Counter-conditioning habitual rumination with a concrete-thinking exercise

Submitted by Max Buchanan, to the University of Exeter
as a thesis for the degree of Doctor of Clinical Psychology, May 2017

Signature:

Table of Contents

List of Tables

Literature Review

Empirical Paper

List of Figures

Literature Review

Empirical Paper

SCHOOL OF PSYCHOLOGY

DOCTORATE IN CLINICAL PSYCHOLOGY

LITERATURE REVIEW

Mental Habits in Anxiety and Depression: A Systematic Review

Trainee Name:	**Max Buchanan**
Primary Research Supervisor:	**Professor Edward Watkins** Professor of Experimental and Applied Clinical Psychology, Director of Research for Professional Doctorates, University of Exeter
Secondary Research Supervisor:	**Dr Nicholas Moberly** Senior Lecturer, School of Psychology, University of Exeter
Target Journal:	Clinical Psychology Review
Word Count:	3996 words (excluding abstract, table of contents, list of figures, references, footnotes, appendices)

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

Abstract

Objective: Anxiety and depression have been conceptualised as being associated with *"an abundance of habit and a dearth of control"* (Hertel, 2015, p. 1). There has been a recent and burgeoning interest toward understanding the role of habits in health psychology and in the psychological disorders of obsessive-compulsive disorder and addiction in particular. To the author's knowledge, there has been no previous systematic review that aimed to summarise the research investigating the involvement of mental habits in anxiety and depression in clinical and non-clinical populations.

Method: The term habit was operationalized and inclusion criteria were specified in the domains of habit measurement, research paradigms, and manipulation tasks. A search across four databases was conducted: Web of Science, EBSCOhost, PubMed and OVID (PsycARTICLES and Journals@OVID). A progressive screening procedure yielded 8 relevant studies related to mental habits in anxiety (*n* = 1), depression (*n* = 4) and both anxiety and depression (*n* = 3).

Results: Self-report habit measures correlate with the presence of symptoms. Computational modelling reinforcement learning and goal-devaluation paradigms demonstrate that anxiety and depression are associated with deficits in goal-directed learning and decision-making in favour of habitual learning strategies. Cognitive bias modification meets the criteria for enabling habit change and can strengthen or weaken interpretative habits in response to training.

Conclusions: Despite considerable variability and limitations in the design of the studies appraised in this review, overall findings indicate support for habitual thought processes being implicated in anxiety and depression. Treating problematic thought processes in anxiety and depression as habitual – cued automatically by contextual cues, not goal-dependent and resistant to change – may be beneficial for future research and clinical applications.

Keywords: Automaticity, habit, rumination, stimulus-response

Introduction

Habit in Psychology

Habitual behaviours have been defined as a case of "cue contingent automaticity… Performance of a habit therefore involves delegating behavioural control to the cues that were, in the past, contiguous with performance" (Orbell & Verplanken, 2010 p. 374). The current psychological understanding of habit converges around the following four interrelated principles (Watkins & Nolen-Hoeksema, 2014; Orbell & Verplanken, 2014): (1) habits are acquired slowly through repetition or practice (Verplanken & Aarts, 1999); (2) once formed they are no longer mediated by goals (Neal, Wood, Labrecque & Lally, 2012; Orbell & Verplanken, 2010); (3) they are triggered by stable contexts where the behaviour has previously been practiced; and (4) habits contain an element of automaticity, which makes them difficult to control and change (Bargh, 1994; Wood & Neal, 2007).

Behavioural reinforcement models (Hull, 1943; Skinner, 1938; Watson, 1913) propose that habits form through repeated reinforcement of a behaviour and repetition of the stimulus-response contingency. Over time responses become (i) unintentional, (ii) uncontrollable, (iii) efficient and (iv) performed without awareness, what Bargh (1994) terms the *Four Horsemen of Automaticity*. However, automaticity is a necessary but insufficient component of habit (Orbell & Verplanken, 2014) in that not all automatic behaviour is habitual. For example, a response could be primed and acted out without awareness, yet without learning via repetition across contexts and in response to a particular cue, the behaviour would not be considered habitual (Marteau, Hollands & Fletcher, 2012). Once automatically triggered by contextual cues, habits are no longer mediated by pursuit of goals if the cue is present (Wood & Rünger, 2016). Habits strengthen through repeated practice of the habitual response to the same contextual cue, making unwanted habits hard to change despite good intentions or occasional attempts to

counter habitual responses (Wood & Neal, 2007). Habits are insensitive to changes in reward, continuing after outcomes have been devalued (Dickinson, 1985).

Habit in Mental Health

Habits have been identified as important in physical health and health psychology with sustained changes in unhealthy behaviours (e.g., smoking), and healthy behaviours (e.g., physical exercise) hypothesized to require habit change (Lally & Gardner, 2013; Marteau et al. 2012). In mental health literature there has been a recent emerging interest in the role of habitual responses, particularly with regard to obsessive –compulsive disorder (OCD), addiction, stress, and eating disorders. Though at an exploratory stage, research suggests that OCD, stress, addiction and binge-eating disorder (BED) cluster around habitual compulsivity where, for those with symptoms, there is an overreliance on habitual control of behaviour over goal-directed decision-making (Gillan et al. 2016).

A paradigm to investigate the distinction between automatic habitual behaviour and deliberate goal-directed behaviour has been developed within models of reinforcement learning in cognitive neuroscience. Dual-process decision-making models investigate two cooperating and competing systems of control over behaviour. The model-based system of reinforcement learning is goal-directed and involves conscious reflection and weighing up of future actions and outcomes. The model-free system is habitual and relies upon reflexive and retrospective learning, where previous experience shapes the decision (Dolan & Dayan, 2013).

Two experimental approaches using behavioural indicators have been developed to assess the relative influence of these two systems, namely outcome devaluation tasks and sequential-learning tasks (Friedel et al. 2014). Outcome devaluation tasks indicate that strategies for learning begin as goal-directed but following over-training can develop into habitual model-free strategies. Habitual responding is identifiable by the tendency for behaviour to be repeated in the extinction (e.g., satiety) stage of the task when the reward has been devalued (Dickinson, 1985).

The relative influences of model-free and model-based decision-making can be investigated by computational modelling, utilising sequential-learning tasks. In two-step tasks (Daw, Niv & Dayan, 2005), model-based thinking and learning strategies predict different subsequent first-stage decision strategies following reward obtained in the second stage (Daw, Gershman, Seymour, Dayan, & Dolan, 2011). Stage one of the two-step task involves a choice between two options. The second stage also requires two options, which then lead to rewards. Each set of choices has a probability attached (e.g., 70% for one option and 30% for the other). The ultimate probability of a reward can be changed according to a schedule. In an example scenario, a first-stage choice does not usually lead to a second-stage reward. Then, the schedule is shifted and reward is increased. Behavioural theory would predict, because of the increased reward, an increased probability of repeating the first choice. However, as Daw and colleagues (2011) explain, because of the prospective nature of model-based learning, those using this strategy should decrease their tendency to choose the same first-stage option. This is because the increase in the value of the second-stage option will increase the value associated with the first-stage option that leads to it. As the original choice did not lead to increased reward, it is less likely to be repeated. A best fit to either a model-based or model-free system can be assessed, as model-based learning is a more computationally demanding process compared to model-free processes.

Evidence is emerging that those with mental health difficulties may be prone to learning habitual strategies at the expense of goal-directed decision-making. In experimental studies, participants with OCD showed a tendency to continue with over-trained responses despite reward devaluation compared to healthy controls, providing evidence of a habitual compulsivity (Gillan et al. 2016; Gillan et al. 2015). Compulsivity is evidenced as habit in drug addiction with a shift from goal-directed voluntary drug seeking to automatic habitual drug seeking and consumption via repetition of the stimulus-response contingency, despite intention to quit (Everitt, 2014). Stress has been found to shift the balance toward habitual decision-making in those experiencing chronic stress

(Radenbach et al, 2015) and those with low capacity in working memory (Otto, Raio, Chiang, Phelps & Daw, 2013). In a two-step task, BED patients were less sensitive to changes in monetary reward following training than healthy controls (Voon et al. 2015).

Habits in Anxiety and Depression

Given the high prevalence and impact of anxiety and depression (NICE, 2011), a question arises as to the extent to which the role of habits has been investigated in these psychological disorders. Epidemiological surveys estimate that up to a third of the population of Europe will experience an anxiety disorder during their lifetime (Bandelow & Michaelis, 2015). In England between four and 10% of the population will experience an episode of major depression in their lifetime (McManus, Meltzer, Brugha, Bebbington & Jenkins, 2009). The World Health Organisation (WHO; 2017) now ranks depression as the leading cause of disability worldwide. In the UK co-morbid anxiety and depression is the most common mental health disorder with 7.8% of the population meeting criteria for diagnosis (NICE, 2011). These findings emphasize the need for further understanding and intervention in these disorders.

Anxiety and depression have been conceptualised as being associated with *"an abundance of habit and a dearth of control"* (Hertel, 2015, p. 1). Rumination, the tendency to respond to emotional distress through self-focus on its meaning and causes (Nolen-Hoeksema, 1991), is implicated in the onset and maintenance of anxiety and depression (Lyubomirsky, Layous, Chancellor, & Nelson, 2015). As a thinking process that is triggered frequently across stable contexts without awareness, rumination can be considered a mental habit (Watkins & Nolen-Hoeksema, 2014), though the explicit role of habit remains relatively under-investigated (Teasdale, 1988; Nolen-Hoeksema & Watkins, 2014). Habit research has focused mainly on behaviour, but habit criteria can also apply to thinking. Mental habits are characterized by thinking being persistent, automatic, unintentional and, once established, difficult to avoid or control (Verplanken & Fisher 2014). These cognitive processes are thought to be stable over time and therefore difficult

to change (Hertel, 2004). Negative self-thinking, rumination, decision-making and negative interpretations of ambiguous information are thinking processes considered to meet the definition of mental habit outlined in this review (Verplanken, 2006; Watkins & Nolen-Hoeksema, 2014; Hertel, 2015)

Delineating the role of habit across mental health disorders may have important clinical implications for treatment, as targeting habits requires interventions designed to form positive alternative habits and/or disrupt and reduce unhelpful habits (Graybriel, 2008; Wood & Rünger, 2016).

Aim of the Systematic Review

This systematic review aimed to assess the extent to which habits of thought are implicated in anxiety and depression.

The question for this review is; are mental habits involved in the experience of anxiety and depression?

Method

The review is structured in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta Analyses; Liberati et al. 2009) to provide a consistent framework to evaluate the evidence.

Eligibility criteria

The PECO method (Participants, Exposure, Comparator & Outcome) was utilised to devise the eligibility criteria for this review (Higgins & Green, 2011). This method was chosen because the majority of studies are correlational rather than interventions.

A mental habit is operationally defined as a learnt cognitive process that is automatically cued by context, not mediated by goal-directed decision-making, performed without conscious awareness and is insensitive to changes in reward (Dickinson, 1985; Gillan et al, 2011; Orbell & Verplanken, 2010)

Studies included involved (i) a recognised measure, paradigm or manipulation of a mental habit that is (ii) associated with symptoms of anxiety and depression.

Participants. There were no exclusion criteria for participants. Clinical and non-clinical samples were included.

Exposure. Studies are included where (i) the presence of anxiety and depression are assessed by use of an appropriate standardized measure e.g., the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), the Patient Health Questionnaire-9 (PHQ-9, Kroenke, Spitzer & Williams, 2001), diagnostic criteria or diagnosis; (ii) where a mental habit is measured through questionnaires or paradigms consistent with the operationalization of mental habit (e.g., the Self-Report Habit Index, [Verplanken & Orbell, 2003], goal devaluation and contingency degradation tasks used to test whether actions are goal-directed in instrumental conditioning [Ostlund & Balleine, 2008], extinction tests during which a habit will continue as it is insensitive to changes in reward value once learnt [Dickinson, 1985], category-learning tasks where participants actions are observed whilst learning to assign unfamiliar stimuli to categories [Ashby & Maddox, 2005], associative learning tasks to assess how participants develop associations between stimuli or between stimulus and response [Asaad, Rainer & Miller, 1998], and the previously described two-step tasks) and/or manipulated through tasks or interventions designed to change habits e.g., Cognitive Bias Modification for Interpretation (CBM-I; e.g., Hertel & Matthews, 2011), concreteness training (Watkins, Baeyens & Read, 2009); (iii) there is an explicit description of the relationship between symptoms and mental habit.

Questionnaire measures include: the Self-Report Habit Index (SRHI), which focuses on factors related to frequency and automaticity of behaviours, and the Habitual Index of Negative Thinking (HINT; Verplanken, 2006), which is the SRHI adapted for negative thinking (e.g., sample item: *negative thinking* is something I do automatically, rated on a 5-point scale from 1 *strongly disagree* to 5 *strongly agree*).

The research in other mental disorders (e.g., OCD) has indicated that individuals with psychological disorders may be more prone to habit formation, as assessed using

computational modelling of responses on learning tasks (e.g., two-step and outcome-devaluation tasks). Because such differences in habit formation may underpin differences in mental habits in depression and anxiety, such tasks were explicitly included in the review, when the learning process studied was clearly relevant to cognitive processes, e.g., category-learning, decision-making.

Behavioural indicators of habitual thinking processes include the measurement of continued responding following outcome devaluation in instrumental learning paradigms. The two-step decision-making task, and variants such as the leapfrog task (Daw et al. 2005; Knox, Otto, Stone, & Love, 2012) are included as they provide behavioural indicators of cognitive strategies and can disentangle the relative impact of model-free and model-based system involvement on the task. Unscrambling ambiguous sentences under high cognitive load and low cognitive load can indicate when prior training has become habitual (Wenzlaff, 1993). Cognitive load does not interfere with habit because it is not a reflective process.

CBM-I is one example of an intervention designed to change mental habits. CBM-I involves associative learning through repetition until the trained response is automatic and no longer goal-directed. Recent evidence demonstrates that CBM-I does involve a component of training habit (Hertel, Holmes & Benbow, 2014; Hertel, Vasquez & Benbow, 2011) as evidenced by use of process-dissociation procedures (Hay & Jacoby, 1996) to estimate the extent to which automatic or conscious control contributes to performance on near-transfer tasks. CBM studies are included where there is a measure of both automaticity and impact of the intervention on symptoms of anxiety and depression. Concreteness training uses CBM principles and is consistent with mental habit change as it counter-conditions the abstract thinking associated with rumination (Watkins, Baeyens & Read, 2009). Studies measuring automaticity in isolation were excluded, as automaticity is only one necessary component of a habit (see page nine for the four interrelated components).

Comparator. Designs were included that assessed the presence of mental habits within clinical or analogue populations with symptoms of anxiety and/or depression or across patient versus control groups.

Outcomes. The outcome of primary interest is the relationship between a measure of mental habit and symptoms of anxiety and depression. This relationship is evidenced through correlation between measures of habit and symptoms, relative levels of habit indices between clinical groups and controls or the impact of targeting mental habits on clinical outcomes.

Information Sources

Following an initial scoping review to generate relevant terms for mental habit and paradigms, tasks, and manipulations associated with symptoms of anxiety and depression, the following four electronic databases were searched from first available entries until 6th February 2017: Web of Science, EBSCOhost, PubMed and OVID (PsycARTICLES and Journals@OVID). Peer-reviewed journal articles including experimental, correlational or prospective designs exploring mental habits in anxiety and depression were included. Grey literature was not searched. Theoretical papers, reviews and, qualitative studies were excluded, as were foreign language papers due to research limitations with regard to translation facilities.

Search Terms

The following search terms were entered into the databases.

Table 1.

Search Terms Entered in Databases

Research question area	Search terms
Psychological disorders (anxiety, depression)	(Depression OR anxiety OR worry* OR rumination OR depression and anxiety OR depressed mood OR dysphori* OR dysthymi* OR Affective Disorder) AND
Habits (as process, paradigm or manipulation)	(“Habit” OR “habits” OR “habitual” OR “mental habit(s)” OR “cognitive habit(s)” OR "Habitual Negative Self-Thinking" OR “learned stimulus-response association” OR “habit change” OR “habit-goal” OR “goal-directed Vs habit” OR “Stimulus response” OR “S-R” OR “Context-cued” OR “goal devaluation” OR “process dissociation” OR “reinforcement learning” OR “computational modelling” OR “extinction test” OR “two-step task” OR “contingency degradation” OR model-free learning OR model-based Vs model-free)

*Note: Search items were grammatically adapted according to specific search conventions of each database. * Signifies possible multiple variations of search terms*

A progressive screening procedure (see Figure 1) was carried out to select relevant studies. Studies were searched via titles and abstracts and screened for inclusion criteria. Review papers were removed only after further review of reference lists. The remaining articles were read in full and assessed again against criteria.

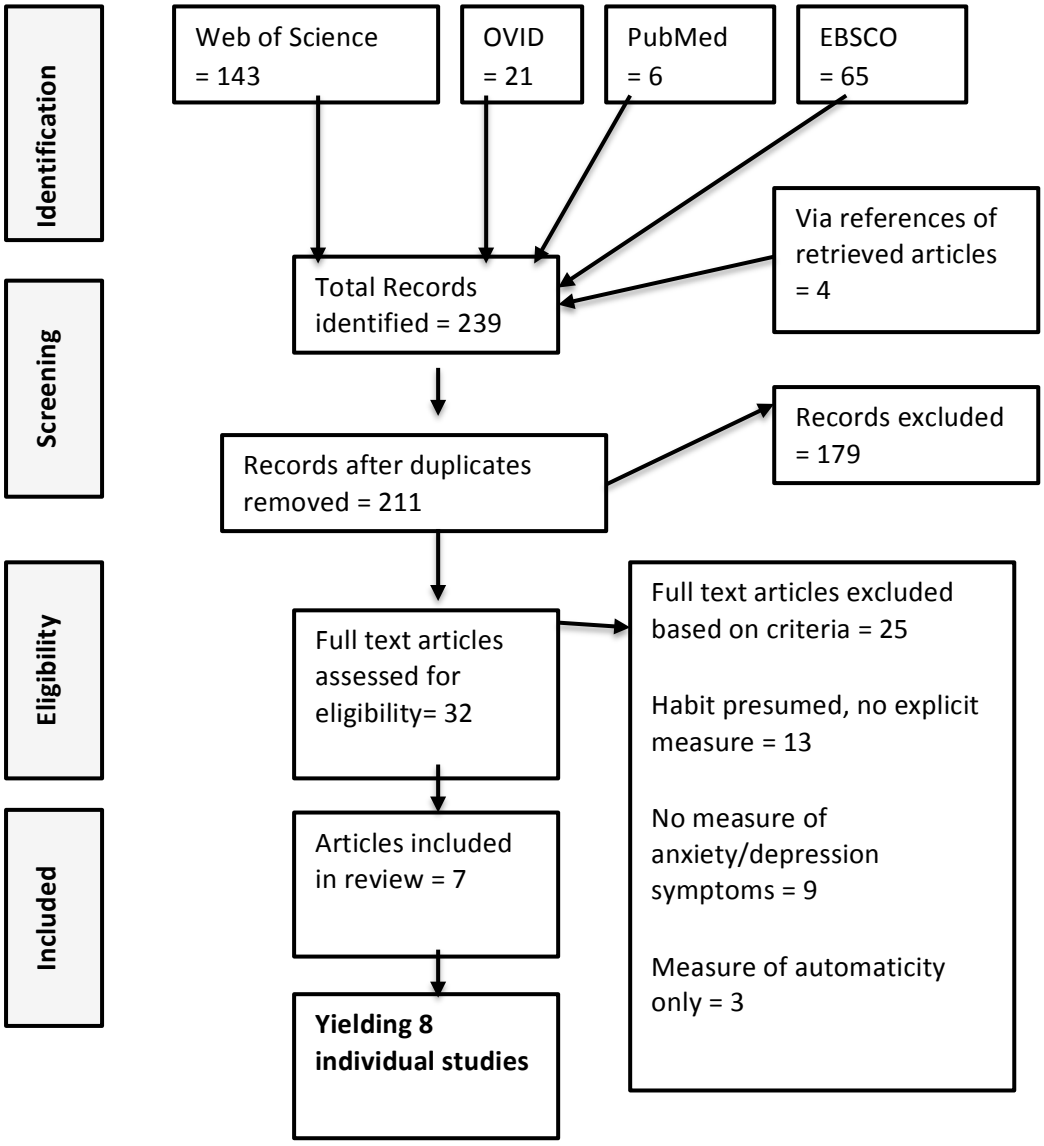


Figure 1. PRISMA Progressive Screening Process of Inclusion and Exclusion.

Data Extraction

An extraction-checking template (Cochrane Collaboration, 2016) was used to determine study eligibility. For all eight remaining studies, data were summarized using a proforma based upon population, exposure, comparator and outcomes (PECO;

O'Connor, Green, & Higgins, 2011) following the categories: (a) study design, (b) sample characteristics, (c) exposure, (d) measures including habit measures, (e) main findings, (f) evaluation and (g) quality rating.

Risk of Bias in Studies

All studies were assessed for risk of bias using the Quantitative Assessment Tool for Quantitative Studies (QATQS; Thomas, Ciliska, Dobbins & Micucci, 2004) in order to have a consistent framework to evaluate the evidence. The QATQS accommodates multiple study designs. Ratings relate to selection bias, study design, confounders, blinding, data collection and withdrawals (see table 2). Four of the eight (50%) final studies were re-assessed by an independent researcher against inclusion criteria yielding 100% agreement. Studies were not excluded for weak ratings but the quality informed the synthesis.

Results

Critical Summary

Of the seven journal articles identified in the literature search, a total of eight studies met the eligibility criteria for inclusion in the review. These are summarised in table 2. One study investigates the role of mental habits in anxiety (8), four in depression (3, 4, 5, 7) and three in both anxiety and depression (1, 2, 6). All papers were published in 2006 or later indicating this is an emerging research area. Participants are drawn from non-clinical populations (studies 1 to 6) and clinical samples (7 and 8).

Design of Studies

There are three types of study design: cross-sectional (1 to 5), longitudinal (6) and clinical trial (7 and 8). Studies are further sub-divided by the measure of habit used.

Table 2. *Studies Included in the Review, Organized by Study Design*

Study	Design	Sample	Exposure	Measure(s)	Main Findings	Evaluation	QATQS ratings*
1. Armstrong et al (2014)	Cross-sectional	45 older adults, 33 female, age 60-89 (M_{age} = 73.5, *SD* =7.5); 60 young adults (u/g), 51 female, age 18-24 (M_{age} = 19.1, *SD* = 1.3	Compare self-reported worry, depression and negative self-thinking (habit) across older and younger adults.	Habitual index of Negative Thinking (HINT) (cronbach alpha α =.94 for younger and older adults), PSWQ, CES-D, MCQ-30, BMCM.	HINT correlates with depression symptoms (CES-D) (*b* = .57) and worry (PSWQ) (*b* = .66) partially mediating the relationship between age and worry and completely mediating the relationship between age and depression.	**Strengths:** Novel use of HINT. Between groups design. **Limitations:** No comparison within age groups. Non-clinical sample.	A –Weak B – Weak C Moderate D – N/A E Moderate F – Weak **Global: Weak**
2. Verplanken (2006) Study 2	Cross-sectional	194 u/g students, 123 female. Non-clinical sample.	Regression analysis to test whether HINT was more predictive than frequency measure of negative thinking (ATQ) for depression and anxiety symptoms and self-esteem.	HINT (α = .95), ATQ, HADS, SLCS.	HINT as measure of habit and ATQ as measure of frequency of negative self-thinking both significantly correlated with anxiety and depressive symptoms (HINT R^2 = .544) (ATQ = R^2 = .500) HINT showed small independent contribution over and above ATQ in predicting presence of anxiety and depression symptoms HINT including automaticity questions only correlated with presence of anxiety /	**Strengths:** Novel approach. First use of HINT. **Limitations:** Poor demographic detail. Non-clinical sample.	A –Weak B –Weak C – Weak D – N/A E Moderate F – Weak **Global: Weak**

		depressive symptoms (score 16 or more on CES-D), 95 non-depressive.	(Knox, Otto, Stone, & Love, 2012) to assess habitual exploratory decision-making deficits in people with symptoms of depression. In this decision-making task the relative value of one of two options can change with the inferior option becoming superior on any trial (thus 'leapfrog'). The change is on a fixed probability schedule.	participants data was a best fit model-free learning or model-based.	model-free system than people without depression (21%), p=.002, suggesting a tendency towards habit formation on a decision-making task in people with depression People with depression best fit by model-free system had a higher mean CES-D score (M=27.6, SD=7.73) than those best fit by the model-based system (M=22.7, SD=5.55) p=.03, d=.73]. Within depressive participants there is a relationship between decreased expression of reflective strategies and higher depressive symptoms.	**Limitations:** Analogue population. Presence of clinical depression and use of medication not assessed.	C – Weak D – N/A E Moderate F Moderate **Global: Weak**
4. Maddox et al 1 (2014) Experiment 1	Cross-sectional	217 community adults with (n=69) and without (n=148) depression symptoms (16+ on CES-D).	Dual-process paradigm in auditory category learning (ACL) to test prediction that participants with depression would show a cognitive processing deficit in reflective ACL task but an advantage in reflexive-optimal ACL task (model-free, habitual).	Computational modelling. Category learning. Dependent variable = trials-to-reach criterion of 10 correct responses in a row.	A two participant group depressed vs. not depressed x 2 task (optimal reflexive vs. optimal reflective) between groups ANOVA was conducted on the trials-to-criterion measure. Individuals with elevated depressive symptoms took significantly more trials to reach criterion in the reflective-optimal task than individuals without elevated depressive symptoms (p = .038, partial η^2 = .041).On the reflective optimal task: those with elevated depressive	**Strengths:** Novel model-based Vs model-free differentiation. Novel task. **Limitations:** Analogue population. Presence of MDD not assessed. No assessment of confounders that may effect ACL e.g., education level.	A Moderate B Moderate C – Weak D – N/A E Moderate F – Weak **Global: Weak**

				.	symptoms took significantly more trials than those without to reach criterion (p = .025, partial η^2 = .045) Rate of learning did not differ across tasks for those without depressive symptoms, p = .57, partial η^2 = .002.Individuals with depression show advantage in reflexive optimal ACL compared to reflective optimal task. p = .001, partial η^2 = .145] suggesting a tendency toward habit formation in those with depression.		
5. Maddox et al 2 (2014) Experiment 2	Cross-sectional	65 community adults. 30 depressive, 19 female (M_{age} =19, SD = 2.37, CES-D M = 19.17, SD= 2.37). 35 non-depressive, (M_{age} 19, SD = 3.11, CES-D M = 7.91, SD =3.47).	Comparing depressed and non-depressed subjects in learning new speech categories (Mandarin tones), which benefits habitual cognitive processing.	On each trial, participants were presented with a single exemplar from one of four Mandarin tone categories (*bu, di, lu, ma & mi*) and instructed to categorize the stimulus into one of four equally likely categories.	Individuals with elevated depression were more accurate when learning non-native speech category structure (p = .026, partial η^2 = .076) and used reflexive strategies significantly sooner after 3.33 blocks compared to control subjects (4.86 blocks) (p = .007) and significantly more frequently (M = 2.50) compared to control (1.57) (p = .05). Effect size not calculable, no SD data. Increased reflexive learning showed an advantage in learning a non-native speech category structure due to faster and frequent use of	**Strengths:** Novel model-based Vs model-free differentiation. Considered advantages of reflexive processing. **Limitations:** Analogue population. Presence of MDD not assessed. No assessment of confounders that may affect ACL e.g., education level, IQ	A- Moderate B Moderate C – Weak D – N/A E Moderate F – Weak **Global: Weak**

					reflexive strategies.	No effect size.	
6. Verplanken et al (2007) Study 8	Longitudinal	Representative sample of Norwegian population. 1682 respondents at Time 1, 936 female, age 25 to 51 (M_{age} = 40.27, *SD* =8.23) 1102 respondents to questionnaire at T1 and T2, 641 female, age 25-51 (M_{age} = 40.27, *SD* = 8.23).	Test whether negative self-thinking habit and dysfunctional cognitive attitudes predict symptoms of anxiety and depression. Online questionnaire at T1 and T2 (9 months later).	T1; HINT (α = .95), HADS, DAS, T2 HINT for reliability (α = .95), HADS, negative life event checklist.	Using multiple regression analysis to control for confounding variables HINT predicted anxiety and depression symptoms at time 1 and prospectively at time 2 nine months later. HINT T1 anxiety (*r* = .373), HINT T2 anxiety (*r* = .528) . HINT T1 depression (*r* = .288), HINT T2 depression (*r* = .456). All *p* < .001 HINT showed a small but statistically significant effect at predicting changes in anxiety and depression at T2 over and above measure of negative attitudes (DAS anxiety T2 *r* = .511, T2 *r* = .422).	**Strengths:** First longitudinal use of HINT **Limitations:** Selection bias. No reason for dropouts given.	A –Weak B – Weak C Moderate D – N/A E Moderate F Moderate **Global: Weak**
7. Watkins et al (2012)	Clinical Trial	121 participants meeting criteria for current episode of major depression (MDD) (*n*=105) or meeting four symptom criteria of MDD.	Randomly allocated to TAU (treatment as usual) or TAU+CNT (Concreteness training) or TAU+RT (relaxation training) Hypothesized that CNT works by becoming habitual from repetition in context. CBM paradigm.	HAMD rating scale for depression, BDI-II, PHQ-9, GAD-7, RRS, brief single-item self-report measure of extent of self-help response becoming a habit.	CNT reduced depression significantly more than RT in those who reported that CNT practice became habitual (*p* =.02) but a reverse pattern when CNT had not become habitual (*p* = .06). TAU+CNT resulted in significantly fewer depressive symptoms post intervention compared to TAU (HAMD *p* = .006, *d* = .76) and fewer anxious symptoms (GAD-7 *p*= .0001, *d* = .85). Improvements	**Strengths:** Clinical population. RCT. **Limitations:** One-item measure of habit. No baseline measure of habit to assess change.	A –Strong B – Strong C – Strong D Moderate E – Strong F – Strong **Global: Strong**

					maintained at 3 and 6-month follow-up. No significant difference between reduction on measures between TAU+CNT & TAU+RT (p > .05) unless CNT reported as habitual.		
8. Bowler et al (2012)	Clinical Trial	63 subjects, 43 female (M_{age} =22.7, SD=5.87) with social anxiety (scoring 17 or more on Fear of negative evaluation scale (FNE) CBM-I group: n=21, 16 female (M_{age} =24.14, SD=7.92) cCBT group: (n=21), 14 female (M_{age} =21.86, SD=5.31) Control group: (n=21), 13 female (M_{age} =21.95, SD=3.53).	Comparing cCBT CBM-I and control to alleviate anxiety CBM-I: 4 sessions presenting 40 ambiguous scenarios (with final word missing) that may concern anxious individuals. Participants completed final word following benign training. cCBT: participants completed 4 online CBT sessions (modules) for social anxiety.	FNE, SPIN (social anxiety), STAI (trait anxiety);BDI-II depression (depression); ASSIQ (interpretative bias). Scrambled sentences test (SST) to assess effect of interventions on interpretative bias under high Vs low mental load (remembering six-digit number).	Significant time x group reductions in SPIN comparing CBM-I with control (p = .007, η^2 = .17), and cCBT with control (p = .01, η^2 = .14), but not comparing intervention groups (p = .30, η^2 = .03) Significant effect of load (p = .02, η^2 = .09), group (p = .003, η^2 = .18) and group x load interaction (p = .042, η^2 = .10) on change in negative interpretations post intervention. Both CBM-I and cCBT groups reduced negative biases on SST under load compared to control suggesting benign training has become habitual. CBM significantly more effective than cCBT when under cognitive load (p = .05).	**Strengths:** Randomized into 3 groups. Intention to treat analyses (5 drop out). Reliable change index used for clinically significant change. **Limitations:** Laboratory setting. Need real life practice.	A Moderate B – Strong C – Strong D – Weak E – Strong F – Strong **Global: Moderate**

Note: *QATQS ratings: A = Selection Bias, B = Study Design, C = Confounders, D = Blinding, E = Data Collection Method, F = Withdrawals and Dropouts. T1 = Time 1, T2 = Time 2, MDD = Major Depressive Disorder, cCBT = Computerised cognitive behaviour therapy, CNT = Concreteness Training, CBM-I = Cognitive Bias Modification for Interpretation, u/g = undergraduate, HINT = Habitual Index of Negative Thinking, PSWQ = Penn State Worry Questionnaire, CES-D = The Centre of Epidemiologic Studies Depression Scale, MCQ-30 = The Metacognitions Questionnaire-30, BMCM = The Billings and Moos Coping Measure, HADS = Hospital Anxiety and Depression Scale, DAS = Dysfunctional Attitude Scale, FNE = Fear of Negative Evaluation Scale, ATQ = Automatic Thoughts Questionnaire, BDI-II = Beck Depression Inventory – Second Edition, HAMD = Hamilton Rating Scale for Depression.

Cross-sectional/correlational Designs

Self-report. The Armstrong et al (2014) and Verplanken (2006) studies demonstrate a large correlation between habitual negative thinking and anxious and depressive symptoms. In addition, the HINT, which includes frequency and automaticity questions, accounts for more variance in anxiety and depression symptoms than measures of frequency only (Verplanken, 2006) and problem-solving and positive beliefs (Armstrong et al, 2014). However, these studies suffer from sampling bias and, as correlational studies, do not allow any inference as to the causal direction between habitual negative self-thinking and symptoms of anxiety and depression.

Computational reinforcement learning paradigms. Blanco et al (2013) and Maddox et al (2014, studies 1 & 2) used computational modeling to differentiate between model-free (habitual) and model-based (goal-directed) category-learning and decision-making in participants with depressive symptoms following a task. Results show a tendency for those with greater depressive symptoms to use habitual decision-making strategies when learning. Maddox et al (2014 study 2) demonstrated that deficits in reflective processing can lead to a tendency to employ habitual learning strategies in participants with depression symptoms and this can confer a learning advantage on particular tasks that require reflexive processing (learning Mandarin tones). These studies did not assess the presence of major depression diagnosis or carry out checks for educational or intellectual functioning, which may have impacted upon cognitive performance.

Prospective Design

The large online study (Verplanken et al, 2007) demonstrated a moderate effect of the habit scores predicting the presence of anxiety and depression symptoms nine months later, controlling for symptoms at baseline, over and above a measure of negative-thought content only. However, there were relatively high drop-out rates for participants.

Clinical Trials

The studies by Bowler et al (2012) and Watkins et al (2012) both involve the manipulation of habit. The principles of CBM (the repeated practice of cognitive exercises in context until a habit is formed) are used for training designed to change habit. Both studies have an index with which to measure targeted habit change. Both studies use clinical populations and there are pre and post measures of symptom change. Watkins et al (2012) used a one-item measure of concrete thinking becoming habitual at post intervention only, so changes in self-reported habit could not be assessed. Results from the use of the scrambled-sentence-task, under cognitive load and no load (Bowler et al, 2012), suggests that CBM was more effective at changing interpretations in contexts when more automatic responses were elicited. Though habits are generally considered resistant to change, Bowler et al (2012) gives an example of positive habit formation in four sessions with associated reductions in anxious symptomology.

