligible to participate. Given the wish to avoid interfering with treatment-as-usual, those currently taking psychotropic medication for depression or any other

eligible comorbidity were eligible. To avoid confounding any effects of daily mST-training with those of standard psychological treatment, however, individuals currently receiving active psychological treatment were ineligible. Four participants indicated a current mental health diagnosis (depression $n = 2$, post-traumatic stress disorder $n = 1$, obsessive-compulsive disorder $n = 1$), of which two were currently receiving pharmacological treatment (antidepressants) and three had received previous, but not current, psychological therapy.

All participants were paid 50p per-day for their participation, up to a maximum £17.50 for completing the full 5-weeks.

Measures

Eligibility measures.

The Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991). The RRS is a 22-item measure of ruminative disposition, rating the frequency of various ruminative strategies. The brooding subscale consists of five items, with scores ranging from 5-20 (higher scores indicate higher levels of trait rumination). The brooding subscale has demonstrated acceptable levels of internal consistency ($\alpha = .77$), but only moderate test re-test reliability ($r = .62$), potentially due to its brevity (Treyner et al., 2003).

Phase-change measures.

The Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer, & Williams, 2001). The PHQ-9 is a nine-item questionnaire that assesses each DSM-V diagnostic criterion for depression. Scores range from 0-27, with higher scores indicating greater depression severity. The PHQ-9 has demonstrated excellent internal ($\alpha = .89$) and test re-test reliability ($r = .84$), as well as acceptable validity (Kroenke et al., 2001).

The Affective Shift Task (AST; De Lissnyder, Koster, Derakshan, & De Raedt, 2010). Performance on the AST was used as an indicator of non-trained inhibition (near-transfer) at baseline, pre- and post-training. The AST was programmed using an open-source web application that facilitates the design and online administration of psychological studies (Just Another Tool for Online Studies [JATOS]; Lange, Kühn, & Filevich, 2015). Using this platform, participants were able to download and complete the AST on any university- or personally-owned computer.

Following the procedure used by De Lissnyder et al. (2010), all AST stimuli were created using a subset of 12 happy and 12 angry faces from the Karolinska Directed Emotional Faces database (KDEF; Lundqvist, Flykt, & Öhman, 1998), validated as highly representative of the intended emotional expression (Goeleven, De Raedt, Leyman, & Verschuere, 2008). Potentially distracting background stimuli were obscured (including hair) and all images were presented in greyscale. These images were then used to create 48 composite AST stimuli, each displaying four facial images simultaneously in a 2x2 grid. Each stimulus image was composed such that it was possible to identify a single “odd-one-out” across each of three key dimensions (emotion [happy vs angry], gender [male vs female], and colour [light vs dark grey]). The positioning of each respective odd-one-out varied randomly between trials. All composite stimuli were presented against a black background on the computer screen.

For each trial (see Figure 1), participants were first shown one of three cue words, “emotion”, “gender” or “colour”, presented in white, uppercase text in the centre of the screen for 500ms. This cue word signalled which attribute participants should use to identify the odd-one-out within the facial composite stimuli, which

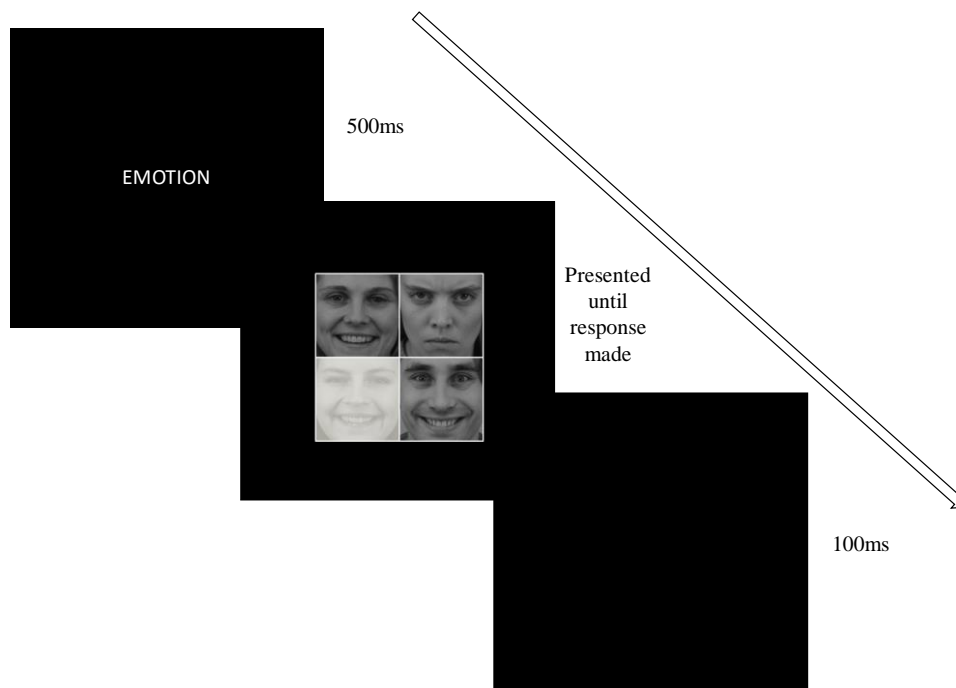


Figure 1. Example AST trial (adapted from De Lissnyder et al., 2010) indicating the participant should judge which face is the odd-one-out based on the emotional expression.

immediately followed the cue and remained on-screen until the participant made their choice response. On presentation of the facial composite, participants were instructed to indicate which image represented the odd-one-out as quickly and accurately as possible, using designated keyboard response keys that corresponded to the on-screen positioning of each image (i.e., “q” = upper left, “p” = upper right etc.). Responses were followed by a blank screen, presented for 100ms before the start of the next trial. During each completion of the AST, participants completed an initial five practice trials, followed by 216 full trials, divided equally into two rounds that were separated by a short rest break. Accuracy and reaction time (RT) data were recorded for each trial.

The AST procedure was programmed to contain a pre-designated number of four *trial types* (inhibition [48], control [48], unclassified [48], and repeat [72]), each of which comprised of three full trials (see Table 1) and were used to calculate an index of non-trained inhibition (RT inhibition – RT control; higher score indicated greater attentional control).

Table 1

Example AST trial types

Trial type	Trial 1 cue	Trial 2 cue	Trial 3 cue
Inhibition (a-b-a)	Emotion	Colour	Emotion
Control (c-b-a)	Gender	Colour	Emotion
Unclassified (b-b-a)	Colour	Colour	Emotion
Repeat (a-a)		Emotion	Emotion

Daily rating measures.

The Positive and Negative Affect Schedule-Expanded Form (PANAS-X; Watson & Clark, 1994). The PANAS-X is a 60-item self-report questionnaire that rates levels of different emotional states within a specified time-period (in this case, the last 24 hours). Within the current study, only items from the positive affect (PA), negative affect (NA), and sadness scales were used. The PANAS-X subscales have demonstrated good internal reliability (PA, NA, and sadness $\alpha = .89, .87, \text{ and } .87$ respectively) and acceptable construct validity (Watson & Clark, 1994).

In-vivo Ruminative Brooding Scale (IRBS). Following contemporary guidelines for assessing state rumination (Mor & Daches, 2015) participants were asked to recall the most unpleasant event experienced within the last 24 hours. They then completed a modified version of the RRS brooding subscale, reflecting the extent to which they had engaged in rumination about that particular event over the last 24 hours. Based on participant data collected during the first 14 days of the current study (before the training procedure was introduced for any participant; number of completions $n = 105$), the IRBS demonstrated excellent internal reliability ($\alpha = .96$).

Intervention.

Daily modified-Sternberg training (mST). Following the procedure used by LeMoult and colleagues (LeMoult et al., 2014; Schreiner et al., 2015), daily AC training consisted of an affective version of the modified-Sternberg task (Joorman & Gotlib, 2008). The mST was also programmed and administered online using JATOS (Lange et al., 2015), such that participants could download and complete their daily training from their personal computers. Following the procedure used by Joorman and Gotlib (2008), all mST trials consisted of three displays, *learning*, *cue*, and *probe* (see Figure 2). During the learning-display, participants were presented with a fixation cross for 500ms, followed by two word-lists containing three words each (one printed in red, the other in blue), and were instructed to memorise each of these words whilst they were displayed on-screen (7800ms). After a blank screen was shown for 800ms, participants were then presented with the cue-display for 1000ms, which consisted of either a red or blue frame presented in the centre of the screen, indicating which word list was relevant to their decision regarding the upcoming probe. The probe then appeared in the centre of the frame, printed in

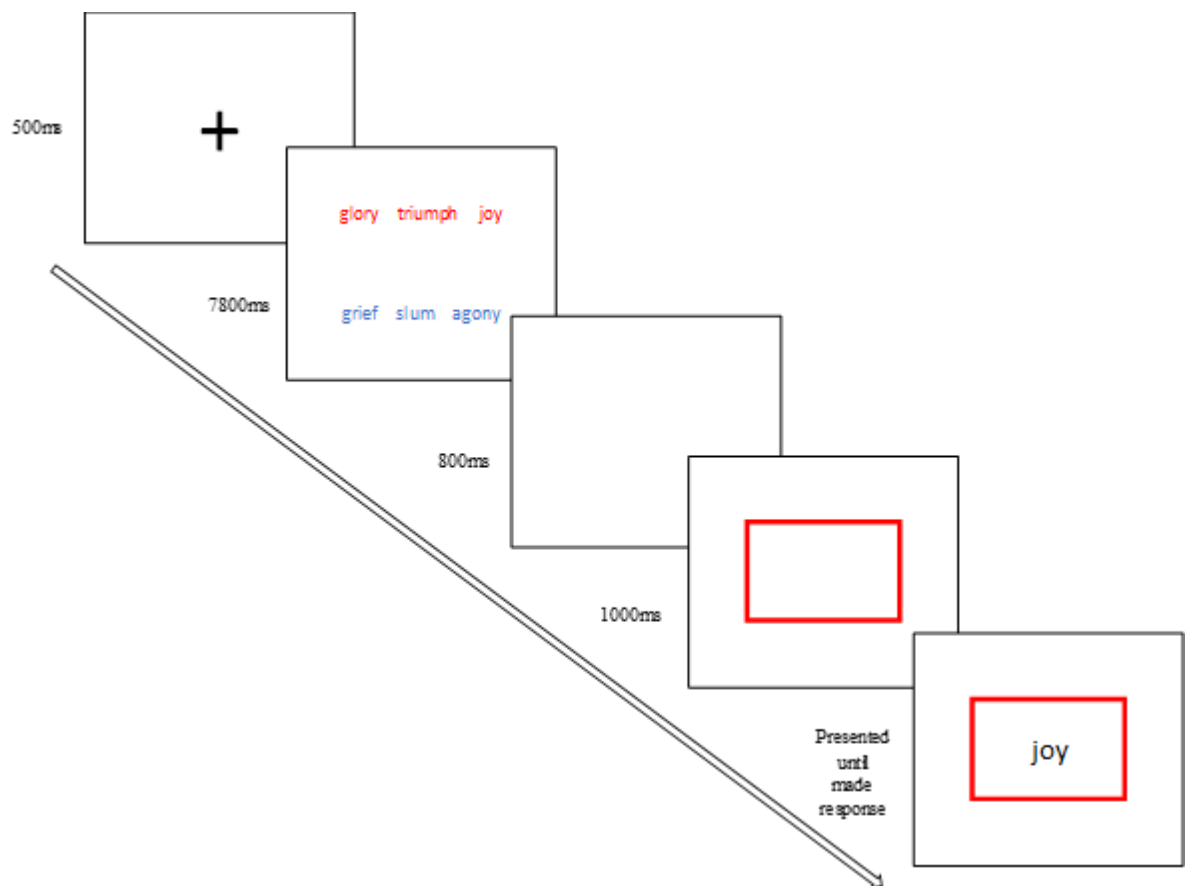


Figure 2. Example mST trial designed to train removal of negative information. Cue display contains red frame, indicating the positive word-list is to-be-remembered and, thus, the negative word list should be removed from WM and not used to judge familiarity of probe.

black lower-case text, and participants were asked to judge as quickly and accurately as possible whether the probe belonged to the previously presented cued word-list, using designated keyboard response keys (y = yes, n = no). The probe-display remained on-screen until the participant made their response. Accuracy and reaction time (RT) data were recorded for each trial.

