**Rumination and Complex Task Performance**

Submitted by Geoffrey Duggan, to the University of Exeter
as a thesis for the degree of Doctor of Clinical Psychology, May 2015

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**SCHOOL OF PSYCHOLOGY**

**DOCTORATE IN CLINICAL PSYCHOLOGY**

LITERATURE REVIEW

# Review of the Association between Depressive Rumination and Social Problem Solving


| | |
|---|---|
| Trainee Name: | **Geoffrey Duggan** |
| Primary Research Supervisor: | **Dr Nick Moberly**<br>Senior Lecturer, Mood Disorders Centre |
| Secondary Research Supervisor: | **Professor Ed Watkins**<br>Professor of Experimental and Applied Clinical Psychology, Mood Disorders Centre |
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## Abstract

Depressive rumination and deficits in social problem solving (SPS) are both associated with the onset and maintenance of depression. Understanding the interaction between these processes may increase the understanding of depression and inform clinical interventions. A literature search identified fourteen studies that manipulated state rumination or measured trait rumination and required participants to complete a SPS task. Results indicated that when dysphoric or depressed individuals ruminate on their low mood this can impair subsequent social problem solving in comparison to nondysphoric individuals who ruminate or individuals who distract themselves. In depressed or dysphoric individuals rumination appears to affect problem definition, the generation of solutions and decision making. The activation of overgeneral autobiographical memories may be a mechanism by which rumination impairs these component processes of SPS.

## Introduction

Depressive 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). There is strong evidence that links depressive rumination to the onset and maintenance of depression (Nolen-Hoeksema, 1991, 2000). This definition and connection to depressive symptoms means that rumination can be understood as incorporating a large proportion of the cognitive component of depression. Furthermore, this suggests the potential for therapeutic intervention within depression through modification of cognitions or altering ruminative patterns of behaviour (Watkins et al., 2007, Watkins et al., 2011).

Watkins (2008) reviewed a range of classes of repetitive thought that have features in common with depressive rumination as defined above. For example, control theory conceptualises rumination as repetitive, thematic, relatively uncontrollable thought that occurs independent of the context requiring it. It emphasises that rumination is instigated by problematic goal progress (Martin & Tesser, 1996). Following Nolen-Hoeksema (1991), the approach adopted here is to characterise depressive rumination as a *response style* to depressive mood. This can include a trait that is measured using validated questionnaires or a state induced in people low in mood through a laboratory procedure that requires participants to focus on current feelings and physical sensations (Nolen-Hoeksema & Morrow, 1991). This definition of rumination is adopted here, to the exclusion of other types of repetitive thought (Watkins, 2008), to concentrate on the role of rumination within depression. More specifically, the review concentrates on the role of depressive rumination within social problem solving.

Social problem solving (SPS) refers to problem solving as it occurs in the natural environment where “social problems” can be interpersonal or intrapersonal (D’Zurilla & Nezu, 2007; Nezu, 2004). Deficits in SPS have been found in people suffering from depression (D’Zurilla, Chang, Nottingham & Faccini, 1998; Goddard, Dritschel & Burton, 1996), ineffective problem solving increases the impact of life stressors on depressive symptoms (D’Zurilla & Nezu, 2007; Nezu, 2004) and targeting improvements in SPS is an effective treatment for depression (Bell & D’Zurilla, 2009). Thus, SPS has an important role in both the maintenance and reduction of depressive symptoms.

SPS contains two components, firstly, the problem orientation which is the individual’s general attitudes to the problem and to their ability to solve it, and secondly the problem solving skill which refers to the ability to complete the necessary steps required to solve the problem. D’Zurilla and Goldfried (1971) describe these steps as (a) problem definition and formulation; (b) generation of potential solutions; (c) decision making; and (d) solution implementation and verification. D’Zurilla and Maydeu-Olivares (1995) review a range of methods used to assess SPS, many of which are questionnaire based. The most widely adopted task used to measure SPS skill is the Means-End Problem Solving task (MEPS, Platt & Spivack, 1975). This requires participants to write down solutions to hypothetical problem situations and describe the constituent steps of these solutions. The MEPS assesses the ability to generate relevant means (or the number of relevant steps taken to solve a problem) and the overall effectiveness of the solution.