Quality of Studies

Use of the QATQS assessment tool revealed a wide range of bias within the studies. The QATQS ratings do not allow for any design other than randomised or controlled clinical trials to receive overall strong ratings. All non-clinical trials were rated weak overall with a pattern of high drop-out rates, reasons for withdrawals not described and possible confounding variables not controlled for. In response to the different methodologies and analyses, studies presented varying effect size results. Effect sizes for self-report use of the HINT were moderate to large indicating habitual negative thinking is moderately associated with anxiety and depression. Effect sizes for reinforcement learning paradigms indicate a moderate effect of habitual learning styles being associated with anxiety and depression symptoms. Both treatment studies are less restrained by bias than other designs suggesting important clinical applications for the consideration of treating thinking processes in anxiety and depression as habitual.

Discussion

Summary of Evidence

Despite heterogeneity and limitations of the studies, the findings suggest the involvement of mental habits in anxiety and depression with a similar pattern of results found across all designs and tasks. Several studies employing the HINT demonstrate that mental habits are associated with and can prospectively predict anxious and depressive symptoms. Computational learning and associative learning paradigms demonstrate that those with anxiety and depression show a greater tendency toward using habitual (model-free) strategies for learning. It could be hypothesised that those prone to rumination (habitual negative self-thinking) may be so because of their increased tendency to habitual learning in associative learning tasks. Two clinical trials have been published to date that suggest that psychological interventions targeting habits can be effective in improving symptoms of anxiety and depression.

The results extend findings from computational research in other disorders. The same relative dysfunction of reflective strategies in favour of habitual reflexive strategies found in anxiety and depression are found in healthy subjects under stress (Radenbach et al. 2015), those with OCD (Gillan et al. 2011) and addictions (Everitt et al. 2014), which suggests a potential transdiagnostic, rather than disorder specific phenomenon (Gillan et al, 2016; Nolen-Hoeksema & Watkins, 2011).

Limitations

This review has a number of limitations therefore conclusions drawn from the results need to be tentative. Generalizability of the findings is limited given the small number of studies reviewed and the variability in methodology. There is an inherent risk of bias in published papers towards reporting positive results. Future reviews may wish to search unpublished data. The variable quality of the studies, suggested by the QATQS, indicates this is an area of research in its relative infancy with novel approaches using a typically weak methodology. A systematic approach to the search was used which was intended to reduce bias. However the decision, based on resources, not to

use a second rater for searches, screening or data extraction is a further limitation of this review. A second rater would have provided an independent test of reliability and decreased the risk of subjective bias in the search.

Other possible explanations for the results present themselves. The effect sizes for the HINT correlating with symptoms of anxiety and depression may be artificially high due to content overlap. Because the HINT focuses on negative thought, and the anxiety and depression measures also focus on negative mood and thought (via symptoms), there is likely to be a positive correlation between scores due to similar content. The HINT is necessarily retrospective and reflective as one cannot report on automaticity in the moment. The HINT therefore may be better suited reflecting on past thoughts rather than assessment of triggering cues in the moment (Labrecque & Wood, 2015). Most published studies to date have employed correlational methodology, making it difficult to understand causal relationships or temporal sequencing of habits of thought and symptoms of anxiety or depression. The non-clinical studies tended not to assess co-morbidity so the results may not be specific to symptoms of anxiety and depression. Other potential confounding variables not assessed in the studies include use of medications, educational level, and general cognitive deficits or abilities. Furthermore, studies did not address all aspects of habit in ecological contexts. Although studies employing the HINT involved assessing habits of thought in real-world situations, they did not address how these habits are cued. Studies using behavioural indicators of habitual thinking utilised novel non-everyday tasks and measures but these are difficult to replicate outside laboratory conditions.

Future Implications for Research and Clinical Application

The findings from this review support the claim that habitual thinking may be a component of anxiety and depression. The majority of the findings are correlational, however the two clinical studies suggest that there is clinical value in targeting mental habits in anxiety (Bowler et al, 2012) and depression (Watkins et al, 2012). Should such findings be found to be robust then clinical implications could involve an explicit

agreement between clinician and client to target mental habits in anxiety and depression. Intervention techniques, such as CBM-I and concreteness training could become complementary elements to currently provided psychological interventions such as cognitive behaviour therapy or cognitive analytic therapy and would be adopted to increase the likelihood that adaptive strategies will become habitual. Treatment may be enhanced by explicit discussion of habit change and the use of approaches designed to target habit change such as the use of IF-THEN plans linked to identified cues for the habitual behaviour to be targeted. Monitoring of treatment would involve asking about how automatic the adaptive (and maladaptive) strategies have become. This monitoring would influence what to do next. For example, treatment and practice could stop once the new strategy had become habitual. If positive strategies were not yet habitual then practice would continue until an agreed level of automaticity is reached. Clinicians and service providers might helpfully consider how they would ensure that an adequate number of follow-up sessions are provided to enable monitoring and further practice as required. An additional benefit of a habit focus for treatment lies in the potential for relapse prevention. Because formed habits are predicted to get stronger over time due to them being automatically triggered by context therefore becoming more efficient and effortless over time, it is predicted that a relapse is less likely for those with a formed adaptive habit compared to those who have experienced behaviour change but a habit has not yet formed. (Watkins & Nolen-Hoeksema, 2014; Lally & Gardner, 2013)

The HINT and variants are yet to be used with clinical populations or extended beyond negative self-thinking. Besides negative self-thinking, negative interpretations, category-learning and decision-making being indicated as habits of thought related to anxiety and depression, this may not be an exhaustive list and other thought processes may qualify as habitual. Comparisons between anxiety, depression and other disorders could explore whether particular mental habits may be considered transdiagnostic or whether they are disorder-specific. More studies are needed to test the extent to which CBM-I training is shown to be automatic on process-dissociation tasks and also to

specifically test whether this habitual aspect of CBM is directly associated with changes in mood or symptoms produced by CBM training. The possibility that a tendency towards model-free learning (i.e., easier habit formation) underpins increased risk for habitual negative self-thinking needs to be directly tested in experimental studies.

As suggested, problematic cognitive processes such as rumination and negative self-thinking may be defined operationally as habits. Therefore, a viable approach to symptom reduction would be to conceptualise them as habits. Literature on successful habit change in health related behaviours (Marteau et al. 2012) suggests that long-term reductions in habits of thought require direct targeting of the stimulus-response association by practicing a new alternative behaviour in response to triggers until an alternative and helpful new habit forms (Hertel, 2004; Hertel, 2015; Watkins & Nolen-Hoeksema, 2014; Wood & Neal, 2007). Concreteness training and CBM-I are examples of interventions that meet these requirements and also provide alternative and complementary options to those more typically available such as Cognitive Behavioural Therapy (CBT) to treat problematic habits of thought such as rumination (Watkins et al, 2012; Watkins 2015).

Conclusion

Despite the limitations of the study designs, mental habits of rumination, negative interpretations, category-learning and decision-making are implicated in anxiety and depression. The review was necessarily broad in terms of study design in order to capture the current state-of-play in this relatively new area of research. Correlational studies using self-report measures demonstrated an association between habits of thought and anxiety and depression. Computational modeling tasks investigating reinforcement learning suggest that depression impairs more reflective cognitive processing in favour of habitual strategies. Clinical trials have important applications in demonstrating that CBM-I (i.e., associative learning of responses until they become automatic) can induce benign habitual responding following training and reduce symptoms of anxiety and depression in clinical populations.

References

Armstrong, L., Wuthrich, V. M., Knight, A., & Joiner, R. (2014). Worry and depression in the old and young: Differences and mediating factors. *Behaviour Change*, *31*, 279-289. doi:10.1017/bec.2014.21

Bandelow, B., & Michaelis, S. (2015). Epidemiology of anxiety disorders in the 21st century. *Dialogues in Clinical Neuroscience*, *17*, 327. doi :10.1038/srep28033

Bargh, J. A. (1994). The four horsemen of automaticity: Intention, awareness, efficiency, and control in social cognition. In Wyer, R, S & Skrull, T, K. (Eds.). *Handbook of Social Cognition (Vol. 1*), 1-40, Hillsdale, NJ: Erlbaum. doi.org/10.4135/9781473915312

Blanco, N. J., Otto, A. R., Maddox, W. T., Beevers, C. G., & Love, B. C. (2013). The influence of depression symptoms on exploratory decision-making. *Cognition*, *129*, 563-568. doi:10.1016/j.cognition.2013.08.018

Bowler, J. O., Mackintosh, B., Dunn, B. D., Mathews, A., Dalgleish, T., & Hoppitt, L. (2012). A comparison of cognitive bias modification for interpretation and computerized cognitive behavior therapy: Effects on anxiety, depression, attentional control, and interpretive bias. *Journal of Consulting and Clinical Psychology*, *80*, 1021. doi; 10.1080/23311908.2015.1011905

Cella, M., Dymond, S., & Cooper, A. (2010). Impaired flexible decision-making in major depressive disorder. *Journal of Affective Disorders*, *124*, 207-210. doi: 10.1016/j.jad.2009.11.013

Cochrane Collaboration (2016). Cochrane Consumers and Communication*: Data extraction template for included studies.* Retrieved from http://cccrg.cochrane.org/sites/cccrg.cochrane.org/files/public/uploads/

Daw, N. D., Gershman, S. J., Seymour, B., Dayan, P., & Dolan, R. J. (2011). Model-based influences on humans' choices and striatal prediction errors. *Neuron*, *69*, 1204-1215. doi: 10.1016/j.neuron.2011.02.027

Daw, N. D., Niv, Y., & Dayan, P. (2005). Uncertainty-based competition between prefrontal and dorsolateral striatal systems for behavioral control. *Nature Neuroscience*, *8*, 1704-1711. doi :10.1038/nn1560

Dickinson, A. (1985). Actions and habits: the development of behavioural autonomy. *Philosophical Transactions of the Royal Society of London, series B, Biological Sciences*, *308*, 67-78. doi: 10.1098/rstb.1985.0010

Dolan, R. J., & Dayan, P. (2013). Goals and habits in the brain. *Neuron*, *80*, 312-325. doi: 10.1016/j.neuron.2013.09.007

Everitt, B. J. (2014). Neural and psychological mechanisms underlying compulsive drug seeking habits and drug memories–indications for novel treatments of addiction. *European Journal of Neuroscience*, *40*, 2163-2182. doi: 10.1111/ejn.12644

Friedel, E., Koch, S. P., Wendt, J., Heinz, A., Deserno, L., & Schlagenhauf, F. (2014). Devaluation and sequential decisions: linking goal-directed and model-based behavior. *Frontiers in Human Neuroscience, 8.* doi: 10.3389/fnhum.2014.00587

Gillan, C. M., Apergis-Schoute, A. M., Morein-Zamir, S., Urcelay, G. P., Sule, A., Fineberg, N. A., ... & Robbins, T. W. (2015). Functional neuroimaging of avoidance habits in obsessive-compulsive disorder. *American Journal of Psychiatry*, *172*, 284-293. doi: 10.1176/appi.ajp.2014.14040525

Gillan, C. M., Kosinski, M., Whelan, R., Phelps, E. A., & Daw, N. D. (2016). Characterizing a psychiatric symptom dimension related to deficits in goal-directed control. *Elife*. doi: 10.7554/eLife.11305

Gillan, C. M., Papmeyer, M., Morein-Zamir, S., Sahakian, B. J., Fineberg, N. A., Robbins, T. W., & de Wit, S. (2011). Disruption in the balance between goal-directed behavior and habit learning in obsessive-compulsive disorder. *American Journal of Psychiatry*, *168*, 718-726. doi: 10.1176/appi.ajp.2011.10071062

Graybiel, A. M. (2008). Habits, rituals, and the evaluative brain. *Annual Review of Neuroscience*, *31*, 359-387. doi: 10.1146/annurev.neuro.29.051605.112851

Hay, J. F., & Jacoby, L. L. (1996). Separating habit and recollection: memory slips, process dissociations, and probability matching. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 1323. doi: 10.1037/0278-7393.22.6.1323

Hertel, P. T. (2004). Memory for emotional and nonemotional events in depression: A question of habit? In Reisberg, D & Hertel, P (Eds.), *Memory and emotion* (pp. 186-216). New York: Oxford University Press. doi: 10.1093/acprof:oso/9780195158564.003.0006

Hertel, P. T. (2015). Cognition in emotional disorders: An abundance of habit and a dearth of control. In Lindsay, D. S., Kelley, A., Yonelinas, & Roediger, H. L. (Eds), *Remembering: Attributions, processes, and control in human memory*, p 322-335. New York, NY: Psychology Press. doi: 10.1037/a0030923

Hertel, P. T., Holmes, M., & Benbow, A. (2014). Interpretive habit is strengthened by cognitive bias modification. *Memory*, *22*, 737-746. doi: 10.1080/09658211.2013.820326

Hertel, P. T., & Mathews, A. (2011). Cognitive bias modification: Past perspectives, current findings, and future applications. *Perspectives on Psychological Science*, *6*, 521-536. doi:10.1177/1745691611421205

Hertel, P. T., Vasquez, E., Benbow, A., & Hughes, M. (2011). Recollection is impaired by the modification of interpretation bias*. Journal of Abnormal Psychology, 120,* 902-916*.* doi: 10.1037/a0023974

Higgins, J. P., & Green, S. (Eds.). (2011*). Cochrane handbook for systematic reviews of interventions (Vol. 4).* John Wiley & Sons*.* Retrieved from http://www.cochrane-handbook.org

Hull, C. L. (1943). *Principles of behavior*. New York, NY: Appleton-Century-Crofts

Knox, W. B., Otto, A. R., Stone, P., & Love, B. C. (2012). The nature of belief-directed exploratory choice in human decision-making. *Frontiers in Psychology 2*, 1-13 doi: 10.3389/fpsyg.2011.00398

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The phq-9. *Journal of general internal medicine*, *16*, 606-613. doi: 10.1046/j.1525-1497.2001.016009606.x

Labrecque, J. S., & Wood, W. (2015). What measures of habit strength to use? Comment on Gardner (2015). *Health Psychology Review*, *9*, 303-310. doi: 10.1080/17437199.2014.992030

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review*, *7*(sup1), 137-158. doi: 10.1080/17437199.2011.603640

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., … Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: Explanation and elaboration. *British Medical Journal*, *339*, b2700. doi:10.1136/bmj.b2700

Lyubomirsky, S., Layous, K., Chancellor, J., & Nelson, S. K. (2015). Thinking about rumination: The scholarly contributions and intellectual legacy of Susan Nolen-Hoeksema. *Annual Review of Clinical Psychology*, *11*, 1-22. doi: 10.1146/annurev-clinpsy-032814-112733

Maddox, W. T., Chandrasekaran, B., Smayda, K., Yi, H. G., Koslov, S., & Beevers, C. G. (2014). Elevated depressive symptoms enhance reflexive but not reflective auditory category learning. *Cortex*, *58*, 186-198. doi: 10.1016/j.cortex.2014.06.013

Marteau, T. M., Hollands, G. J., & Fletcher, P. C. (2012). Changing human behavior to prevent disease: the importance of targeting automatic processes. *Science*, *337*, 1492-1495. doi:10.1126/science.1226918

Mathews, A., & MacLeod, C. (2005). Cognitive vulnerability to emotional disorders. *Annual Review of Clinical Psychology, 1*, 167-195. doi: 10.1146/annurev.clinpsy.1.102803.143916

McManus, S., Meltzer, H., Brugha, T. S., Bebbington, P. E., & Jenkins, R. (2009). *Adult psychiatric morbidity in England, 2007: results of a household survey*. The NHS Information Centre for health and social care. doi: 10.13140/2.1.1563.5205

Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses*: The PRISMA Statement. PLoS Med *6*: doi: 10.1002/14651858.MR000035

Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology*, *48*, 492-498. doi:10.1016/ j.jesp.2011.10.011

NICE (2011) *Common mental health disorders: the NICE guideline on identification and pathways to care*. NICE Clinical Guideline 123. Retrieved from www.nice.org.uk/CG123

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100,* 569-582. doi:10.1037/0021-843X.100.4.569

Nolen-Hoeksema, S., & Watkins, E. R. (2011). A heuristic for transdiagnostic models of psychopathology: Explaining multifinality and divergent trajectories. *Perspectives on Psychological Science, 6,* 589–609. doi:10.1177/1745691611419672

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

O'Connor, D., Green, S., & Higgins, J. P. T. (2011). Chapter 5: Defining the review question and developing criteria for including studies. In J. P. T. Higgins & S. Green (Eds.), *Cochrane handbook for systematic reviews of interventions,* version 5.1.0. The Cochrane Collaboration. doi: 10.1002/9780470712184.ch5

Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: habit as cue-contingent automaticity. *Health Psychology*, *29*, 374. doi:10.1037/a0019596

Orbell, S., & Verplanken, B. (2015). The strength of habit. *Health Psychology Review*, *9*, 311-317. doi: 10.1080/17437199.2014.992031

Otto, A. R., Raio, C. M., Chiang, A., Phelps, E. A., & Daw, N. D. (2013). Working-memory capacity protects model-based learning from stress. *Proceedings of the National Academy of Sciences*, *110*, 20941-20946. doi: 10.1073/pnas.1312011110

Radenbach, C., Reiter, A. M., Engert, V., Sjoerds, Z., Villringer, A., Heinze, H. J., ... & Schlagenhauf, F. (2015). The interaction of acute and chronic stress impairs model-based behavioral control. *Psychoneuroendocrinology*, *53*, 268-280.doi: 10.1016/j.psyneuen.2014.12.017

Skinner, B. F. (1938). *The behavior of organisms.* Appleton-Century-Crofts, New York.

Teasdale, J. D. (1988). Cognitive vulnerability to persistent depression. *Cognition & Emotion, 2*, 247-274. doi: 10.1080/02699938808410927

Thomas, B. H., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A process for systematically reviewing the literature: Providing the research evidence for public health nursing interventions. *Worldviews on Evidence-Based NursingWorldviews on Evidence-Based Nursing, 1*, 176-184. doi: 10.1111/j.1524-475X.2004.04006.x

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology*, *45*, 639-656. doi:10.1348/ 014466605X49122

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: is habit an empty construct or an interesting case of goal-directed automaticity? *European Review of Social Psychology*, *10*, 101-134. doi:10.1080/14792779943000035

Verplanken, B., & Fisher, N. (2014). Habitual worrying and benefits of mindfulness. *Mindfulness*, *5*, 566-573. doi 10.1007/s12671-013-0211-0

Verplanken, B., Friborg, O., Wang, C. E., Trafimow, D., & Woolf, K. (2007). Mental habits: Metacognitive reflection on negative self-thinking. *Journal of Personality and Social Psychology*, *92*, 526-541. doi:10.1037/0022-3514.92.3.526

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33,* 1313–1330. doi:10.1111/j.1559-1816.2003.tb01951.x

Voon, V., Derbyshire, K., Rück, C., Irvine, M. A., Worbe, Y., Enander, J., ... & Robbins, T. W. (2015). Disorders of compulsivity: a common bias towards learning habits. *Molecular Psychiatry*, *20*, 345-352. doi: 10.1038/mp.2014. 44

Watkins, E. (2015). Psychological treatment of depressive rumination. *Current Opinion in Psychology*, *4*, 32-36. doi: 10.1016/j.copsyc.2015.01.020

Watkins, E. R., Baeyens, C. B., & Read, R. (2009). Concreteness training reduces dysphoria: Proof-of-principle for repeated cognitive bias modification in depression. *Journal of Abnormal Psychology, 118*, 55-64. doi:10.1037/a0013642

Watkins, E. R., & Nolen-Hoeksema, S. (2014). A habit-goal framework of depressive rumination. *Journal of Abnormal Psychology*, *123*, 24. doi: 10.1037/a0035540

Watkins, E.R., Taylor, R.S., Byng, R., Baeyens, C.B., Read, R., Pearson, K., & Watson, L. (2012). Guided self-help concreteness training as an intervention for major depression in primary care: a phase II randomized controlled trial. *Psychological Medicine, 42*, 1359-1373. doi: 10.1017/S0033291711002480

Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review*, *20*, 158.

Wenzlaff, R. M. (1993). The mental control of depression: Psychological obstacles to emotional well-being. In Wegner,D, M., & Pennebaker, J, W. (Eds.), *Handbook of Mental Control. 239-257*. Englewood Cliffs, NJ. Prentice Hall.

World Health Organisation (2017). Depression: World Health Organisation fact sheet no 369. Retrieved from http://www.who.int/mediacentre/factsheets/fs369/en/

Wood, W., & Neal, D.T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*, 843-863. doi:10.1037/0033-295X .114.4.843

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology*, *67*, 289-314. doi: 10.1146/annurev-psych-122414-033417

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. Acta Psychiatrica Scandinavica, *67*, 361-370. doi : 10.1111/j.1600-0447.1983.tb09716.

Appendices

Appendix A: Quality Assessment Tool for Quantitative Studies

QUALITY ASSESSMENT TOOL FOR QUANTITATIVE STUDIES

COMPONENT RATINGS

A) SELECTION BIAS

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

1 Very likely
2 Somewhat likely
3 Not likely
4 Can't tell

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

1 80 - 100% agreement
2 60 – 79% agreement
3 less than 60% agreement
4 Not applicable
5 Can't tell

RATE THIS SECTION	STRONG	MODERATE	WEAK
See dictionary	1	2	3

B) STUDY DESIGN

Indicate the study design

1 Randomized controlled trial
2 Controlled clinical trial
3 Cohort analytic (two group pre + post)
4 Case-control
5 Cohort (one group pre + post (before and after))
6 Interrupted time series
7 Other specify _____
8 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

C) CONFOUNDERS

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

1 Yes
2 No
3 Can't tell

The following are examples of confounders:

1 Race
2 Sex
3 Marital status/family
4 Age
5 SES (income or class)
6 Education
7 Health status
8 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)?

1 80 – 100% (most)
2 60 – 79% (some)
3 Less than 60% (few or none)
4 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?

1 Yes
2 No
3 Can't tell

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

1 Yes
2 No
3 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?

1 Yes
2 No
3 Can't tell

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

1 Yes
2 No
3 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?

1 Yes
2 No
3 Can't tell
4 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).

1 80 -100%
2 60 - 79%
3 less than 60%
4 Can't tell
5 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?

1 80 -100%
2 60 - 79%
3 less than 60%
4 Can't tell

(Q2) Was the consistency of the intervention measured?

1 Yes
2 No
3 Can't tell

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

4 Yes
5 No
6 Can't tell

H) ANALYSES

(Q1) Indicate the unit of allocation (circle one)

community organization/institution practice/office individual

(Q2) Indicate the unit of analysis (circle one)

community organization/institution practice/office individual

(Q3) Are the statistical methods appropriate for the study design?

1 Yes
2 No
3 Can't tell

(Q4) Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?

1 Yes
2 No
3 Can't tell

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**
3	**WEAK**

Quality Assessment Tool for Quantitative Studies 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?

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 affects 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.

(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: willbeassignedtothosethatusedanyothermethodordidnotstatethemethodused.

C) CONFOUNDERS

Strong: will be assigned to those articles that controlled for at least 80% of relevant confounders (Q1is2);**or**(Q2is1).

Moderate: will be given to those studies that controlled for 60–79% of relevant confounders (Q1is1)**and**(Q2is2).

Weak: will be assigned when less than 60% of relevant confounders were controlled (Q1is1) **and** (Q2is3) **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 t**he 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 b**linding 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).
Weak: The data collection tools have not been shown to be valid (Q1 is 2) **or** both reliability and validity described (Q1 is 3 and Q2 is 3).

F) WITHDRAWALS AND DROP-OUTS - a rating of:
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).

Appendix B: Preparation and Submission Requirements for *Clinical Psychology Review*

Article structure

Subdivision - unnumbered sections

Divide your article into clearly defined sections. Each subsection is given a brief heading. Each heading should appear on its own separate line. Subsections should be used as much as possible when cross-referencing text: refer to the subsection by heading as opposed to simply 'the text'.

Appendices

If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

• Title. Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.

• Author names and affiliations. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.

• Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.

• Present/permanent address. If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent address') may be indicated as a

footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract

A concise and factual abstract is required with a maximum length of 200 words. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Graphical abstract

Although a graphical abstract is optional, its use is encouraged as it draws more attention to the online article. The graphical abstract should summarize the contents of the article in a concise, pictorial form designed to capture the attention of a wide readership. Graphical abstracts should be submitted as a separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. You can view Example Graphical Abstracts on our information site.

Authors can make use of Elsevier's Illustration and Enhancement service to ensure the best presentation of their images and in accordance with all technical requirements: Illustration Service.

Highlights

Highlights are mandatory for this journal. They consist of a short collection of bullet points that convey the core findings of the article and should be submitted in a separate editable file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points

(maximum 85 characters, including spaces, per bullet point). You can view example Highlights on our information site.

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, to be chosen from the APA list of index descriptors. These keywords will be used for indexing purposes.

Abbreviations

Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).

SCHOOL OF PSYCHOLOGY

DOCTORATE IN CLINICAL PSYCHOLOGY

EMPIRICAL PAPER

Counter-conditioning habitual rumination with a concrete thinking exercise: A single-case experimental design utilising an AB phase randomized multiple baseline case series across participants

Trainee Name:	**Max Buchanan**
Primary Research Supervisor:	**Professor Edward Watkins** Professor of Experimental and Applied Clinical Psychology, Director of Research for Professional Doctorates, University of Exeter
Secondary Research Supervisor:	**Dr Nicholas Moberly** Senior Lecturer, School of Psychology, University of Exeter.

Target Journal:	*Behaviour Research and Therapy*
Word Count:	7972 words (excluding abstract, table of contents, list of figures, references, footnotes, appendices)

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

Abstract

This study investigated predictions from the habit-goal framework for depressive rumination (Watkins & Nolen-Hoeksema, 2014) using a simultaneous replication single case experimental design in a multiple baseline case series. Seven high ruminators were recruited from community and university settings (with one participant's data later excluded due to insufficient baseline rumination). Following a baseline monitoring period, participants received an intervention that included (i) spotting personal triggers for rumination and (ii) the practice of a scripted concrete thinking exercise (CTE) in response to these triggers, utilising an implementation intention (If-Then plan). It was predicted that practice of the IF-THEN CTE, linked to warning signs, would result in a significant reduction in both frequency and automaticity of rumination in the intervention phase compared to baseline.

At the group level, using randomization tests (Onghena & Edgington, 2005), reductions in automaticity of rumination were trending toward statistical significance whilst the impact of the intervention on rumination frequency was not statistically significant. Effect size calculations, using nonoverlap of all pairs, demonstrated a medium effect of the intervention on automaticity (*NAP* = .76) and weak to medium effect on frequency of rumination (*NAP* = .66).

Visual and statistical analysis of individual data demonstrated that two participants experienced statistically significant benefits ($p < .05$) for a reduction in automaticity of rumination and one participant's frequency of rumination was significantly reduced. These two participants also showed the greatest levels of automaticity for the IF-THEN-CTE intervention during the

intervention phase. Five participants demonstrated a strong or medium effect of the intervention on automaticity and two participants demonstrated a medium effect on frequency. Taken together, the data is broadly consistent with the predictions made by the habit-goal framework.

Pre and post measures indicate reductions for all participants in rumination as habit using the self-report habit index (SRHI) and overall rumination levels rated on the ruminative responses scale (RRS). At post intervention three participants no longer met criteria for inclusion to the study on the RRS. Despite mixed results, feedback at debrief indicated that the intervention was acceptable to participants who reported that they would carry on using it after the study ended.

Keywords: Counter-conditioning, habit, randomization test, rumination, stimulus-response

Introduction

Rumination has been defined as *"behaviors and thoughts that focus one's attention on one's depressive symptoms and on the implications of these symptoms"* (Nolen-Hoeksema, 1991, p. 569). Nolen-Hoeksema's Response Styles Theory (1991, 2000, 2008) conceptualises rumination as a habitual response style. Rumination is a stable, maladaptive tendency to respond to emotional distress by overthinking and focusing on its causes, meaning and consequences. The repeated focus on one's depressive symptoms inhibits instrumental and problem-solving behaviour (Nolen-Hoeksema et al. 2008). When used in response to negative mood, rumination exacerbates both negative thinking and negative mood (Nolen-Hoeksema, 2000).

Rumination and Psychological Disorders

Rumination has been shown to increase vulnerability to a range of psychological disorders (Lyubomirsky, Layous, Chancellor & Nelson, 2015). It is implicated in the development and maintenance of depression (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco & Lyubomirsky, 2008; Teasdale, 1988) and is predictive of the intensity and duration of depressive episodes (Treynor, Gonzalez & Nolen-Hoeksema, 2003). Depression is maintained through the process of ruminative self-focus exacerbating mood-congruent thinking and impairment of problem-solving through abstract thinking (Nolen-Hoeksema et al. 2008). Rumination has been identified as a risk factor in the development of anxiety (Nolen-Hoeksema & Watkins, 2011), binge-eating patterns of behaviour (Selby, Anestis & Joiner, 2008) and the tendency to abuse substances (Nolen-Hoeksema & Harrell, 2002). Because rumination is

associated with the development of multiple disorders it has been conceptualised as a transdiagnostic pathological process (McLaughlin & Nolen-Hoeksema, 2011; Nolen-Hoeksema & Watkins, 2011).

Theories of Rumination

Over the past 25 years, two theories of rumination have become particularly influential in psychological research, namely Response Styles Theory (Nolen-Hoeksema, 1991) as outlined above and the application of Control Theory to rumination (Martin & Tesser, 1996). Regardless of affect, control theory suggests rumination is a result of poor perceived goal progress and continues until sufficient progress to the goal has been attained or goal attainment is abandoned. Though rumination can be seen as an attempt to problem solve, it is a process that tends to inhibit the finding of beneficial solutions as thought leads to more thought (Nolen-Hoeksema, 2004). One factor explaining the distinction between maladaptive rumination and adaptive problem-solving is the distinction between abstract versus concrete thinking processes. In the context of negative mood, abstract processing is maladaptive relative to concrete processing (Watkins, Baeyens & Reed, 2009). Rumination is characterized by abstract thinking, which is decontextualized and focused on meaning and consequences of negative events, such as asking “Why?” questions. In contrast, concrete processing is characterized by specific, contextualiized thinking on the details of negative events, for example asking “How?” questions. Relative to abstract thinking, concrete thinking has constructive consequences as it leads to better problem-solving and improved emotional recovery (Watkins & Moulds, 2005; Watkins, 2008).

Habit Formation

Psychological models of habit relevant to the conceptualisation of rumination-as-a-habit include the behavioural understanding that habits form from the frequent repetition of a stimulus-response (S-R) contingency (Hull, 1943; Skinner, 1938). Dual-process models differentiate between behaviours of thought that are habitual and those that are goal-directed, with the former characterised by processes that are inflexible, automatic and based on past experience and the latter by flexible, conscious choices based upon the weighing up of possible outcomes (Dolan & Dayan, 2013). Habits are insensitive to changes in value of available rewards and will continue once an outcome has been devalued (Dickinson, 1985).

Recent definitions of habit converge around the following interrelated elements (Verplanken & Fisher, 2014). First, habits are cued by stable contexts in which the behaviour has already been performed (Neal, Wood, Lebrecque & Lally, 2012). Second, although habits develop via goal-pursuit, once formed a habit is no longer in the service of goals (Wood & Neal, 2007; Verplanken & Aarts, 1999). Third, habits contain an element of automaticity, performed without awareness or intention, which makes them efficient and difficult to control (Bargh, 1994; Wood & Neal, 2007). Fourth, habits form slowly and across numerous contexts, which makes them resistant to change despite individuals recognizing the negative consequences and adopting goals to change (Wood & Neal, 2007; Wood & Rünger, 2016). Automatic behaviour requires less mental capacity than intentional behaviours, which further entrenches the habit (Gardner, 2012). Uncontrollability of trait-like persistent

negative thoughts is a key feature of rumination (Nolen-Hoeksema, 1987; 1991).

A Habit-Goal Framework of Rumination

The habit-goal framework of rumination (Watkins & Nolen-Hoeksema, 2014) is a recent addition to theories of rumination that proposes that rumination can helpfully be conceptualised as a mental habit. Building upon work on the habit-goal interface (Wood & Neal, 2007) and rumination as a habit of thought (Hertel, 2004), the habit–goal framework predicts that rumination can start off being driven by unresolved goals but can become an automatic habit with repeated pairing of rumination with the same context. In this way, the habit goal framework combines state accounts (Control Theory application) and trait accounts (Response Styles Theory) of rumination.

The habit-goal framework suggests that specifically targeting the components involved in habit formation would lead to positive habit change. It has been demonstrated that targeting changes to intention or attitude alone are unlikely to be effective interventions in reducing habitual behaviour longer-term (Verplanken & Wood, 2006; Webb & Sheeran, 2006). Treatment of rumination through the targeting of goals or beliefs is also unlikely to be effective (Watkins & Nolen-Hoeksema, 2014). Overall, effective treatment of rumination has thus far utilised cognitive behavioural interventions (Watkins et al. 2009, 2011, 2012), mindfulness-based approaches (Campbell, Labelle, Bacon, Faris, & Carlson, 2012) or a combination (Van Aalderen, et al. 2012). Rumination has, however, been shown to be resistant to generic cognitive behaviour therapy (Schmaling, Dimidjian, Katon & Sullivan, 2002).

The habit-goal model suggests two methods of reducing rumination via targeting the S-R contingency. One method is to remove or interrupt the cueing trigger by, for example, changing aspects of the environment that trigger the rumination. However, though spotting and removing triggers may reduce rumination in the short-term, because the S-R contingency will likely remain intact, any subsequent return to a triggering context will result in a relapse via an automatic re-triggering of a ruminative response (Watkins & Nolen-Hoeksema, 2014).

The other option, which focuses upon both stimulus and response, is to counter-condition a new, alternative response to the triggering stimulus by repeating that response to the cueing stimulus until an alternative and helpful new habit forms (Hertel, 2004; Watkins & Nolen-Hoeksema, 2014; Wood & Neal, 2007).

A challenge faced in attempts to counter-condition S-R habits is that, because of their conservative nature and slow acquisition, new habit development may require extensive practice and therefore any intervention risks relatively high levels of attrition.

Rationale for Intervention and Aim of Current Study

An appropriate intervention to counter-condition rumination as habit is derived from concreteness training (Watkins et al. 2009, 2012). Concreteness training involves directly targeting the thinking process rather than content involved in rumination. Training involves repeated practice at adopting a concrete style of thinking to shift away from the unhelpful abstract processing characteristic of rumination. The individual focuses upon specific details of negative events, what makes the event unique, answers “how?” questions as

to the sequence preceding and during the event and generates a step-by-step plan of how to proceed. In this way the individual learns a helpful strategy that is incompatible with the abstract, overgeneralizing and decontextualized thinking processes associated with unhelpful rumination (Watkins, 2008). Randomised controlled trials have identified that concreteness training resulted in significantly reduced rumination and depression levels compared to no-intervention and attentional control conditions in a dysphoric sample (Watkins et al. 2009), and when used in conjunction with treatment-as-usual (TAU) as compared to TAU or TAU plus relaxation training in patients with major depression (Watkins et al. 2012).