Each day, the mST consisted of 120 trials, separated into three equal blocks with a short rest between each block. Trials consisted of nine different types (see Appendix B), depending on the word-list cued within the cue-display and the probe shown during the probe-display. During the eight critical trial types, each word-list contained exclusively positive or negative words and the two lists differed in valance. The positioning (top vs bottom) of positive vs negative and red vs blue word-lists was counterbalanced across all such trials. The ninth trial type represented control trials in which the valance of both word-lists was mixed. All words were selected from a list of 208 nouns taken from the Affective Norms of English Words (Bradley & Lang, 1999), previously matched for word-length and arousal ratings (Joorman & Gotlib, 2008).

In order to train RPI for negative material, the proportion of trial types was skewed such that participants practised removing negative word-lists from their WM on 70% of the trials (see Figure 2 for an example). Within the current study, performance on the mST was operationalised using the negative intrusion index (NI), calculated using trials in which the probe represented a negative intrusion (previously but no longer relevant word from negative word-list) and trials where the probe was an entirely new negative word (RT Negative-Intrusion trials – RT Negative-New trials; lower score indicated greater attentional control).

Procedure

All interested participants were directed to complete the online RRS screening questionnaire. Ineligible respondents were thanked and debriefed via email, whereas eligible respondents were invited to attend a baseline assessment session, during which they completed the demographic questionnaire and, if eligible, completed the baseline PHQ-9 and AST measures. Participants were then randomly assigned to

an *a priori* point of phase shift and entered the baseline phase, during which they provided daily ratings of their mood and brooding using online versions of the IRBS and PANAS-X subscales.

The day before their randomly determined point of phase shift, each participant was instructed via email to complete the pre-training PHQ-9 and AST online. Participants then entered the training phase and, in addition to their daily mood/brooding ratings, completed approximately 35-minutes of mST-training per day (depending on their speed of performance). Throughout both the baseline and training phases, participants received daily reminder emails to complete their ratings/training and were also contacted once a week via an additional email to monitor their progress and sense of well-being. Once each participant had completed the full 5-week study, they were again contacted via email and instructed to complete the post-training PHQ-9 and ATS online. Participants then received a full written and verbal debrief (in person $n = 4$, via telephone $n = 7$), along with their study payment. All aspects of the study were approved by the University of Exeter Department of Psychology Ethics Committee (see Appendix C).

Analysis

Training effect. Based on procedures for demonstrating improved performance within other cognitive training programmes (i.e., Cogmed, 2011), the impact of daily training on mST performance was assessed by comparing the average score of day 2 and 3 of training with the average of the two best scores achieved within the second half of each participant's training phase. Given the small number of participants, such scores were compared using the non-parametric *t*-test equivalent (Wilcoxon Signed-Rank test).

Transfer effects. The limited number of data observations precluded the use of traditional parametric and/or randomisation tests for comparing baseline, pre-training, and post-training scores within the AST and PHQ-9. Thus, the impact of training on depressive symptomology (far-transfer) was examined by determining whether participants demonstrated reliable, clinically significant change within the PHQ-9 (pre-post training score reduction ≥ 5 points and Reliable Change Index > 1.96 ; Jacobson & Truax, 1991; Kroenke & Spitzer, 2002). Given there were no equivalent guidelines regarding clinically significant change within the AST, evidence of near-transfer was assessed by comparing inhibition scores at baseline, pre-training and post-training assessments using the non-parametric within-subject ANOVA equivalent (Friedman's test).

Daily rating measures. Given that data within a single case-series typically violate the assumptions of parametric testing, it was not possible to conduct traditional inferential analyses on the daily brooding/mood ratings (Edgington & Onghena, 2007). Following guidelines for quality single-case research (Tate et al., 2016), analysis consisted of systematic visual analysis (Kratochwill et al., 2013) and randomisation tests designed to examine the null hypothesis that responses on the daily measures were independent of study phase (Edgington & Onghena, 2007).

Visual analysis. Following guidelines provided by Gast and colleagues (Gast, 2010; Lane & Gast, 2014), daily ratings for each participant were subjected to systematic within- and between-condition visual analyses, examining indices of central tendency/level, trend, variability, immediacy, and overlap. The broadened median was used as a robust indicator of central tendency (less influenced by outliers; Morley, 2017). The relative level change and split-middle methods were used to evaluate the presence of within-condition trend, and stability envelopes

calculated to assess variability (Gast, 2010). Given the assumption that the effects of training are likely to be delayed rather than immediate, the relative level change was considered a more useful estimate of between-condition differences than the absolute level change (Gast, 2010). Finally, non-overlap of all pairs (NAP; Parker & Vannest, 2009) was calculated using an online calculator (Vannest, Parker, Gonen, & Adiguzel, 2016) to provide a robust, overlap based index of effect size for each participant (Manolov et al., 2016). Reporting standards produced by Kratochwill et al. (2013) were then used to determine whether the current visual analysis provided evidence of an effect of mST-training on the daily rating measures, defined as three distinct demonstrations of an effect, in the absence of any failures to observe an effect.

Statistical analysis. While visual analysis remains the most common means of assessing single-case data, such methods are prone to an increased risk of Type I errors and can be enhanced by complementary statistical analyses (Kratochwill et al., 2013). While a number of approaches to the statistical analysis of single-case data have been proposed, randomisation tests have the benefit of being simple to calculate, making no assumptions about the underlying error structure or sampling of the data, and adapting to a wide range of single-case designs, including MBD (Morley, 2017). Within the current study, all randomisation tests were computed using the Single-Case Randomisation Test (SCRT) package within “R” (Bulté & Onghena, 2009). Given the limited number of points of potential phase-shift ($n = 7$), randomisation tests were calculated for each daily rating outcome variable across the participant group as a whole, as it was not possible to examine individual significance for each participant separately.

For each analysis, following the recommendations of Bulté and Onghena (2008), a Student's T value was computed for each participant by subtracting the mean of scores within the treatment phase from the mean of scores obtained in the baseline phase $T = (\bar{A} - \bar{B})$.⁹ This observed value was then compared against all other potential values generated using a systematic randomisation distribution calculated by SCRT, and aggregated across all participants to determine the combined p value (defined as the proportion of generated test statistics that are equal to or exceed the observed test statistic). Thus, the resulting p value reflects the likelihood that the same results would have been obtained if the data were assigned to re-arranged placements (Bulté & Onghena, 2008).

Due to the large number of possible placements (defined as points of phase shift (k) to the power of number of participants (n); $k^n = 7^8 = 5,764,801$), Monte-Carlo simulations were used to select a random sample of 1000 possible placement combinations for the purpose of calculating statistical significance within all randomisation tests (Bulté & Onghena, 2009). The level of statistical significance was set at $\alpha = .05$. Recent simulation studies indicate that MBD with at least 30 data-points typically achieve adequate power ($> .80$) to calculate randomisation tests at the group level when there are four or more participants (Heyvaert et al., 2017). Average NAP was then calculated as a measure of effect size for each of these aggregated results (Petersen-Brown, Karich, & Symons, 2012).

⁹ Except for the analyses for PA where ($T = \bar{B} - \bar{A}$) was used, given that an increase in scores was predicted.

Results

Training Compliance

While 11 participants began the study, one participant withdrew on the first day of training, whilst another withdrew after completing seven days of training. Both participants cited excessive training duration as their reason for withdrawing. No additional adverse events were noted for the remaining participants. Of those that completed the full 5-weeks, the average number of training days completed was 12.30 (range 2-20). Given the low compliance rate of one participant (completed training $n = 2$), the decision was made to exclude their data from all formal analyses (final $n = 8$).¹⁰ Figure 3 depicts the MBD sequence completed by each participant.

Participant	Sequence	Day of phase shift
1	AAAAAAAAAAAAAAAABBBBBBBBBBBBBBBBBBBB	15
2	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBB	22
3	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBB	19
4	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBB	16
5	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBB	20
6	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBB	17
7	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBB	18
8	AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABBBBBBBBBBBBBBBB	19

Figure 3. Sequence completed for each participant.

¹⁰ In keeping with best practice recommendations for reporting the outcomes of SCED (Tate et al., 2016), graphical data are provided for this participant in Appendix D

Training Effects

Based on the scoring procedure described by Joorman and Gotlib (2008), only correct responses <3000ms were used to calculate daily NI for each participant. As shown in Table 2, by comparing NI scores at the start and end of training (Cogmed, 2011), each participant demonstrated improved mST performance. Furthermore, this improvement was significant across the group as a whole ($Z = -2.52, p = .012, r = .63$).

Transfer Effects

Near-transfer. Table 3 contains AST inhibition scores for each participant at baseline, pre- and post-training. Following the scoring procedure described by De Lissnyder et al. (2010), only full trials in which all three trials were correct were included for analysis. Based on these same guidelines, improved attentional control was conceptualised as *increased* scores on the inhibition index. Against predictions (H3), the results indicated no significant differences between inhibition scores at any time point ($\chi^2(2) = 4.00, p = .13$) and, thus, no evidence of near-transfer following daily mST-training. When programming the AST, however, a programming error was made such that several participants were not shown any emotional control trials (i.e., judging the odd-one-out based on emotional expression after previously judging this based on gender and colour). As reaction times to this trial type are required to calculate an index of inhibition during this task (De Lissnyder et al., 2010), it was not possible to calculate valence-specific indices of inhibition (i.e., negative versus neutral inhibition abilities). As such, the current data represent average performance across all three trial types (emotion, gender, and colour trials) and, thus, act as an indicator of generalised, rather than valence-specific inhibition abilities.

Table 2

Negative Intrusion Scores Demonstrating the Impact of Daily Training

Participant	NI-start	NI-end
1	386.43	54.23
2	450.40	-113.16
3	332.65	156.95
4	462.18	3.55
5	50.33	-39.81
6	460.41	100.16
7	162.65	-5.28
8	266.02	76.50
Mean	321.39	29.14

Note: NI-start = Average negative intrusion score for day 2 and 3 of training; NI-end = Average negative intrusion score for best two days during second half of training phase.

Table 3

Scores within the Affective Shift Task

Participant	Inhibition baseline	Inhibition pre-training	Inhibition post-training
1	-285.27	20.30	-62.28
2	-535.98	114.87	81.05
3	477.76	726.35	188.00
4	53.98	391.88	318.80
5	315.92	-293.49	364.27
6	-135.56	198.28	-99.76
7	-347.30	63.43	-245.42
8	93.97	-142.17	87.96
Mean	-45.31	134.93	79.08

Far-transfer. PHQ-9 scores, change scores, and RCIs for each participant at each time-point are summarised in Table 4. Against predictions (H4), one participant demonstrated a reliable, clinically significant increase in PHQ-9 scores between baseline and pre-training (before the introduction of daily mST-training), followed by a reliable, clinically significant decrease in scores between pre-post training (P7). Such patterning may indicate that this contra-therapeutic increase in depression

severity was unrelated to the introduction of daily mST-training and, instead, represented a return to prior levels of functioning after a temporary reprieve of symptoms over the course of this participant's baseline. In line with predictions (H4), two participants demonstrated a clinically significant, reliable change between pre-post training (P1,3). The remaining five participants demonstrated non-significant and/or unreliable change within the PHQ-9.

Daily Ratings

Visual analysis. Figures 4-7 display the daily rating data acquired for the in-vivo brooding measure and each PANAS-X subscale. Dashed lines indicate the split middle trend line for each phase.¹¹

Within-condition analysis. Given the importance of baseline stability when seeking to infer an effect of treatment, for each outcome across each participant, the final five baseline data points were inspected for evidence of adequate stability (80% of data points falling within 20% of the median; see Appendix E) and indices of trend were inspected for evidence of absent or contra-therapeutic baseline trend (Gast,

¹¹ Please see Appendix E for full raw data across all daily rating measures

Table 4

PHQ-9 Scores, Score Changes and Reliable Change Indices

Participant	Baseline PHQ9 (A)	Pre-training PHQ9 (B)	Post-training PHQ9 (C)	B-A	A-B RCI ^a	C-B	B-C RCI ^b
1	19	21	16	2	0.85	-5	-2.16*
2	3	7.88 [†]	9	4.88	2.09*	1.12	0.48
3	8	8	2	0	0	-6	-2.60*
4	8	7	6	-1	-0.43	-1	-0.43
5	6	2	0	-4	-1.71	-2	-0.87
6	11	12	11	1	0.43	-1	-0.43
7	15	9	14	-6	-2.56*	5	2.16*
8	7	5	7	-2	-0.85	2	0.87

Note: PHQ9 = Patient Health Questionnaire-9; RCI = Reliable Change Index; * $p < .05$; [†] = pro-rated score due to missing data point;

^acalculated using baseline PHQ-9 $\alpha = 0.81$ and $SD = 5.37$; ^bcalculated using pre-training PHQ-9 $\alpha = 0.88$ and $SD = 6.68$.

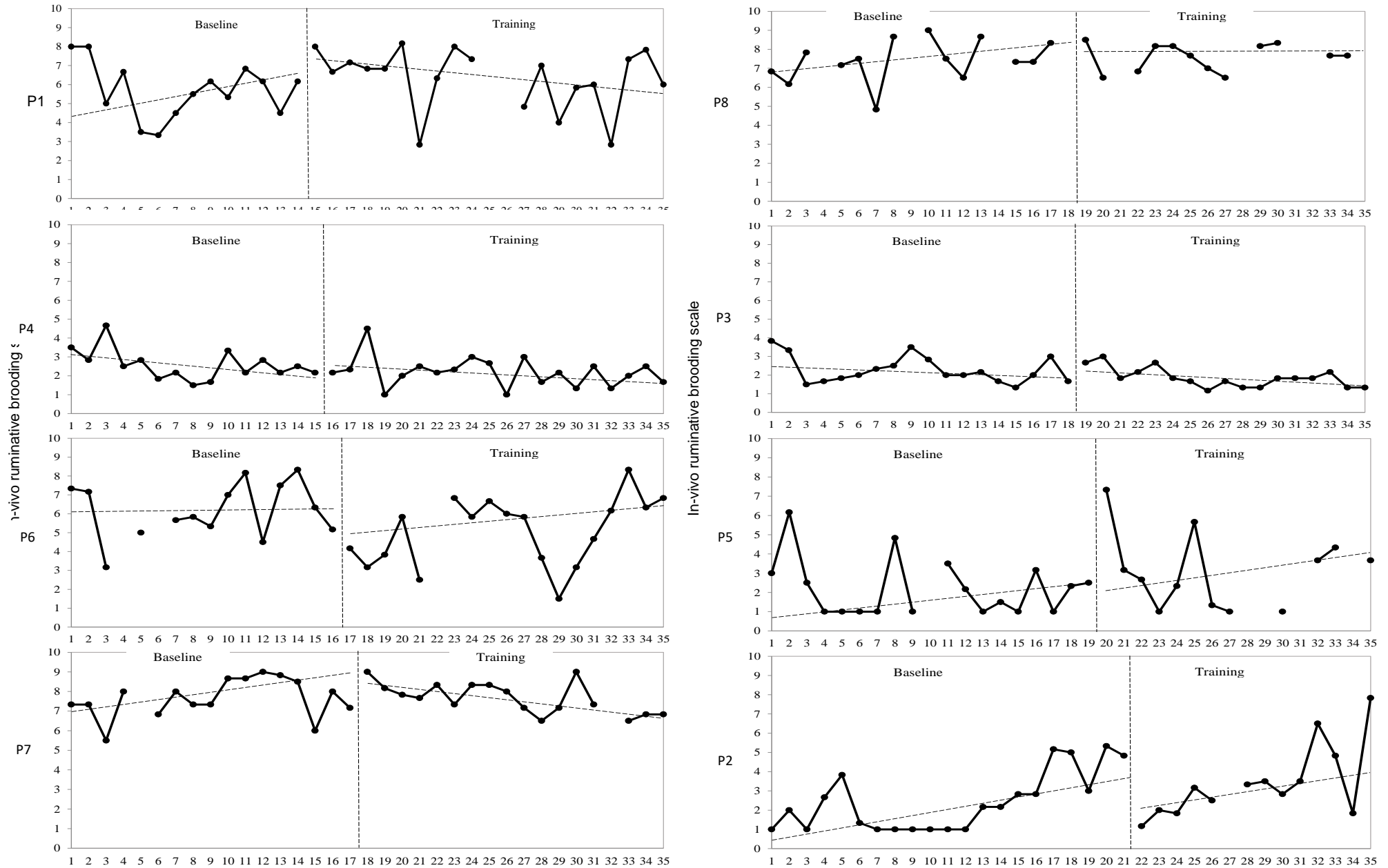


Figure 4. Multiple baseline design across eight participants for daily ratings within the in-vivo ruminative brooding scale.

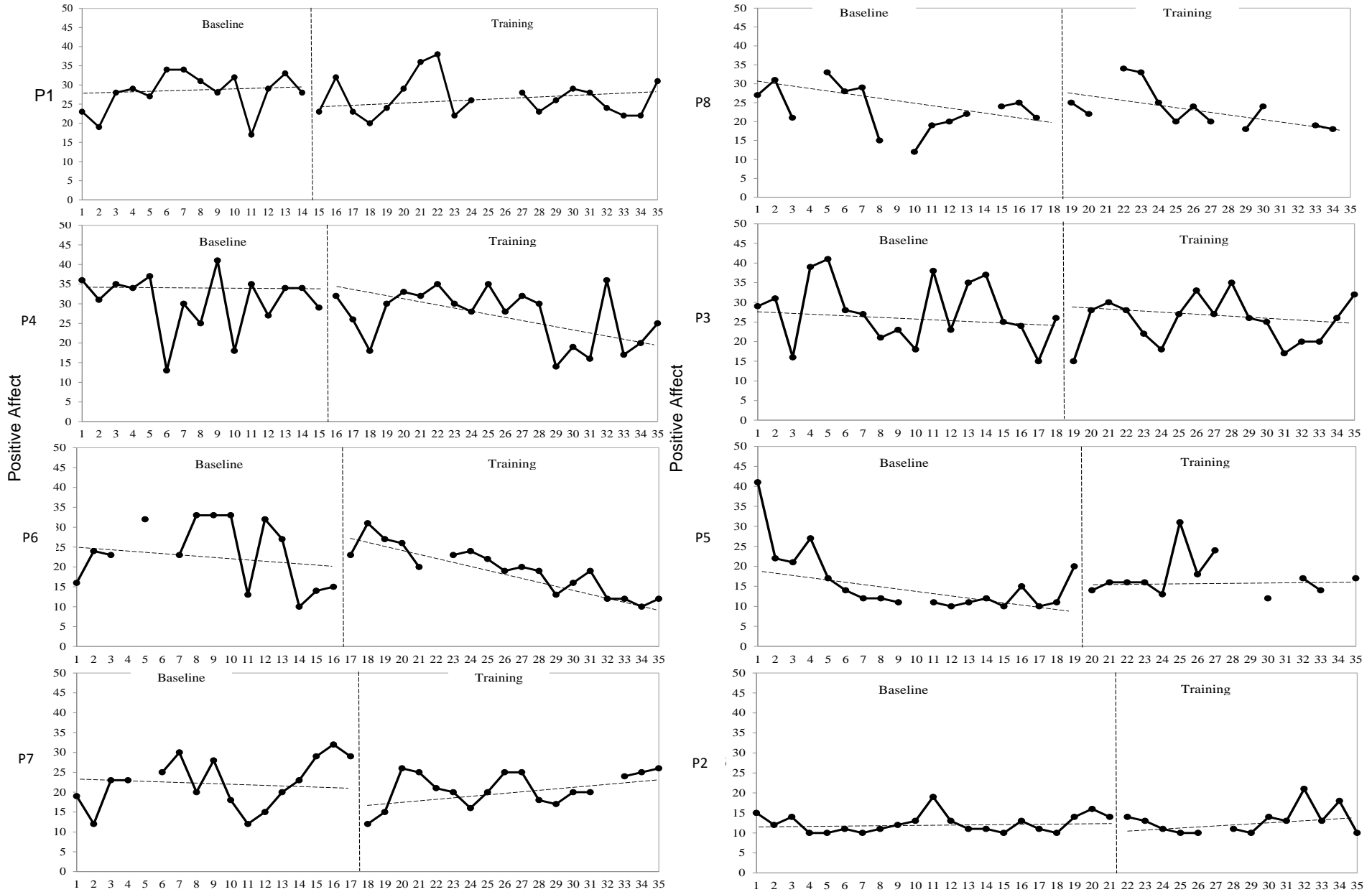


Figure 5. Multiple baseline design across eight participants for daily ratings within the PANAS positive affect scale.

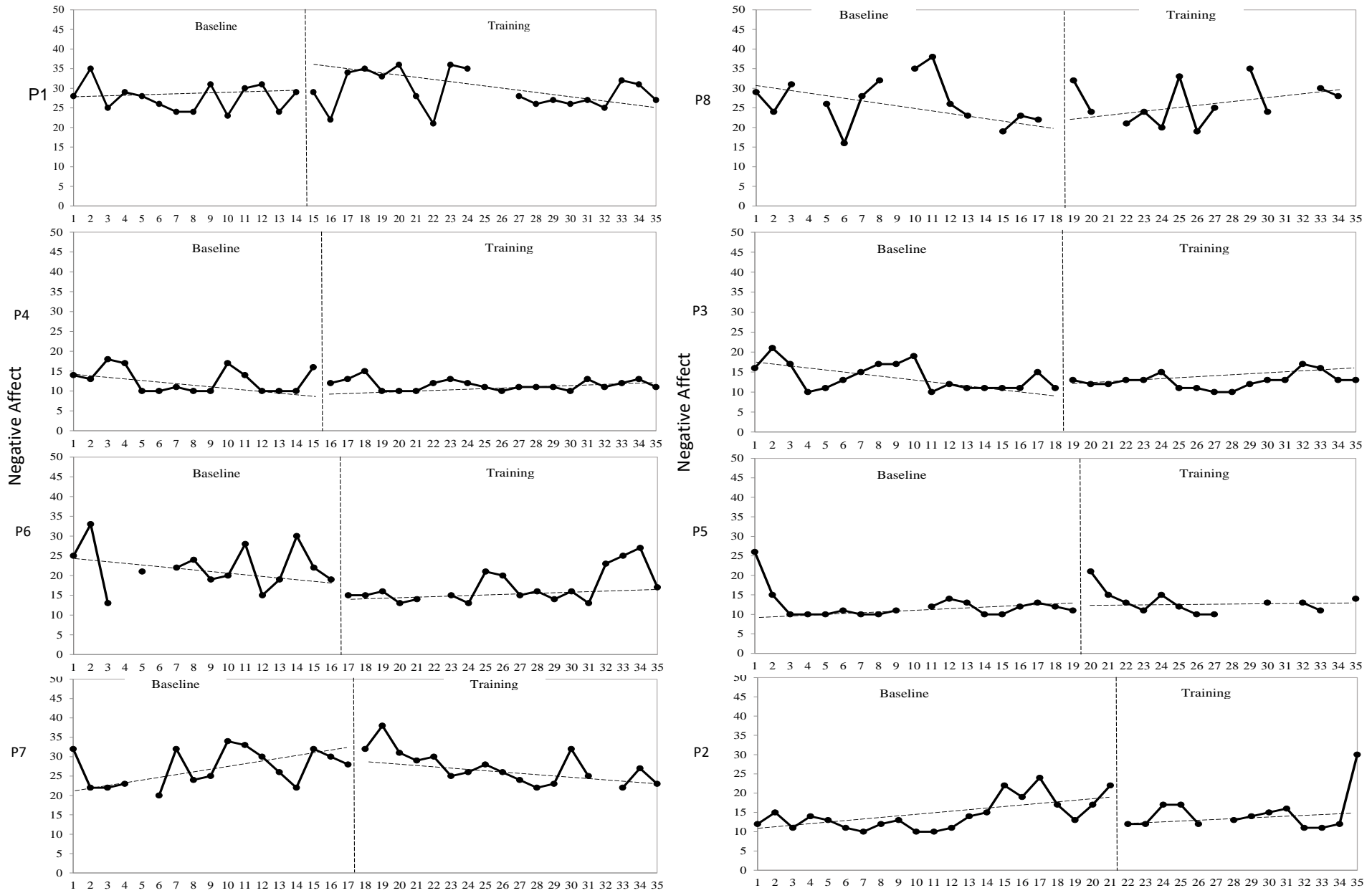


Figure 6. Multiple baseline design across eight participants for daily ratings within the PANAS negative affect scale.