Implementation intentions are an approach well suited to efforts to form and change habits as they explicitly link the habit cue and new behaviour (Gollwitzer, 1999). Implementation intentions specify how, when and where one intends to act and take the form of IF-THEN plans. The S-R component of habits is targeted by explicitly pairing the trigger stimuli with an alternative response ("IF cue X occurs, then I will do Y behaviour"; Webb & Sheeran, 2006). Forming an implementation intention leads to the automatic initiation of a response as a result of a mental representation of the cue (IF) becoming immediately accessible, which initiates the goal-directed behaviour (THEN) without the need for further conscious intent (Bayer, Achtziger, Gollwitzer & Moskowitz, 2009).

The habit-goal model of rumination (Watkins & Nolen-Hoeksema, 2014) therefore predicts that targeting the S-R association with repeated practice of an IF-THEN plan ("IF I spot my specific triggers for rumination, THEN I will practice my concrete thinking exercise (CTE)") would be effective in reducing

levels of rumination in high ruminators by counter-conditioning rumination as a S-R habit. This prediction can be tested using a multiple baseline case series. Whilst Watkins et al (2012) in a randomized controlled trial showed that concreteness training, including linking concreteness training to warning signs, reduced depression and rumination, this study did not specifically test whether it worked by changing the habitual nature of rumination – ie., reducing the automatic nature of rumination. This case series is therefore designed to investigate whether the intervention works through reducing the habitual nature of rumination. The research question for this study is; Does an IF-THEN concrete thinking exercise reduce rumination by targeting rumination as a habitual process?

Hypotheses:

Training non-clinical high ruminators in IF-THEN CTE as an alternative and incompatible response to rumination will result in:

1. a significant reduction in the automaticity of participants' rumination;
2. a significant decrease in the frequency of participants' rumination during the intervention stage compared to baseline.

Statistical significance will be analysed using randomization tests (Onghena & Edgington, 2005), an innovative statistical technique requiring *a priori* random assignment of participants to moments of phase change.

Methods

Design

To evaluate the effect of IF-THEN CTE on rumination levels, a replicated single case experimental design (SCED) in the form of a randomized multiple baseline design across participants (MBD) was used. The design is a simultaneous replication design in which each participant starts and ends the study on the same dates (31-10-16 to 11-12-16) but is randomized to a different moment of phase change. A particular strength of this design is that it facilitates randomization tests, effect size calculations and visual analysis.

To enable transparency, future replication and evaluation of scientific quality, this study adhered to the 23-item checklist from the Single-Case Reporting guideline In BEhavioural Interventions (SCRIBE; Tate et al. 2016). Additional reference has been made to the What Works clearing house standards for conducting SCEDs (Kratochwill et al. 2010).

The study required participants to enter daily outcome observations onto the study's website or paper diary over 42 days. These 42 measurement times (MT) comprised a minimum of 11 MTs each for the baseline and intervention phases with 21 possible moments of phase change in-between, such that the intervention phase could start on any day between the 12th and 32nd days. What Works standards recommend a minimum of five measurement points per phase when recording the dependent variables (Kratochwill et al. 2010). The staggered beginning of treatment is required to ensure that the randomization is sufficiently powered because the greater the number of possible phase changes, the less likely that any improvement will be randomly associated with the particular phase change implemented.

Participants were randomised *a priori*, using R software. See Figure 1 for randomised moment of phase change for each participant.

In MBDs, repeated measurements of outcome variables are taken repeatedly (daily) and split into treatment phases. Comparisons are possible both within and between data series (i.e., participants) (Kratochwill & Levin, 2014).

Participant	Sequence
1	AAAAAAAAAAAAAAAAAA*BBBBBBBBBBBBBBBBBBBBBBB*
2	AAAAAAAAAAAAAAAAAAAAAAAAAAAA*BBBBBBBBBBBB*
3	AAAAAAAAAAAAAAAAAAAAAAAAAAAAA*BBBBBBBBBB*
4	AAAAAAAAAAAAAAAAAAAA*BBBBBBBBBBBBBBBBBBB*
5	AAAAAAAAAAAAAAAAAAAA*BBBBBBBBBBBBBBBBBBB*
6	AAAAAAAAAAAAAAAAAAAAAAAAAAAA*BBBBBBBBBB*
7	AAAAAAAAAAAAAA*BBBBBBBBBBBBBBBBBBBBBBBBB*

Figure 1. Sequence of A and B phase for individual participants.

This study utilises an AB phase design to test the effect of a repeated IF-THEN CTE intervention (B phase) on rumination levels (habit strength as frequency and automaticity) following baseline measures (A Phase).

An AB phase MBD enables causal inferences to be made between intervention and behaviour. With a staggered moment of phase change for each participant, sustained reductions in rumination levels seen following the introduction of the intervention would indicate that improvement in symptoms is likely due to the intervention rather than threats to validity such as selection, spontaneous remission, maturation effects, individual differences, history or statistical regression (Kratochwill et al. 2010; Manolov, Losada, Chacón-

Moscoso, & Sanduvete-Chaves, 2016; Tate et al. 2013). Each participant serves as her or his own control.

Sample/Participants.

Participants were drawn from a non-clinical population. Five females (three from the community, two from university) and two males (one from the community and one from university) were recruited via posters. Age ranged from 25 to 36 (*Mean* = 31, *SD* = 4.32). Interested participants were directed to the study's website (www.ruminationstudymb610.co.uk) for the screening questionnaire (Ruminative Responses Scale; RRS; Nolen-Hoeksema & Morrow, 1991) and information sheet (see Appendix A). Participants were entered into a draw to win £150 in vouchers.

Inclusion Criteria

Participants were required to be 18 years or older. At screening, participants identified that they ruminated at least twice daily and scored 40 or higher on the Ruminative Responses Scale (Nolen-Hoeksema & Morrow, 1991). The cut-off score of 40 represented the upper 75th percentile for the population in a large-scale study (Topper, Emmelkamp, Watkins, & Ehring, 2014). Scores above this percentile were considered "excessive rumination" therefore this was seen as an appropriate inclusion criterion for this study with an analogue population.

Exclusion Criteria

Participants were to be excluded if at screening they were receiving current treatment for depression or met criteria for moderately severe depressive disorder as per cut-off (>15) or score 1-3 on the suicidal ideation

and self-harm question on the Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer, & Williams, 2001). This was a preventative measure to ensure that the intervention would not interfere with current treatment for depression whilst potentially providing evidence of significant reductions in rumination following intervention. The PHQ-9 was completed in the presence of the researcher who was able to signpost to appropriate support, as necessary.

The study was approved by the University of Exeter Ethics Approval Committee (See Appendix B).

Measures and Materials

Pre and Post-study Outcome Measures (see Appendix C)

Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991). The RRS measures trait rumination, the extent to which individuals focus on the symptoms, causes, and consequences of their mood in response to depressed mood. The RRS has 22 items (sample item: thinking “Why do I always react this way?”) that ask about frequency of various responses to feeling sad or depressed, scored from 1 (*almost never*) to 4 (*almost always*), with higher scores indicating greater trait tendency toward depressive rumination. The RRS has been shown to have very good internal consistency, good test-retest reliability and acceptable construct validity (Nolen-Hoeksema & Morrow, 1991; Treynor, Gonzalez, & Nolen- Hoeksema, 2003).

The Patient Health Questionnaire (PHQ-9; Kroenke, Spitzer, & Williams, 2001). The PHQ-9 utilises nine items to assess the frequency of experiencing nine depressive symptoms over the preceding two weeks

(sample item: “Over the past two weeks how much have you been bothered by feeling down, depressed or hopeless?”), scored from 0 (*not at all*) to 3 (*nearly every day*). A score of 15 or higher is indicative of a provisional diagnosis of moderate major depression. The PHQ-9 has been shown to have good validity and reliability (Kroenke, Spitzer, & Williams, 2001) and a high sensitivity to change (Löwe, Kroenke, Herzog, & Gräfe, 2004).

Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003). Recent literature suggests that measures of habit strength should include the dimensions of frequency and automaticity (Gardner, 2012). The 12-item SRHI measures habit via the frequency, automaticity and relevance to self-identity of the behaviour. Participants are asked to reflect on past rumination (sample item: *Rumination is something I start before I realise I am doing it*, scored from 1 (*strongly disagree*) to 5 (*strongly agree*), giving scores from 12 – 60). The SRHI has been found to have high test-retest reliability and internal validity (Verplanken & Orbell, 2003). Although used mainly to measure habit-strength of health-related behaviours (Gardner, de Bruijn & Lally, 2011), the stem can be adapted to capture any habitual behaviour including mental habits (Verplanken, 2006). The SRHI does not have a pre-defined cut-off to identify a behaviour/process as habitual. Following Lally and colleagues (Lally, van Jaarsfeld, Potts & Wardle, 2010), a mean score below 3 (*neither agree or disagree*) is taken to indicate that that the behaviour cannot be considered habitual.

Daily Outcome Measures (see Appendix D). The daily recording measure, designed specifically for this study, has two forms: a baseline measure

comprising seven items and an intervention version comprising twelve items. The first seven questions common to both formats assess frequency and automaticity of rumination and mood (sad-happy and anxious-calm, e.g., *How anxious-calm have you been today?* scored from 1 (*very anxious*) to 9 (*very calm*). The additional questions on the intervention daily measure relate to frequency and automaticity of the alternative concreteness behaviour in response to the warning signs for rumination. Daily automaticity questions are taken from the four-item Self-Report Behavioural Automaticity Index (SRBAI; Gardner, Abraham, Lally, & de Bruijn, 2012), a reduced version of the SRHI containing automaticity items only, e.g., *Rumination is something I do automatically*, scored from 1 (*strongly disagree*) to 5 (*strongly agree*). The SRBAI is a reliable and valid measure of habit and is strongly correlated with the longer SRHI (Gardner et al. 2012).

Intervention

The intervention for this study (IF-THEN CTE) utilises the concreteness training previously developed and evaluated (Watkins et al. 2009; Watkins et al. 2012). The IF-THEN CTE adapts the seven-minute first aid exercise (Watkins et al. 2012) used to apply concrete thinking in response to triggers for rumination in real time.

An intervention meeting lasting one-hour (arranged at baseline meeting) took place for each participant on the day before, or morning of, their moment of phase change to ensure that no prior knowledge of the IF-THEN CTE was available before the intervention phase began. The three steps for developing a new concrete thinking habit (see below) were worked through

collaboratively and written into each participant's intervention pack (see Appendix E for intervention pack and meeting script).

1. Unique triggers for rumination were identified via a functional analysis to identify unique triggering cues for participant's rumination (Kanter, Cautilli, Busch, & Baruch, 2005)
2. These triggers were inserted into IF-THEN plan statements (sample: IF I spot my *named trigger(s)* for rumination……THEN I will practice my concrete-thinking exercise).
3. The CTE was practiced with a personal example of the participant's rumination. The script was read out and discussed and worksheet examples worked through.

The IF-THEN plan directly targets the S-R association of rumination as habit and provides the intention for repeated practice. An MP4 audio file and CD of the IF-THEN CTE exercise was given out along with the participant pack. Text messages were sent every few days to each participant to check on progress and included encouraging quotes regarding habit formation.

Procedure

A pilot study with two participants was trialled prior to the full empirical study. The pilot included consultation with members of the Lived Experience Group (LEG) within the Mood Disorders Centre at the University of Exeter to assess the feasibility of the design, face validity of materials and acceptability of the intervention. Suggestions from LEG and pilot participants were incorporated into the main study.

The setting for the main study was naturalistic with participants practising IF-THEN CTE and completing the recording format at a time and place suitable to them and fitting in with their daily routines. Meetings with the researcher took place at the University of Exeter and/or community settings where confidentiality and privacy could be maintained. Blinding was not possible for this study as the main researcher was aware of the unique participant numbers ascribed.

At a one-hour pre-study meeting with the researcher the study was outlined, examples of rumination discussed, measures completed (SRHI, PHQ-9), daily recording practiced and, following a risk protocol, informed consent was given. A baseline pack including dated recording forms was given to participants (See Appendix F for pack and consent form). As agreed, the researcher sent text messages every three days to check on progress.

At the intervention meeting as well as working through the three steps to develop concrete thinking and trialling the intervention, participants also practiced completion of the intervention phase daily recording form and discussed potential barriers to completing the twice a day (or more) practice of the IF-THEN CTE. Six participants met face-to-face with the researcher and one had a telephone meeting.

Following completion of the study each participant had a third face-to-face meeting with the researcher for a debriefing including post intervention completion of SRHI, PHQ-9 and RRS and to offer their feedback regarding their experience (see Appendix G for debrief and feedback form). If the intervention was helpful, participants were encouraged to continue practising their IF-THEN CTE.

Data Analysis Plan

In keeping with recent recommendations for conducting SCEDs (Kratochwill et al. 2010; Tate et al. 2016; Shadish, 2014) this study supplemented traditional visual analysis with statistical analysis (Onghena, Vlaeyen, & de Jong, 2007) as they are considered complementary approaches (Maggin & Odom, 2014).

Visual analysis

Visual analysis has long been seen as adequate in behavioural research to ascertain the effect of interventions (e.g., Knapp, 1983). Visual analysis facilitates analysis of trend, immediacy of effect, variability, level and overlap (Cooper, Heron & Heward, 2007; Kratochwill et al. 2010). Graphs were developed using Microsoft Excel. Visual inspection is useful for initial assessment of the effects of interventions (Bulte & Onghena, 2008; Heyvaert & Onghena, 2014; Kazdin, 2011). There is however evidence to suggest that such analysis can be unreliable and increase the risk of Type I errors so it is advisable to add randomization tests where possible (Onghena & Edgington, 2005).

Statistical Analysis

Randomization tests have been developed to evaluate the statistical significance of outcomes from SCEDS (Onghena, 1992; Onghena & Edgington, 2005). Randomization tests are a nonparametric statistical technique where participants are randomized to moments of phase change *a priori* (Marascuilo & Busk, 1988). For k possible intervention start points and N participants, there are k to the power N (k^N) possible randomization start points for the intervention (Morley, in press). For example, for five possible moments

of phase change with four participants, this would yield 625 (5^4) possible start points, and a potential *p* value of 0.0016 (1/625). Randomization tests are useful when conclusions made from visual analysis are unclear or debatable (Bulté and Onghena, 2013).

A statistical software package (SCRT; Bulté & Onghena 2008) has been developed to enable researchers to design and analyse case series experiments within the R open source statistical environment (R Development Core Team, 2014; http://www.r-project.org).

This study conservatively follows the recommendation that 80% power for a specified significance test with alpha = .05 is achieved when there is a minimum of 20 measurement times and 5 participants (Heyvaert et al. 2017). Randomization tests require an appropriate test statistic (*T*) that reflects the predicted effects (*T* = the difference between the (sums of) means for baseline and treatment phases). *T* is first calculated for the randomized assignment then for each of the other possible assignments. These are then placed in order to assess what proportion of test statistics are equal to or greater than the randomized test statistic, generating a *p* value.

More data points yield greater statistical power. In this study k (21 possible moments of phase change) to the power N (six participants) (21^6) yields 85,766,121 possible randomization starts. The *p* value of the randomization test is calculated as the proportion of possible test statistic values that are equal to or more extreme than the observed test statistic. If, for example, 20,180 combinations are larger than the observed test statistic then the *p* value is significant at 0.000235 (20,180/85,766,121). This study,

therefore has more than sufficient power to detect statistically significant change across phases at $p = .05$.

Given the number of possible randomizations available in this study it was necessary to utilise a Monte-Carlo simulation (Bulté & Onghena, 2009, 2013) where, in this case, a random sample of 1,000 possible combinations are chosen by R upon which to base the calculation of statistical significance. Each random sample will be different meaning that each *p* value calculation will be very slightly different and, this is expected as an artefact of the calculation.

The power for tests on change for individual participants is much reduced (though possible for this study) requiring 20 or more possible moments of phase change to detect a *p* value of .05 (i.e., 1/20). In this study each individual is randomized to one of 21 possible assignments. This was chosen to provide sufficient power to calculate a *p* value of < .05. This is calculated as 1/21 or .047 which is the smallest possible *p* value for this individual AB design with 21 points of phase change (Heyvaert et al, 2017). In order for results to be statistically significant for an individual no other possible randomized test statistics can be equal to or greater than the observed test statistic.

Effect Size Calculations

There is no agreed standard for effect size measure used in SCEDs. This study used two effect size measures based on the extent to which data across phases overlap. The first was the percentage of data points in the intervention phase exceeding the median for the baseline phase (in this case scores below the median given the prediction of the one tailed hypotheses) (PEM; Ma,

2006). The second was the Nonoverlap of All Pairs (NAP; Parker & Vannest, 2009). The NAP is an overlap index that is becoming more widely used in SCEDs (Manolov, et al. 2016; Morley, in press). For NAP calculations each data point in the intervention stage is paired with every point in the baseline with the resultant score representing the proportion of all possible pairs comparisons where intervention phase scores are different to baseline scores, taking into account the desired direction of intervention effect. For both PEM and NAP, scores closer to one indicate larger effects, representing a smaller number of overlapping pairs (Jamieson, Cullen, McGee-Lennon, Brewster & Evans, 2013). Using two effect size measures gives some confidence as to the validity of the results (Kratochwill et al. 2010). PEM was calculated using R and NAP via the NAP-calculator at www.singlecaseresearch.org. Conventions for effect sizes using NAP suggest values of .50 – .65 for a weak effect, .66 - .92 for a medium effect and .92 - 1.00 for a strong effect (Parker & Vannest, 2009). There are no such guidelines for PEM though higher scores represent larger effect size.

Pre and Post Intervention Data

Pre and post intervention data from the PHQ-9 (depression), RRS (rumination scores) and SRHI (rumination automaticity scores) are presented using descriptive statistics in table format.

Feedback at Debrief

Feedback at debrief related to questions as to whether participants would continue to use the IF-THEN CTE intervention in the future, significant life events during the study, and the acceptability of the intervention.

Results

Appendix H details all raw participant data and coding inputted into R to calculate the randomization tests. Seven participants completed the 42 day study, however, participant 2's data were not included in calculations as they ruminated only eight times across the 29 days of their baseline phase which is a mean daily frequency (.28 per day) below that stipulated for inclusion in the study (twice a day). Participant 2's data were not included in group calculations, however, as they chose to complete the study their results are presented in appendix I. This was the only procedural change necessary following the start of the study.

Compliance was excellent, with only one daily recording opportunity missed across all participants. The missing data point for participant 3 on day 31 was managed by calculating the median for the previous 5 days on the relevant subscale.

Table 1 details the number of times the IF-THEN CTE was practiced by each participant across intervention days

Table 1.

Intervention Length and Practice for Participants.

Participant	Length of intervention phase	Total IF-THEN CTE practice completed in the intervention phase	Mean practice per day of intervention
1	24	102	4.25
3	11	28	2.54
4	20	52	2.60
5	21	48	2.28
6	19	29	1.52
7	27	40	1.48

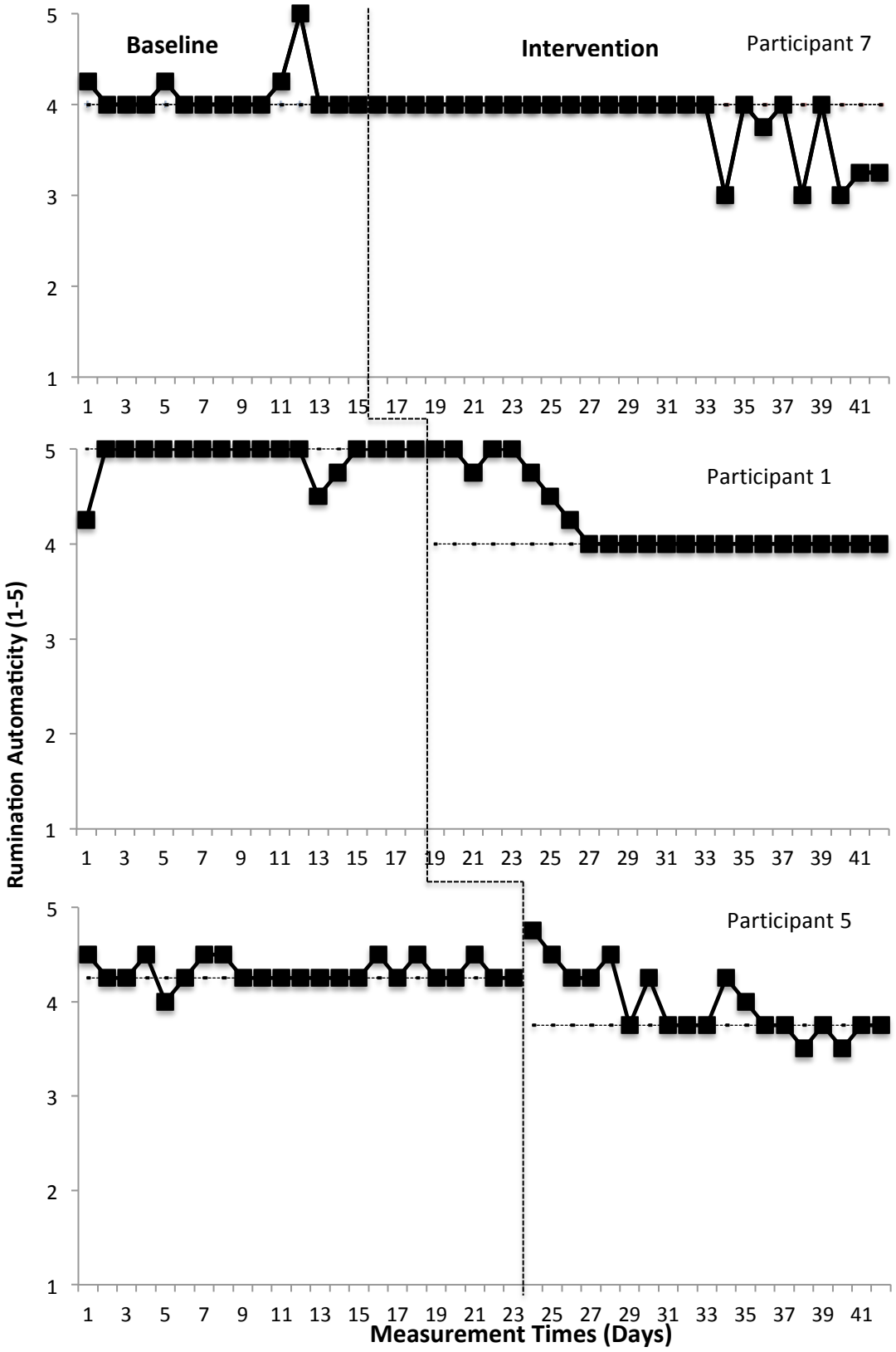
Note: Participant 2 data not included

Participants were committed to the training with every participant averaging practice more than once a day.

The primary dependent variables in the study are the automaticity and frequency of rumination measured across the 42 days. Given the lack of variability in the four daily rumination automaticity questions (i.e., participants tended to score the same rating on any given day), automaticity is presented as a daily mean score of the four automaticity questions. Results for secondary dependent variables related to sad-happy mood and anxious-calm mood are found in appendix L.

Hypothesis 1: Practice of the IF-THEN CTE as an alternative and incompatible response to rumination would result in a significant decrease in the automaticity of participants' rumination.

The presented graphs (see Figure 2) incorporate the median as the line of central tendency for each phase. Participants are sequenced from shortest to longest baseline phase. Further graphs in Appendix J show the trend for automaticity (using the split-middle method). Statistical analysis incorporating statistical significance, effect size, and descriptive statistics relating to automaticity of rumination across baseline and intervention phases is presented in Table 2.


Baseline
Intervention
Participant 7
Participant 1
Participant 5
Rumination Automaticity (1-5)
Measurement Times (Days)

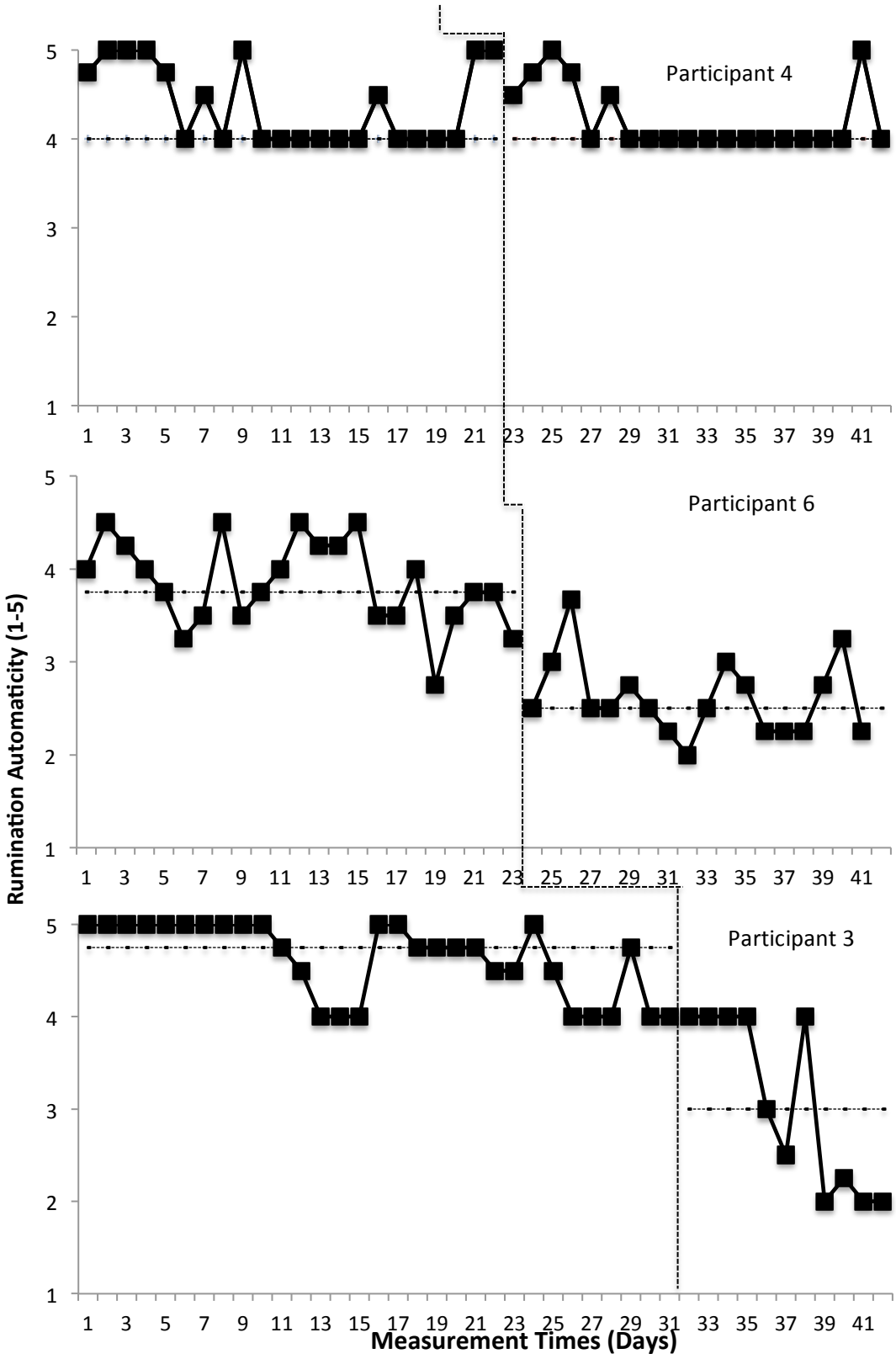


Figure 2. Rumination Automaticity across A & B phases

(Median as line of central tendency)

Table 2.

Automaticity of Rumination: Randomization Tests and Effect Size.

Participant	Phase A length (days)	Phase B length (days)	Phase A Mean {median} (SD)	Phase B Mean {median} (SD)	*p* value Automaticity of rumination	NAP	PEM-	Statistically significant change?
7	15	27	4.13 {4} (0.27)	3.83 {4} (0.36)	.90	.69	22.22	No
1	18	24	4.94 {5} (0.24)	4.33 {4} (0.48)	.67	.89	83.33	No
5	21	21	4.32 {4.25} (0.14)	3.97 {3.75} (0.36)	.52	.77	57.14	No
4	22	20	4.39 {4} (0.45)	4.23 {4} (0.37)	.67	.60	0.00	No
6	23	19	3.85 {3.75} (0.47)	2.61 {2.5} (0.43)	.047	.96	100.00	Yes
3	31	11	4.63 {4.75} (0.41)	3.07 {3} (0.94)	.047	.94	100.00	Yes
Group	**130**	**122**	**4.38 {4.25} (0.49)**	**3.75 {4} (0.74)**	**.089**	**.76**	**60.45**	**No**

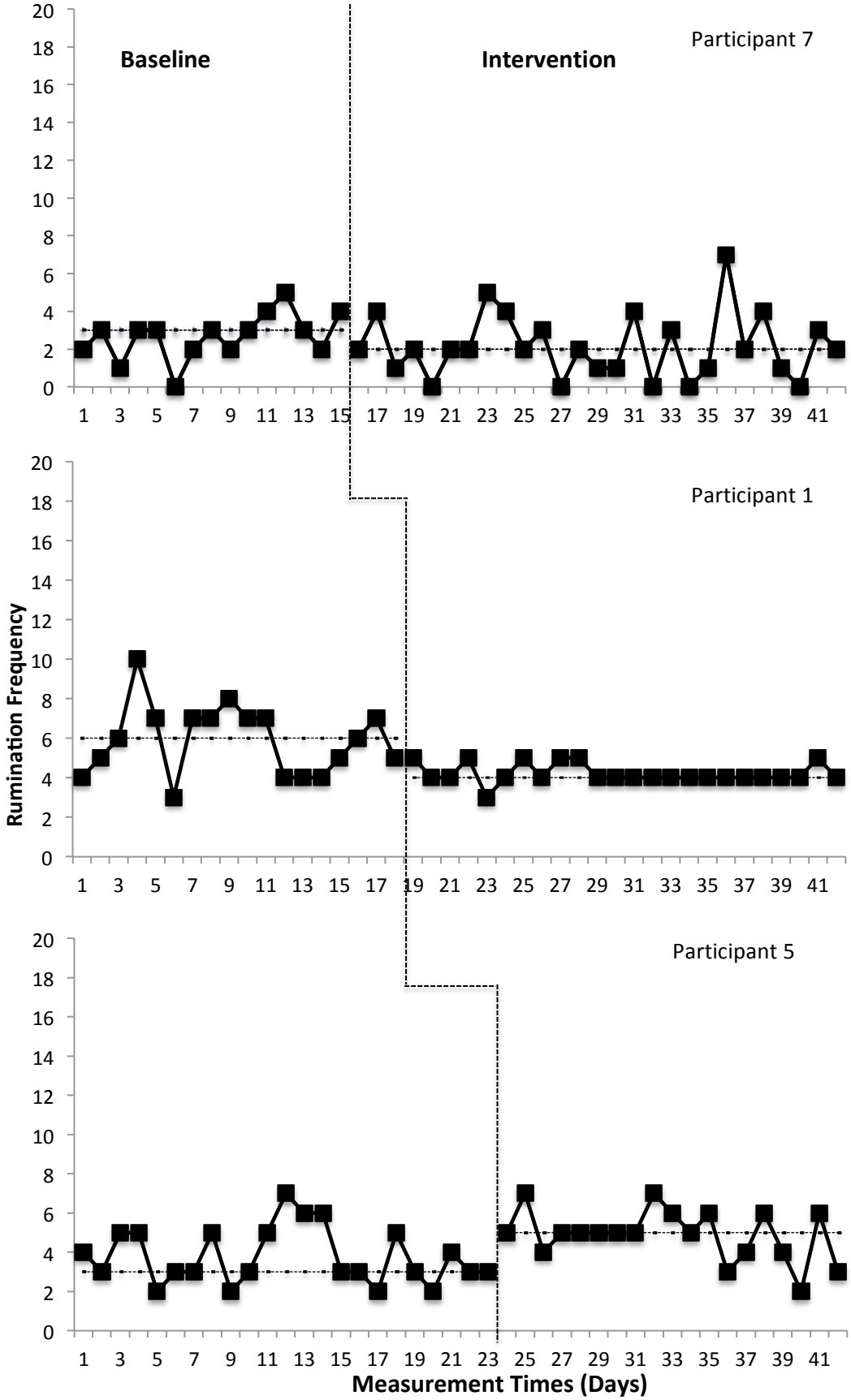
At the group level there was a mean reduction in rumination automaticity trending toward significance (p = .089). Overall there was a medium effect of IF-THEN CTE on rumination automaticity (*NAP* = .76). Each participant reported rumination as a habit during the baseline based on an average score of 3 or

higher on the 1-to-5 automaticity scale (Lally et al. 2010).

During the intervention phase, only participant 6 demonstrated a reduction below an average score of 3 during the intervention phase indicating that rumination was no longer habitual. Two participants (3 and 6) demonstrated statistically significant reductions in levels of automaticity at intervention compared to baseline (both $p = 0.047$). Effect size (NAP) calculations indicate a weak effect of IF-THEN CTE on automaticity for participant 4, a medium effect for 1, 5 and 7 and a strong effect for 3 and 6. Analysis of trend (see Appendix J), using the split-middle method, where each phase is split into two parts and the median score for each segment is joined by a line, indicates a small but positive trend towards rumination becoming less automatic for participants 1, 5 and 4 and a strong positive trend for participant 3. Participant 7 showed a positive trend only toward intervention end suggesting a delay in effect. Participant 6 demonstrates an immediate effect of the intervention and stable scores following its introduction.

Hypothesis 2: Practice of the IF-THEN CTE as an alternative and incompatible response to rumination would result in a significant decrease in the frequency of participants' rumination.

The presented graphs (see Figure 3) incorporate the median as line of central tendency for each phase. Participants are sequenced from shortest to longest baseline phase. Trend graphs for frequency are presented in Appendix K. Statistical analysis incorporating statistical significance, effect size, and descriptive statistics relating to frequency of rumination across baseline and intervention phases is presented in Table 3.


Baseline
Intervention
Participant 7
Participant 1
Participant 5
Rumination Frequency
Measurement Times (Days)

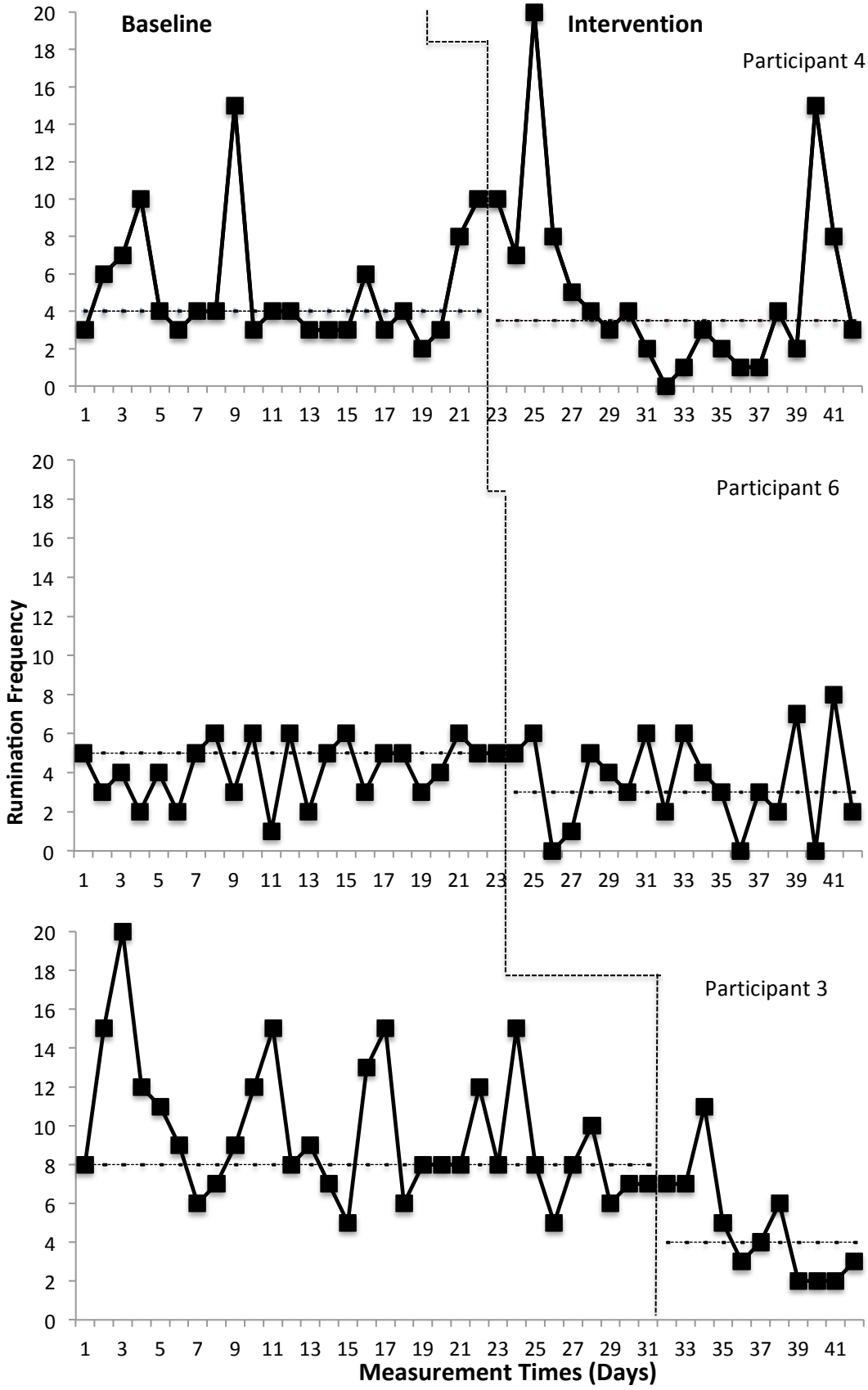


Figure 3. Rumination Frequency across A & B phases

(Median as line of central tendency)

Table 3.

Frequency of Rumination: Randomization Tests and Effect Size.

Participant	Phase A length (days)	Phase B length (days)	Phase A Mean {median} (SD)	Phase B Mean {median} (SD)	*p* value Frequency of rumination	NAP*	PEM-	Statistically significant change?
7	15	27	2.6 {3} (1.24)	2.15 {2} (1.73)	.24	.63	63.16	No
1	18	24	5.89 {6} (1.78)	4.21 {4} (0.51)	.19	.79	100.00	No
5	21	21	3.78 {3} (1.44)	4.89 {5} (1.33)	.81	.33	4.76	No
4	22	20	5.09 {4} (3.18)	5.15 {3.5} (5.06)	.71	.58	50.00	No
6	23	19	4.17 {5} (1.53)	3.53 {3} (2.44)	.19	.58	0.00	No
3	31	11	9.58 {8} (3.58)	4.73 {4} (2.83)	.047	.89	90.91	Yes
Group	**130**	**122**	**5.63 {5} (3.42)**	**3.94 {4} (2.78)**	**.221**	**.66**	**62.58**	**No**

**NAP = Non-overlap All Pairs effect size measure. Scores range from .50 to 1.00 for non-deteriorating data. Scores < .50 represent an effect in the unwanted direction.*

At the group level there was a small mean reduction in rumination frequency, though this change was not statistically significant (p = .221). Effect size calculations at the group level demonstrate an overall weak to moderate effect of the intervention on frequency (*NAP* = .66).

Plotting the median line across phases demonstrates a reduction in frequency of rumination following intervention for all participants bar participant 5 who experienced an increase. Greatest variability within phases is seen for participants 4 and 3. Participant 4 experienced dental problems requiring medical treatment at the time of phase change that may account for the increase seen around this time.

One participant (3) demonstrated a statistically significant reduction in rumination frequency during intervention phase compared to baseline, which is also apparent on examining the visual graphs. Only this participant demonstrated a positive and relatively immediate effect of the introduction of the intervention. Analysis of trend (see Appendix K for graphs) using the split-middle method, illustrates that participants 5, 4, 6 and 3 show some downward positive trend during the intervention phase. There was a medium effect of IF-THEN CTE on reduction of rumination frequency for participants 1 and 3, a weak effect for 4, 6 and 7 and a weak deteriorating effect for participant 5.

Mood. Visual and statistical analysis for the secondary variables of sad-happy mood and anxious-calm mood was carried out (see Appendix L). Taking the median as line of central tendency, only participant 1 rated her/himself as happier during the intervention phase compared to baseline. Downward trends in a contra-therapeutic direction are seen for participants 3 and 5 with participant 4 moving in an upward direction.

Anxious-calm scores improved during intervention for participants 3 and 7 and deteriorated for participants 5, 6 and 7. Participants 4 and 6 experienced a positive trend during intervention phase. At the group level, the deteriorating sad-happy scores and the improving anxious-calm scores were not statistically

significant (p = .92 and p = .98 respectively).

Automaticity trend for the IF-THEN CTE. Although no comparisons could be made with baseline scores, the automaticity of the intervention was plotted (see Appendix M) as an indication as to whether concrete thinking was becoming more automatic over time. All participants showed some movement in the hoped for direction for automaticity of the intervention indicating that the participants were learning in the intervention phase. Participants 3, 6 & 7 reported automaticity levels at 3 or higher toward the end of the intervention phase indicating that the intervention has potential to become habitual over time with further repetition.

Pre and Post Measures

As shown in table 4, following intervention, scores for the RRS had reduced for all participants with a mean reduction of 20 points compared to pre-intervention scores (pre-intervention M = 58.67, SD = 10.82, post intervention M = 37.33, SD = 4.46). Three participants (1, 6 and 7) would no longer be eligible for the study, scoring below the cut-off score of 40 on the RRS. There were reductions for all participants on the SRHI indicating that participants experienced their rumination as becoming less habitual. PHQ-9 scores remained relatively stable, reflecting low levels at baseline.

Table 4

Pre and Post Study Scores for Participants.

	RRS		PHQ-9		SRHI	
Participant	**Baseline**	**Post intervention**	**Baseline**	**Post intervention**	**Baseline**	**Post intervention**
7	48	34	4	4	48	38
1	57	30	4	6	59	30
5	71	41	4	2	53	44
4	57	40	8	5	55	44
6	47	38	8	5	46	34
3	72	41	10	10	60	30
Group Mean (SD)	**58.67 (10.82)**	**37.33 (4.46)**	**6.33 (2.66)**	**5.33 (2.66)**	**53.50 (5.68)**	**36.67 (6.41)**

Feedback at Post-Intervention Debrief

All participants reported that they would use the intervention post-study. Three reported difficulties with maintaining a stable personal definition of rumination, for example, feeling unclear as to whether obsessive or worrying thoughts should be recorded as rumination. Difficulties in accuracy in reporting frequency were described i.e., when recording at the end of the day it was not always easy to remember exactly how many times rumination had occurred. It was reported that it was harder to find time to complete the daily practice when under stress, when busy, and when ill.

Discussion

The purpose of this study was to investigate predictions commensurate

with the habit-goal framework of depressive rumination (Watkins & Nolen-Hoeksema, 2014). Specifically it was predicted that repetition of an IF-THEN concreteness training exercise would result in a significant reduction in both automaticity and frequency of rumination during the intervention phase compared to baseline. At the group level there was a trend toward a statistically significant reduction in rumination automaticity, which is broadly consistent with the theoretical model, particularly in light of the moderate effect size for the impact of the IF-THEN CTE on automaticity. There was no statistically significant reduction in rumination frequency, however there was a weak-moderate effect of the IF-THEN CTE on frequency, which suggests that the positive impact of the intervention may not be trivial.

Data from individual data, though variable, are encouraging with results from two participants (3 and 6), consistent with the model, experiencing a statistically significant reduction in rumination automaticity and one demonstrating significant reduction in frequency (3). Five participants experienced a strong or medium effect of the intervention on automaticity and two participants demonstrated a medium effect on frequency. A question arises as to why some participants (particularly 3 and 6) responded better than others. Participants 3 and 6 practiced less than other participants and had the shortest intervention phases suggesting that positive results were not due to frequency of practice alone. Participants 3 and 6 also showed the greatest increase in the IF-THEN CTE intervention becoming automatic and habitual during the intervention phase. This raises the possibility that the beneficial effect of the intervention does depend on it being counter-conditioned as an alternative helpful habit to rumination, consistent with the rumination-as-habit hypothesis.

However, it cannot be ruled out that increases in automaticity of the coping strategy are secondary to reductions in the automaticity of rumination given the concurrent nature of assessment.

With regard to theoretical implications for the habit-goal model for rumination, although the overall results are inconsistent with the model, with the intervention being unsuccessful at reducing the automatic nature of rumination, the intervention period and practice was relatively brief compared to the previous successful Watkins et al (2012) study which may account for these results. In Watkins et al (2012) practice was for 15-30 minutes per day, whereas in the current study, practice was for approximately 14 minutes per day for between 11-27 days, which constitutes less intense training. The extent of training may therefore have an impact upon changing habits. Furthermore, the concreteness training (Watkins et al. 2012) included three telephone contacts with a coach, so increased therapeutic contact may also impact on outcomes.

Despite burgeoning interest in the role of habit in psychology (e.g., Wood & Rünger, 2016), very little research evidence suggests the length of time or repetitions necessary for any type of habit to develop. Lally and colleagues (Lally et al. 2010) found a median of 66 practices for a lifestyle habit such as walking after dinner, to reach asymptote i.e., further efforts did not increase how automatic the response was. However habit acquisition was highly variable ranging between from 18 to 254 occasions of practice for participants. Were this study to be repeated then it would be recommended that the minimum length of intervention stage be extended to account for this variability. Such an extension (a four week extension was acceptable to participants at debrief) may facilitate further weakening of rumination and strengthening of concrete thinking as habit.

It is possible that the null effects observed result from insufficient length of training – in Watkins et al (2012) concreteness training continued for six weeks. It would be useful to investigate where the cross-over point occurs when rumination is no longer habitual and concrete thinking becomes the dominant automatic response. For participants 3 and 6 this cross over point occurred early around day five of intervention, a result that was surprising given the literature on habits being resistant to change. These results might relate to these participants expecting the intervention to be successful, which is a potential problem for internal validity. However, cognitive bias modification research has demonstrated that habitual benign interpretations of ambiguous information can be trained in just four sessions (Bowler et al. 2012).

Overall there was a statistically non-significant adverse effect of the intervention on mood compared to baseline. This move toward anxiety and sadness, though undesired, is perhaps expected, as the intervention requires participants to bring attention to triggers for depressive symptoms. Longer intervention phases may have indicated whether mood improved to baseline levels and beyond following further practice.

The sizable positive reductions in scores on the SRHI post intervention for all participants are seemingly at odds with the data from the daily measures. Though there are shared questions across the measures in the form of the SRBAI, one possible explanation for this discrepancy may lie in the SRHI being used to invite participants to reflect upon their rumination as a whole rather than for a particular day. It is also possible that expectancy effects are stronger for pre-post measures than for daily measures with participants expecting the intervention to have worked post-intervention and responding accordingly. This

suggests that whilst post scores for the RRS and SRHI are encouraging, primacy should be given to the daily measure scores.

At debrief all participants reported that they would continue to use IF-THEN CTE post-study, indicating the perceived utility and acceptability of the intervention. Learning to notice the space between the triggering context and the rumination and choosing to take action by using (parts of) the IF-THEN CTE were the most commonly cited helpful aspects of the practice. Participants felt this gave them greater control to decide whether to ruminate or think concretely. The extent of practice of the IF-THEN CTE and lack of missed days of recording indicates that this mixed group of community and university participants were motivated and engaged in the process. It may be that people with major depression might find regular practice more difficult, however, attrition rates were low for previous concreteness training (Watkins et al. 2012)

Overall participants reported that the intervention was quick to learn and after a few days the audio-guided script was no longer needed so could be practiced with ease across multiple contexts. This ease of practice also meant that the exercise could be practised close in time to spotting the triggers and in the relevant naturalistic context rather than having to wait until later in the day. The habit-goal framework along with behavioural theory in general (e.g., Hull, 1943), predicts that this temporal contingency would increase the future effectiveness of the intervention.

Three participants reported shifts or confusion in rumination as a concept. For example it was questioned whether there was a line between obsessive thoughts, overthinking and rumination. When reported during the study these questions were answered with reference to the definition provided

in the participant pack. This confusion highlights that exact definitions of rumination are not necessarily shared and might explain relatively low levels of change for this intervention. For example, as participant 5 experienced, including obsessional thoughts in his/her personal definition of rumination resulted in a reduced perception of change, as the obsessional thoughts did not diminish during the intervention. Future studies might helpfully spend more time in clarifying a personally helpful and stable definition of rumination as well as screening for other forms of negative and unhelpful repetitive thinking prior to commencement of the intervention. Two participants (1 and 4) reported reductions in their experience of the intensity and duration of their rumination rather than their automaticity and frequency at debrief. Intensity and duration may be useful additional questions to add to a daily measure of habitual rumination going forward. Discussions at debrief and examination of daily monitoring forms enabled exploration of any sudden changes to outcome data trends. For example, participant 3 demonstrated a significant reduction in frequency of rumination during intervention however there was a brief spike on day 34 to a level above the median for baseline. Recording forms identified an unusually high range of personal triggers for rumination on that day which reflected the particular stresses in their life at the time. It would be expected that there is a return to a reliance on habitual strategies when under stress as cognitive ability is impaired (Otto, Raio, Chiang, Phelps & Daw, 2013).

The trend toward significance observed at the group level for rumination automaticity, individually significant results, effect sizes and participants reporting that the intervention was helpful, suggest that the IF-THEN CTE may be a helpful intervention in it’s own right. A further clinical implication is that the

intervention may also be complimentary to existing psychological interventions such as CBT or cognitive analytic therapy where there is a particular proposed benefit of targeting habitual processes. The preliminary data from this study suggest that this intervention may be more effective if used over a longer period of time. In a clinical setting this might mean that the intervention would run for longer or over more repetitions of practice until a new habit is formed. A measure of habit strength (e.g., SRHI or SRBAI) could be used to assess the strength of the rumination habit and concrete thinking habit with treatment ending only when the former is no longer habitual and the latter has reached an agreed level of automaticity.

When treating rumination as habit it is important to take into account wider systems as contextual factors outside the individual can be considered a mediating factor for habitual rumination. When incorporating IF-THEN concrete thinking exercises into treatment packages it is important to consider whether the context is facilitative or obstructive to the treatment process. Changing context such as the physical environment or the behaviour of other people has been shown to influence habit change (Wood & Neal, 2007). By way of example, an attempt to develop a concrete thinking habit is unlikely to be successful if a partner is critical every time a trigger is noticed, however if that partner became a resource by agreeing to prompt and practice concrete thinking in response to triggers for rumination the intervention would have a far greater chance of success.

A particular strength of the study was the use of a simultaneous replication MBD design that facilitated the combination of randomization tests and effect size calculations as well as traditional visual analysis. A potential

limitation of this simultaneous MBD using randomization tests lies within the randomization itself. Because randomization is *a priori* and requires a prespecified analysis plan, this limits flexibility in the design (which is available if visual analysis is used), as adjustments cannot be made once the study is started. This inflexibility of design did not allow for extensions to the intervention phase after the study had started that might have identified when rumination was no longer habitual. In addition, this design could potentially limit use in clinical settings where changes to phase lengths may be required and any withholding of an intervention may be inappropriate (Campbell, Herzinger & Gast 2010). However where randomization is possible it provides a powerful tool to use in addition to visual analysis to assess the functional impact of interventions (Shadish, 2014). Despite the existence of standards for conducting SCEDs (Tate et al, 2016; Kratochwill et al. 2010, 2013) there currently exists no absolute consensus as to which statistical approaches are most appropriate for SCEDs and MBDs.

This is the only study known to the author that explicitly measures rumination as habit using a daily subjective measure of automaticity and frequency. A limitation of self-report measures of habit however, is that it is not possible to introspect and provide accurate judgements on automatic processes as they arise (Sniehotta & Pressau, 2012) and the measures are therefore limited to reflecting on past rumination in relation to cues which may impact on accurate reporting (Labrecque & Wood, 2015). Future studies would helpfully include an extended intervention period in order to better ascertain when rumination may no longer be considered habitual and a habit starts to form for the IF-THEN CTE. A follow-up may be beneficial to ascertain any longitudinal

effects of the intervention after the study ends particularly in relation to the hypothesis that a positive habit may increase in strength over time.

Conclusion

This study adds to emerging research into rumination as a mental habit. Using a single case experimental design in the form of a multiple baseline case series, this study tested predictions from the habit-goal framework for rumination. A trend toward statistically significant changes in rumination automaticity at the group level was evidenced by the results. Significant results for rumination automaticity were found for two out of the six participants who also demonstrated the greatest levels of automaticity for the IF-THEN-CTE intervention during the intervention phase. These findings, added to the weak to moderate effect size calculations for the impact of the intervention on rumination frequency and moderate effect size for automaticity suggest that the results are broadly consistent with the theoretical model presented. Further evidence is required to ascertain whether further repetitions and greater length of intervention phase might be needed to result in positive benefit for all participants.

References

Ashby, F. G., & Maddox, W. T. (2005). Human category learning. *Annual Review of Psychology, 56*, 149-178. doi 10.1146/annurev.psych.56.091103.070217

Asaad, W. F., Rainer, G., & Miller, E. K. (1998). Neural activity in the primate prefrontal cortex during associative learning. *Neuron, 21*, 1399-1407. doi: 10.1016/S0896-6273(00)80658-3

Bargh, J. A. (1994). The four horsemen of automaticity: Intention, awareness, efficiency, and control in social cognition. In Wyer, R, S & Skrull, T, K. (Eds.). *Handbook of social cognition*, (pp. 1-40), Hillsdale, NJ: Erlbaum. doi:10.4135/9781473915312

Bayer, U. C., Achtziger, A., Gollwitzer, P. M., & Moskowitz, G. B. (2009). Responding to subliminal cues: do if-then plans facilitate action preparation and initiation without conscious intent? *Social Cognition*, *27*, 183-201. doi: 10.1521/soco.2009.27.2.183

Bowler, J. O., Mackintosh, B., Dunn, B. D., Mathews, A., Dalgleish, T., & Hoppitt, L. (2012). A comparison of cognitive bias modification for interpretation and computerized cognitive behavior therapy: Effects on anxiety, depression, attentional control, and interpretive bias. *Journal of Consulting and Clinical Psychology*, *80*, 1021. doi; 10.1080/23311908.2015.1011905

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

Bulté, I., & Onghena, P. (2012). When the truth hits you between the eyes: A software tool for the visual analysis of single-case experimental data. Methodology*, 8,* 104-114. doi: 10.1027/1614-2241/a000042

Bulté, I., & Onghena, P. (2013). The single-case data analysis package: Analysing single-case experiments with R software. *Journal of Modern Applied Statistical Methods*, *12*, 28. doi:10.1080/09602011.2013.818564

Campbell, J. M., Herzinger, C. V., & Gast, D. (2010). Statistics and single subject research methodology. *Single Subject Research Methodology in Behavioral Sciences*, 417-453.

Campbell, T. S., Labelle, L. E., Bacon, S. L., Faris, P., & Carlson, L. E. (2012). Impact of mindfulness-based stress reduction (MBSR) on attention, rumination and resting blood pressure in women with cancer: A waitlist-controlled study. *Journal of Behavioral Medicine*, *35*, 262-271. doi: 10.1007/s10865-011-9357-1

Cooper, J. O. H., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd Ed.). Upper Saddle River, NJ: Pearson.

Dickinson, A. (1985). Actions and habits: the development of behavioural autonomy. *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences*, *308*, 67-78. doi: 10.1098/rstb.1985.0010

Dolan, R. J., & Dayan, P. (2013). Goals and habits in the brain. *Neuron*, *80*, 312-325. doi: 10.1016/j.neuron.2013.09.007

Gardner, B., de Bruijn, G. J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the self-report habit index to nutrition and physical activity behaviours. *Annals of Behavioral Medicine*, *42*, 174-187. doi: 10.1007/s12160-011-9282-0

Gardner, B. (2012). Habit as automaticity, not frequency. *European Health Psychologist*, *14*, 32-36. doi: 10.1111/j.2044-8287.2011.02056.x

Gardner, B., Abraham, C., Lally, P., & de Bruijn, G. J. (2012). Towards parsimony in habit measurement: Testing the convergent and predictive validity of an automaticity subscale of the self-report habit index. *International Journal of Behavioral Nutrition and Physical Activity*, *9*, 1-12. doi: 10.1186/1479-5868-9-102

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist*, *54*, 493. doi: 10.1037/0003-066X.54.7.493

Hertel, P. (2004). Memory for emotional and nonemotional events in depression. *Memory and emotion*, 186-216. doi:10.1093/acprof:oso/9780195158564.003.0006

Hertel, P. T. (2015). Cognition in emotional disorders: An abundance of habit and a dearth of control. In Lindsay, D. S., Kelley, C. M., Yonelinas, A. P., & Roediger, H. L. (Eds.), *Remembering: Attributions, processes, and control in human memory* (pp. 322-335). New York, NY: Psychology Press. doi: 10.1037/a0030923

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. *The Journal of Experimental Education*, *85*, 175-196. doi:10.1080/00220973.2015.1123667

Heyvaert, M., & Onghena, P. (2014). Analysis of single-case data: randomization tests for measures of effect size. *Neuropsychological Rehabilitation*, *24*, 507-527. doi: 10.1080/09602011.2013.818564

Hull, C. L. (1943). *Principles of behavior*. New York, NY: Appleton-Century-Crofts.

Jamieson, M., Cullen, B., McGee-Lennon, M., Brewster, S., & Evans, J. J. (2014). The efficacy of cognitive prosthetic technology for people with memory impairments: A systematic review and meta-analysis. *Neuropsychological rehabilitation*, *24*, 419-444. doi: 10.1080/09602011.2013.825632

Kanter, J.W.; Cautilli, J.D.; Busch, A.M. & Baruch, D.E. (2005). Toward a comprehensive functional analysis of depressive behavior: five environmental factors and a possible sixth and seventh. *The Behavior Analyst Today, 6,* 65–81. doi.10.1037/h0100055

Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings.* Oxford University Press.

Knapp, T. J. (1983). Behavior analysts' visual appraisal of behavior change in graphic display. *Behavioral Assessment*. Retrieved from http://www. psycnet.apa.org

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). Single-case designs technical documentation. *What Works Clearinghouse*. doi:10.1177/0741932512452794

Kratochwill, T. R., & Levin, J. R. (2014). *Single-case intervention research: Methodological and statistical advances*. American Psychological Association.

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9. *Journal of General Internal Medicine*, *16*, 606-613. doi: 10.1046/j.1525-1497.2001.016009606.x

Labrecque, J. S., & Wood, W. (2015). What measures of habit strength to use? Comment on Gardner. *Health Psychology Review*, *9*, 303-310. doi: 10.1080/17437199.2014.992030

Lally, P., & Gardner, B. (2013). Promoting habit formation. *Health Psychology Review*, *7*, 137-158. doi: 10.1080/17437199.2011.603640

Lally, P., Van Jaarsveld, C. H., Potts, H. W., & Wardle, J. (2010). How are habits formed: Modelling habit formation in the real world. *European Journal of Social Psychology*, *40*, 998-1009. doi:10.1002/ ejsp.674

Löwe, B., Kroenke, K., Herzog, W., & Gräfe, K. (2004). Measuring depression outcome with a brief self-report instrument: Sensitivity to change of the Patient Health Questionnaire (PHQ-9). *Journal of Affective Disorders*, *81*, 61-66. doi: 10.1016/S0165-0327(03)00198-8

Lyubomirsky, S., Layous, K., Chancellor, J., & Nelson, S. K. (2015). Thinking about rumination: The scholarly contributions and intellectual legacy of Susan Nolen-Hoeksema. *Annual Review of Clinical Psychology*, *11*, 1-22. doi: 10.1146/annurev-clinpsy-032814-112733

Ma, H. H. (2006). An alternative method for quantitative synthesis of single-subject researches: Percentage of data points exceeding the median. *Behavior Modification*, *30*, 598-617. doi: 10.1177/0145445504272974

Maggin, D. M., & Odom, S. L. (2014). Evaluating single-case research data for systematic review: A commentary for the special issue. *Journal of School Psychology*, *52*, 237-241. doi: 10.1016/j.jsp.2014.01.002

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

Marascuilo, L. A., & Busk, P. L. (1988). Combining statistics for multiple-baseline AB and replicated ABAB designs across subjects. *Behavioral Assessment*.

Marteau, T. M., Hollands, G. J., & Fletcher, P. C. (2012). Changing human behavior to prevent disease: The importance of targeting automatic processes. *Science*, *337*, 1492-1495. doi:10.1126/science.1226918

Martin, L. L. & Tesser, A. (1996). Some ruminative thoughts. In R.S.Wyer (Ed.), *Ruminative thoughts. Advances in social cognition Vol 9* (pp.. 1-47). Hillsdale, NJ: Lawrence Erlbaum Associates.

McLaughlin, K. A., & Nolen-Hoeksema, S. (2011). Rumination as a transdiagnostic factor in depression and anxiety. *Behaviour Research and Therapy*, *49*, 186-193. doi: 10.1016/j.brat.2010.12.006

Morley, S. (in press). *Single case methods for busy clinicians*.

Neal, D. T., Wood, W., Labrecque, J. S., & Lally, P. (2012). How do habits guide behavior? Perceived and actual triggers of habits in daily life. *Journal of Experimental Social Psychology*, *48*, 492-498. doi:10.1016/ j.jesp.2011.10.011

Nolen-Hoeksema, S. (1987). Sex differences in unipolar depression: evidence and theory. *Psychological Bulletin*, *101*, 259-282. doi.apa.org/journals/bul/101/2/259

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100,* 569-582. doi.apa.org/journals/abn/100/4/569

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109,* 504-511. doi: 101037/10021-843X.109.3.504

Nolen-Hoeksema, S. (2004). The response styles theory. In Papageorgiou, C., & Wells, A. (Eds.). *Depressive rumination: Nature, theory and treatment*. John Wiley & Sons.

Nolen-Hoeksema, S., & Harrell, Z. A. (2002). Rumination, depression, and alcohol use: Tests of gender differences. *Journal of Cognitive Psychotherapy*, *16*, 391-403. doi:10.1891/jcop.16.4.391.52526

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. doi:10.1037/0022-3514.61.1.115

Nolen-Hoeksema, S., & Watkins, E. R. (2011). A heuristic for developing transdiagnostic models of psychopathology explaining multifinality and divergent trajectories. *Perspectives on Psychological Science*, *6*, 589-609. doi:10.1177/1745691611419672

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

Onghena, P. (1992). Randomization tests for extensions and variations of ABAB single-case experimental designs: A rejoinder. *Behavioral Assessment*, *14*, 153-153. Retrieved from: http://ppw.kuleuven.be

Onghena, P., & Edgington, E. S. (2005). Customization of pain treatments: Single-case design and analysis. *The Clinical Journal of Pain*, *21*, 56-68. doi: 10.1097/00002508-200501000-00007

Onghena, P., Vlaeyen, J. W., & de Jong, J. (2007). Randomized replicated single-case experiments: Treatment of pain-related fear by graded exposure in vivo. In S Sawilowsky (Ed.) *Real data analysis*, (pp. 387-396). Charlotte, NC: Information Age Publishing.

Ostlund, S. B., & Balleine, B. W. (2009). On habits and addiction: An associative analysis of compulsive drug seeking. *Drug Discovery Today: Disease Models*, *5*, 235-245. doi: 10.1016/j.ddmod.2009.07.004

Otto, A. R., Raio, C. M., Chiang, A., Phelps, E. A., & Daw, N. D. (2013). Working-memory capacity protects model-based learning from stress. *Proceedings of the National Academy of Sciences*, *110*, 20941-20946. doi: 10.1073/pnas.1312011110

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

Rothman, A. J., Gollwitzer, P. M., Grant, A. M., Neal, D. T., Sheeran, P., & Wood, W. (2015). Hale and hearty policies: How psychological science can create and maintain healthy habits. *Perspectives on Psychological Science*, *10*, 701-705. doi: 10.1177/1745691615598515

Schmaling, K. B., Dimidjian, S., Katon, W., & Sullivan, M. (2002). Response styles among patients with minor depression and dysthymia in primary care. *Journal of Abnormal Psychology*, *111*, 350. doi: 10.1037//0021-843X.111.2.350

Selby, E. A., Anestis, M. D., & Joiner, T. E. (2008). Understanding the relationship between emotional and behavioral dysregulation: Emotional cascades. *Behaviour Research and Therapy*, *46*, 593-611. doi: 10.1037/a0029933

Skinner, B. F. (1938). *The Behavior of Organisms.* Appleton-Century-Crofts, New York.

Sniehotta, F. F., & Presseau, J. (2012). The habitual use of the self-report habit index. *Annals of Behavioral Medicine*, *43*, 139-140. doi: 10.1007/s12160-011-9305-x

Tate, R. L., Perdices, M., Rosenkoetter, U., McDonald, S., Togher, L., Shadish, W., ... & Sampson, M. (2016). The Single-Case Reporting Guideline In BEhavioural Interventions (SCRIBE) 2016: Explanation and elaboration. *Archives of Scientific Psychology*, *4*, 10.

Tate, R. L., Perdices, M., Rosenkoetter, U., Wakim, D., Godbee, K., Togher, L., & McDonald, S. (2013). Revision of a method quality rating scale for single-case experimental designs and n-of-1 trials: The 15-item Risk of Bias in N-of-1 Trials (RoBiNT) Scale. *Neuropsychological Rehabilitation*, *23*, 619-638. doi: 10.1080/09602011.2013.824383

doi:10.1080/10413200.2012.709579

Teasdale, J. D. (1988). Cognitive vulnerability to persistent depression. *Cognition & Emotion, 2*, 247-274.

Topper, M., Emmelkamp, P. M., Watkins, E., & Ehring, T. (2014). Development and assessment of brief versions of the Penn State Worry Questionnaire and the Ruminative Response Scale. *British Journal of Clinical Psychology*, *53*, 402-421. doi: 10.1111/bjc.12052

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

Van Aalderen, J. R., Donders, A. R. T., Giommi, F., Spinhoven, P., Barendregt, H. P., & Speckens, A. E. M. (2012). The efficacy of mindfulness-based cognitive therapy in recurrent depressed patients with and without a current depressive episode: A randomized controlled trial. *Psychological Medicine*, *42*, 989-1001. doi:10.1017/S0033291711002054

Verplanken, B. (2006). Beyond frequency: Habit as mental construct. *British Journal of Social Psychology*, *45*, 639-656. doi:10.1348/014466605X49122

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: Is habit an empty construct or an interesting case of goal-directed automaticity? *European Review of Social Psychology*, *10*, 101-134. doi:10.1080/14792779943000035

Verplanken, B., & Fisher, N. (2014). Habitual worrying and benefits of mindfulness. *Mindfulness*, *5*, 566-573. doi 10.1007/s12671-013-0211-0

Verplanken, B., & Orbell, S. (2003). Reflections on past behavior: A self-report index of habit strength. *Journal of Applied Social Psychology, 33,* 1313–1330. doi:10.1111/j.1559-1816.2003.tb01951.x

Verplanken, B., & Wood, W. (2006). Interventions to break and create consumer habits. *Journal of Public Policy & Marketing, 25,* 90–103. doi: 10.1509/jppm.25.1.90

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

Watkins, E.R. (2011). Dysregulation in level of goal and action identification across psychological disorders. *Clinical Psychology Review, 31, 260-278.* doi: 10.1016/j.cpr.2010.05.004

Watkins, E. R., Baeyens, C. B., & Read, R. (2009). Concreteness training reduces dysphoria: Proof-of-principle for repeated cognitive bias modification in depression. *Journal of Abnormal Psychology, 118*, 55-64. doi:10.1037/a0013642

Watkins, E., & Moulds, M. (2005). Distinct modes of ruminative self-focus: Impact of abstract versus concrete rumination on problem solving in depression. *Emotion, 5*, 319-328. doi: 10.1037/1528-3542.5.3.319

Watkins, E.R., Mullan, E.G., Wingrove, J., Rimes, K., Steiner, H., Bathurst, N., Eastman, E., & Scott, J. (2011). Rumination-focused cognitive behaviour therapy for residual depression: phase II randomized controlled trial. *British Journal of Psychiatry, 199,* 317- *322.* doi: 10.1192/bjp.bp.110.090282

Watkins, E. R., & Nolen-Hoeksema, S. (2014). A habit-goal framework of depressive rumination. *Journal of Abnormal Psychology*, *123*, 24. doi: 10.1037/a0035540

Watkins, E., Scott, J., Wingrove, J., Rimes, K., Bathurst, N., Steiner, ….Malliaris, Y. (2007). Rumination-focused cognitive-behaviour therapy for residual

depression: A case series. *Behaviour Research and Therapy, 45,* 2144-2154. doi:10.1016/j.brat.2006.09.018

Watkins, E.R., Taylor, R.S., Byng, R., Baeyens, C.B., Read, R., Pearson, K., & Watson, L. (2012). Guided self-help concreteness training as an intervention for major depression in primary care: A phase II randomized controlled trial. *Psychological Medicine, 42*, 1359-1373. doi:10.1017/S0033291711002480

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin*, *132*, 249. doi: 10.1037/0033-2909.132.2.249. 249

Wood, W., & Neal, D.T. (2007). A new look at habits and the habit-goal interface. *Psychological Review, 114*, 843-863. doi: 10.1037/0033-295X.114.4.843. 843

Wood, W., & Rünger, D. (2016). Psychology of habit. *Annual Review of Psychology*, *67*, 289-314. doi: 10.1146/annurev-psych-122414-033417

Appendices

A. Information Sheet for Participants

B. Ethical Approval Screen Shot

C. Pre and Post Study outcome Measures

    1. Ruminative Responses Scale (RRS)
    2. Patient Health Questionnaire (PHQ-9)
    3. Self-Report Habit Index (SRHI)

D. Daily Outcome Measures

E. Intervention Participant Pack and Script

F. Baseline Participant Pack, Consent Form and Script

G. Debrief Agenda and Feedback Form

H. All Participants' Raw data and Coding Inputted into R

I. Participant 2 Individual Data (and as Part of Group)

J. Rumination Automaticity Graphs with Trend Line

K. Rumination Frequency Graphs with Trend Line

L. Sad-Happy Mood and Anxious-Calm Mood Visual and Statistical Analysis

M. Automaticity of IF-THEN CTE During Intervention Phase

N. Dissemination Statement

O. Preparation and Submission Requirements for *Behaviour Research & Therapy*

Appendix A: Information Sheet for Participants

Information Sheet

Research Title: Using a training exercise to reduce rumination

Purpose of research: To investigate if rumination can be reduced by practicing a self-help exercise

Researchers: Max Buchanan, Prof Ed Watkins & Dr Nick Moberly

We would like to invite you to take part in a research study looking at whether rumination can be reduced by practicing a new self-help exercise. Rumination involves overthinking and focusing on the meaning and causes of events and why these have an effect upon our mood. You have shown an interest in the study and the brief assessment you completed indicated that you tend to ruminate daily and that your rumination impacts on your life at present (see advert for web link for screening if you have not yet completed the screening assessment).