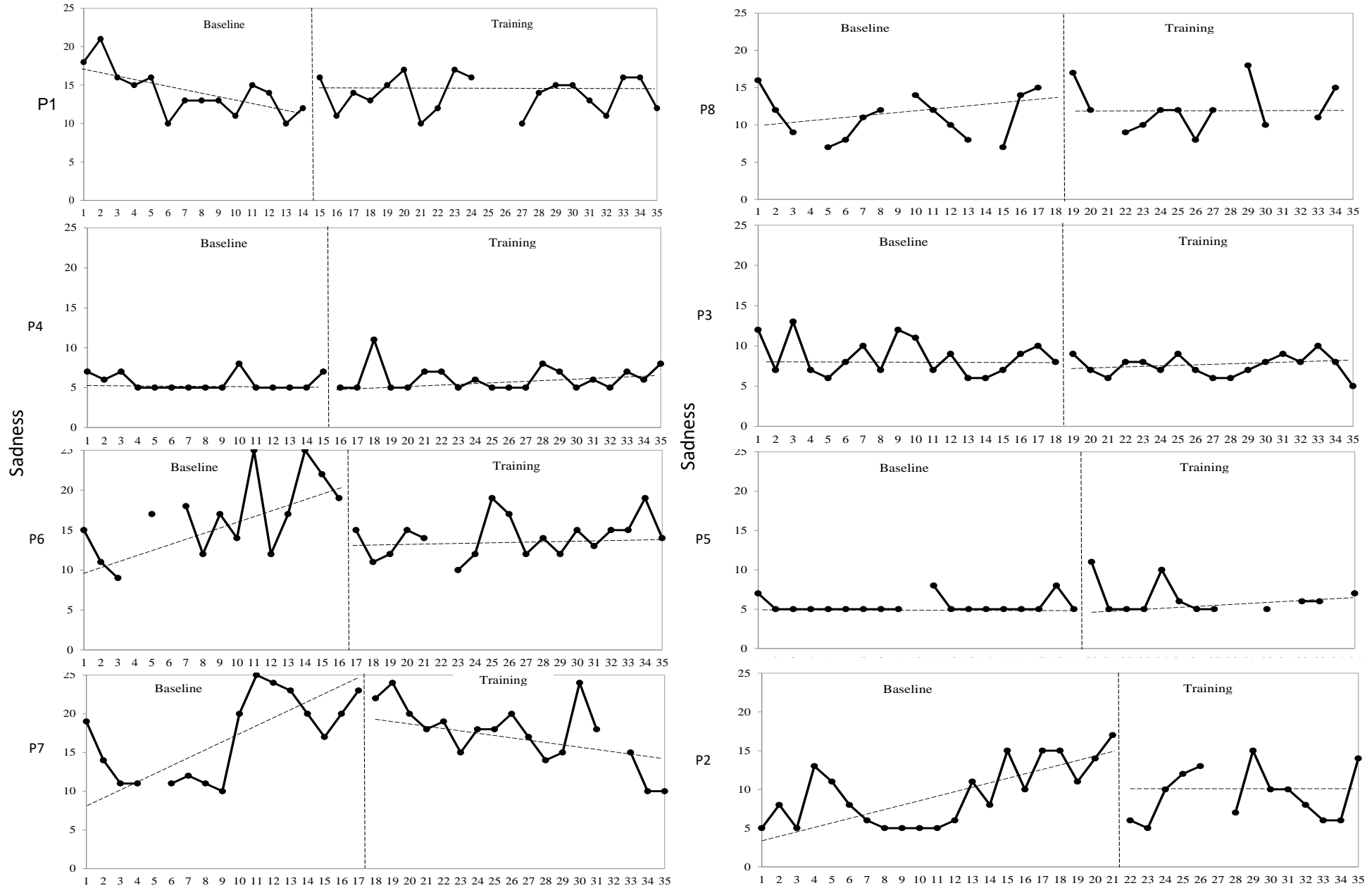


Figure 7. Multiple baseline design across eight participants for daily ratings within the PANAS sadness scale.

2010). Only one participant demonstrated adequate baseline stability and the absence of significant baseline trend across all four outcomes (P1). Examination of the relative level change and split middle indices revealed that a further three participants (P2,5,7) demonstrated baseline trends that were at odds with the predicted benefits of training (i.e., they showed *increases* in rumination, sadness and negative affect, and *decreases* in positive affect over the course of the baseline phase). Whilst not ideal, these trends were considered unlikely to undermine or contaminate the ability to detect significant changes in the predicted direction during the training phase. However, baseline phases for the remaining four participants demonstrated significant baseline instability and/or pre-existing trends in the predicted direction of treatment, factors which could undermine the interpretation of any significant effects of training upon their daily ratings. Ideally, such participants would have continued providing baseline ratings of their mood/brooding until sufficient stability was achieved (Gast, 2010). Unfortunately, such idiographic procedures would have precluded the use of randomisation tests within a multiple-baseline design, which require all participants to complete an equal number of ratings overall and the use of pre-determined, randomised points of phase-change (Edgington & Onghena, 2007).

Examination of the broadened median stability envelopes also revealed variability within the training phase; no participant met the criterion for phase stability across all four outcome measures consistently (see Appendix E). Such variability hinders the ability to detect clear patterns and/or infer effects within the training phase (as variability may be due to extraneous events; Gast, 2010). From examining the within-phase trend indices, over the course of training, four participants demonstrated predicted reductions in brooding (P1,3,4,7), three

demonstrated predicted improvements in PA (P1,2,7), two demonstrated predicted reductions in NA (P1,7), and one demonstrated a predicted reduction in sadness (P7). The magnitude of such changes remained small, however, and must be interpreted in light of any existing baseline trends, as examined through the between-condition analyses below.

Between-condition analysis. Comparison of baseline versus training trends indicated that, across participants, the majority of outcome measures demonstrated either continued deterioration across baseline and training phases, or initiated deterioration during the training phase itself (20/32 measures). Of the remaining 12 outcomes that demonstrated some level of improvement over the course of training, six of these occurred in the context of an existing baseline trend towards improvement, undermining the ability to infer a causal effect of training on such ratings. Thus, comparing baseline and training conditions directly, only one participant demonstrated a convincing change from deterioration to improvement on all four outcome measures (P7) and one other participant also showed similar improvements for NA and brooding (P1). With the exception of P7's sadness scores, the magnitude of such changes in trend remained small, however.

Relative change level analyses revealed that, for PA and sadness, an equal number of participants showed signs of deteriorating and improving following the introduction of training, whilst, for brooding and NA, the majority of participants either remained stable or deteriorated in their scores following the introduction of training. Again, the magnitude of such changes remained small. Indeed, as a measure of the degree of overlap between data within the baseline and training phases, NAP calculations revealed that the majority of effect sizes were small (≤ 0.65 ; Parker & Vannest, 2009), the only exceptions being evidence of medium-sized reductions in

rumination, NA and sadness for P6, a medium-sized decrease in rumination for P3, and a medium-sized increase in PA for P5.

Overall, based on current reporting standards (Kratochwill et al., 2013), the results of systematic visual analysis provide *no evidence* to support an effect of daily mST-training on either brooding or any of the mood subscales.

Statistical analysis. For all randomisation tests, missing values were replaced using the broadened median for the relevant phase. The results indicated no significant improvement at the group level for self-reported brooding ($p = .404$, NAP = 0.45), PA ($p = .615$, NAP = 0.51) or NA ($p = .444$, NAP = 0.49). Although there was evidence of a trend towards a reduction in self-reported sadness, this change also remained non-significant with only a small effect size ($p = .052$, NAP = 0.50).

Discussion

The current study aimed to investigate the impact of inhibition-based CCT on depressive rumination and mood, using a multiple baseline SCED. Whilst participants' performance within the mST improved over the course of training, against predictions (H3), this did not generalise to increased performance within a non-trained task of inhibition (no evidence of near-transfer). This lack of transfer may indicate that the observed within-task improvements were merely due to the effects of practice, rather than a true increase in inhibition abilities, potentially undermining the validity of mST-training as an effective form of CCT. Alternatively, such null-effects could be due to the limitations of using the current AST as an index of near-transfer. Firstly, due to a programming error, it was only possible to calculate global changes in inhibition across all trial types, rather than focusing on changes in

the ability to inhibit emotional content specifically (which are more consistently implicated in rumination/depression; Koster et al., 2011). Relatedly, transfer tasks may be more valid/informative if completed within an emotional context (so that they adequately activate the cognitive processes associated with rumination; Koster et al., 2017), a stipulation which was not ensured within the current procedure. Thus, it is possible that daily mST-training conferred generalised gains in inhibition that were undetected by a potentially invalid transfer task. Nonetheless, the current lack of near-transfer must be kept in mind when interpreting further outcomes.

Also against predictions (H1/2), systematic visual analysis found no evidence that daily mST-training resulted in reduced rumination or improved mood, and such null-effects were then replicated at the group level using randomisation tests for MBD. Whilst visual analysis indicated that one participant showed an improving trend during the training phase, current guidelines require three separate demonstrations of an effect (in the absence of any failed effects) for MBD data to be considered convincing evidence for a given hypothesis (Kratochwill et al., 2013). Similarly, whilst the randomisation test revealed a trend towards reduced sadness levels at the group level, the effect size and, thus, clinical utility of this change remained small. In addition, there was little evidence that mST-training led to reductions in scores within the PHQ-9 (H4). Thus, the current study provides no support for AC theories of rumination that suggest depressive symptomology may be remediated by the use of CCT procedures, and adds to the currently equivocal experimental evidence for such accounts.

There are a number of possible explanations for the current null findings, including the possibility that AC theories of rumination are incorrect and previous promising findings were the result of suboptimal designs that led to an

overestimation of the effects of CCT (Koster et al., 2017). Indeed, the current study addressed several methodological limitations of previous studies (use of a validated training task and emotional training context, adequate training dosage; Koster et al., 2017; Roberts et al., 2015; Shipstead et al., 2012), yet still failed to find evidence of a causal relationship. If future, well-designed studies replicate such null-effects, evidence may amass to support alternative interpretations of the association between AC and rumination (i.e., reverse relationship or third-variable influences) and argue against the continued pursuit of CCT as a treatment for depressive rumination. Yet, the presence of other well-designed studies that report significant therapeutic effects of CCT for rumination cannot be overlooked (e.g. Hoorelbeke et al., 2015), and there are several potential explanations for the divergence between the results of these studies and those of the current investigation.