What happens next?

FACE-TO-FACE MEETING: Contact Max (contact details at end or use web link) and we will arrange to meet (for up to 60 minutes) so we can talk through what the study entails. Practical advice will be given as to the recording you will be asked to do throughout. Recording takes less than 5 minutes a day and we will practice in the session. We will discuss the level of commitment required for participation so you know exactly what is expected.

In the meeting I will ask you to complete 2 screening forms to make sure it is safe and appropriate for you to participate. If you meet the study criteria and are still interested in participating I will ask you to read and sign a consent form for taking part. If the measures indicate particular symptoms of depression then we will undertake a risk assessment together and I might direct you towards support that may be more beneficial to you at this point (e.g. your GP, student health centre).

WHAT YOU WILL DO IN THE STUDY? The study requires a relatively significant level of commitment. You will record your levels of rumination each day over a 6-week period. If you agree to sign up to the study you (and other participants) will begin recording on 31st October 2016. I will give you a participant pack with simple instructions for completion of the study and exactly the right amount of daily recording sheets you will need.

THE INTERVENTION:
At the meeting I will give you a date to start practicing an exercise that is designed to reduce levels of rumination (each participant starts practicing the exercise on a different day). The exercise takes 7-10 minutes each time it is practiced and you will need to practice 2 or more

times a day. Please note that once you get used to the exercise it will take far less time and you may wish to practice more than twice a day.

The day before you are due to start practicing the exercise I will meet with you (or call you if this is not possible) to run through the exercise with you. You will then practice the exercise every day until the end of the study and continue daily recording. The study ends for all participants on Sunday 11th December. Following the study you will have opportunity for a debrief with a researcher.

To enable us to see changes it is really important that the daily recording is completed every day. If, for any reason, a day is missed then please fill it in retrospectively and continue recording as normal.

Do I have to participate?
No, if you do not wish to take part in the study, you do not have to. You can withdraw from the study at any time and you do not have to explain your reasons for doing so.

What could go wrong?
The daily recording over 6 weeks and the practice of a daily exercise requires some commitment and on rare occasions may lead to dropping out of the study. We do not use any exercises that are designed to make you have uncomfortable thoughts, however we recognise that reflecting on the amount you ruminate may potentially result in brief and transient low mood for some, but not all, people.

How could my participation help?
Taking part in this study could help reduce the amount of time that you ruminate by giving you an alternative strategy. It will also help us understand rumination better by testing whether it can be understood as a habit. Undergrads receive 10 credits also.

What happens to my information?
All information, which is collected during the research, will be kept strictly confidential within the limits of the law. You will be allocated a unique study code number, ensuring that all information that you give will be stored against your code rather than your actual name i.e. anonymously. Only immediate members of the research team will be able to link the number to your name. Identifiable information will be stored in a locked cabinet and/or password protected computer and only the researchers of this project will have access to it. The only exception would be if the screening process revealed a significant risk of harm to you or others. In this case, information may be fed back to your GP and, if applicable, your mental health professional but normally only after discussion with you.

In accordance with British Psychological Society research guidelines, all data for the study will be securely stored away for 5 years and will be destroyed after this time. Any identifiable information will never be used directly in any publications or reports from this study. Your results will be kept anonymous.

The study findings will be written up and reported (a thesis) in part completion of a Doctorate in Clinical Psychology. In accordance with University of Exeter Open Research Exeter policy, the thesis will be stored electronically at the University of Exeter, and will be accessible online (open access). The study findings may also be written up for publication in

research journals and presented at conferences. The published article will also be available online (open access, University of Exeter).
A 2 page summary of the results of the research will be made available to you as soon as it completed. Identifiable information about you will not be used in any publication

How do I sign up or find out more?
If you are interested in finding out more or would like to ask any questions, please contact the principal researcher (Max Buchanan) using the contact details below or via the website link, and we can arrange a meeting to talk through what is required and complete the consent form.

Principal Researcher

Max Buchanan
Mood Disorder Centre
Wellcome Building for Mood
Disorder Research
School of Psychology
College of Life and
Environmental Sciences
University of Exeter
Exeter
EX4 4QG
Phone: (0752 535 9468)
Email: mb610@exeter.ac.uk

Study Supervisors:

Professor Edward Watkins
Mood Disorder Centre
Sir Wellcome Building for Mood
Disorder Research
School of Psychology
College of Life and Environmental Sciences
University of Exeter
Exeter

EX4 4QG
Tel: 01392 724692
Email : E.R.Watkins@exeter.ac.uk

Dr Nick Moberly
Washington Singer Building
School of Psychology
College of Life and Environmental Sciences
University of Exeter
Perry Road
Exeter

EX4 4QG
Tel: 01392 724656
Email :N.J.Moberly@exeter.uk

Appendix B: Ethical Approval Screen Shot

Your applications

16/11	Max Buchanan, Prof Ed Watkins, Dr Nick Moberley	Depressive rumination as habit: counter-conditioning rumination using an IF-THEN concreteness exercise. Thesis in part fulfilment of the doctorate in clinical psychology	accepted

This Application has been marked as accepted, so no further edits can be made.

Project details

nditions of ceptance Please add to the debrief sheet that the study has been approved by the School of Psychology Ethics Committ chair's contact details (Dr. Lisa Leaver, l.a.leaver@ex.ac.uk) if they have any questions about it.

® Title of Project (max 25 words)
Depressive rumination as habit: counter-conditioning rumination using an IF-THEN concreteness exercise. Thesis in part fulfilment of the doctorate in clinical psychology

® Names of researchers
Max Buchanan, Prof Ed Watkins, Dr Nick Moberley

® Correspondent's Email (separate with a semi-colon if providing more than one)
mb610@exeter.ac.uk

Wed 4/5/2016
Ref ethics application 2016/1114

Hi Max,
It is a full approval, we don't send out anything more than that, so it should be fine. If there is any problem, you can attach this email as proof!
Best
Lisa

Lisa Leaver
Senior Lecturer in Animal Behaviour
University of Exeter
Ext: 4641
http://psychology.exeter.ac.uk/staff/index.php?web_id=lisa_leaver
Washington Singer, University of Exeter, Exeter, EX4 4QG

Appendix C: Pre and Post Study Outcome Measures

1. Ruminative Responses 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

2. The Patient Health Questionnaire-9

The Patient Health Questionnaire-9 (PHQ-9; Kroenke, Spitzer, & Williams, 2001)

Over the last 2 weeks how often have you been bothered by any of the following symptoms?	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things				
2. Feeling down, depressed, or hopeless				
3. Trouble falling or staying asleep, or sleeping too much				
4. Feeling tired or having little energy				
5. Poor appetite or overeating				
6. Feeling bad about yourself — or that you are a failure or have let yourself or your family down				
7. Trouble concentrating on things, such as reading the newspaper or watching television				
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				
9. Thoughts that you would be better off dead or of hurting yourself in some way				

If you checked off **any** problems, how **difficult** have these problems made it for you to keep up with your work or study, take care of things at home, or get along with other people? (please circle)

Not difficult at all Somewhat difficult Very difficult Extremely difficult

PHQ9 total score ____

3. The Self-Report Habit Index (SRHI; Verplanken & Orbell, 2003).

Instruction: Rumination is overthinking, brooding and repeatedly dwelling on upsetting feelings, problems and difficulties and their meaning, causes, implications and consequences. Please indicate how much you agree or disagree with the following statements.

Rumination is something . . .

	1	2	3	4	5
I do frequently	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do automatically	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do unintentionally	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
that feels sort of natural to me	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do without further thinking	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
that would require mental effort to leave	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do every day	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I start doing before I realize I'm doing it	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I would find hard not to do	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I don't do on purpose	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
that's typically "me"	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I have been doing for a long time	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree

Appendix D: Daily Outcome Measures

Baseline daily measure

Date:

Time:

Please answer all of the following questions towards the end of each day based on your experience of today.

	Please circle									
1. How sad-happy have you been today?	1 Very sad	2	3 Moderately sad	4	5 Neither happy or sad	6	7 Moderately happy	8	9 Very happy	
2. How anxious-calm have you been today?	1 Very anxious	2	3 Moderately anxious	4	5 Neither calm or anxious	6	7 Moderately calm	8	9 Very calm	
3. How many times have you ruminated today?	0	1	2	3	4	5	6	7	8	
4. Based on your experience over today, please rate the following questions: Rumination is something..										
I do automatically	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree					
I do without having to consciously remember	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree					
I do without thinking	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree					
I start before I realise I'm doing it	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree					

Note on question 3. If you have ruminated more than 8 times today please, as accurately as you can, write in how many times this has happened in the empty box on this line

Intervention daily measure

Date:

Time:

Please answer all of the following questions towards the end of each day based on your experience of today.

Please circle

1. How sad-happy have you been today?	1 Very sad	2	3 Moderately sad	4	5 Neither happy or sad	6	7 Moderately happy	8	9 Very happy	
2. How anxious-calm have you been today?	1 Very anxious	2	3 Moderately anxious	4	5 Neither calm or anxious	6	7 Moderately calm	8	9 Very calm	

3. How many times have you ruminated today?	0	1	2	3	4	5	6	7	8	

4. Did you notice your triggers or signs of rumination today? (if so, please say which)	Yes	No

5. Based on your experience over today, please rate the following questions:
Rumination is something…

I do automatically	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do without having to consciously remember	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do without thinking	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I start before I realise I'm doing it	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree

9. How often did you practice your concrete-thinking-exercise today?	0	1	2	3	4	5	6	7	8	

10. Based on your experience over today, please rate the following questions:
Concrete Thinking (my alternative strategy to rumination) is something…

I do automatically	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do without having to consciously remember	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I do without thinking	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree
I start before I realise I'm doing it	Strongly disagree	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Strongly agree

Appendix E: Intervention Participant Pack and Meeting Script

Using a training exercise to reduce rumination

Intervention Phase Participant Pack

Thank you again for continuing to take part in this study. Here's a reminder of what to expect and what you'll be doing.

This is the pack for the 2nd phase of the study where you practice your concrete thinking-exercise in response to your triggers for rumination 2 or more times a day and record each day

Your unique participant number is _____

Your baseline phase start date was **31st October 2016**

Your intervention phase start date is _____

Your end date for the study is **11th December 2016**

Attached are the daily recording sheets, worksheets and materials you need for the second part of the study

Contact details for Max

mb610@exeter.ac.uk

tel: 0752 535 9468

Principal Researcher

Max Buchanan

Mood Disorder Centre
School of Psychology
College of Life and
Environmental Sciences
University of Exeter
Exeter
EX4 4QG
Phone: (07525359468)
Email: mb610@exeter.ac.uk

Study Supervisors:

Professor Edward Watkins
Mood Disorder Centre
Sir Wellcome Building for Mood
Disorder Research
School of Psychology
College of Life and Environmental Sciences
University of Exeter
Exeter

EX4 4QG
Tel: 01392 724692
Email : E.R.Watkins@exeter.ac.uk

Dr Nick Moberly
Washington Singer Building
School of Psychology
College of Life and Environmental Sciences
University of Exeter
Perry Road
Exeter

EX4 4QG
Tel: 01392 724656
Email :N.J.Moberly@exeter.uk

www.ruminationstudymb610.co.uk

The concrete-thinking-exercise

1. identify triggers and early warning signs for rumination

If rumination is a habit then it can be changed by spotting the warning signs and triggers for when you ruminate and immediately (or as soon as possible) practicing the **concrete-thinking-exercise** as a way to develop a new and helpful habit. Warning signs can include events like conflicts, disappointments, novelty, uncertainties, challenges, risks….they can be physical feelings like tension, butterflies, a "sinking feeling" in the stomach, tiredness…they can be emotions like anxiety, irritability, frustration….they can be mental experiences like attention becoming narrowed, thinking becoming confused and foggy…they can be situations like feeling under pressure, trying to do too many things at once… they can be thoughts such as doubts and self-criticism.

Your unique early warning signs and triggers for rumination are

1.

2.

3.

4.

5.

..

..

..

It is helpful to use these early warning signs and triggers for rumination to develop IF-THEN plans that are unique to you as these personal statements will help you commit to practicing the **concrete-thinking-exercise** in response to noticing your triggers. IF-THEN plans are statements that take the form of..

"<u>IF</u> I notice my triggers or warning signs, <u>THEN</u> I will practice my concrete-thinking-exercise"

2. Write your IF-THEN plans

Now write the triggers and warning signs for your rumination in the gaps of the following IF-THEN plans.

My IF-THEN plans are

"IF I notice…… THEN I will practice my concrete-thinking-exercise"

"IF I notice…… THEN I will practice my concrete-thinking-exercise"

"IF I notice…… THEN I will practice my concrete-thinking-exercise"

"IF I notice…… THEN I will practice my concrete-thinking-exercise"

"IF I notice…… THEN I will practice my concrete-thinking-exercise"

Between the trigger and rumination is a space, and in that space is the freedom to choose to do something different

Whenever you notice that your mood is slipping or you are starting to overthink, you can deliberately choose to use an IF-THEN plan as a strategy to remind you to practice the **concrete-thinking-exercise** to cope better with this difficulty.

To begin with we suggest that when you spot your triggers and activate your IF-THEN plan that you practice the **concrete-thinking-exercise** by following the instructions from the audio and complete a worksheet. You can pause the instructions at any point. After you have practised this way for a while, you should begin to be able to focus on the **concrete-thinking-exercise** from memory without the need for the audio or worksheets. You will soon start to use the CD / audio less and less

The script for the concrete-thinking-exercise is also provided below.

Here is a reminder of some key differences between abstract and concrete thinking. You might want to refer to this information periodically.

Abstract / rumination	Concrete thinking
Asking WHY did this happen Focus on meanings, causes and implications Thoughts lead to thoughts (rumination to more rumination) Impairs problem solving More procrastination, less action Problems snowball – overwhelmed Makes us jump to conclusions (catastrophise) *Worse* to think "I am a complete failure" rather than "I failed because I was tired and unprepared" Leads to self-criticism, blame, why can't I change? BENEFITS Might be good for BIG questions like why should I move to Devon, go too this university, planning a round the world trip, thinking about philosophy – less good for managing mood and problem solving in the here and now	Asking HOW did this happen What, when, how, who questions. Focuses on contextual detail Sensory detail, sequence of events, how events unfold in time, breaking event down into small manageable steps, the uniqueness of a situation BENEFITS 1. Keeps difficult events and situations in perspective (stops us jumping to conclusions, stops us generalizing from one situation to another) 2. Helps us to learn. Focus on the sequence helps us see where we can take action and make decisions. If every situation is different what can I learn from another situation to help with this one? 3. Action-oriented. Imagining the details of an event and what you might do next helps to generate possible alternative courses of action, which improve problem-solving. 4. being more concrete helps us to get started on plans and actions by breaking the problem down into smaller, more manageable steps so that it does not seem so overwhelming, so huge. Thinking concretely increases activity: Concrete thinking tends to lead to

	• finding a solutions to the problem • leads to action • making useful plans • Feeling calmer • Keeping things in perspective • Slowing things down • Helps us learn • The more detail you have the better it will be moving forward • Moving forward in manageable steps (SMART) falls out of the process *Better* to think "I failed because I was tired and unprepared" than to think "I am a complete failure"

The concrete-thinking exercise

[CHIME]
Well done for committing to practice this **concrete-thinking-exercise**

Step 1. Focusing on your breathing
Begin this **concrete-thinking-exercise** by focusing on your breathing…… as best you can focus your attention on your breath [2] – let the breathing become deep and regular ….. slow….. steady……relaxed…….noticing how each breath that you take in…[2] allows you to grow a little more comfortable… more relaxed within yourself ……. Breathe in …[3]…and …..out…[3] ..nice and slow [2]…….Calm ... and relaxed. [2]

Step 2. Recognising your triggers for rumination
Now.. either cast your mind back to a very recent time that you were beginning to ruminate OR focus on the present moment if you are beginning to ruminate right now.
What triggers or early warning signs for your rumination have you spotted? What do you notice that prompts you to activate one of your IF-THEN plans? An IF-THEN plan that takes the form of *'IF I notice… a trigger or early warning sign… THEN I will practice my concrete-thinking-exercise'.* The trigger might be a mood, a feeling in your body, a situation, a thought..

Step 3: Pay attention to the details of the situation in the moment
Now, as best you can, focus your attention on experiencing as concretely as possible what is happening in the moment when you spot your triggers and begin to ruminate

[3] Notice the specific details of what is happening around you [5]. Observe where you are, become aware of your surroundings [3]. Notice what you can see, the specific noises you can hear, scents you can smell, textures you can feel [3] Focus on the sensations you feel in your body. [3] Notice any feelings, thoughts or concerns that might be bothering you. Pay close attention to your experience of any feelings, thoughts or problems.

Step 4: Pay attention to the uniqueness of this situation

Focus your attention on the specific details which make this experience different from any other moment.

Notice what marks this problem or concern out in time…, in place….setting…..circumstances. What have you or other's just said or done? What makes this situation a one-off? What makes it unique?

How would you describe this situation so that someone else could clearly imagine the scene? [5].

Step 5: Pay attention to the build up

Now focus your attention on *how* this situation occurred … the sequence of events leading up to this moment … As vividly and as concretely as possible recreate the series of steps, of actions and events that led up to this moment and to this difficulty, *as if looking out from your own eyes* rather than looking *at* yourself in a scene, …..did this sequence of events take place over seconds, minutes, hours, days, weeks? …Notice when the problem started [5]

Now, here's an important part of this concrete thinking exercise…..As you focus on the sequence of events that led up to this moment, start to spot any clues or warning signs that indicated that this difficulty was starting[5].

Notice any points where a different decision or action might have changed what happened [8].

Step 6: Moving Forward

Next focus your attention on how you can move forwards from this point … the steps you can take to improve things … to make decisions and plans…to move into helpful action [2] ...

Imagine as best you can, as vividly and concretely as possible a film, frame by frame of what you can do next to improve your situation, over the next few seconds, or over minutes or over days, weeks or months [3]. … See the first step in the chain of actions that you can take to move forwards [3]. … and then follow the sequence of how one step leads to another … imagining it as vividly as possible … … how you plan to move forwards [5].

And now continuing to feel relaxed …….continuing to look at things in a concrete way as this practice comes to an end….you can begin to take action, to take control and move forwards positively

Over time and with practice you will find that you are able to practice concrete thinking without the need for either this audio or a worksheet. You will be able to use this skill in the moment that you need it, as soon as you notice your triggers. Following the steps to concrete thinking can become automatic, a new and positive habit to take control and gently counter rumination.

Finally - As you move forward, remember that between the trigger and rumination there is always a space, and in that space there is the freedom to choose to do something different.
[CHIME]

Here is a brief reminder of the steps to concrete thinking that you can take whenever you want

1. Begin by focusing on your breathing
2. Recognise the early warning signs and triggers for your rumination
3. Pay attention to the sensory detail of what was/is happening
4. Consider what was/is unique about this situation
5. Focus on the sequence of events leading up to this situation and notice any points where a different decision or action could have positively changed what happened
6. Clearly visualize a step-by-step way of moving forward from this point and take action

The concrete-thinking-exercise Worksheet

Worked Example 1

Step 1: Begin by focusing on your breathing…
as best you can focus your attention on your breath – let the breathing become deep and regular ….. slow….. steady……relaxed…….noticing how each breath that you take in and then out allows you to grow more comfortable… more relaxed within yourself ……. Breathe in …and …..out ..nice and slow …….Calm ... and relaxed.

Step 2: Noticing triggers and early warning signs for rumination or worry		
Commit to your IF-THEN plan by making a note of the triggers and early warning signs you have just noticed		
<u>IF</u> I notice	**my triggers or warning signs..** being home alone, having returned from work / uni	**<u>THEN</u> I will practice my concrete-thinking - exercise"**

Step 3: Pay attention to the details of the situation in the moment
What is happening in the moment that you spot your triggers and begin to ruminate? What can your hear? smell? textures you can feel? Where? When? With whom?. What sensations, feelings, thoughts or concerns are bothering you?
-place, senses, thoughts, feelings….. I'm standing in the kitchen I've just put the radio on Coat and shoes still on I can see a few bits of washing up need doing – just a cereal bowl and cups I'm noticing I'm tired and my feet are sore My breathing is quite high up in my chest I feel tired, really tired, annoyingly tired! I'm thinking why am I so tired? I shouldn't be, other people aren't as tired What is it about me? It's always like this
Step 4: Pay attention to the uniqueness of this situation
What marks this problem or concern out in time….place….setting…..circumstances? what makes this concern a one-off"? How would you describe this situation so that someone else reading this can imagine the scene?
Maybe it's not *ALWAYS* like this, I've probably never stood here with this particular song playing, whilst wearing these exact same clothes and I've *certainly* never been here at this exact point in time on this day, year..

Step 5: Pay attention to the build up
What was the sequence of events leading up to this moment? Notice when the problem started. Notice any points where a different decision or action or different circumstances might have changed what happened.
It was a normal busy day at work, I remember not taking a lunch break, just snacked at my desk, a bit of a rush to leave and catch my bus as I needed to get a piece of work finished. Just managed to catch the bus in time, the journey was slow and frustrating, I got off the bus to walk home and had the thought that tonight would be boring, I'd be too tired to do anything, I got in and just stood in the kitchen knackered

Step 6: Moving Forward
Imagine as vividly as possible a movie of what you can do next to improve your situation, over the next few seconds, over minutes or over days, weeks or months … See the first step in the chain of actions that you can do to resolve this situation … and then follow the sequence of how one step leads to another … imagining it as vividly as possible … **Make a note of what you have learnt and the action you plan to do NEXT**
I'll keep practicing my concrete thinking exercise Tomorrow I will take a proper lunch break and/or I'll start packing up earlier to leave work I'll ask myself whether the last bit of work can wait til tomorrow (or start it earlier) When I walk from the bus stop to home after work I'll check in with how I'm feeling and thinking so that when I get home I can do something immediately that is welcoming and calming for me (choose music to put on, have a quick shower to perk myself up, get changed out of work gear…) I'll be kind and remind myself that just because I'm tired now I might not be later I could ring my friends and see what they are up to I'll congratulate myself for noticing my trigger and deciding to act a bit differently

Remember: practicing this new response strengthens this new helpful habit and weakens the rumination habit

Intervention meeting script (last updated 9 10 16)

Materials

- **SCRIPT**
- **Participant Intervention Pack**
- **Ask for baseline pack back**

Triggers for rumination sheet	
IF-THEN plans sheet	
concrete-thinking-exercise script,	
Worksheets (LOTS!)	
CD (MP4 emailed)	
All the recording sheets you need (LOTS!)	
Baseline pack given back to me	
Ensure PHQ-9 is attached to recording sheets	
Ensure SRHI is attached to recording sheets	
a copy of meeting notes?	
Date booked for debrief and collecting recording sheets	

Thanks for meeting with me today. So you've got to the end of the baseline phase of the study. How have you found it?

Let's have a quick look at the recording sheets. We've now got a good idea of how your rumination typically presents and how habitual or automatic it is

Today we are meeting to develop and practice the exercise that you'll start using tomorrow and we'll also go through your intervention pack and the new recording format that you'll use every day until the end of the study
Today will take 60 minutes and by the end you'll have everything you need to complete the study. Have you any questions at this point?
The new exercise will be practiced twice every day or more often if you can. It takes roughly 6 minutes each time but the 6 minutes is as you learn using a CD/audio and optional worksheet. Over time it gets much quicker.

Abstract Vs Concrete Thinking

I want to start by emphasising the kind of thinking involved in rumination - abstract thinking.

Abstract thinking = processes like overthinking, brooding, reflecting and repeatedly dwelling on upsetting feelings, problems or difficulties. When you are ruminating you may be attempting to solve a problem but you end up spending a lot of time thinking about yourself and how you feel?

- You might get stuck thinking over *why* you feel low or reviewing failings and mistakes?
- You might worry about things?
- asking yourself questions like "why is this happening to me?"
- perhaps judging and evaluating yourself,
  All of these difficulties are very common experiences for people who ruminate

The abstract thinking in rumination tends to prevent problem solving and can make tasks seem bigger

EXAMPLE OF ABSTRACT Vs CONCRETE THINKING

Imagine a time when you've expected to meet someone and they've not shown up.

If you are someone who tends to ruminate you might ask yourself

- "Why is this happening?"…(3)
- "Why is this happening to me?" …(3)
- "what-if something has happened?"
- "What does this mean or say about me?" ……(3)
- "isn't this just like other times when I've been stood up or disappointed?" ……(3)
- "What will the consequences be?" …(3)
- "Why does this keep happening to me?" (3)
- "Why me?" (3)
- etc

Can you see what tends to happen when more abstract, why-type questions that focus on causes, meanings and implications are used?? …

- They can lead to *more* rumination and worry rather than less?
- Abstract thoughts tend to produce more abstract thoughts
- whys and what-ifs produce more whys and what-ifs (can always find another why or what-if as soon as you think you've solved one)
- mood might worsen – feeling low, anxious, self-critical
- thinking in this more abstract way might distract you from forming a detailed plan as to how you might move on from here?
- A rule of thumb: if your thinking leads to more thoughts rather than plans, actions or decisions then you are ruminating

So what can be done?....

1.1.1 Concrete Thinking (in response to difficulty)

There's a more helpful way of thinking about stress and difficulties than the abstract thinking in rumination, we call this **Concrete thinking**. Concrete thinking is the opposite of the abstract thinking involved in rumination.

Concrete thinking leads to problem solving and moving forward from difficult situations in a helpful way

Concrete thinking involves using what, when, how and who questions rather than WHY questions. There is a focus upon the sensory details of a situation, on the uniqueness of the situation, of the sequence of events that led up to a difficult situation.

If we use the example expecting to meet someone and they've not shown up.

Thinking concretely would involve

- Noticing the details of what is going on in the situation, both inside you and around you. Sensory details like <u>What</u> you can see, smell, hear, touch, taste. A focus on your current thoughts and feelings. Being an observer from your perspective in that moment (looking out from your own eyes). This anchors you in the present time and slows things down, keeping things in perspective
    - Can you get a sense of these details?

- Noticing How is this situation different from other times when I have met people as planned?" how is it unique?
    - What makes this concern a one-off – in time, place, context?
- Asking "What is the sequence of events that led up to the person not showing up?" (3)…
    - you break it down into small steps – smaller the better
    - this allows you to spot clues as to when things changed, when the problem started, or when you could have made different plans or decisions
        - In this example you might note that the person you arranged to meet was bit distracted when you made arrangements
        - That it was a tentative arrangement
        - Did we say 7.30 or 8.30?
        - You remember there is an event on in town so traffic is likely to be bad
        - do they know where / when to meet
        - are there 2 cafes in the same chain
        - essentially what plausible explanations are there for the person not turning up?

- Asking How do I move forward from here? Concrete thinking involves visualising ways forward and enables you to take decisions, make plans and take action in manageable steps rather than being overwhelmed

The more detail you give about the sequence the more likely you will be able to spot possible solutions and ways to move forward

So what could you do? What would make a difference? What is the first step I can take?

Plan to take the mickey out of them for being late when they show

Take 5 deep breaths

Decide that next time we'll be clearer about the arrangements

Recognise that I tend to worry and situations can escalate in your mind and that there are plausible explanations for lateness

Sit with the discomforting feeling until it passes

Read a book, make a drink..

Ring them now or decide to wait X minutes as they are only 2 minutes late

How do you think you would feel following the concrete thinking process rather than the more abstract process?

e.g. Calmer, in control, in perspective…more able to make plans, make choices and take action

How might you compare the 2 thinking processes? How might you sum up the differences?

Are you feeling clear about the differences between concrete thinking and the abstract thinking found in rumination?

>So what we are going to do today is practice a concrete-thinking-exercise that is relevant to you

(perhaps start to bring to mind a very recent time where you found yourself ruminating – thoughts leading to thoughts and no solutions

but there is another element before we start

Rumination as Habit

Your questions on the recording form you completed every day focused upon how automatic your ruminative thoughts were. We asked this question because we think that rumination can become a habit over time, it becomes automatic, we do it without effort.

Rumination may have become a habit in the following ways

- You tried to solve a problem or respond to a difficult situation or mood by thinking deeply about it using abstract thinking such as "why?" type questions (Intention and taking action)
- Over time you did this more often across lots of situations (repetition in context)
- Now rumination is triggered by the environment (internal mood / external cues)
- rumination became a mental habit. Like other habits it happens in response to triggers that are personal to you, the trigger for rumination can be a place, a situation, a person , a thought or a feeling. Over time ruminative thinking happens without intention or effort as it is triggered by the context in which it typically happens. For example if rumination normally happens whilst driving on your own it may be triggered automatically every time you are in that situation

The question therefore is if rumination is a habit how do I form a more helpful one?

There are 3 steps

1. spot the triggers for the habit
2. commit to taking action
3. practice the new skill, action, exercise in response to the triggers for the old habit until the new habit becomes formed, until it can be done automatically

The steps for developing a new concrete thinking habit are

1. **To Identify triggers for rumination.** become aware of your triggers and cues for your rumination / abstract thinking then you will be in a better place to do something about it

2. **Make IF-THEN plans.** These are statements personal to you that help you commit to practicing the concrete thinking exercise e.g. "IF I notice my triggers THEN I will practice my concrete-thinking-exercise"

3. **practice the concrete-thinking-exercise in response to your triggers for rumination.** as many times as possible as soon as you can after the triggers arise. Do this as quickly as possible to nip it in the bud (i.e. close in time to the trigger). The closer in time you can practice the concrete-thinking-exercise in response to the triggers the better it is for forming a new helpful habit

The good news is that although new helpful habits take effort to start with, over time with repeated practice they become automatic, you can do it without effort, like being on positive "automatic pilot".

Habits get stronger the more you practice in response to different triggers and across different contexts particularly if there is a reward from the practice i.e. if you notice the concrete thinking helps you problem solve and you ruminate less.

Over time concrete-thinking will be triggered automatically by the triggers for your rumination so the more effort that goes in in the next few weeks the more likely that less effort will be needed in the future.

Appendix F: Baseline Participant Pack, Consent Form and Meting Script

Using a training exercise to reduce rumination

Participant Pack

Thank you again for agreeing to take part in this study. Here's a reminder of what to expect and what you'll be doing.

There are 2 phases to the study that together last 6 weeks, the baseline phase where you record every day followed by the intervention phase where you practice a new skill 2 or more times a day and record each day

Your unique participant number is _____

Your baseline phase start date is **31st October 2016**

Your intervention phase start date is _____

We'll meet to discuss your exercise on _____

Your end date for the study is **11th December 2016**

Attached are the daily recording sheets you need for the first part of the study

Contact details for Max

mb610@exeter.ac.uk

tel:XXXXXXXXXXXXXX

Principal Researcher

Max Buchanan

Mood Disorder Centre
Sir Wellcome Building for Mood
Disorder Research
School of Psychology
College of Life and
Environmental Sciences
University of Exeter
Exeter
EX4 4QG
Phone: (07525359468)
Email: mb610@exeter.ac.uk

www.ruminationstudymb610.co.uk

Rumination can be defined as overthinking, brooding, reflecting and repeatedly dwelling on upsetting feelings, problems or difficulties. It's a type of thinking process. It seems that it is an attempt to problem solve (so comes from a positive place) but Rumination can be problematic as it is involved in the onset and maintenance of anxiety and depression.
Examples Asking WHY did this happen Focus on meanings, causes and implications Thoughts lead to thoughts (rumination to more rumination) Impairs problem solving More procrastination, less action Problems snowball – overwhelmed Makes us jump to conclusions (overgeneralise / catastrophise) *Worse* to think "I am a complete failure" rather than "I failed because I was tired and unprepared" Leads to self-criticism, blame, why can't I change? BENEFITS Might be good for BIG questions like why should I move to Devon, go too this university, planning a round the world trip, thinking about philosophy – less good for managing mood and problem solving in the here and now

Consent form

Participant number: **Version: 1.0**

Title: Using a training exercise to reduce worry and rumination

Purpose of research: To investigate if rumination can be reduced following repeated practice of a self-help exercise. Researchers: Max Buchanan, Supervised by Prof Ed Watkins & Dr Nick Moberly

1) I confirm I have read and understood the information sheet and have had the opportunity to ask questions. ☐
2) I understand that I am taking part on a voluntary basis and can withdraw from the study at any time without providing a reason ☐
3) I understand all information provided will be kept completely confidential by the research team. ☐
4) I understand I can contact the researcher for a summary of the study's results on completion. ☐
5) I agree to take part in the study. ☐
6) I agree to complete the daily recording measures and practice the exercises (approximately 30 minutes a day in total) and understand that the study will be take 6 weeks to complete ☐
7) I understand that if I am an undergraduate psychology student I will be offered 1.5 course credits for taking part in this study. ☐

_____	_____	_____
Name of participant (print)	**Date:**	**Signature**
_____	_____	_____
Name of researcher (print)	**Date:**	**Signature**

The study has been approved by the School of Psychology Ethics Committee. The committee's chairperson (Dr. Lisa Leaver, l.a.leaver@ex.ac.uk) can be contacted if you have any further questions or concerns.

Baseline Meeting script

Materials

- **Completed RRS – to comment on**
- **Information sheet**
- **SRHI**
- **PHQ-9**
- **Spare recording form to practice on in session**
- **Consent Form**
- **Pack for baseline phase (dated recording sheets)**
- **A copy of script notes**

Check 60 mins available

"Thank you for your interest in taking part in this study and agreeing to meet today.

By the end of this meeting you should have all the information you need in terms of what the study entails so that you can make a decision as to whether you'd like to take part. You've already had an information sheet which has outlined the research but here we'll be able to go into more detail. Can I check that you've had a chance to read the information sheet?

Yes.. Great
No.. We'll make sure all the points are covered

stop me at any point to ask questions, for clarification or for any other reason.
Any questions at this point?

The agenda for today

1. We'll look at your scores on the ruminative responses scale and briefly discuss rumination, talking through some examples
2. We'll then discuss what the study entails, how long it takes and what you'll be doing and what I'll be doing too
3. Along the way I'll ask you to complete 2 brief measures, one of which is to ensure that it is safe and appropriate for you to participate in this study. If the measures indicate particular symptoms then we will undertake a risk assessment together as was stated in the information sheet
4. I'll ensure you know what happens to your information during and following study completion
5. If you meet the study criteria and are still interested in participating I will ask you to read and sign a consent form for taking part.
6. Towards the end I'll give you a pack to get started as well as a copy of these notes. We'll also plan another time to meet approximately halfway through the study

At any point, today or during the study, you can decide to opt out and you don't have to tell me why you'd rather not take part

Rumination

You completed the Ruminative Responses Scale (RRS) and this brief assessment suggests that you ruminate or worry at least twice daily and that your rumination impacts on your life at present. For the purpose of this study we wanted to recruit participants who ruminate relatively frequently as this would allow us to understand whether the exercise that you'll practice in the doing phase of the study (intervention) is helpful in reducing this type of thinking.