Firstly, as previously discussed, the current failure to demonstrate near-transfer may mean that mST-training failed to adequately target or train participants' inhibition abilities, providing a potentially parsimonious explanation for these divergent findings. Secondly, the current investigation focused on training a specific sub-type of inhibition that has well-documented links with rumination (RPI; Roberts et al., 2015), yet differs from the constructs targeted within some previous studies. Whilst some of the previously used tasks demonstrate questionable validity and may have reduced rumination via constructs other than improved AC (e.g., NAP used by Daches & Mor, 2014), others represent well-validated measures of different AC facets (e.g., PASAT used to target updating abilities by Hoorelbeke et al., 2015; Siegle et al., 2014). This fundamental difference in the constructs targeted by the current and previous CCT procedures may account for the current divergence in findings. It also reiterates the importance of conceptual clarity when considering the

impact of CCT upon rumination and the need to move towards standardised procedures to aid empirical consistency within this field. Similarly, it has been suggested that CCT procedures need to be adaptive in order to effectively impact cognitive processing (Shipstead et al., 2012). Whilst other procedures (e.g., PASAT) do indeed adapt to the performance of participants, it was not possible to incorporate this feature within the mST, which may also explain the current null findings.

Such reasoning cannot, however, explain why the current study did not replicate the previous significant findings of Lemoult and colleagues (LeMoult et al., 2014; Schreiner et al., 2015), who used an almost identical training procedure. These differences may be accounted for by a number of methodological discrepancies. For example, whilst the previous two studies involved patients with a diagnosis of Major Depressive Disorder, the current investigation involved an “at-risk” sample of high-ruminators. Existing evidence suggests CCT interventions may only be effective among those with clear deficits in AC, which may be more likely among clinical populations (Koster et al., 2017). Indeed, the average NI-start score among the current sample more closely resembled that obtained within normative than clinical samples in previous research using the mST (Joorman & Gotlib, 2008), suggesting the sample did not have pronounced AC deficits to begin with and introducing a potential ceiling effect.

Crucially, the studies also differed in terms of experimental design (pre-post versus MBD), both of which have different strengths and weaknesses. For example, the use of pre-post comparisons with a small sample may have increased the risk of a Type I error for Schreiner et al. (2015), as may the lack of control group within Lemoult et al. (2014). Conversely, several conditions may have undermined the use of a MBD to evaluate the current hypotheses. Firstly, due to time-constraints (yet

against some recommendations; Gast, 2010), baseline stability was not achieved before participants transitioned to the training phase. Such variability reduces the ability to detect an effect of training via visual analysis and may have contributed to the current null findings. In contrast, determining the point of phase transition *a priori* is typically a pre-requisite for the use of randomisation tests (Edgington & Onghena, 2007), demonstrating a potential point of contention between the use of visual and statistical analysis within MBD. Recently, however, solutions have been suggested to this dilemma (such as randomising phase change after stability has been achieved; Morley, 2017), which future studies may wish to apply to strengthen the validity of their design. Secondly, the ability to detect delayed effects is typically weakened within MBD, making them a “risky” design choice in such situations (Lieberman, Yoder, Reichow, & Wolery, 2010, p.41). Given the effects of CCT are thought to be accumulative rather than immediate (Koster et al., 2017), this may also explain the current inability to demonstrate individual change within visual analysis. Relatedly, the study may also have benefited from the inclusion of a follow-up period to assess any longer term or delayed effects of training upon rumination (Koster et al., 2017). To combine some of the benefits of MBD with more traditional pre-post designs, future studies may wish to explore the use of experience sampling methods, which provide similar opportunities for more fine-grained analyses of change (Koster et al., 2017).

The current study was also limited by the recruitment of an entirely female, university sample, which may limit the extent to which findings can be generalised to other populations. Reliance upon self-report measures of mood and rumination also represents a significant (yet, perhaps, unavoidable) limitation of the current study, as such measures are vulnerable to a range of response-biases (e.g., demand

characteristics, social desirability, memory biases, mood-congruent responding). Research into potential physiological/neurological indicators of rumination, that may provide alternative means of assessment, remains ongoing (e.g., Siegle & Thayer, 2004). Finally, previous research has demonstrated that task engagement/motivation is a key moderator of the efficacy of CCT interventions (Bowie et al., 2013; Siegle et al., 2014). Yet, based on qualitative feedback received from the current participants, daily mST-training was experienced as overly long, boring, and repetitive, which may have hindered its ability to effect change. Given the known issues concerning reduced motivation within depression generally, future research may wish to consider ways of making CCT interventions more engaging/enjoyable (e.g., Prins, DAVIS, Ponsioen, Ten Brink, & Van der Oord, 2011).

Conclusion

In conclusion, using a MBD, the current investigation found no significant effects of daily mST-training upon rumination or mood among a sample of high-ruminators. Whilst such null findings merely add to rather than resolve the existing uncertainty regarding the role of AC in rumination and, thus, the clinical potential of CCT for depression, they must be interpreted in light of several methodological limitations. Moreover, if further progress is to be made, ongoing research into the use of such interventions must take into account ongoing concerns regarding the need for greater conceptual clarity and procedural standardisation when investigating the role of AC in rumination (Koster et al., 2017).

References

- Beshai, S., Dobson, K. S., Bockting, C. L., & Quigley, L. (2011). Relapse and recurrence prevention in depression: Current research and future prospects. *Clinical Psychology Review, 31*, 1349-1360. doi:10.1016/j.cpr.2011.09.003
- Bowie, C. R., Gupta, M., Holshausen, K., Jokic, R., Best, M., & Milev, R. (2013). Cognitive remediation for treatment-resistant depression: Effects on cognition and functioning and the role of online homework. *The Journal of Nervous and Mental Disease, 201*, 680-685. doi:10.1097/NMD.0b013e31829c5030
- Bradley, M. M., & Lang, P. J. (1999). *Affective Norms for English Words (ANEW): Technical manual and affective ratings*. The Centre for Research in Psychophysiology: Gainesville, FL.
- Bulté, I., & Onghena, P. (2008). An R package for single-case randomization tests. *Behavior Research Methods, 40*, 467-478. doi:10.3758/BRM.40.2.467
- Bulté, I., & Onghena, P. (2009). Randomization tests for multiple baseline designs: An extension of the SCRT-R package. *Behavior Research Methods, 41*, 477-485. doi:10.3758/BRM.41.2.477
- Ciesla, J. A., & Roberts, J. E. (2002). Self-directed thought and response to treatment for depression: A preliminary investigation. *Journal of Cognitive Psychotherapy: An International Quarterly, 16*, 435-453. doi:10.1891/jcop.16.4.435.52528
- Cogmed. (2011). *Cogmed Coaching Manual*. Retrieved from <http://cogmed.com/wp-content/uploads/2010/07/Coaching-manual-US-1.0.9.pdf>
- Daches, S., & Mor, N. (2014). Training ruminators to inhibit negative information: A preliminary report. *Cognitive Therapy and Research, 38*(2), 160-171. doi:10.1007/s10608-013-9585-5

- Daches, S., Mor, N., & Hertel, P. (2015). Rumination: Cognitive consequences of training to inhibit the negative. *Journal of Behavior Therapy and Experimental Psychiatry, 49*, 76-83. doi:10.1016/j.jbtep.2015.01.010
- De Lissnyder, E., Koster, E. H. W., Derakshan, N., & De Raedt, R. (2010). The association between depressive symptoms and executive control impairments in response to emotional and non-emotional information. *Cognition & Emotion, 24*(2), 264-280. doi:10.1080/02699930903378354
- De Putter, L. M. S., Vanderhasselt, M. A., Baeken, C., De Raedt, R., & Koster, E. H. W. (2015). Combining tDCS and Working Memory Training to Down Regulate State Rumination: A Single-Session Double Blind Sham-Controlled Trial. *Cognitive Therapy and Research, 39*, 754-765. doi:10.1007/s10608-015-9710-8
- De Raedt, R., Koster, E. H. W., & Joorman, J. (2010). Attentional control in depression: A translational affective neuroscience approach. *Cognitive, Affective, & Behavioral Neuroscience, 10*, 1-7. doi:10.3758/CABN.10.1.1
- de Voogd, E. L., Wiers, R. W., Zwitter, R. J., & Salemink, E. (2016). Emotional working memory training as an online intervention for adolescent anxiety and depression: A randomised controlled trial. *Australian Journal of Psychology, 68*(3), 228-238. doi:10.1111/ajpy.12134
- Edgington, E. S., & Onghena, P. (2007). *Randomization tests* (4th ed.). Boca Raton, FL: Chapman & Hall.
- Ellis, H. C., & Ashbrook, P. W. (1988). Resource allocation model of the effects of depressed mood states on memory. In K. Fielder (Ed.), *Affect, cognition, and social behaviour* (pp. 25-43). Göttingen: Hogrefe.

- Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General*, *133*, 101-135. doi: 10.1037/0096-3445.133.1.101
- Gast, D. L. (2010). *Single subject research methodology in behavioral science*. New York, NY: Routledge.
- Goeleven, E., De Raedt, R., Leyman, L., & Verschuere, B. (2008). The Karolinska Directed Emotional Faces: A validation study. *Cognition and Emotion*, *22*, 1094-1118. doi:10.1080/02699930701626582
- Hartlage, S., Alloy, L. B., Vazquez, C., & Dykman, B. (1993). Automatic and effortful processing in depression. *Psychological Bulletin*, *113*(2), 247-278.
- Hertel, P. T. (1998). Relation between rumination and impaired memory in dysphoric moods. *Journal of Abnormal Psychology*, *107*, 166-172.
- Heyvaert, M., Moeyaert, M., Verkempynck, P., Van Den Noortgate, W., Vervloet, M., Ugille, M., & Onghena, P. (2017). Testing the intervention effect in single-case experiments: A Monte Carlo simulation study. *Journal of Experimental Education*, *85*, 175-196. doi:10.1080/00220973.2015.1123667
- Hoorelbeke, K., Koster, E., Vanderhasselt, M. A., Callewaert, S., & Demeyer, I. (2015). The influence of cognitive control training on stress reactivity and rumination in response to a lab stressor and naturalistic stress. *Behaviour Research and Therapy*, *69*, 1-10. doi:10.1016/j.brat.2015.03.010
- Hoorelbeke, K., Koster, E. H. W., Demeyer, I., Loeys, T., & Vanderhasselt, M. A. (2016). Effects of cognitive control training on the dynamics of (mal)adaptive

emotion regulation in daily life. *Emotion*, 16, 945-956.

doi:10.1037/emo0000169

Iacoviello, B. M., Wu, G., Alvarez, E., Huryk, K., Collins, K. A., Murrough, J. W.,...

Charney, D. S. (2014). Cognitive-emotional training as an intervention for major depressive disorder. *Depression and Anxiety*, 31, 699-706.

doi:10.1002/da.22266

Jacobson, N. S., & Truax, P. (1991). Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology*, 59, 12-19. doi: 10.1037/0022-006X.59.1.12

Joorman, J., & Gotlib, I. H. (2008). Updating the contents of working memory in depression: Interference from irrelevant negative material. *Journal of Abnormal Psychology*, 117, 183-192. doi:10.1037/0021-843X.117.1.182

Joorman, J., & Vanderlind, M. W. (2014). Emotion regulation in depression: The role of biased cognition and reduced cognitive control. *Clinical Psychological Science*, 2, 402-421. doi:10.1177/2167702614536163

Joormann, J., Yoon, K. L., & Zetsche, U. (2007). Cognitive inhibition in depression. *Applied & Preventive Psychology*, 12(3), 128-139.

doi:10.1016/j.appsy.2007.09.002

Kazdin, A. (2003). *Methodological issues and strategies in clinical research* (3rd ed.). Washington, DC: American Psychological Association.

Koehler, M., & Levin, J. (1998). Regulated randomization: A potentially sharper analytical tool for the multiple-baseline design. *Psychological Methods*, 3, 206-217.

Koster, E. H. W., De Lissnyder, E., Derakshan, N., & De Raedt, R. (2011).

Understanding depressive rumination from a cognitive science perspective:

- The impaired disengagement hypothesis. *Clinical Psychology Review*, 31(1), 138-145. doi:10.1016/j.cpr.2010.08.005
- Koster, E. H. W., Hoorelbeke, K., Onraedt, T., Owens, M., & Derakshan, N. (2017). Cognitive control interventions for depression: A systematic review of findings from training studies. *Clinical Psychology Review*, 53, 79-92. doi:10.1016/j.cpr.2017.02.002
- Kratochwill, T. R., Hitchcock, J. H., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M.,... Shadish, W. R. (2013). Single-case intervention research design standards. *Remedial and Special Education*, 34, 26-38. doi:10.1177/0741932512452794
- Kroenke, K., & Spitzer, R. L. (2002). The PHQ-9: A new depression diagnostic and severity measure. *Psychiatric Annals*, 32, 509-515. doi: 10.3928/0048-5713-20020901-06
- Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, 16, 606-613. doi:10.1046/j.1525-1497.2001.016009606.x
- Lane, J. D., & Gast, D. L. (2014). Visual analysis in single case experimental design studies: Brief review and guidelines. *Neuropsychological Rehabilitation*, 24, 445-463. doi:10.1080/09602011.2013.815636
- Lange, K., Kühn, S., & Filevich, E. (2015). "Just Another Tool for Online Studies" (JATOS): An easy solution for setup and management of web servers supporting online studies. *PLoS ONE*, 10, e0130834. doi:10.1371/journal.pone.0130834
- LeMoult, J., Foland-Ross, L. C., Sorenson, J., Ordaz, S. J., Bergman, S. R., & Gotlib, I. H. (2014). Neural effects of working memory training in major depressive

- disorder: Facilitating scientific translation. *Biological Psychiatry*, 75, 399S-400S. doi:<http://dx.doi.org/10.1016/j.biopsych.2014.03.016>
- Lieberman, R. G., Yoder, P. J., Reichow, B., & Wolery, M. (2010). Visual analysis of multiple baseline across participants graphs when change is delayed. *School Psychology Quarterly*, 25, 28–44. doi:10.1037/a0018600
- Lilienthal, L., Tamez, E., Shelton, J. T., Myerson, J., & Hale, S. (2013). Dual n-back training increases the capacity of the focus of attention. *Psychonomic Bulletin & Review*, 20, 35–141. doi:10.3758/s13423-012-0335-6
- Linville, P. (1996). Attention inhibition: Does it underlie ruminative thought? In R. S. Wyer (Ed.), *Ruminative thoughts: Advances in social cognition* (Vol. IX, pp. 121-133). Mahwah, NJ: Erlbaum.
- Lundqvist, D., Flykt, A., & Öhman, A. (1998). *The Karolinska Directed Emotional Faces (KDEF)*. Department of Neurosciences, Karolinska Hospital: Stockholm.
- Manolov, R., Losada, J. L., Chacón-Moscoso, S., & Sanduvete-Chaves, S. (2016). Analyzing two-phase single-case data with non-overlap and mean difference indices: Illustration, software tools, and alternatives. *Frontiers in Psychology*, 7, 1-16. doi:10.3389/fpsyg.2016.00032
- Mayr, S., & Buchner, A. (2007). Negative priming as a memory phenomenon: A review of 20 years of negative priming research. *Journal of Psychology*, 215, 35-51. doi:10.1027/0044-3409.215.1.35
- Mor, N., & Daches, S. (2015). Ruminative thinking: Lessons learned from cognitive training. *Clinical Psychological Science*, 3, 574-592. doi:10.1177/2167702615578130

- Morley, S. (2017). *Single case methods for busy clinicians*. Manuscript in preparation.
- Moshier, S. J., & Otto, M. W. (2017). Behavioral activation treatment for major depression: A randomized trial of the efficacy of augmentation with cognitive control training. *Journal of Affective Disorders, 210*, 265-268.
doi:10.1016/j.jad.2017.01.003
- Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100*, 569-582.
- Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109*, 504-511.
- Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and posttraumatic stress symptoms after a natural disaster: The 1989 Loma Prieta Earthquake. *Journal of Personality and Social Psychology, 61*, 115-121.
- Onraedt, T., & Koster, E. H. W. (2014). Training Working Memory to Reduce Rumination. *PLoS One, 9*(3). doi:10.1371/journal.pone.0090632
- Parker, R. I., & Vannest, K. (2009). An improved effect size for single-case research: Nonoverlap of all pairs. *Behavior Therapy, 40*, 357–367.
doi:10.1016/j.beth.2008.10.006
- Petersen-Brown, S., Karich, A. C., & Symons, F. J. (2012). Examining estimates of effect using non-overlap of all pairs in multiple baseline studies of academic intervention. *Journal of Behavioral Education, 21*, 203–216.
doi:10.1007/s10864-012-9154-0

- Prins, P. J., DAVIS, S., Ponsioen, A., Ten Brink, E., & Van der Oord, S. (2011). Does computerized working memory training with game elements enhance motivation and training efficacy in children with ADHD? *Cyberpsychology, Behavior, and Social Networking*, *14*(3), 115–122.
doi:10.1089/cyber.2009.0206
- Roberts, H., Watkins, E., & Wills, A. J. (2015). Does rumination cause “inhibitory” deficits? Retrieved from <http://www.willslab.co.uk/pubs/roberts2015.pdf>
- Schreiner, C., LeMoult, J., & Gotlib, I. (2015). Reducing cortisol reactivity to stress in major depressive disorder: The effects of rumination-reduction training. *Biological Psychiatry*, *77*(9 suppl. 1), 381s. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1111/bipr.12215>
- Shilyansky, C., Williams, L. M., Gyurak, A., Harris, A., Usherwood, T., & Etkin, A. (2016). Effect of antidepressant treatment on cognitive impairments associated with depression: A randomised longitudinal study. *The Lancet Psychiatry*, *3*, 425-435. doi:10.1016/S2215-0366(16)00012-2
- Shipstead, Z., Redick, T. S., & Engle, R. W. (2012). Is working memory training effective? *Psychological Bulletin*, *138*, 628-654. doi:10.1037/a0027473
- Siegle, G. J., Price, R. B., Jones, N. P., Ghinassi, F., Painter, T., & Thase, M. E. (2014). You gotta work at it: Pupillary indices of task focus are prognostic for response to a neurocognitive intervention for rumination in depression. *Clinical Psychological Science*, *2*, 455-471. doi:10.1177/2167702614536160
- Tate, R. L., Perdices, M., Rosenkoetter, U., McDonald, S., Togher, L., Shadish, W., ... Vohra, S. for the SCRIBE Group (2016). The Single-Case Reporting Guideline in Behavioural Interventions (SCRIBE) 2016: Explanation and

elaboration. *Archives of Scientific Psychology*, 4, 10-31.

doi:doi:10.1037/arc0000027 .

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

Vanderhasselt, M. A., & De Raedt, R. (2009). Impairments in cognitive control persist

during remission from depression and are related to the number of past

episodes: An event related potentials study. *Biological Psychology*, 81(3),

169-176. doi:10.1016/j.biopsycho.2009.03.009

Vannest, K. J., Parker, R. I., Gonen, O., & Adiguzel, T. (2016). Single Case

Research: Web based calculators for SCR analysis (Version 2.0). Retrieved

from <http://www.singlecaseresearch.org/calculators/nap>

Wanmaker, S., Geraerts, E., & Franken, I. (2015). A working memory training to

decrease rumination in depressed and anxious individuals: a double-blind

randomized controlled trial. *Journal of Affective Disorders*, 175, 310-319. doi:

10.1016/j.jad.2014.12.027

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought.

Psychological Bulletin, 134(2), 163-206. doi:10.1037/0033-2909.134.2.163

Watkins, E. R. (2009). Depressive rumination and co-morbidity: Evidence for

brooding as a transdiagnostic process. *Journal of Rational-Emotive and*

Cognitive-Behavior Therapy, 27, 160-175. doi:10.1007/s10942-009-0098-9

Watkins, E. R. (2015). Psychological treatment of depressive rumination. *Current*

Opinion in Psychology, 4, 32-36. doi:10.1016/j.copsyc.2015.01.020

- Watkins, E. R., & Brown, R. G. (2002). Rumination and executive function in depression: An experimental study. *Journal of Neurology Neurosurgery and Psychiatry*, *72*, 400-402.
- Watson, D., & Clark, L. A. (1994). *The PANAS-X: Manual for the Positive and Negative Affect Schedule-Expanded Form*. The University of Iowa. Ames.
- World Health Organisation (2017). Depression: World Health Organisation fact sheet no 369. Retrieved from <http://www.who.int/mediacentre/factsheets/fs369/en/>
- Yang, Y., Cao, S., Shields, G. S., Teng, Z., & Liu, Y. (2016). The relationships between rumination and core executive functions: A meta-analysis. *Depression and Anxiety*, *34*, 37-50. doi:10.1002/da.22539

Appendices

Appendix A – Author Guidelines – Journal of Experimental Psychopathology

Scope of the Journal. The Journal of Experimental Psychopathology is an e-journal created to publish cutting-edge original contributions to scientific knowledge in the general area of psychopathology. Although there will be an emphasis on publishing research which has adopted an experimental approach to describing and understanding psychopathology, the journal will also welcome submissions that make significant contributions to knowledge using other empirical methods such as correlational designs, meta-analyses, epidemiological and prospective approaches, and single-case experiments. Theoretical and review articles addressing significant issues in the description, aetiology, and treatment of psychopathologies are also welcome. The Editors and Associate Editors will make an initial determination of whether or not submissions fall within the scope of the journal and are of sufficient merit and importance to warrant full review.

Submitting Manuscripts. Authors should submit their manuscript electronically via the journal's editorial system (<http://jep.textrum.com/>). Your manuscript will then be allocated to an Associate Editor who will manage the peer review process. You should submit your manuscript in an editable version of WORD or a similar format (not as a pdf). You should also retain a copy of your manuscript because this may be needed for further processing should your manuscript be accepted for publication. DO NOT submit manuscripts or revised manuscripts with tracked changes or tracked comments on them, and do not submit manuscripts with other forms of mark ups on them (e.g. Endnote). This is because your final uncorrected manuscript may be made publicly available in press prior to typesetting in the event of it being accepted for publication. There is no word-limit to articles that may be accepted for publication, but the Editors would expect presentation to be efficient, concise and informative. Most articles accepted for publication would usually be no more than 50 manuscript pages. Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the Editors.

Presentation of the Manuscript. The manuscript should follow American Psychological Association (APA) publication manual guidelines. All pages should be typed double-spaced and numbered (including pages containing the title, authors names and affiliation footnotes, abstract, acknowledgments, references, tables, and figure caption list)

Title Page. A title page should be provided and should include the full title of the article, the authors' names and affiliations, and a suggested running head. The affiliation should include the department, institution, city or town, and country. It should be made clear in which institution(s) the research was carried out. The suggested running head should be no more than 80 characters. The title page should also clearly indicate the name, address, email address, fax number and telephone number of the corresponding author.

Abstract. An abstract following American Psychological Association guidelines should be provided and preferably be no longer than 150 words. The abstract page should also provide a list of 5-10 key words that accurately reflect the content of the article and can be used for indexing and search purposes.