Can we spend a moment to consider your rumination. This is important, as you'll be asked to reflect on your rumination throughout the study so you'll want a point of reference

What form does rumination take for you?
How do you manage it?
Prompts…

- spending a lot of time thinking about yourself and how you feel?
- Do you ever get stuck thinking over why you feel depressed or reviewing your failings and mistakes?
- Do you often worry about things?
- Do you often ask yourself "why me?"
- Are you often judging and evaluating yourself, checking up on how well you are doing things, focusing on where you don't meet your expectations?
- Barriers to participation and

Do you EVER find that dwelling on things over and over again isn't particularly helpful to you and can even make you feel worse?

Can you give me a recent example?

This form of repetitive thinking is what we call **RUMINATION**

So In general Rumination can be defined as overthinking, brooding, reflecting and repeatedly dwelling on upsetting feelings, problems or difficulties. It's a type of thinking process. It seems that it is an attempt to problem solve (so comes from a positive place) but Rumination can be problematic as it is involved in the onset and maintenance of anxiety and depression.
These are some of the ways that rumination can be problematic and over time rumination can become very ingrained and difficult to shift as it becomes 'second-nature', habitual and automatic. so the aim of the study is to see if rumination can be reduced using a self-help exercise.

> COMPLETE SRHI
automaticity – unconscious (unaware)-efficient (without attention or minimal attention

needed)-uncontrollable (limited ability to avoid)-unintentional (no goal is required)

> COMPLETE PHQ-9
what the study entails
The study will take place over 6-weeks.

It is in 2 phases, a baseline phase where you do some recording at the end of every day over followed by an intervention phase where you will continue to record every day *and* practise an exercise designed to reduce rumination.
It starts 31st October and ends 11th December
(get baseline recording form out)
In the first baseline phase you'll be aske to complete this recording form which consists of 7 questions. I'll give you the forms you need and a start and end date today. Let's practice completing this recording form
> COMPLETE BASELINE DAILY FORM - go through automaticity questions

TIP: you might want to complete this at the same time each day or before or after a regular evening activity e.g. brushing your teeth or having a bath, so you don't forget.
Q. *What if you forget to complete the daily recording?*
A. Should you miss a day then you can complete the record retrospectively (up to 3 days). It is best to record every day of course as the questions are about that particular day

The intervention.
In the second phase of the study, an exercise will be practiced every day at least twice which takes about 7 minutes a time (to start with, then quicker). You'll also complete a slightly longer daily recording form.
Your exercise will have elements that are unique to you but we can't discuss the exercise today as you might unwittingly start practicing before we've captured what typically happens for you. We'll arrange a date to meet on the day before the exercise starts so that you are ready to start practicing the exercise
During both phases I'll contact you every few days to see how you are doing. I was planning to do this by text, does this sound OK? you'll have my details so you can text, call or email me at any point

Let's talk about what happens to the data that is collected?

All information, which is collected during the research, will be kept strictly confidential. You will be allocated a unique study code number, ensuring that all information that you give will be stored against your code rather than your actual name i.e. anonymously. Only immediate members of the research team will be able to link the number to your name. Identifiable information will be stored in a locked cabinet and a password protected computer and only the researchers of this project will have access to it. The only exception would be if the screening process revealed a significant risk of harm to you or others. In this case, information may be fed back to your GP and, if applicable, your mental health professional but normally only after discussion with you.
In accordance with British Psychological Society research guidelines, all data for the study will be securely stored away for 5 years and will be destroyed after this time. Any identifiable information will never be used directly in any publications or reports from this study. Your results will be kept anonymous.
The study findings will be written up and reported (in a thesis) as part of a Doctorate in Clinical Psychology. In accordance with University of Exeter Open Research Exeter policy, the thesis will be stored electronically at the University of Exeter, and will be accessible online (open access). The study findings may also be written up for publication in research journals and presented at conferences. The published journal article will also be available online (open access, University of Exeter).

A 2 page summary of the results of the research will be made available to you as soon as it completed. Identifiable information about you will not be used in any publication
Just to reiterate, your participation is voluntary so you can withdraw from the study at any time without providing a reason

Have you got any questions at this point?

What could go wrong?
The daily recording over 6 weeks and the practice of a daily exercise requires effort and on rare occasions may lead to dropping out of the study. We do not use any exercises that are designed to make you have uncomfortable thoughts, however we recognise that reflecting on the amount you ruminate may potentially result in brief and transient low mood for some, but not all, people.
How could my participation help?
Taking part in this study could help reduce the amount of time that you ruminate by giving you an alternative strategy. It will also help us understand rumination better.

You'll get 10 credits for taking part. In order to collect your 1 credit please email me mb610@exeter.ac.uk
Alternatively, and/or if you have any further questions please contact either myself, or my supervisors (Prof ed Watkins and Dr Nick Moberly) using the contact details below: e.d.watkins@exeter.ac.uk or n.j.moberly@exeter.ac.uk

>Let's have a look at the consent form.
Take a minute to have a read and check the boxes as you go if you agree. Take your time.
Your unique participant number is _____

Your baseline phase start date is 31 10 16

Your intervention phase start date is _____

We'll meet to discuss your exercise on _____

Your end date for the study is 11 12 16
->Book pre intervention meeting
your start date has been randomised to
Barriers
Just before we finish it might be a good idea to think about Problem solving around potential blocks to continued participation – anything coming up that you might need to plan around? It might be good to have a particular time when you record

It only remains to thank you for today and for agreeing to take part. I hope you find taking part interesting and useful
I will see you on
Date:
Venue:
Time:

END

Appendix G: Debrief and Feedback Form

Debrief form (including notes on continued practice)

Thank you for taking part in this study.

Using a training exercise to reduce rumination

What were the aims of the study?

To investigate if levels of worry and rumination can be reduced by practicing a new alternative habit. If rumination is a habit then it forms through being repeated in different settings so that the context becomes an automatic trigger to the behaviour. This study investigated whether rumination can be reduced by learning and practicing a new helpful concrete-thinking habit. You were supported to identify your individual triggers for rumination and to practice a concrete thinking exercise in response to these triggers. The exercise involved focused on the specific sensory details of the moment, noticing the sequence of events leading to this point and generating an action plan to proceed. Concrete thinking is incompatible with the abstract thinking in rumination. The intervention was a repeated IF-THEN concrete thinking exercise.

Researchers: Max Buchanan, Prof Ed Watkins & Dr Nick Moberly

I am interested in how you found participating in the study (you are not required to share this information) but I am interested in your experience, what you found easy, difficult etc (see feedback form for possible discussion)

You can choose to withdraw your data at a later date. You can contact me with any questions at mb610@exeter.ac.uk

If you feel you have been adversely affected by taking part in this study, and would like to speak to an independent support service you are advised to seek help from:

Student Counselling Service

The Counselling Service is available free of charge to all students, full-time, part-time, undergraduate and postgraduate. Because student life can be stressful, the Counselling Service is there to provide confidential help and support. We aim to help students cope more effectively with any personal problems or emotional difficulties that may arise during their time at University.

Telephone (to book an appointment): (01392) 264381

Email: counselling@exeter.ac.uk

Website: http://services.exeter.ac.uk/counselling/about.html

Student Counselling Service (opening hours: 9.30 – 1.00pm, 2 – 5pm)
Reed Hall, Hailey Wing
Streatham Drive
Exeter EX4 4PD

VOICE (University of Exeter)
Voice is a student run listening and information service, run by students for fellow students at the University of Exeter and is available from 8pm to 8am every night during term time. It is completely confidential, anonymous and prejudice-free, which means you can call with the confidence of knowing you can discuss anything you want without being judged.
Telephone (8pm – 8am): 4000 (internal, free of charge)
External: (01392) 275284
Website: http://www.exetervoice.co.uk/

Exeter Samaritans
Samaritans provides confidential emotional support, 24 hours a day for people who are experiencing feelings of distress or despair. Samaritans are there if you're worried about something, feel upset or confused, or you just want to talk to someone.

10 Richmond Road
Exeter
Devon
EX4 4JA (open 10.30am – 9.30pm Mon–Sat, 1.30pm – 9.30pm Sun)

24 hour telephone helpline: 01392 411711 (Exeter branch) / 08457 909090 (national)
Email: jo@samaritans.org
Website: http://www.exetersamaritans.org/

Depression Alliance
Depression Alliance is a charity working to relieve and to prevent depression by providing information, support and understanding. Depression Alliance offers a range of publications and self-help groups.
Depression Alliance
20 Great Dover Street
London
SE1 4LX

Telephone: 0845 123 23 20 (for an information pack only)
Email: information@depressionalliance.org
Website: http://www.depressionalliance.org/

If you have any further questions please contact either myself, or my supervisor (Prof Ed Watkins) using the contact details below:
e.d.watkins@exeter.ac.uk

I will send you a 2-page summary of the results when they become available
My sincere thanks again for participating in this study.

Max Buchanan

Keeping concrete thinking going and the likelihood of the odd lapse.

I hope you have found participating in this research interesting but more importantly useful. You have practiced your concrete thinking on dozens of occasions now and probably across several contexts and in response to different situations. This means that you are on track for developing and maintaining a new helpful habit. One of the great things about habits (helpful ones at least) is that they can only get stronger (become more automatic) the more you practice in different situations.

It is worth noting the probability that, even if you feel your concrete thinking habit is well established, that lapses will occur from time to time. This is expected for a few reasons; your rumination is probably well established in the first place and its been practiced in many situations. New learning does not destroy old learning, the rumination is still there but you have created another option now with the concrete thinking. At some point a situation or context will arise that you have not yet practiced your concrete thinking in but where rumination has happened before so it's the rumination that will likely be triggered automatically. What to do?

Don't panic. This is expected and part of behaviour change and helpful habit formation. If you can spot this trigger and then take a second or two to decide what to do you'll be able to choose concrete thinking instead. Now it's the concrete thinking that becomes more likely to be triggered by this context next time. Periodically have a quick look at your IF-THEN plans to engage with your intention to do something different to rumination, this can re-ignite motivation. Maybe have a look to at the steps for concrete thinking every now and again or listen to the audio guide or use a worksheet periodically as a top up.
If you practice the concrete thinking as many times as you can and in as many different situations as possible then this will become the go-to thinking process for you rather than rumination

Best of luck

Max

Feedback Form

Study: Reducing Rumination with an IF-THEN Concrete Thinking Exercise

Question	**Rating (circle) / comments**
Was it easy to maintain a stable personal definition of rumination for your recording throughout the study?	Yes / No
Do you feel that your levels of rumination have reduced?	Yes / No
Do you consider that concrete thinking became more automatic over time (i.e. needed less awareness, became more efficient, needed less effort)	Yes / No
Will you continue to use concrete thinking now that the study has ended?	Yes / No
Did you find yourself (intentionally or otherwise) practicing the concrete thinking at the same time(s) of day or attaching the practice to an existing habit (e.g. practice after you brushed your teeth)?	Yes / No

The study took place over 42 days. This is plenty of time for life to happen. Were there any particular factors that helped or hindered your participation and engagement in the study? *(no need to share personal information, but it might be relevant if you were ill for example, or there was a point when the practice became easier etc)*	
If the study was to be repeated with another group of participants how might it be improved? *(This information might be really useful for future studies or practice so be as honest as you like!)*	
Other Comments?	

Appendix H: All Participants' Raw Data and Coding Inputted into R

Instructions (step by step) for using R software in this study
Includes all raw data entered into R Studio

This code enables replication / expansion of the study

Visit Cran-r project website to download R Studio (free open source software). Then download the following plug-ins SCRT (single case randomization tests), SCMA (single case meta analyses(for effect sizes PEM or PND if required)) & SCVA (single case visual analyses, for graphs). Alternatively one can download RcmdrPlugin.SCDA which contains SCRT,SCVA & SCMA in one package. On Cran you can download a manual but this is not necessary if these instructions are followed

Script inserted into the Console (RStudio) is prefaced with a > sign. A # is an instruction that is a note for the researcher but R will ignore

```
>library (SCRT)# this is how to load the single case randomisation test package. Recommend loading SCMA & SCVA at the same time by typing

>library(SCRT, SCMA, SCVA)
```

Note: you can put notes in R by using the # before typing them

When you open R console (I'll just call it R from now on) you will see 4 boxes. The one you are most interested in is the bottom left one, this is the console that you type script into. On the bottom left you can click on packages and a list will show, tick and download SCRT, SCMA (effect sizes one) and SCVA (graphics) or you can do this from CRAN. download the pdf for each (might be helpful but not strictly necessary)

Randomizing individual participants to a moment of phase change using R

```
# design for this study is AB phase with 42 measurement times (MT) (i.e. daily recording for 6 weeks) with a minimum of 11 MTs for baseline and intervention
> library () # shows packages available and downloaded to your R Studio
 >library (RcmdrPlugin.SCDA) # this loads SCRT, SCMA & SCDA, the three individual packages that make up SCDA
>quantity(design="AB",MT=42,limit=11) # this calculates the 21 possible moments of phase change
>assignments(design="AB",MT=42,limit=11) # lists all possible starting points (21)on screen
>selectdesign(design="AB",MT=42,limit=11) # this randomises an individual to a start point.
```

#Frequency of Rumination

First make an excel spreadsheet of all data. Input the data starting in box A1 with no headings. it must look like the following brief example where A = A phase and numbers are the scores for the relevant day. This is only partial as there are 294 data points for whole study (for 7 participants, 252 for 6 participants)

```
A3A2A4A6
A4A2A5A6
A2A3A4A5
A1A6A4A4
A2A6A3A4
B2B2B2B2
B3B2B2B2
B3B2B3B1

# Use no headings and return click return after the last piece of data entered to ensure all data is read
# click save as and save as a tab delimited text (.txt file and give it a name e.g ALLFreq. Excel will check if sure? click continue
then enter in R..
> ALLFreq<-read.delim(file.choose(), header = FALSE)
#documents page opens and choose the tab delimited file (ALLfreq.txt) containing the relevant data.

> ALLFreq # this is the name of the file, it could be anything relevant for author to recognise. You must type this in to get the data into R which looks like…

> ALLfreq<-read.delim(file.choose(), header = FALSE)
> ALLfreq
```

```
#     P1     P3     P4     P5      P6      P7

> ALLfreq
   V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12
1   A  4  A  8  A  3  A  4  A   5   A   2
2   A  5  A 15  A  6  A  3  A   3   A   3
3   A  6  A 20  A  7  A  5  A   4   A   1
4   A 10  A 12  A 10  A  5  A   2   A   3
5   A  7  A 11  A  4  A  2  A   4   A   3
6   A  3  A  9  A  3  A  3  A   2   A   0
7   A  7  A  6  A  4  A  3  A   5   A   2
8   A  7  A  7  A  4  A  5  A   6   A   3
9   A  8  A  9  A 15  A  2  A   3   A   2
10  A  7  A 12  A  3  A  3  A   6   A   3
11  A  7  A 15  A  4  A  5  A   1   A   4
12  A  4  A  8  A  4  A  7  A   6   A   5
13  A  4  A  9  A  3  A  6  A   2   A   3
14  A  4  A  7  A  3  A  6  A   5   A   2
15  A  5  A  5  A  3  A  3  A   6   A   4
16  A  6  A 13  A  6  A  3  A   3   B   2
17  A  7  A 15  A  3  A  2  A   5   B   4
18  A  5  A  6  A  4  A  5  A   5   B   1
19  B  5  A  8  A  2  A  3  A   3   B   2
20  B  4  A  8  A  3  A  2  A   4   B   0
21  B  4  A  8  A  8  A  4  A   6   B   2
22  B  5  A 12  A 10  B  3  A   5   B   2
23  B  3  A  8  B 10  B  3  A   5   B   5
24  B  4  A 15  B  7  B  5  B   2   B   4
25  B  5  A  8  B 20  B  7  B   2   B   2
26  B  4  A  5  B  8  B  4  B   0   B   3
27  B  5  A  8  B  5  B  5  B   0   B   0
28  B  5  A 10  B  4  B  5  B   3   B   2
29  B  4  A  6  B  3  B  5  B   0   B   1
30  B  4  A  7  B  4  B  5  B   2   B   1
31  B  4  A  7  B  2  B  5  B   1   B   4
32  B  4  B  7  B  0  B  7  B   2   B   0
33  B  4  B  7  B  1  B  6  B   4   B   3
34  B  4  B 11  B  3  B  5  B   2   B   0
35  B  4  B  5  B  2  B  6  B   2   B   1
36  B  4  B  3  B  1  B  3  B   0   B   7
37  B  4  B  4  B  1  B  4  B   1   B   2
38  B  4  B  6  B  4  B  6  B   3   B   4
39  B  4  B  2  B  2  B  4  B   3   B   1
40  B  4  B  2  B 15  B  2  B   0   B   0
41  B  5  B  2  B  8  B  6  B   2   B   3
42  B  4  B  3  B  3  B  3  B   1   B   2

> pvalue.random(design="MBD", statistic = "A-B", number
=1000)
```

```
[1] 0.655

# this is the randomization test. The random element is
the 1000 in the code referring to a monte-carlo
randomization where a random 1000 randomizations are
chosen on which to base the calculation. 1000
randomizations still gives plenty of power to detect
p.value but won't crash the computer. If one were using
all possible randomisations then pvalue.systematic rather
than random would be typed (see later individual
randomization tests

# the statistic is the sum of the means in B phase minus
that in A phase


# there will be 2 pop up menus before the result is
delivered. Choose the tab delimited file with your data in
(ALLFreq.txt) first then choose the file where you have
inputted all possible start points. Again this first needs
to be entered into excel then saved as a tab dlimited
file. In the txt file make sure to click return after last
data entry at bottom right. For this study it looks like..

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

# the p value then appears

[1] 0.754 # if we do it again I'll get a slightly
different p value and this is as it should be due to the
randomizations being different each time

[1] 0.775

> ES(design="MBD", ES ="PEM-",data = ALLFreq)

#PEM- is the Effect Size, Percentage of data exceeding the
median of the baseline (Ma, 2006). The minus sign
indicates an expected decrease

[1] 68.72294
> ES(design="MBD", ES ="PND-",data = ALLFreq)
#PND is another effect Size measure, percentage of non
overlapping data, i.e. the percentage of intervention
points that are lower than the lowest point in the
```

```
baseline
[1] 6.616541
```

nonoverlap all pairs (NAP) effect size is not possible in R but data is simply calculated on singlecaseresearch.org NAP-Calculator

#Automaticity of rumination

```
#Follow same staeps as the Frequency calculations. All raw data as below

ALLauto<-read.delim(file.choose(), header = FALSE)
> ALLauto

#        P1    P3       P4       P5       P6     P7


   V1   V2 V3   V4 V5   V6 V7   V8 V9  V10 V11  V12
1   A 4.25  A 5.00  A 4.75  A 4.50  A 4.00   A 4.25
2   A 5.00  A 5.00  A 5.00  A 4.25  A 4.50   A 4.00
3   A 5.00  A 5.00  A 5.00  A 4.25  A 4.25   A 4.00
4   A 5.00  A 5.00  A 5.00  A 4.50  A 4.00   A 4.00
5   A 5.00  A 5.00  A 4.75  A 4.00  A 3.75   A 4.25
6   A 5.00  A 5.00  A 4.00  A 4.25  A 3.25   A 4.00
7   A 5.00  A 5.00  A 4.50  A 4.50  A 3.50   A 4.00
8   A 5.00  A 5.00  A 4.00  A 4.50  A 4.50   A 4.00
9   A 5.00  A 5.00  A 5.00  A 4.25  A 3.50   A 4.00
10  A 5.00  A 5.00  A 4.00  A 4.25  A 3.75   A 4.00
11  A 5.00  A 4.75  A 4.00  A 4.25  A 4.00   A 4.25
12  A 5.00  A 4.50  A 4.00  A 4.25  A 4.50   A 5.00
13  A 4.50  A 4.00  A 4.00  A 4.25  A 4.25   A 4.00
14  A 4.75  A 4.00  A 4.00  A 4.25  A 4.25   A 4.00
15  A 5.00  A 4.00  A 4.00  A 4.25  A 4.50   A 4.00
16  A 5.00  A 5.00  A 4.50  A 4.50  A 3.50   B 4.00
17  A 5.00  A 5.00  A 4.00  A 4.25  A 3.50   B 4.00
18  A 5.00  A 4.75  A 4.00  A 4.50  A 4.00   B 4.00
19  B 5.00  A 4.75  A 4.00  A 4.25  A 2.75   B 4.00
20  B 5.00  A 4.75  A 4.00  A 4.25  A 3.50   B 4.00
21  B 4.75  A 4.75  A 5.00  A 4.50  A 3.75   B 4.00
22  B 5.00  A 4.50  A 5.00  B 4.25  A 3.75   B 4.00
23  B 5.00  A 4.50  B 4.50  B 4.25  A 3.25   B 4.00
24  B 4.75  A 5.00  B 4.75  B 4.75  B 2.50   B 4.00
25  B 4.50  A 4.50  B 5.00  B 4.50  B 3.00   B 4.00
26  B 4.25  A 4.00  B 4.75  B 4.25  B 3.67   B 4.00
27  B 4.00  A 4.00  B 4.00  B 4.25  B 2.50   B 4.00
28  B 4.00  A 4.00  B 4.50  B 4.50  B 2.50   B 4.00
29  B 4.00  A 4.75  B 4.00  B 3.75  B 2.75   B 4.00
30  B 4.00  A 4.00  B 4.00  B 4.25  B 2.50   B 4.00
31  B 4.00  A 4.00  B 4.00  B 3.75  B 2.25   B 4.00
32  B 4.00  B 4.00  B 4.00  B 3.75  B 2.00   B 4.00
```

```
33  B 4.00  B 4.00  B 4.00  B 3.75  B 2.50   B 4.00
34  B 4.00  B 4.00  B 4.00  B 4.25  B 3.00   B 3.00
35  B 4.00  B 4.00  B 4.00  B 4.00  B 2.75   B 4.00
36  B 4.00  B 3.00  B 4.00  B 3.75  B 2.25   B 3.75
37  B 4.00  B 2.50  B 4.00  B 3.75  B 2.25   B 4.00
38  B 4.00  B 4.00  B 4.00  B 3.50  B 2.25   B 3.00
39  B 4.00  B 2.00  B 4.00  B 3.75  B 2.75   B 4.00
40  B 4.00  B 2.25  B 4.00  B 3.50  B 2.50   B 3.00
41  B 4.00  B 2.00  B 5.00  B 3.75  B 3.50   B 3.25
42  B 4.00  B 2.00  B 4.00  B 3.75  B 2.25   B 3.25
> pvalue.random(design="MBD", statistic = "A-B", number
=1000)
[1] 0.918
> ES(design="MBD", ES ="PEM-",data = ALLauto)
[1] 60.44974
```

Mean, Median, sd for ALL participants Frequency of Rumination for phase A

```
>ALLFreqA<c(5,3,4,2,4,2,5,6,3,6,1,6,2,5,6,3,5,5,3,4,6,5,5,
4,5,6,10,7,3,7,7,8,7,7,4,4,4,5,6,7,5,0,0,0,0,0,2,0,0,0,0,0
,0,0,0,0,0,1,0,3,0,0,0,0,0,2,0,0,0,0,7,3,5,7,7,7,9,7,7,7,3
,9,5,7,5,1,3,7,7,7,7,3,5,1,5,7,7,3,7,3,6,7,10,4,3,4,4,15,3
,4,4,3,3,3,6,3,4,4,4,2,3,8,10,4,3,5,5,2,3,3,5,2,3,5,7,6,6,
3,3,2,5,3,2,4,2,3,1,3,0,2,2,3,2,3,4,5,3,2,4)
> length(ALLFreqA)
[1] 159
> mean(ALLFreqA)
[1] 3.867925
> median(ALLFreqA)
[1] 4
> sd(ALLFreqA)
[1] 2.676937
```

Mean, Median, sd for ALL participants Frequency of Rumination for phase B

```
>ALLFreqB<c(5,6,0,1,5,4,3,6,2,6,4,3,0,3,2,7,0,8,2,5,4,4,5,
3,4,5,4,5,5,4,4,4,4,4,4,4,4,4,4,4,4,4,5,4,0,2,1,0,1,2,2,0,2,
0,0,0,0,7,7,5,7,4,7,7,5,3,5,5,7,5,10,7,20,8,5,4,3,4,2,0,1,
3,2,1,1,4,2,15,8,3,3,3,4,5,5,5,5,5,7,6,5,6,3,4,6,4,2,6,3,2
,4,1,2,0,2,2,5,4,2,3,0,2,1,1,4,0,3,0,1,7,2,4,1,0,3,2)

> length(ALLFreqB)
[1] 135
> mean(ALLFreqB)
[1] 3.703704
> median(ALLFreqB)
[1] 4
> sd(ALLFreqB)
[1] 2.778043
```

Mean, Median, sd for ALL participants
Automaticity of Rumination for Phase A

```
>ALLAutA<c(4.25,5,5,5,5,5,5,5,5,5,5,4.5,4.75,5,5,5,5,2,3
,2,3,3,1.75,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,
3,3,5,5,5,5,5,5,5,5,5,5,4.75,4.5,4,4,4,5,5,4.75,4.75,4.75,
4.75,4.5,4.5,5,4.5,4,4,4,4.75,4,4,4.75,5,5,4,4.5,4,5,4,4,4
,4,4,4,4.5,4,4,4,4,5,5,4.5,4.25,4.25,4.5,4,4.25,4.5,4.5,4.
25,4.25,4.25,4.25,4.25,4.25,4.25,4.5,4.25,4.5,4.25,4.25,4.
5,4,4.5,4.25,4,3.75,3.25,3.5,4.5,3.5,3.75,4,4.5,4.25,4.25,
4.5,3.5,3.5,4,2.75,3.5,3.75,3.75,3.25,4.25,4,4,4,4,4,4,4,4
,4,4.75,5,4,4,4)

> length(ALLAutA)
[1] 159
> mean(ALLAutA)
[1] 4.086478
> median(ALLAutA)
[1] 4
> sd(ALLAutA)
[1] 0.7494657
```

Mean, Median, sd for ALL participants
Automaticity of Rumination for Phase

```
>ALLAutB<c(5,5,4.75,5,5,4.75,4.5,4.25,4,4,4,4,4,4,4,4,4,4,
4,4,4,4,3,3,3,3,3,3,3,3,3,3,3,3,3,4,4,4,4,3,2.5,4,2,2.25,2
,2,4.5,4.75,5,4.75,4,4.5,4,4,4,4,4,4,4,4,4,4,4,4,5,4,4,4.25,
4.25,4.75,4.5,4.25,4.25,4.5,3.75,4.25,3.75,3.75,3.75,4.25,
4,3.75,3.75,3.5,3.75,3.5,3.75,3.75,2.5,3,3,3,3.67,2.5,2.5,
2.75,2.5,2.25,2,2.5,3,2.75,2.25,2.25,2.25,2.75,2.5,3.5,2.2
5,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,4,3,4,3.75,4,3.5,4,3,3
.25,3.25)

> length(ALLAutB)
[1] 135
> mean(ALLAutB)
[1] 3.666074
> median(ALLAutB)
[1] 4
> sd(ALLAutB)
```

#Individual data analysis in R

***P* value and effect size calculation for individual data. Example = Frequency of rumination variable for Participant 1**

```
> P7Freq<-read.delim(file.choose(), header = FALSE)
#choose tab delimited txt file where the individual data
has been saved. This is data for participant 1 frequency
data

> P7Freq # must type this to get the data into R

V1 V2
1   A  2
2   A  3
3   A  1
4   A  3
5   A  3
6   A  0
7   A  2
8   A  3
9   A  2
10  A  3
11  A  4
12  A  5
13  A  3
14  A  2
15  A  4
16  B  2
17  B  4
18  B  1
19  B  2
20  B  0
21  B  2
22  B  2
23  B  5
24  B  4
25  B  2
26  B  3
27  B  0
28  B  2
29  B  1
30  B  1
31  B  4
32  B  0
33  B  3
34  B  0
35  B  1
36  B  7
```

```
37  B  2
38  B  4
39  B  1
40  B  0
41  B  3
42  B  2
> pvalue.systematic(design = "AB", statistic = "A-B",
limit = 11, data=P7Freq) # no pop up appears as you have
added the data=P1Freq to thread, if this were left out
then a pop up would appear where the correct txt file
needs choosing.

[1] 0.2380952

> ES(design="AB", ES ="PEM-",data = P7Freq)

[1] 66.66667
```

#Calculating mean, median, sd for each phase for each participant example participant 1 A phase data

```
>P1Aphase<c(8,15,20,12,11,9,6,7,9,12,15,8,9,7,5,13,15,6,8,
8,8,12,8,15,8,5,8,10,6,7,7)
> length(P1Aphase)
[1] 31
> mean(P1Aphase)
[1] 9.580645
> median(P1Aphase)
[1] 8
> sd(P1Aphase)
[1] 3.584915
```

B phase data

```
P1B<-c(7,7,11,5,3,4,6,2,2,2,3)
> length(P1B)
[1] 11
> mean(P1B)
[1] 4.727273
> median(P1B)
[1] 4
> sd(P1B)
[1] 2.831639
```

#sad-happy data for all 6 participants

```
> ALLsadhappy<-read.delim(file.choose(), header = FALSE)
> ALLsadhappy
#    P1    P3    P4    P5     P6     P7

   V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12
1   A  7  A  7  A  7  A  7  A   7   A   7
2   A  7  A  3  A  8  A  7  A   7   A   7
3   A  7  A  5  A  5  A  6  A   7   A   6
4   A  1  A  7  A  4  A  6  A   7   A   5
5   A  3  A  7  A  8  A  8  A   6   A   5
6   A  5  A  7  A  5  A  8  A   8   A   8
7   A  5  A  9  A  7  A  7  A   7   A   6
8   A  5  A  7  A  7  A  6  A   9   A   6
9   A  5  A  7  A  3  A  8  A   8   A   5
10  A  5  A  7  A  6  A  8  A   7   A   6
11  A  5  A  3  A  6  A  5  A   8   A   4
12  A  5  A  9  A  5  A  6  A   5   A   4
13  A  7  A  5  A  7  A  5  A   7   A   7
14  A  7  A  7  A  6  A  3  A   8   A   5
15  A  5  A  5  A  7  A  8  A   9   A   6
16  A  7  A  1  A  6  A  7  A   7   B   5
17  A  5  A  3  A  7  A  7  A   5   B   4
18  A  5  A  7  A  7  A  7  A   7   B   7
19  B  5  A  7  A  7  A  8  A   9   B   6
20  B  7  A  7  A  7  A  9  A   7   B   7
21  B  7  A  7  A  5  A  7  A   7   B   5
22  B  5  A  3  A  4  A  7  A   7   B   5
23  B  7  A  5  B  2  A  7  A   6   B   3
24  B  7  A  1  B  3  B  6  B   8   B   6
25  B  5  A  5  B  1  B  5  B   7   B   5
26  B  7  A  7  B  3  B  8  B   7   B   5
27  B  5  A  7  B  4  B  8  B   7   B   7
28  B  5  A  3  B  4  B  8  B   6   B   6
29  B  7  A  7  B  5  B  7  B   4   B   5
30  B  7  A  7  B  6  B  5  B   5   B   5
31  B  7  A  7  B  7  B  7  B   5   B   3
32  B  5  B  5  B  8  B  6  B   7   B   7
33  B  7  B  7  B  7  B  6  B   7   B   3
34  B  7  B  4  B  6  B  5  B   7   B   7
35  B  5  B  7  B  5  B  6  B   7   B   5
36  B  7  B  7  B  7  B  6  B   9   B   1
37  B  7  B  5  B  6  B  5  B   5   B   5
38  B  5  B  3  B  6  B  5  B   7   B   4
39  B  5  B  5  B  8  B  6  B   6   B   7
40  B  5  B  5  B  4  B  8  B   7   B   5
41  B  7  B  7  B  7  B  5  B   7   B   7
```

```
42  B  7  B  5  B  8  B  5  B   9   B   5
> pvalue.random(design="MBD", statistic = "B-A", number
=1000)
[1] 0.702
> ES(design="MBD", ES ="PEM+",data = ALLFreqFinal)
[1] 23.7506
```

Anxious-calm data ALL participants

```
> ALLanxcalm<-read.delim(file.choose(), header = FALSE)
> ALLanxcalm

#    P1    P3    P4    P5     P6     P7

   V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12
1   A  7  A  3  A  7  A  4  A   4   A   6
2   A  7  A  1  A  4  A  7  A   7   A   7
3   A  7  A  1  A  3  A  3  A   3   A   4
4   A  1  A  3  A  4  A  5  A   7   A   5
5   A  3  A  3  A  3  A  7  A   6   A   6
6   A  5  A  3  A  4  A  8  A   9   A   8
7   A  5  A  3  A  3  A  6  A   7   A   6
8   A  5  A  3  A  5  A  3  A   7   A   4
9   A  5  A  3  A  3  A  7  A   7   A   5
10  A  5  A  1  A  4  A  7  A   7   A   3
11  A  5  A  1  A  3  A  4  A   9   A   5
12  A  5  A  3  A  4  A  3  A   3   A   4
13  A  7  A  4  A  7  A  3  A   5   A   7
14  A  7  A  2  A  7  A  3  A   7   A   7
15  A  5  A  3  A  5  A  7  A   5   A   6
16  A  7  A  1  A  4  A  5  A   7   B   6
17  A  5  A  1  A  7  A  6  A   3   B   3
18  A  5  A  7  A  6  A  4  A   3   B   7
19  B  5  A  7  A  5  A  7  A   7   B   7
20  B  7  A  3  A  5  A  8  A   9   B   7
21  B  7  A  5  A  3  A  7  A   7   B   5
22  B  5  A  3  A  4  A  6  A   7   B   3
23  B  7  A  3  B  3  A  6  A   7   B   5
24  B  7  A  1  B  3  B  4  B   4   B   7
25  B  5  A  3  B  1  B  3  B   3   B   5
26  B  7  A  7  B  3  B  4  B   7   B   3
27  B  5  A  7  B  6  B  7  B   3   B   7
28  B  5  A  3  B  4  B  7  B   5   B   4
29  B  7  A  5  B  4  B  6  B   3   B   6
30  B  7  A  7  B  4  B  6  B   5   B   3
31  B  7  A  7  B  7  B  5  B   3   B   3
32  B  5  B  5  B  7  B  3  B   8   B   7
```

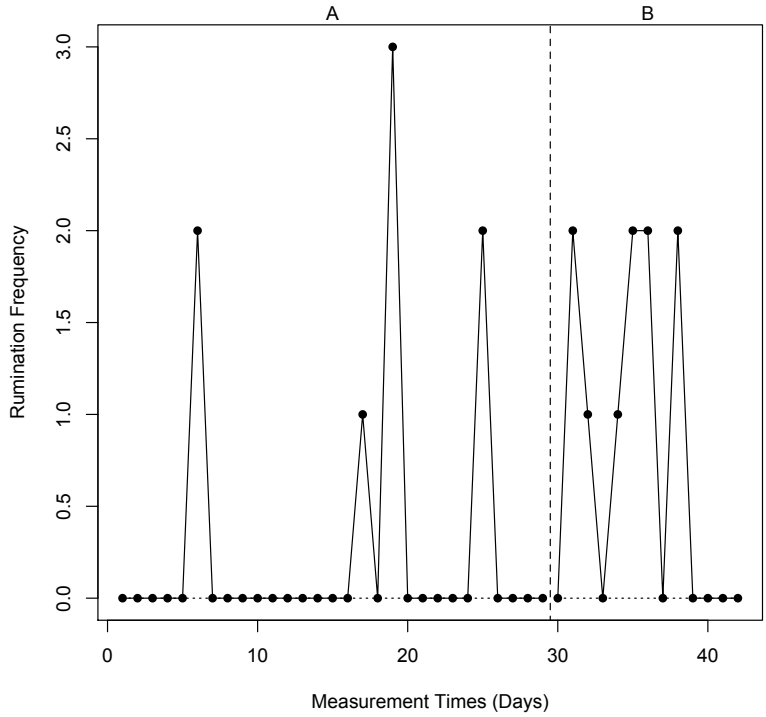
```
33  B  7  B  7  B  7  B  4  B   7   B   4
34  B  7  B  4  B  6  B  3  B   4   B   7
35  B  5  B  7  B  3  B  3  B   6   B   5
36  B  7  B  7  B  7  B  4  B   8   B   1
37  B  7  B  5  B  6  B  4  B   6   B   5
38  B  5  B  3  B  4  B  3  B   8   B   4
39  B  5  B  5  B  7  B  3  B   7   B   7
40  B  5  B  5  B  2  B  7  B   7   B   5
41  B  7  B  7  B  4  B  3  B   2   B   7
42  B  7  B  5  B  7  B  6  B   9   B   5
> pvalue.random(design="MBD", statistic = "B-A", number
=1000)
[1] 0.978
> ES(design="MBD", ES ="PEM+",data = ALLanxcalm)
[1] 44.06964
```

Appendix I: Participant 2 Individual Data (and as if Part of Group)

Results for participant 2 who also completed the experiment but due to <2 frequency of daily rumination at baseline. Participant 2's data was not used in the main body of the study or to calculate significance at the group level.