Format of the article. Divide your article into clearly defined sections with the use of headings (non-numbered). The following headings are mandatory: Abstract, Introduction, Method, Participants, Procedure, Results, Discussion and References, but authors may include other headings where appropriate. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

Figures & Illustrations. Photographs, drawings, diagrams, graphs and charts should be numbered in one consecutive series of Arabic numerals. Each individual figure or illustration should be accompanied by a clearly-worded caption or figure legend. All figures, tables, photographs, drawings, charts and diagrams should be submitted within the manuscript, preferably on separate pages at the end of the manuscript. If your manuscript is accepted for publication you may then be asked to submit your artwork in an electronic format and supply high-quality printouts in case conversion of the electronic artwork is problematic.

Tables. Tables should be numbered in one consecutive series of Arabic numerals. Each table should be typed on a separate page with the title centred above the table and all explanatory footnotes, etc. printed below. Acknowledgements: Do not include acknowledgements on the title page. Place them on a separate page after the main body of the article and before the reference list.

References. Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications should not be in the reference list, but may be mentioned in the text. Citation of a reference as 'in press' implies that the item has been accepted for publication. Citations in the text should follow the referencing style used by the American Psychological Association. You are referred to the Publication Manual of the American Psychological Association, the latest can be found at <http://www.apastyle.org>. References should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters "a", "b", "c", etc., placed after the year of publication.

Examples reference formats include:

JOURNAL ARTICLES

Davey, G.C.L., Startup H.M., MacDonald C.B., Jenkins D. & Paterson K. (2005) The use of 'as many as can' stop rules during worrying. *Cognitive Therapy & Research*, 29, 155-169.

BOOKS

Davey G.C.L. & Wells A. (Eds) (2006) *Worry and its psychological disorders: Theory, assessment and treatment*. Chichester: John Wiley.

BOOK CHAPTERS

Davey G.C.L. (2006) A mood-as input account of perseverative worrying. In G.C.L. Davey & A. Wells (Eds) *Worry and its psychological disorders: Theory, assessment and treatment*. Chichester: John Wiley. Pp217-237

AUTHORED WEB-PAGE

Lecce S. (2005) Should egalitarians be perfectionists? Retrieved January 30, 2008, from <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1467-9256.2005.00237.x?cookieSet=1&journalCode=ponl>

UN-AUTHORED WEB-PAGE

New child vaccine gets funding boost. (2001). Retrieved March 21, 2001, from http://news.ninemsn.com.au/health/story_13178.asp

Supplementary Files. The Editors of the Journal of Experimental Psychopathology are keen to ensure that all published articles come with downloadable supplementary material that will enable readers and researchers to fully appreciate how the research was conducted and analyzed. We believe this will facilitate replication and further research. Depending on the nature of the published article authors will be encouraged to provide supplementary material in a form that can be downloaded and used by students and researchers. These materials might include copies of questionnaires used in the research or developed by the research, instruction sheets, experimental protocols, stimuli and images, audio and visual media clips, computer programs (executables or source code), data analysis macros or scripts if an unusual analysis has been done, scripts for specialist software (e.g., data processing scripts for ERP or EEG data, eprime scripts etc.), photographs of custom-built apparatus, colour images that illustrate data (e.g., fMRI scans, ERP curves) etc. In order to ensure that supplementary material is directly usable, please ensure that data are provided in a file format suitable for downloading. After an article has been accepted for publication, authors will be approached and encouraged to provide what supporting materials they can make available. There will be no transfer of copyright for any of the materials deposited in the Tools & Materials Repository, and this will allow authors to retain copyright of any materials they may have developed themselves or over which they have current copyright ownership. There will be no obligation for authors to provide materials for the repository, and a willingness to provide tools and materials will not be a factor taken into account when deciding whether a manuscript is accepted for publication.

Copyright. Upon acceptance of an article, an e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a link to a Journal Publishing Agreement form. If excerpts from other copyrighted works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article. Proofs: When your manuscript is received by the Publisher it is considered to be in its final form. Proofs are not to be regarded as 'drafts'. One set of page proofs will be sent electronically to the corresponding author, to be checked for typesetting/editing. No changes in, or additions to, the accepted (and subsequently edited) manuscript will be allowed at this stage. Proofreading is solely your responsibility. The Editors reserve the right to proceed with publication if corrections are not communicated.

Blind Review. Authors requesting blind review should explicitly request this when loading their manuscript up to the journal editorial system. The manuscript should also be submitted in a form appropriate to this process (see the APA Publication Manual).

Open Access Option. Many institutions and funding bodies have made funds available to allow authors to publish their research in an open access form. Journal of Experimental Psychopathology offers authors an open access option whereby their article will be freely available to both journal subscribers and nonsubscribers via the journal website. To prevent any conflict of interests, authors can choose to have their article made open access only after the article has formally been accepted for publication. The fee for making an article open access is £1000/US\$1595/€1161 excluding tax, and all authors wishing to take advantage of the open access option should complete and return the open access option form they will receive along with their copyright transfer and publishing forms prior to publication. Authors who wish to take advantage of the open access option will still retain their rights outlined in Textum's Copyright Transfer & Publishing Agreement. Further

information about Textrum's Open Access Options can be obtained by emailing openaccess@textrum.com.

Appendix B – mST Trials

Table A1

mST trial types

Trial Type	Cued Word List	Probe Category
Negative-Relevant	Negative	Old negative word
Negative-Intrusion*	Positive	Old negative word
Negative-NewPos	Negative	New positive word
Negative-NewNeg [†]	Negative	New negative word
Positive-Relevant*	Positive	Old positive word
Positive-Intrusion	Negative	Old positive word
Positive-NewPos*	Positive	New positive word
Positive-NewNeg [†]	Positive	New negative word
Mixed	Mixed	Random

Note: * = Key training trials in which participant has to remove negative words from working memory, collectively constituting 70% of trials overall; [†] = Averaged to create overall Negative-New index used to calculate Negative Intrusion index.

Appendix C – Ethical Approval

Your application for ethical approval (2015/821) has been accepted



apache@exeter.ac.uk on behalf of Ethics Approval System <D.M.Salway@exeter.ac.uk>



Reply all | v

Tue 28/04/2015, 11:16

Pepper, Rebecca ↕

Ethical Approval system

Your application (2015/821) entitled Using Working Memory Training to Reduce Depressive Rumination: A Case Series has been accepted

Please visit <http://www.exeter.ac.uk/staff/ethicalapproval/>

Please click on the link above and select the relevant application from the list.

Appendix D – Graphical Data for P9

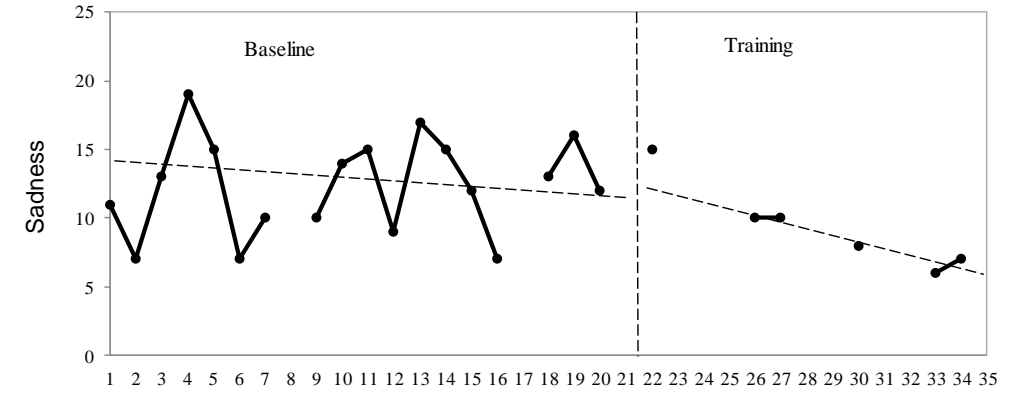
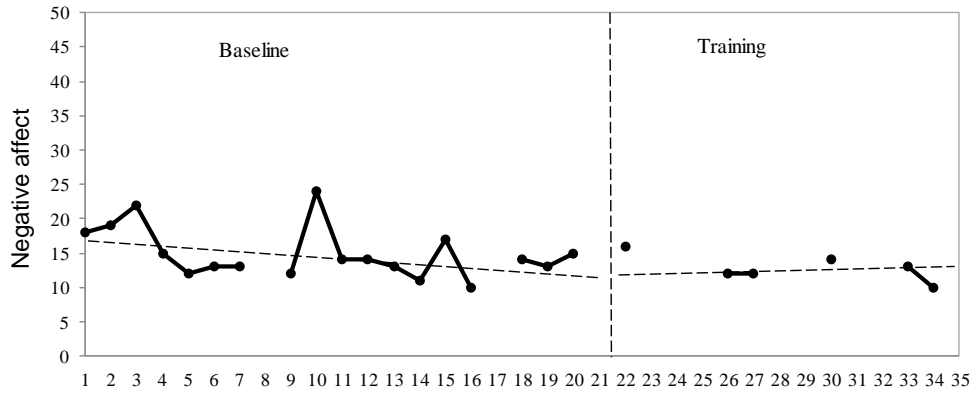
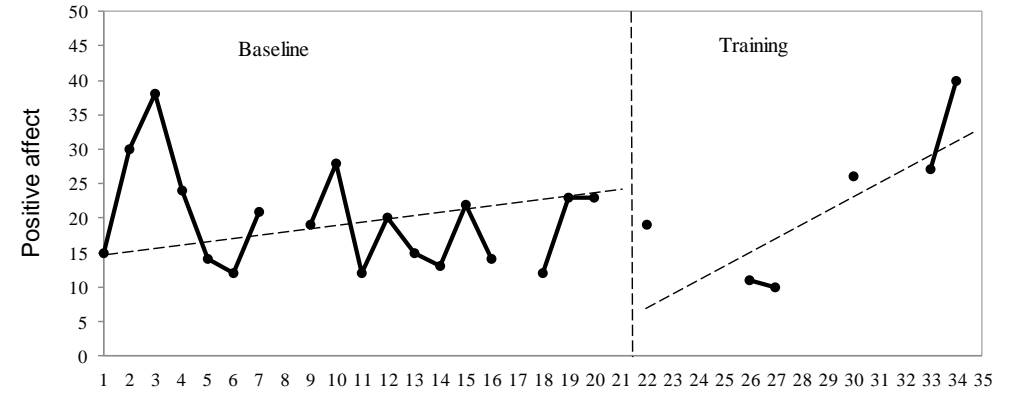
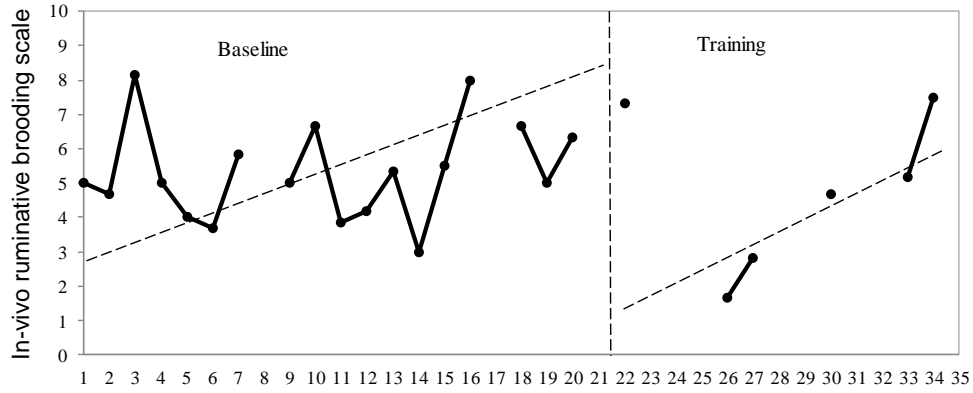