Group level stats including participant 2's data are also presented.

Participant 2: Frequency of rumination (note that graph is not 1-5 on y axis as R used to graph where one cannot prespecify scale of axes)



Participant 2.

Raw Data	P2 Frequency
A	0
A	0
A	0
A	0
A	0
A	2
A	0
A	0
A	0
A	0
A	0
A	0
A	0
A	0
A	0
A	0
A	1
A	0
A	3
A	0
A	0
A	0
A	0
A	0
A	2
A	0
A	0
A	0
A	0
B	0
B	2
B	1
B	0
B	1
B	2
B	2
B	0
B	2
B	0
B	0
B	0
B	0

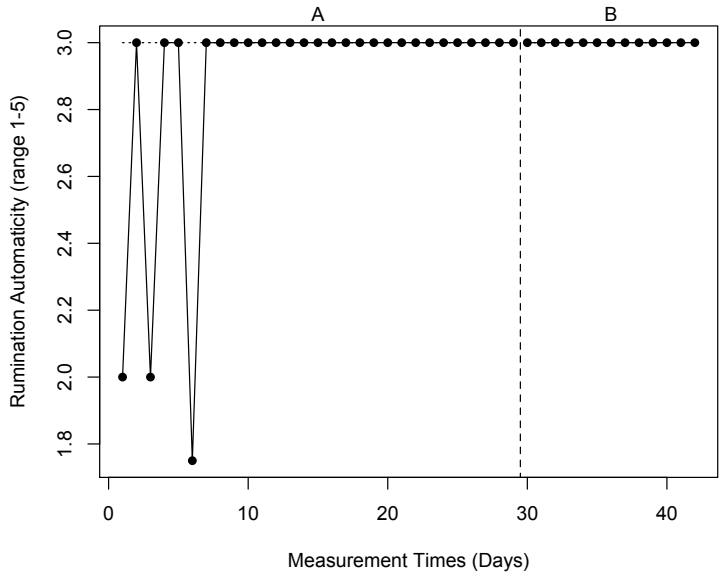
Appendix 19 continued

Frequency of Rumination: Randomization Tests and Effect Size.

Participant	Phase A length (days)	Phase B length (days)	Phase A Mean {median} (SD)	Phase B Mean {median} (SD)	*p* value Frequency of rumination	PND-	NAP*	PEM*	Statistically significant change?
1	18	24	5.89 {6} (1.78)	4.21 {4} (0.51)	0.1904762	0	0.7905	100	No
2	**29**	**13**	**0.28 {0} (0.75)**	**0.77 {0} (0.93)**	**0.9523**	**0**	**0.500**	**0**	**No**
3	31	11	9.58 {8} (3.58)	4.73 {4} (2.83)	0.0476	50	0.8827	90.91	Yes
4	22	20	5.09 {4} (3.18)	5.15 {3.5} (5.06)	0.7142857	20	0.5784	50	No
5	21	21	3.78 {3} (1.44)	4.89 {5} (1.33)	.8095	0	0.3345	4.76	No
6	23	19	4.17 {5} (1.53)	1.52 {2} (1.21)	.0476	26.31	0.8982	100	Yes
7	15	27	2.6 {3} (1.24)	2.15 {2} (1.73)	0.2380952	0	0.6285	66.67	No
Group	**159**	**135**	**3.86 {4} (2.67)**	**3.70 {4} (2.77)**	**0.531**	**6.62**	**0.606**	**55.01**	**No**

**NAP = Non-overlap All Pairs effect size measure. Scores range from .500 to 1.00 for non-deteriorating data. Scores < .500 represent an effect in the unwanted direction.*

Participant 2: Automaticity of rumination



Participant 2 Pre and post scores

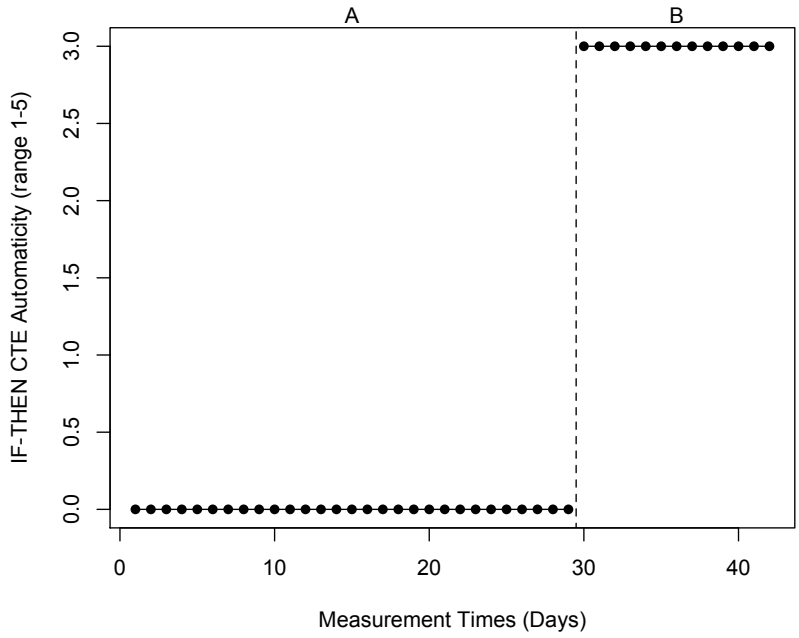
Pre and Post Study Scores for Participants.

	RRS		PHQ-9		SRHI	
Participant	**Baseline**	**Post intervention**	**Baseline**	**Post intervention**	**Baseline**	**Post intervention**
7	48	34	4	4	48	38
1	57	30	4	6	59	30
5	71	41	4	2	53	44
4	57	40	8	5	55	44
6	47	38	8	5	46	34
3	72	41	10	10	60	30
2	70	51	4	4	50	36
Group Mean (SD)	**60.29 (10.71)**	**39.29 (6.58)**	**6 (2.58)**	**5.5 (2.51)**	**53 (5.35)**	**36.57 (5.85)**

Automaticity of Rumination: Randomization Tests and Effect Size.

Participant	Phase A length (days)	Phase B length (days)	Phase A Mean {median} (SD)	Phase B Mean {median} (SD)	*p* value Automaticity of rumination	PND-	NAP	PEM-	Statistically significant change?
1	18	24	4.92 {5} (0.21)	4.26 {4} (0.41)	0.6666667	66.67	0.8866	83.33	No
2	**29**	**13**	**2.89 {3} (0.34)**	**3 {3} (0)**	**0.95763**	**0**	**0.4655**	**0**	**No**
3	31	11	4.63 {4.75} (0.41)	3.07 {3} (0.94)	0.04761905	54.55	0.9413	100	Yes
4	22	20	4.39 {4} (0.45)	4.23 {4} (0.37)	0.6666667	0	0.5955	0	No
5	21	21	4.32 {4.25} (0.14)	4 {3.75} (0.35)	0.5238095	52.38	0.7698	57.14	No
6	23	19	3.85 {3.75} (0.47)	2.61 {2.5} (0.43)	0.04761905	63.16	0.9611	100	Yes
7	15	27	4.13 {4} (0.31)	3.84 {4} (0.32)	0.7619048	22.22	0.689	22.22	No
Group	**159**	**135**	**4.09 {4} (0.75)**	**3.66 {4} (0.73)**	**0.918**	**36.99**	**0.677**	**51.81**	**No**

Participant 2: Automaticity of IF-THEN CTE



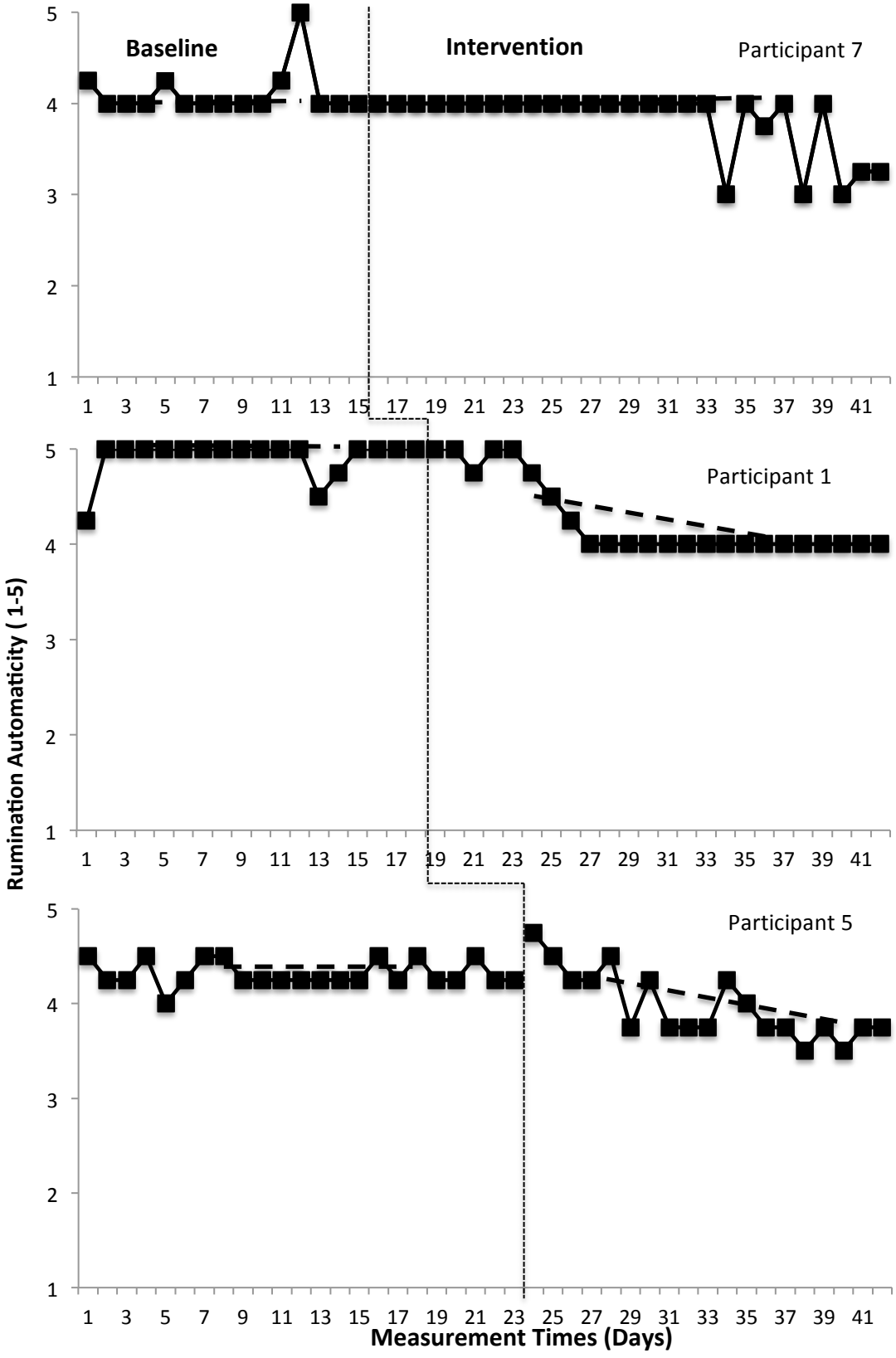
Pre and post measures

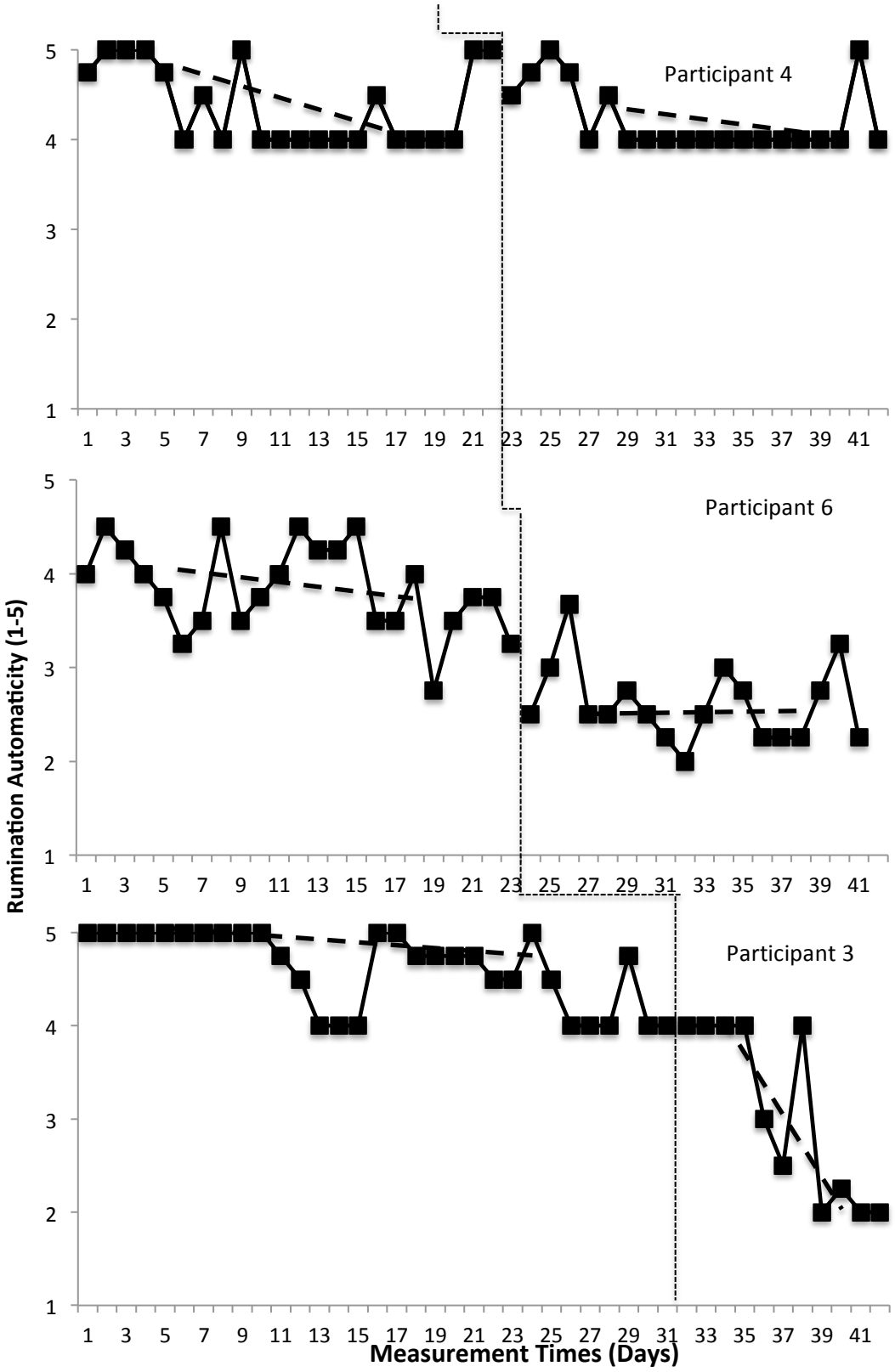
Pre and Post Study Scores for Participants.

	RRS		PHQ-9		SRHI	
Participant	**Baseline**	**Post intervention**	**Baseline**	**Post intervention**	**Baseline**	**Post intervention**
1	57	30	4	6	59	30
2	**70**	**51**	**4**	**4**	**50**	**36**
3	72	41	10	10	60	30
4	57	40	8	5	55	44
5	71	41	4	2	53	44
6	47	38	8	5	46	34
7	48	34	4	4	48	38
Group Mean (SD)	**60.29 (10.71)**	**39.29 (6.58)**	**6 (2.58)**	**5.5 (2.51)**	**53 (5.35)**	**36.57 (5.85)**

Appendix J: Rumination Automaticity Split-Middle Graphs with Trend Line

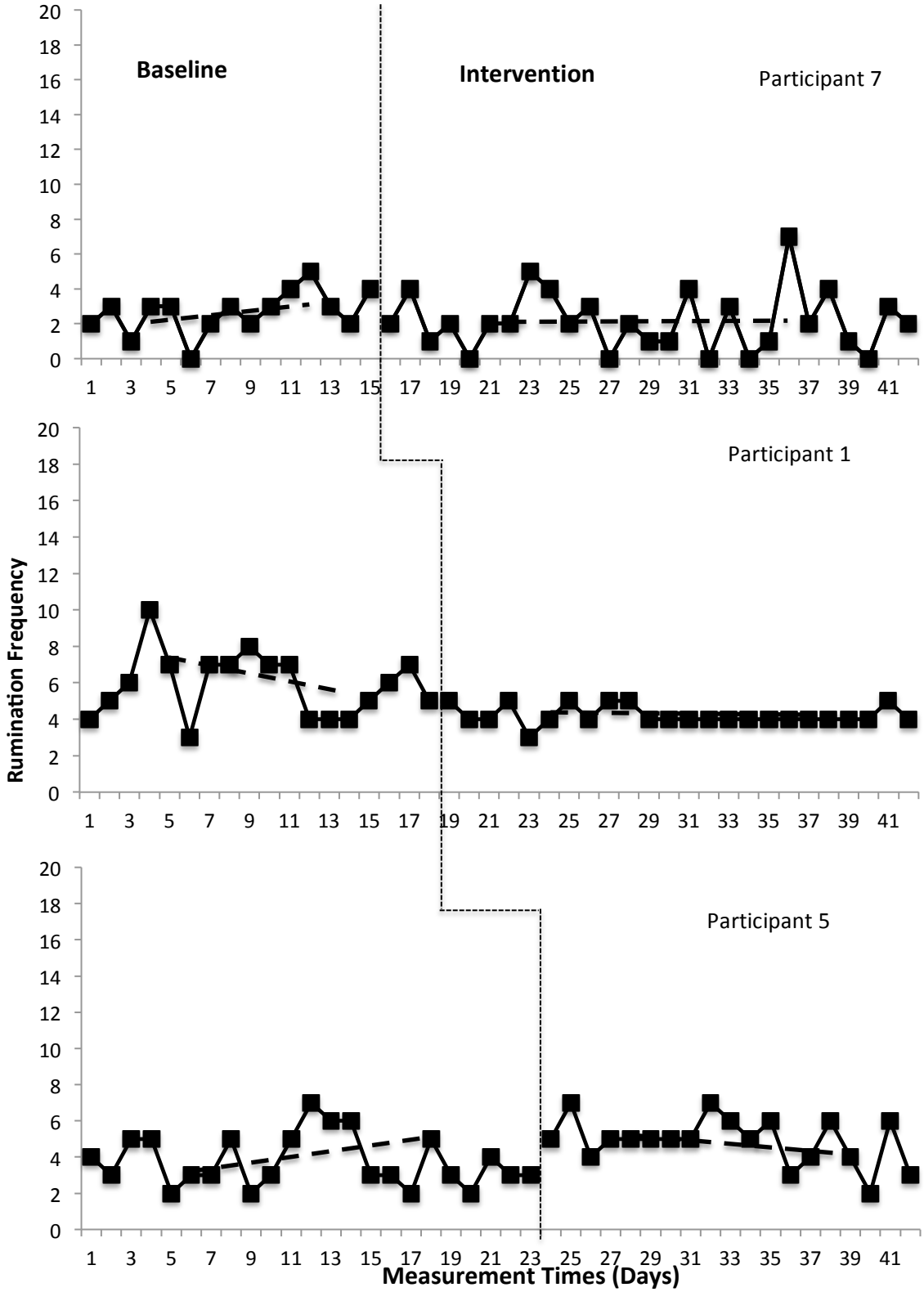
The split-middle method, where each phase is split into two parts and the median score for each segment of the phase are joined by a line, is used to present the trend line of the rumination frequency and automaticity. (See Morley, in press)

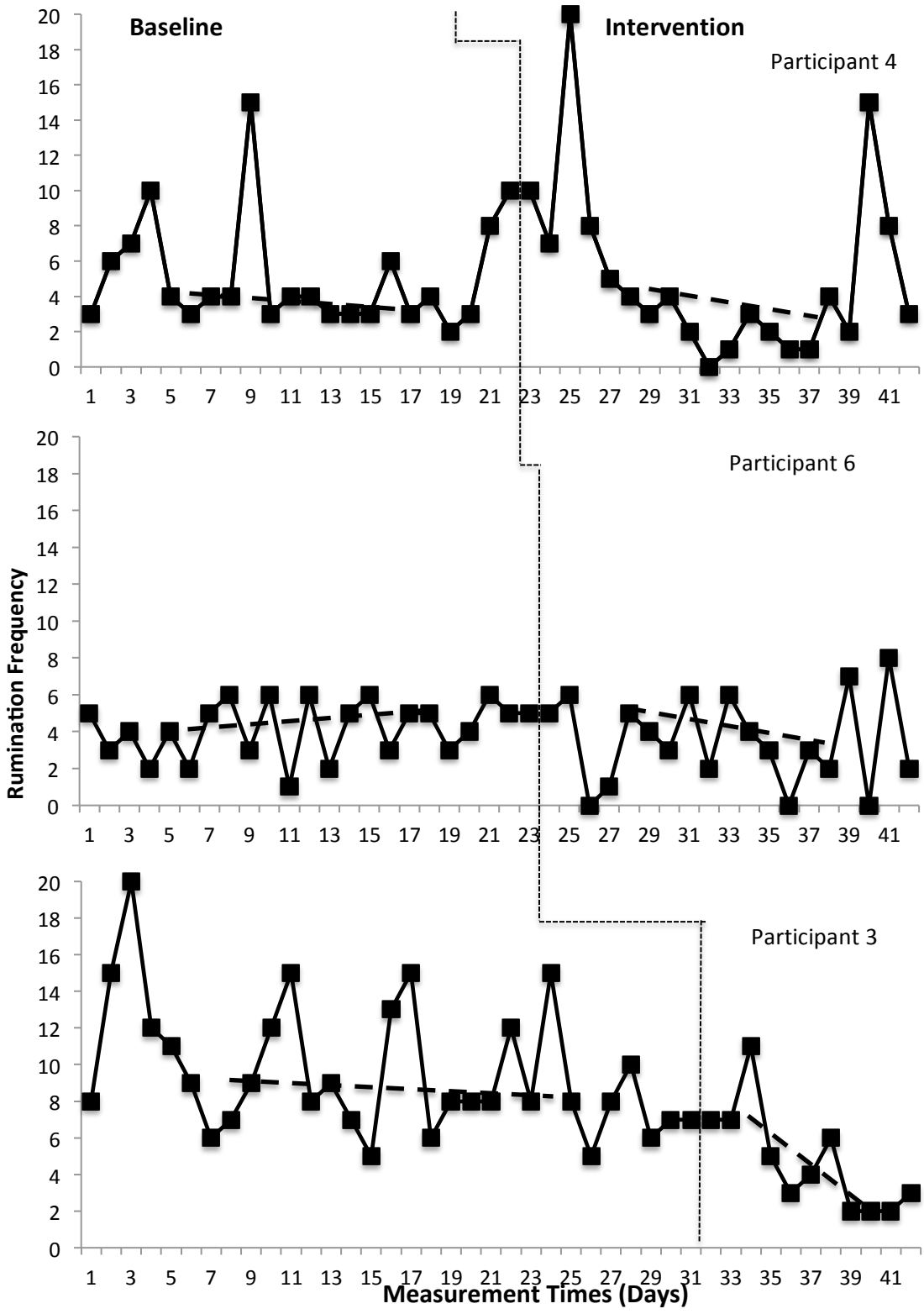

Baseline
Intervention
Participant 7
Participant 1
Participant 5
Rumination Automaticity (1-5)
Measurement Times (Days)
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
1 2 3 4 5



Rumination Automaticity across A & B phases (Split-Middle as Trend line)

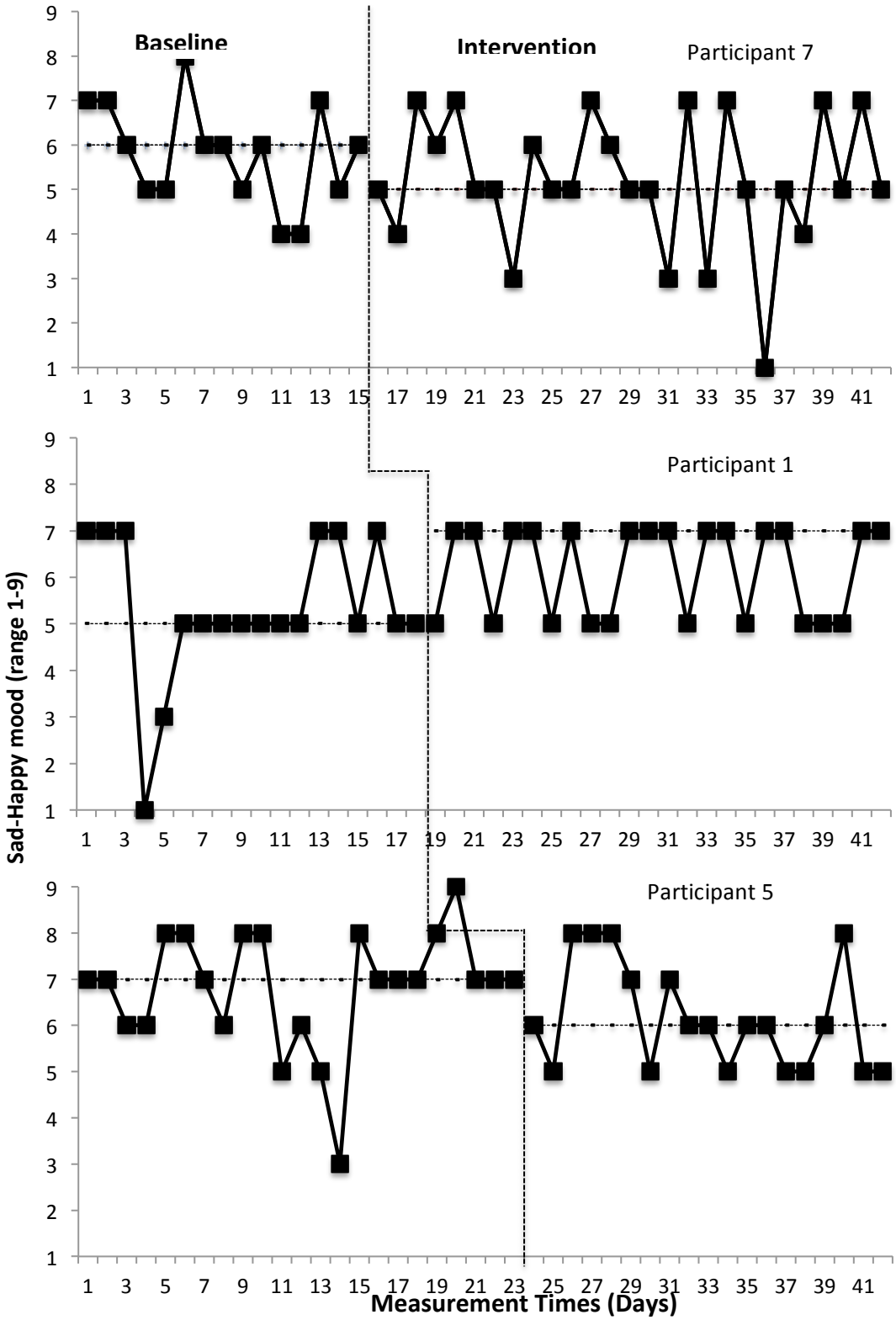
Appendix K: Rumination Frequency Graphs with Trend Line

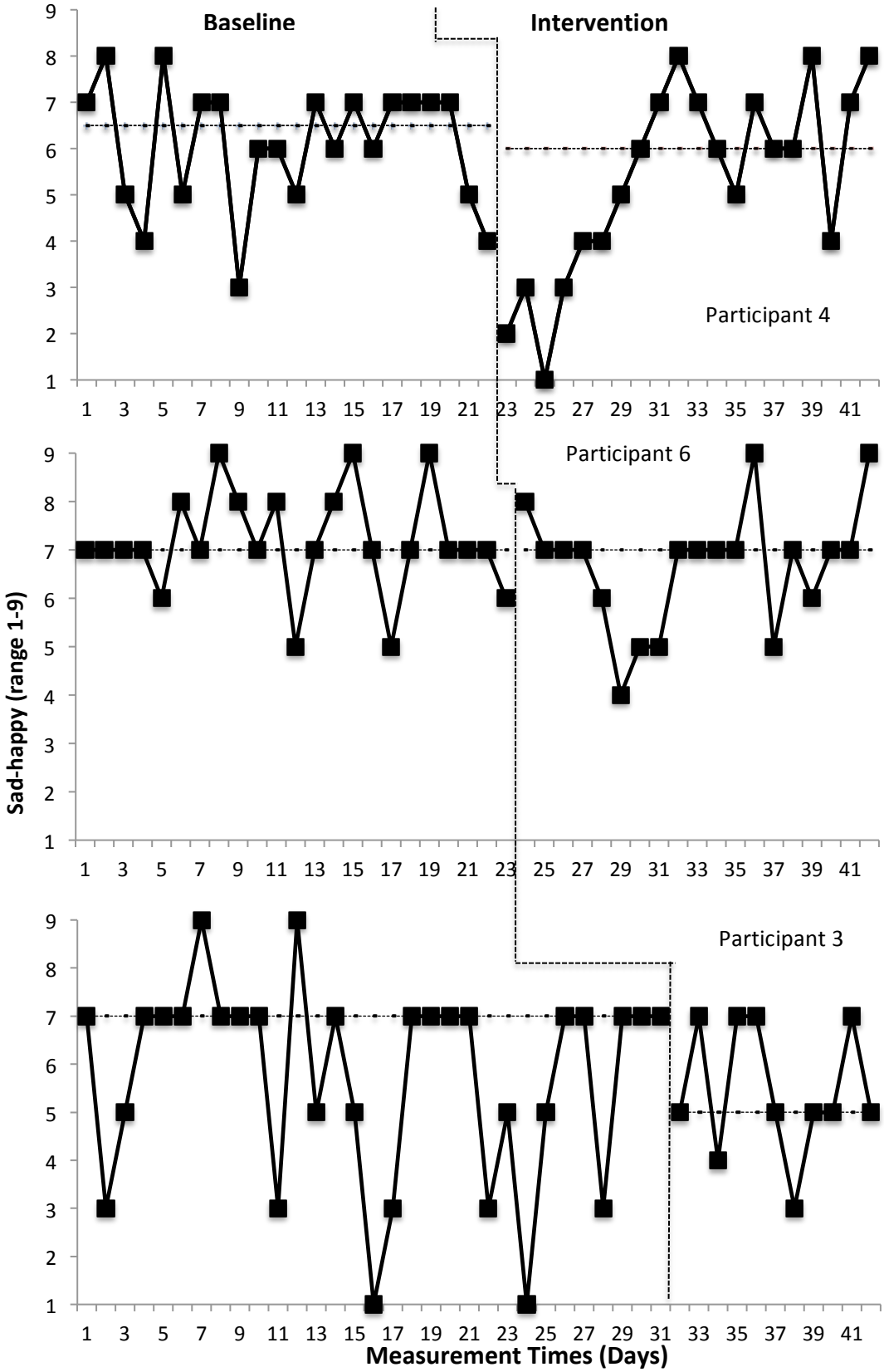




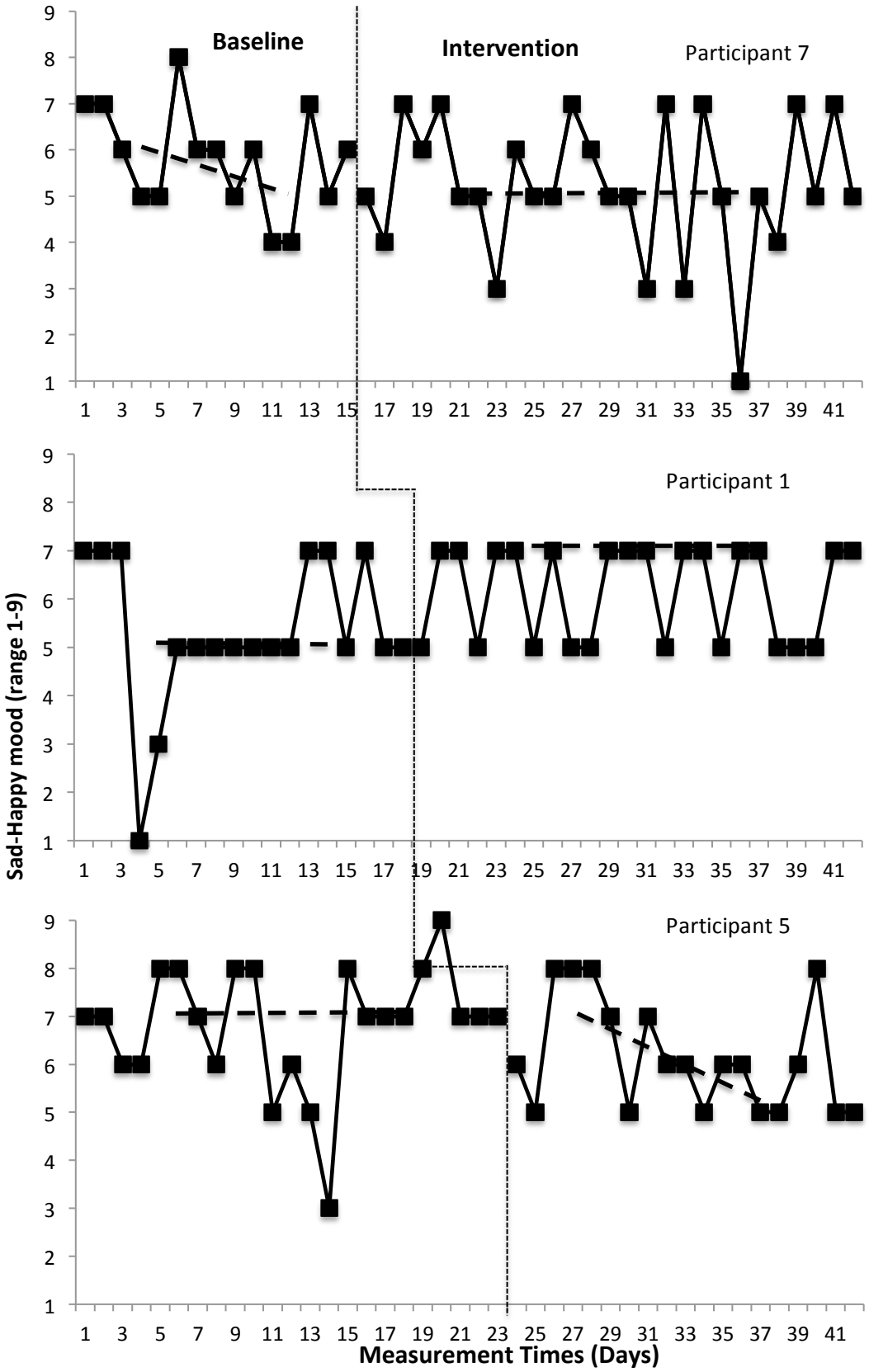
Rumination Frequency across A & B phases (Split-Middle as Trend line)

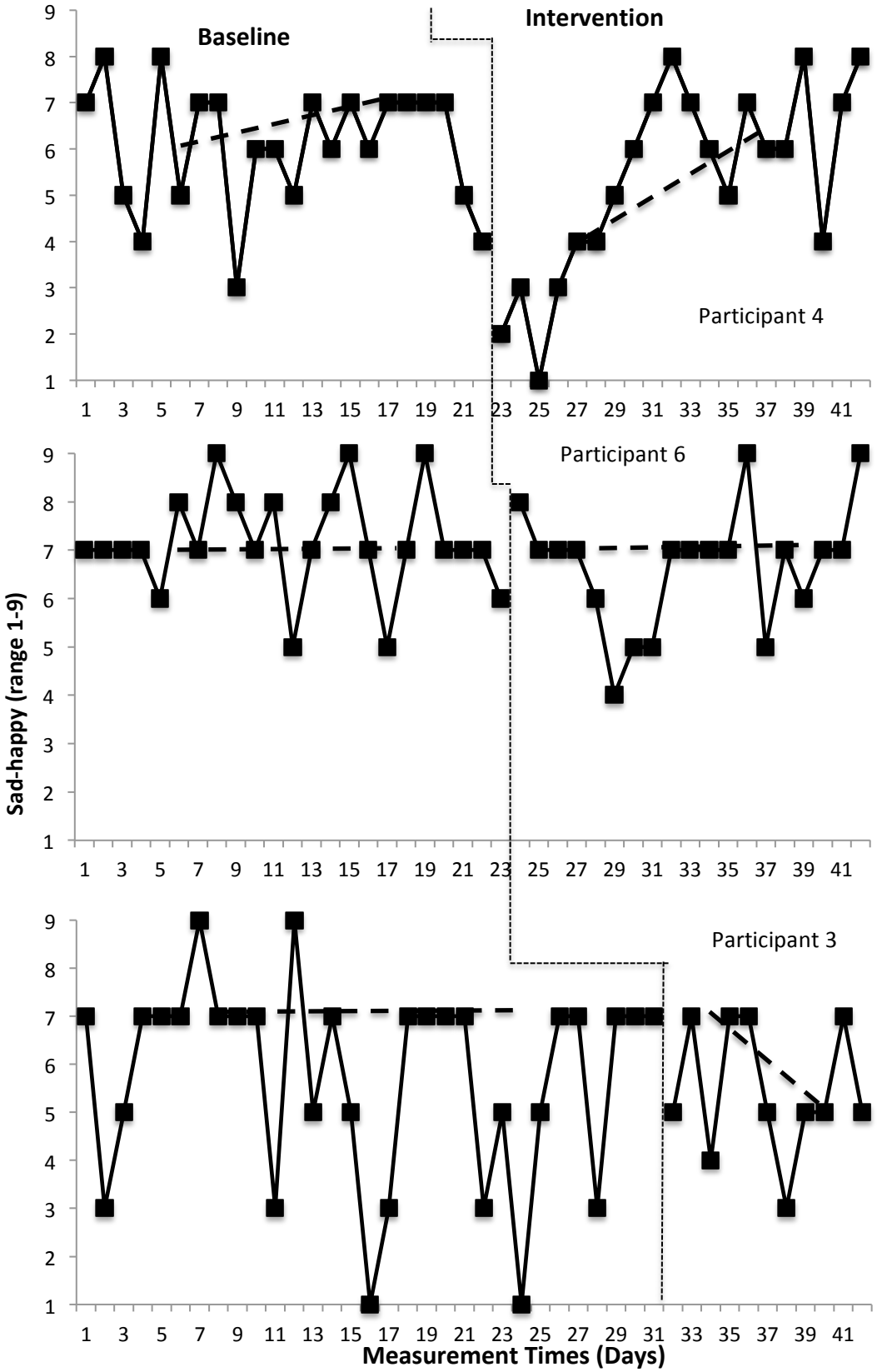
Appendix L: Sad-Happy Mood and Anxious-Calm Mood Visual and Statistical Analysis





Sad-happy mood ratings across A & B phases (Median line plotted)


Baseline
Intervention
Participant 7
Participant 1
Participant 5
Sad-Happy mood (range 1-9)
Measurement Times (Days)



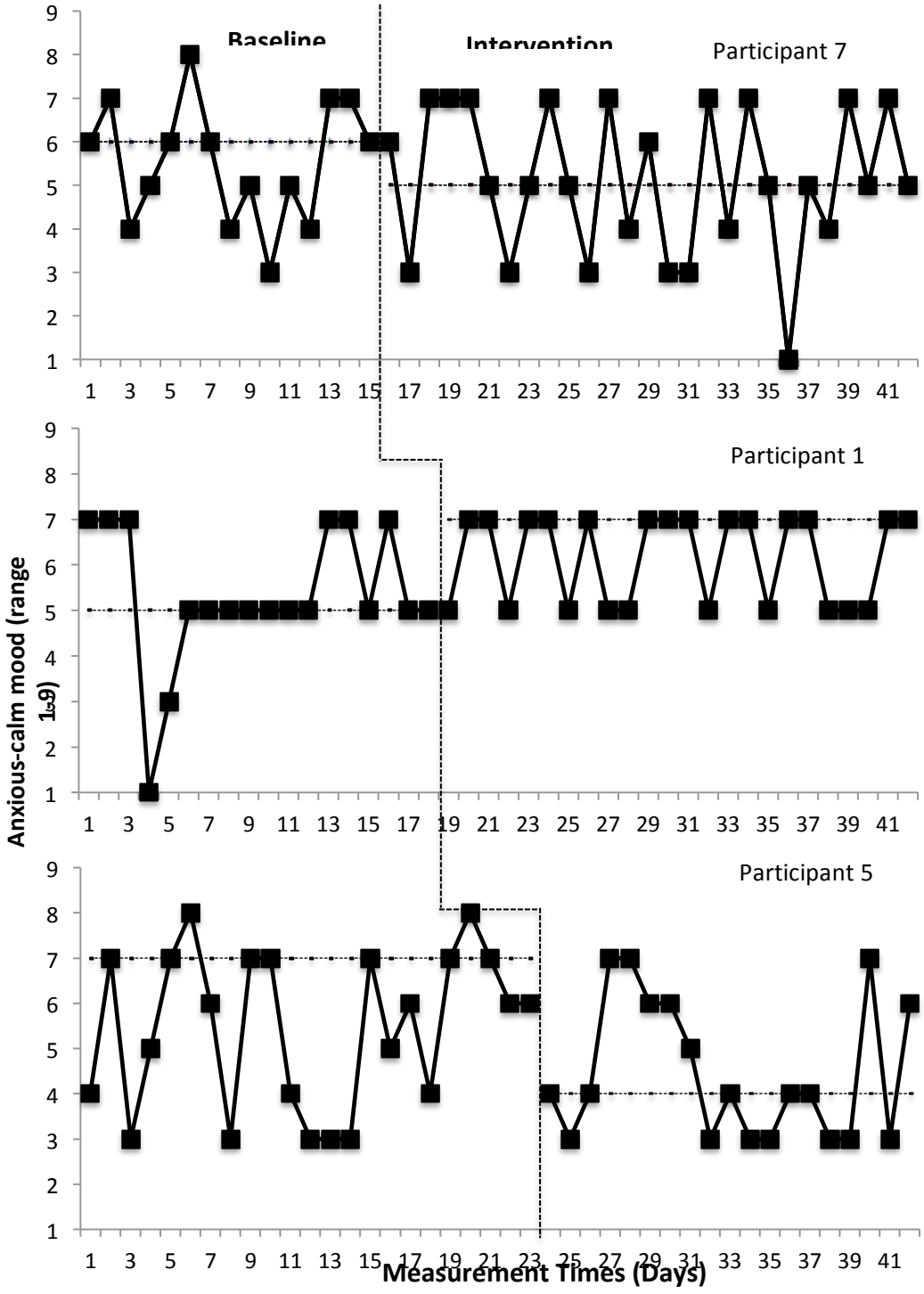
Sad-happy mood across A & B phases (Split-Middle as Trend line)

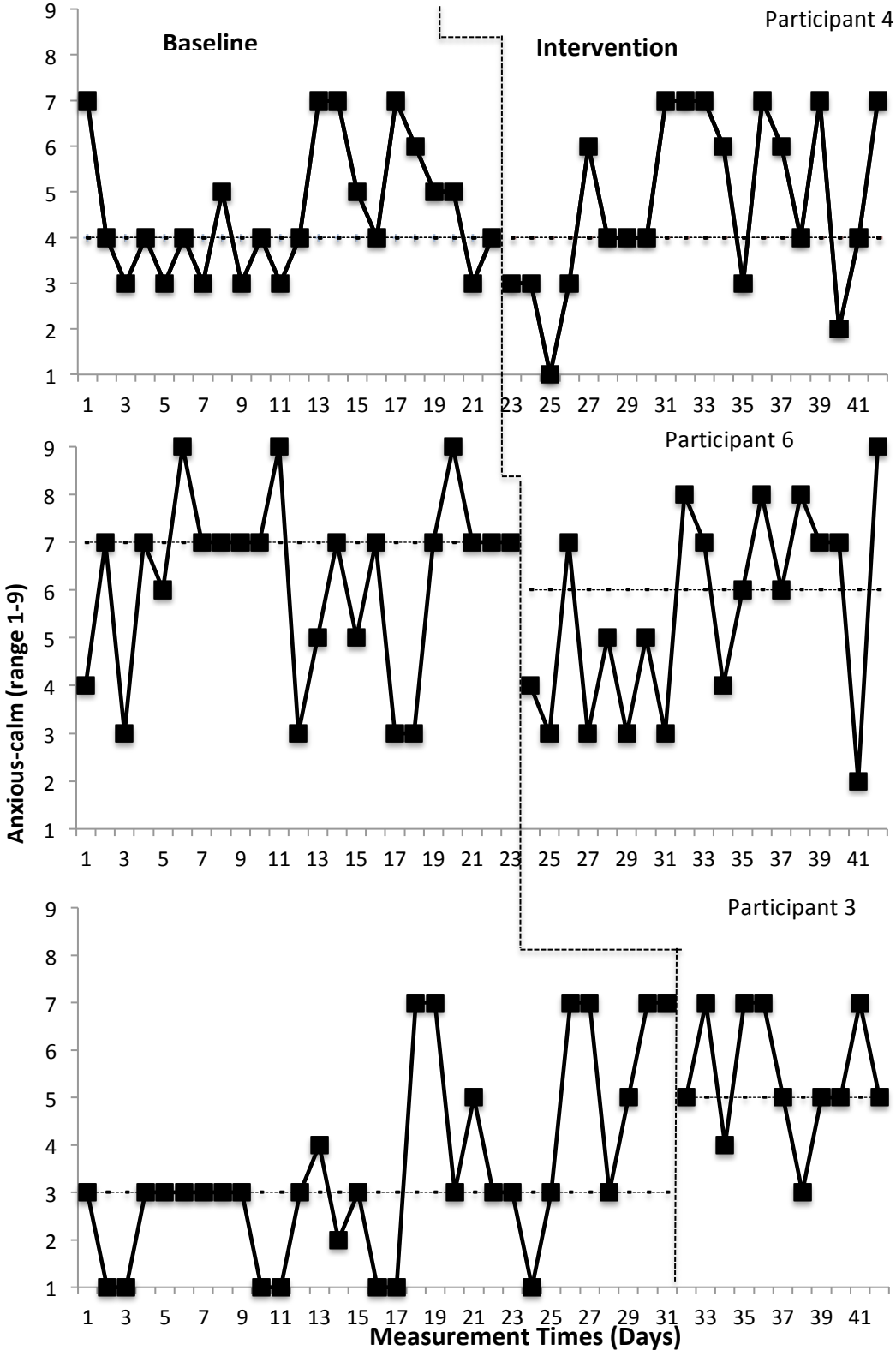
Mood sad-happy, Randomization Tests and Effect Size.

Participant	Phase A length (days)	Phase B length (days)	Phase A Mean {median} (SD)	Phase B Mean {median} (SD)	*p* value sad-happy	NAP	PEM+	Statistically significant change?
7	15	27	5.8 {6} (1.15)	5.19 {5} (1.52)	0.4761	0.3926	25.93	No
1	18	24	5.33 {5} (1.57)	6.17 {7} (1.01)	0.7619	0.6481	58.33	No
5	21	21	6.83 {7} (1.0)	6.16 {6} (0.35)	0.5238	0.7698	57.14	No
4	22	20	6.01 {6.5} (1.34)	5.35 {6} (1.17)	0.2857	0.4387	21.05	No
6	23	19	7.17 {7} (1.08)	6.68 {7} (1.29)	0.6190	0.4005	15.79	No
3	31	11	5.77 {3} (2.11)	5.45 {5} (1.36)	0.6190	0.4135	0	No
Group	**130**	**122**	**6.18 {7} (1.64)**	**5.84 {6} (1.51)**	**0.918**	**0.7626**	**60.45**	**No**

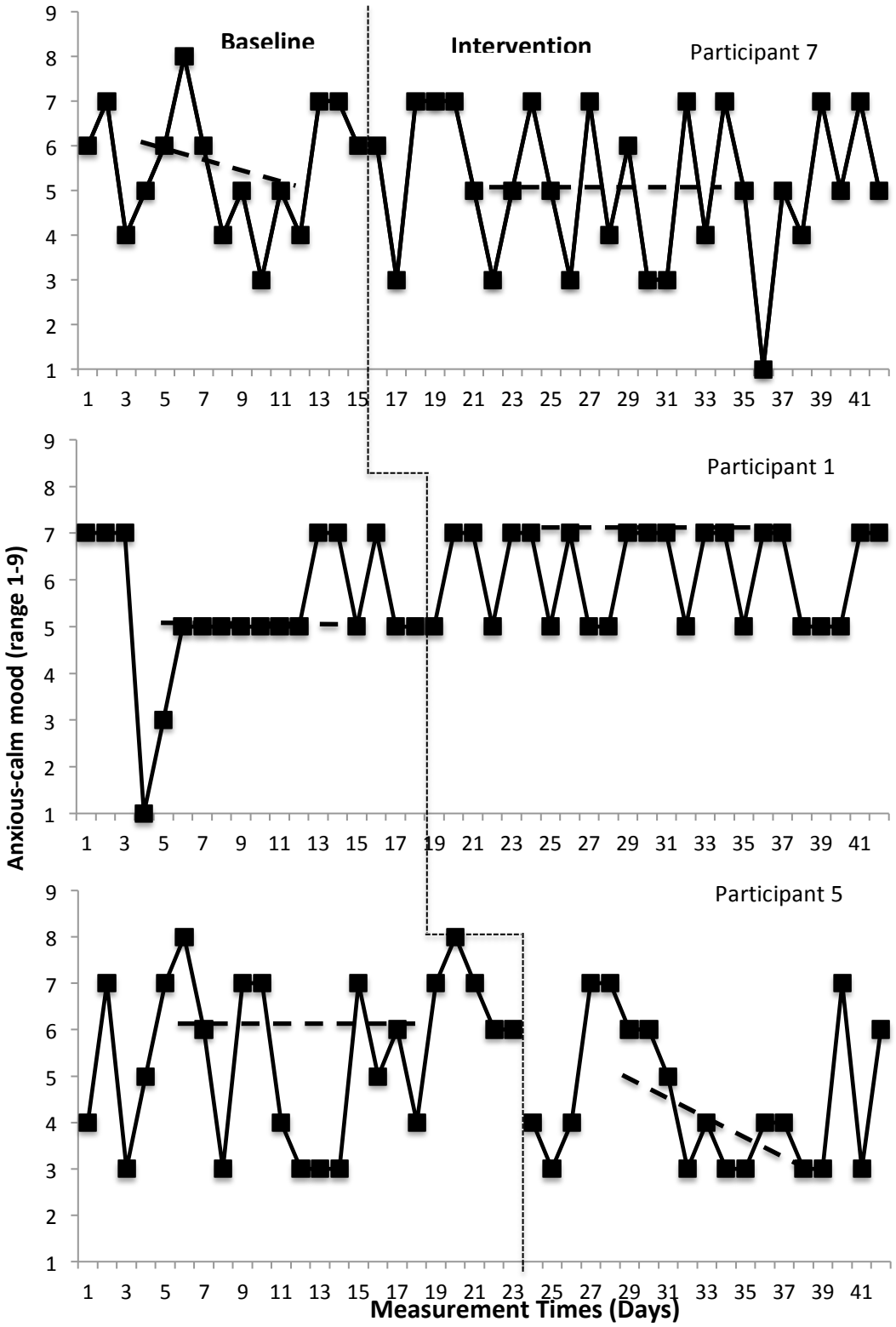
Note: *Very sad=1; moderately sad=3; neither happy or sad=5; moderately happy=7; very happy=9*

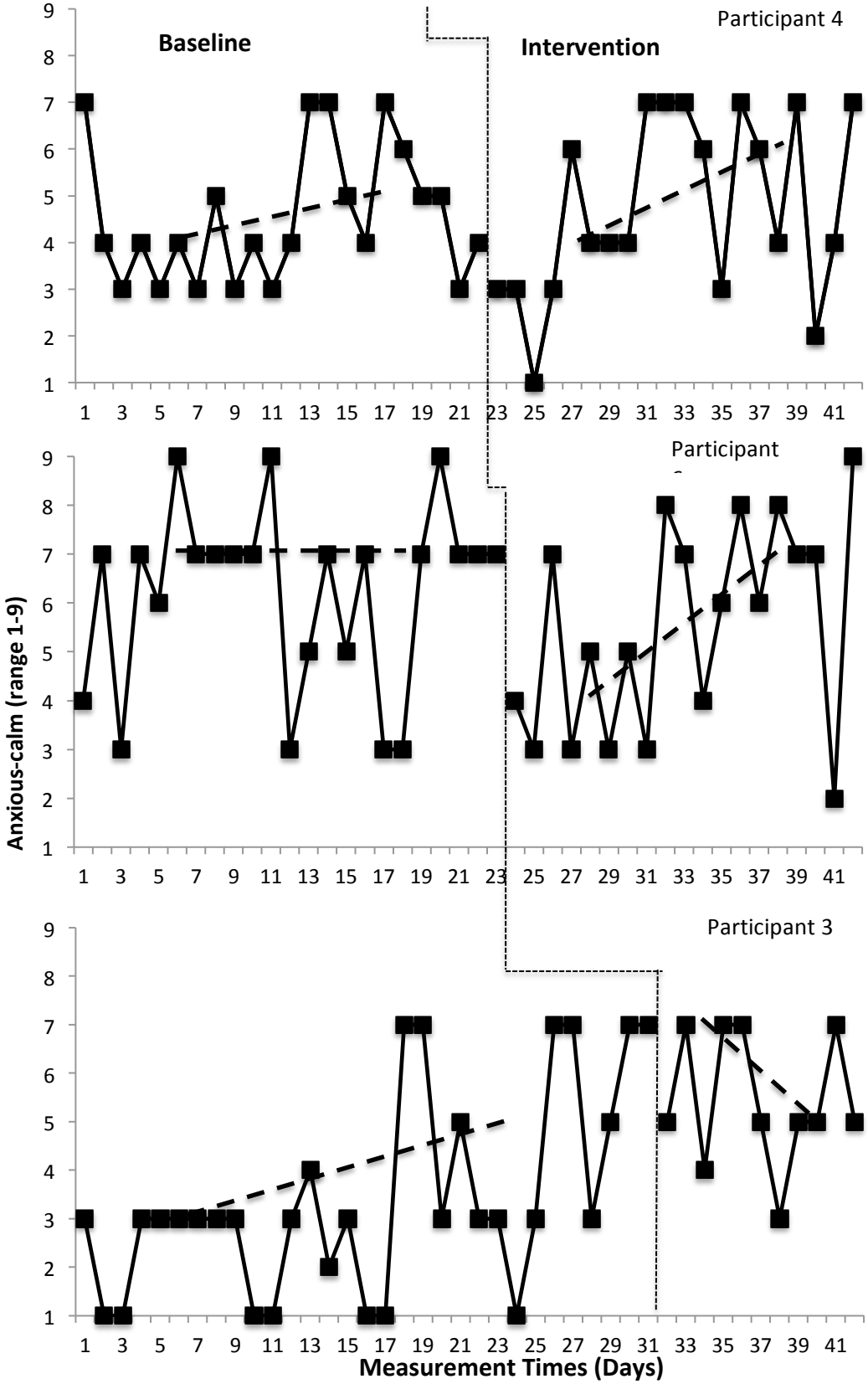
Anxious-calm mood. Median Graphs, Trend Graphs and Table for Statistics





Anxious-calm mood ratings across A & B phases (Median line plotted)


Baseline
Intervention
Participant 7
Participant 1
Participant 5
Anxious-calm mood (range 1-9)
Measurement Times (Days)



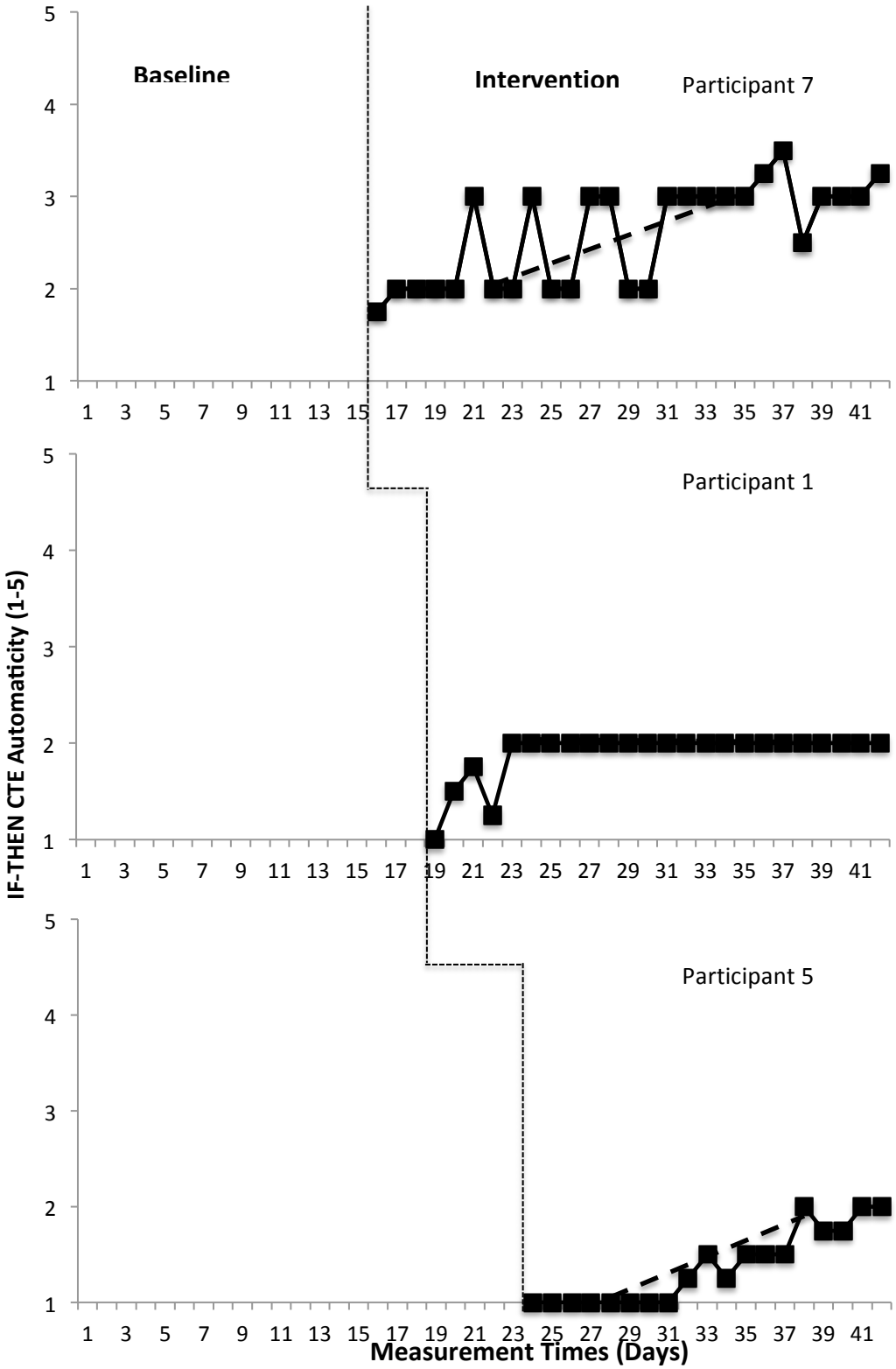
Anxious-calm mood across A & B phases (Split-Middle as Trend line)

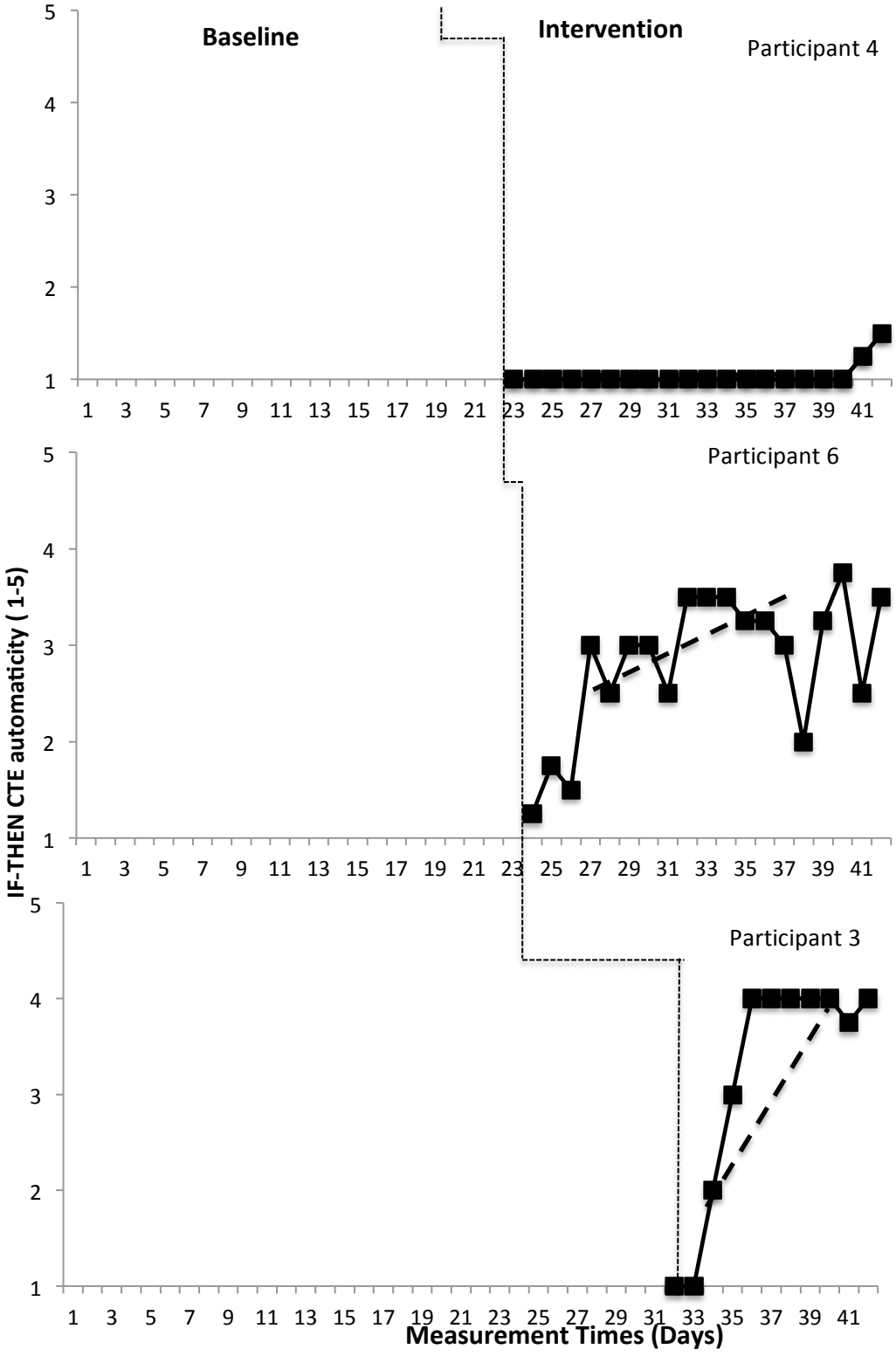
Mood anxious-calm, Randomization Tests and Effect Size.

Participant	Phase A length (days)	Phase B length (days)	Phase A Mean {median} (SD)	Phase B Mean {median} (SD)	*p* value anxious-calm	NAP	PEM+	Statistically significant change?
7	15	27	5.53 {6} (1.41)	5.11 {5} (1.72)	0.6190476	0.4420	33.33	No
1	18	24	5.33 {5} (1.57)	6.17 {7} (1.01)	0.7619048	0.6481	58.33	No
5	21	21	5.48 {6} (1.75)	4.48 {4} (1.54)	0.2380952	0.3639	15.19	No
4	22	20	4.54 {4} (1.44)	4.75 {4} (1.94)	0.2857143	0.5273	45	No
6	23	19	6.21 {7} (1.91)	5.53 {6} (2.14)	0.0952381	0.4861	21.05	No
3	31	11	3.45 {3} (2.06)	5.45 {5} (1.37)	0.0476190 5	0.8444	90.91	Yes
Group	**130**	**122**	**4.95 {5} (1.99)**	**5.27 {5} (1.72)**	**0.978**	**0.5540**	**44.07**	**No**

Note: *Very anxious=1; moderately anxious=3; neither calm or anxious=5; moderately calm=7; very calm=9*

Appendix M: Automaticity of IF-THEN CTE during intervention phase (split-middle as trend line)





Automaticity of IF-THEN CTE (split-middle trend line)

Appendix N: Dissemination Statement

The results of this study will be disseminated to interested parties through feedback, journal publication and presentation.

Dissemination to Participants.

As stated on the participants received initial results of their individual participation at debrief. However, participants have been informed that they may contact myself using the contact details on the debriefing form should they wish to receive further information about the results.

Journal Publication

It is expected that the study will be submitted for publication to Behaviour Research & Therapy (see Appendix O)

Presentation

My research findings will be presented to an academic audience, for peer review, as part of the Doctorate in Clinical Psychology at the University of Exeter in June 2017.

Appendix O: Preparation and Submission Requirements for *Behaviour Research & Therapy*

Article structure

Subdivision - unnumbered sections

Divide your article into clearly defined sections. Each subsection is given a brief heading. Each heading should appear on its own separate line. Subsections should be used as much as possible when cross-referencing text: refer to the subsection by heading as opposed to simply 'the text'.

Appendices

If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

Essential title page information

• Title. Concise and informative. Titles are often used in information-retrieval systems. Avoid abbreviations and formulae where possible.

• Author names and affiliations. Please clearly indicate the given name(s) and family name(s) of each author and check that all names are accurately spelled. Present the authors' affiliation addresses (where the actual work was done) below the names. Indicate all affiliations with a lower-case superscript letter immediately after the author's name and in front of the appropriate address. Provide the full postal address of each affiliation, including the country name and, if available, the e-mail address of each author.

• Corresponding author. Clearly indicate who will handle correspondence at all stages of refereeing and publication, also post-publication. Ensure that the e-mail address is given and that contact details are kept up to date by the corresponding author.

• Present/permanent address. If an author has moved since the work described in the article was done, or was visiting at the time, a 'Present address' (or 'Permanent

address') may be indicated as a footnote to that author's name. The address at which the author actually did the work must be retained as the main, affiliation address. Superscript Arabic numerals are used for such footnotes.

Abstract

A concise and factual abstract is required with a maximum length of 200 words. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

Graphical abstract

Although a graphical abstract is optional, its use is encouraged as it draws more attention to the online article. The graphical abstract should summarize the contents of the article in a concise, pictorial form designed to capture the attention of a wide readership. Graphical abstracts should be submitted as a separate file in the online submission system. Image size: Please provide an image with a minimum of 531 × 1328 pixels (h × w) or proportionally more. The image should be readable at a size of 5 × 13 cm using a regular screen resolution of 96 dpi. Preferred file types: TIFF, EPS, PDF or MS Office files. You can view Example Graphical Abstracts on our information site.

Authors can make use of Elsevier's Illustration and Enhancement service to ensure the best presentation of their images and in accordance with all technical requirements: Illustration Service.

Highlights

Highlights are mandatory for this journal. They consist of a short collection of bullet points that convey the core findings of the article and should be submitted in a separate editable file in the online submission system. Please use 'Highlights' in the file name and include 3 to 5 bullet points (maximum 85 characters, including spaces, per bullet point). You can view example Highlights on our information site.

Keywords

Immediately after the abstract, provide a maximum of 6 keywords, to be chosen from the APA list of index descriptors. These keywords will be used for indexing purposes.

Abbreviations

Define abbreviations that are not standard in this field in a footnote to be placed on the first page of the article. Such abbreviations that are unavoidable in the abstract must be defined at their first mention there, as well as in the footnote. Ensure consistency of abbreviations throughout the article.

Acknowledgements

Collate acknowledgements in a separate section at the end of the article before the references and do not, therefore, include them on the title page, as a footnote to the title or otherwise. List here those individuals who provided help during the research (e.g., providing language help, writing assistance or proof reading the article, etc.).