Figure A1. Multiple baseline data for participant 9 across each outcome variable

Appendix E – Participant Data

Appendix E1 – Raw data for each participant

Table A2

Daily ratings across each outcome measure and daily mST performance for each participant

P	Scale	Day																																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1	IRBS	8	8	5	7	4	3	5	6	6	5	7	6	5	6	8	7	7	7	7	8	3	6	8	7			5	7	4	6	6	3	7	8	6
	PA	23	19	28	9	7	4	4	1	8	2	7	9	3	8	23	32	23	20	24	29	36	38	22	26			28	23	26	29	28	24	22	22	31
	NA	28	35	25	2	2	2	2	2	3	2	3	3	2	2	29	22	34	35	33	36	28	21	36	35			28	26	27	26	27	25	32	31	27
	S	18	21	16	1	1	1	1	1	1	1	1	1	1	1	16	11	14	13	15	17	10	12	17	16			10	14	15	15	13	11	16	16	12
	mST NI															51	42	34				15	24	-		23		32			38	13		14	27	
2	IRBS	1	2	1	3	4	1	1	1	1	1	1	1	2	2	3	3	5	5	3	5	5	1	2	2	3	3		3	4	3	4	7	5	2	8
	PA	15	12	14	0	0	1	0	1	2	3	9	3	1	1	10	13	11	10	14	16	14	14	13	11	10	10		11	10	14	13	21	13	18	10
	NA	12	15	11	4	3	1	0	2	3	0	0	1	4	5	22	19	24	17	13	17	22	12	12	17	17	12		13	14	15	16	11	11	12	30
	S	5	8	5	3	1	8	6	5	5	5	5	6	1	8	15	10	15	15	11	14	17	6	5	10	12	13		7	15	10	10	8	6	6	14
	mST NI																						69	73	16		11	-	34	15						
3	IRBS	4	3	2	2	2	2	2	3	4	3	2	2	2	2	1	2	3	2	3	3	2	2	3	2	2	1	2	1	1	2	2	2	2	1	1
	PA	29	31	16	9	1	8	7	1	3	8	8	3	5	7	25	24	15	26	15	28	30	28	22	18	27	33	27	35	26	25	17	20	20	26	32
	NA	16	21	17	0	1	3	5	7	7	9	0	2	1	1	11	11	15	11	13	12	12	13	13	15	11	11	10	10	12	13	13	17	16	13	13
	S	12	7	13	7	6	8	0	7	2	1	7	9	6	6	7	9	10	8	9	7	6	8	8	7	9	7	6	6	7	8	9	8	10	8	5
	mST NI																			13	51	15	74	39		20	23			48		27	46	33	49	35
4	IRBS	4	3	5	3	3	2	2	2	2	3	2	3	2	3	2	2	2	5	1	2	3	2	2	3	3	1	3	2	2	1	3	1	2	3	2
	PA	36	31	35	4	7	3	0	5	1	8	5	7	4	4	29	32	26	18	30	33	32	35	30	28	35	28	32	30	14	19	16	36	17	20	25
	NA	14	13	18	7	0	0	1	0	0	7	4	0	0	0	16	12	13	15	10	10	10	12	13	12	11	10	11	11	11	10	13	11	12	13	11
	S	7	6	7	5	5	5	5	5	5	8	5	5	5	5	7	5	5	11	5	5	7	7	5	6	5	5	5	8	7	5	6	5	7	6	8
	mST NI															23	51	40	45	27	27	32	53	26	56			28	17		10		17			
															8	6	8	8	8	3	2	4	8	6	0	10	90	2	7	23	51	8	49	9	-3	

P	Scale	Day																																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31					
5	IRBS	3	6	3	1	1	1	1	5	1	4	2	1	2	1	3	1	2	3	7	3	3	1	2	6	1	1						1	4	4	4	
	PA	41	22	21	7	7	4	2	2	1	1	0	1	2	10	15	10	11	20	14	16	16	16	13	31	18	24					12	17	14	17		
	NA	26	15	10	0	0	1	0	0	1	1	1	1	1	10	12	13	12	11	21	15	13	11	15	12	10	10					13	13	11	14		
	S	7	5	5	5	5	5	5	5	5	8	5	5	5	5	5	5	8	5	11	5	5	5	5	10	6	5	5					5	6	6	7	
mST NI																			24	13	-	22	12	13	12									16	18	26	
6	IRBS	7	7	3		5		6	6	5	7	8	5	8	8	6	5	4	3	4	6	3		7	6	7	6	6	4	2	3	5	6	8	6	7	
	PA	16	24	23		2		3	3	3	3	3	3	2	7	0	14	15	23	31	27	26	20		23	24	22	19	20	19	13	16	19	12	12	10	12
	NA	25	33	13		1		2	2	1	2	2	1	1	3		22	19	15	15	16	13	14		15	13	21	20	15	16	14	16	13	23	25	27	17
	S	15	11	9		7		8	2	7	4	5	2	7	5		22	19	15	11	12	15	14		10	12	19	17	12	14	12	15	13	15	15	19	14
mST NI																			41	38	53	33	37		44	27	51	38	24	21	36	41	20	26	55	29	
7	IRBS	7	7	6	8		7	8	7	7	9	9	9	9	9	6	8	7	9	8	8	8	8	7	8	8	8	7	7	7	7	9	7		7	7	7
	PA	19	12	23	3		5	0	0	8	8	2	5	0	3	29	32	29	12	15	26	25	21	20	16	20	25	25	18	17	20	20		24	25	26	
	NA	32	22	22	3		2	3	2	2	3	3	3	2	2		32	30	28	32	38	31	29	30	25	26	28	26	24	22	23	32	25		22	27	23
	S	19	14	11	1		1	2	1	0	0	5	4	3	0		17	20	23	22	24	20	18	19	15	18	18	20	17	14	15	24	18		15	10	10
mST NI																			13	12	19	23		15	13	19	15								10	42	
8	IRBS	7	6	8		7	8	5	9		9	8	7	9		7	7	8		9	7		7	8	8	8	7	7					8	8		8	8
	PA	27	31	21		3	8	9	5		2	9	0	2		24	25	21		25	22		34	33	25	20	24	20					18	24		19	18
	NA	29	24	31		2	1	2	3		3	3	2	2		19	23	22		32	24		21	24	20	33	19	25					35	24		30	28
	S	16	12	9		7	8	1	2		4	2	0	8		7	14	15		17	12		9	10	12	12	8	12					18	10		11	15
mST NI																				25	27	26		27	27	20	26	29	17	42	12					15	
9	IRBS	5	5	8	5	4	4	6		5	7	4	4	5	3	6	8		7	5	6		7				2	3					5			5	8
	PA	15	30	38	4	4	2	1		1	2	1	2	1	1	22	14			12	23	23		19			11	10					26			27	40
	NA	18	19	22	5	2	3	3		2	4	4	4	3	1	17	10			14	13	15		16			12	12					14			13	10
	S	11	7	13	9	5	7	0		0	4	5	9	7	5	12	7			13	16	12		15			10	10					8			6	7
mST NI																							43			64											7

Note: P = participant; IRBS = In-vivo ruminative brooding scale; PA = PANAS positive affect scale; NA = PANAS negative affect scale; S = PANAS sadness scale; mST NI = negative intrusion index for modified Sternberg task

Appendix E2 – Numerical information for visual analysis

Table A3

Broadened median and stability envelope percentages for each outcome across each participant

Participant	Scale	Bmed Phase A	Bmed Phase B	Variability Phase A (%)	Variability Phase B (%)
1	IRBS	6	7	43	29
	PA	29	26	14	14
	NA	28	29	7	33
	Sadness	14	14	36	19
2	IRBS	2	3	86	57
	PA	12	13	10	14
	NA	13	14	43	21
	Sadness	9	10	71	64
3	IRBS	2	2	44	47
	PA	27	26	44	47
	NA	13	13	44	24
	Sadness	8	8	50	12
4	IRBS	4	2	40	45
	PA	33	29	27	35
	NA	12	11	40	5
	Sadness	5	6	20	35
5	IRBS	2	3	89	63
	PA	12	17	37	25
	NA	11	13	26	19
	Sadness	5	6	16	19
6	IRBS	6	5	25	37
	PA	24	20	56	42
	NA	21	16	31	26
	Sadness	16	14	44	16
7	IRBS	8	8	12	0
	PA	22	22	47	22
	NA	27	27	18	6
	Sadness	17	18	59	17
8	IRBS	7	8	11	0
	PA	23	23	33	18
	NA	25	25	33	29
	Sadness	10	12	44	29
9	IRBS	5	5	29	29
	PA	19	19	38	36
	NA	14	13	24	0
	Sadness	13	9	33	7

Note: IRBS = In-vivo ruminative brooding scale; PA = PANAS positive affect scale; NA = PANAS negative affect scale; Sadness = PANAS sadness scale.

Appendix F – Questionnaires

Appendix F1 – Ruminative Response Scale

Rumination Scale

People think and do many different things when they feel depressed. Please read each of the items below and indicate whether you almost never, sometimes, often, or almost always think or do each one when you feel down, sad, or depressed. Please indicate what you *generally* do, not what you think you should do.

1 almost never 2 sometimes 3 often 4 almost always

1. think about how alone you feel
2. think "I won't be able to do my job if I don't snap out of this"
3. think about your feelings of fatigue and achiness
4. think about how hard it is to concentrate
5. think "What am I doing to deserve this?"
6. think about how passive and unmotivated you feel.
7. analyze recent events to try to understand why you are depressed
8. think about how you don't seem to feel anything anymore
9. think "Why can't I get going?"
10. think "Why do I always react this way?"
11. go away by yourself and think about why you feel this way
12. write down what you are thinking about and analyze it
13. think about a recent situation, wishing it had gone better
14. think "I won't be able to concentrate if I keep feeling this way."
15. think "Why do I have problems other people don't have?"
16. think "Why can't I handle things better?"
17. think about how sad you feel.
18. think about all your shortcomings, failings, faults, mistakes
19. think about how you don't feel up to doing anything
20. analyze your personality to try to understand why you are depressed
21. go someplace alone to think about your feelings
22. think about how angry you are with yourself

Appendix F2 – Demographic questionnaire

Participant number:

Age:

Gender:

Ethnicity:

Have you ever suffered from any of the following mental health conditions:

	Current	Past
Alcohol/Substance Abuse or Dependence		
Anxiety Disorder		
Adult ADHD		
Bipolar Disorder		
Depression		
Eating Disorder		
Obsessive-Compulsive Disorder		
Panic Disorder		
Posttraumatic Stress Disorder		
Schizophrenia or Psychosis		
Seasonal Affective Disorder		
Other (please specify): _____		

Have you ever received psychological or pharmacological treatment for these conditions?

- ✓ Yes – current (please specify)
- ✓ Yes – past (please specify)
- ✓ No

Have you ever suffered any form of traumatic brain/head injury?

- ✓ Yes (please specify)
- ✓ No

Appendix F3 – PHQ-9

PATIENT HEALTH QUESTIONNAIRE-9 (PHQ-9)

Over the last 2 weeks, how often have you been bothered by any of the following problems?
(Use "✓" to indicate your answer)

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed? Or the opposite — being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead or of hurting yourself in some way	0	1	2	3

FOR OFFICE CODING 0 + + +
=Total Score:

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult
at all

Somewhat
difficult

Very
difficult

Extremely
difficult

Appendix G – Dissemination Statement

The following dissemination strategy will be used to ensure appropriate feedback on the results of this study to both participants and the wider academic/clinical community.

Dissemination to participants.

As per ethical approval, participants who requested a copy of the results during their debrief will be sent a summary of the study findings via email.

Wider Academic and Clinical Community

In June 2017, my findings will be presented to an academic audience, for peer review, as part of the Doctorate in Clinical Psychology at the University of Exeter. I intend on submitting a reduced research paper for publication in a peer-reviewed journal (Journal of Experimental Psychopathology).