This review builds on the expanding literature on rumination and cognitive control processes such as attention, working memory and executive functioning (Joorman, 2010; Koster, De Lissnyder, Derakshan & De Raedt, 2011; Whitmer &

Gotlib, 2013) by examining the effect of rumination on a more complex cognitive process – SPS. In particular the focus is on the cognitive process of solving problems. Thus, studies are only included if SPS is investigated using a task, for example the MEPS, rather than through self-report questionnaires. A secondary goal for the review is to identify any other cognitive processes within the literature that are implicated in the relationship between SPS and rumination.

In summary, understanding the relationship between rumination and SPS is both theoretically and practically important. Both rumination and SPS are associated with depression and depressive symptoms are reduced through interventions that target either rumination or SPS. Understanding the interaction between these processes may increase the understanding of depression and inform clinical interventions.

Although there is evidence that rumination, SPS and depression are associated with each other, the relationship between all three constructs is less clear. Lyubomirsky, Tucker, Caldwell and Berg (1999) suggested that depressive rumination degraded all four steps within SPS and that the subsequent deficits in SPS increased depressive symptoms. Within this model rumination only affected SPS for dysphoric participants. An alternative approach, has suggested that rumination affects the retrieval of autobiographical memories (Williams et al., 2007) and that overgeneral autobiographical memory moderates SPS effectiveness in depressed individuals (Williams, Barnhofer, Crane & Beck, 2005). Overgeneral autobiographical memory is associated with depression (Williams et al., 2007), thus this suggests a mechanism by which rumination affects both SPS and depression. This review investigates the relationship between SPS and rumination further by asking two questions: Is depressive rumination associated with SPS performance?

Are there any cognitive mechanisms that are implicated in a relationship between depressive rumination and SPS?

## Method

The review is structured in line with the PRISMA guidelines (Preferred Reporting Items for Systematic reviews and Meta Analyses; Liberati et al., 2009).

### Eligibility Criteria

**Types of studies.** Two types of studies were included – studies that used a correlational design to associate trait rumination with SPS and studies that manipulated state rumination with an experimental design using a controlled comparison condition (i.e. distraction, mindfulness) to investigate SPS. Only studies with quantitative data published in peer reviewed journals were included.

**Types of participants.** Participants were 18 years of age or older and studies included at least 10 participants per experimental condition. Depressed and nondepressed participants were included if the study focused on rumination in relation to low mood.

**Types of interventions.** Depressive rumination was defined as repetitively thinking about the self and personal problems as well as focusing on negative mood and the factors contributing to the low mood (Nolen-Hoeksema, 1991; Whitmer & Gotlib, 2013). Studies were included if they measured this tendency using validated scales of trait rumination or manipulated state rumination using a laboratory induction procedure. Validated scales that were included were the Ruminative Response Scale of the Response Styles Questionnaire (Nolen-Hoeksema & Morrow,

1991), Rumination on Sadness Scale (Conway, Csank, Holm & Blake, 2000), Rumination-Reflection Questionnaire (Trapnell & Campbell, 1999) and Global Rumination Scale (McIntosh & Martin, 1992). Studies using other scales that measure repetitive thought were only included if the study explicitly examined depressive rumination.

Studies had to investigate depressive rumination *and* SPS. To be classed as investigating SPS and thus included, studies had to require participants to complete a task that required a response that was adaptive but may not be immediately apparent (Nezu, 2004). This task typically involved an interpersonal problem but could also include complex intrapersonal problems. The problem had to be one that occurred in the natural environment or be a direct simulation of a natural problem solving task, for example the MEPS task. Comparison was across a spectrum of levels of naturally occurring trait rumination or between experimentally induced state rumination and a control condition.

**Types of outcome measures.** Where the MEPS task was used outcome measures were the number of relevant means and the overall effectiveness of the solution. To score the MEPS responses external raters compared solutions generated by participants to ideal solutions. For problems situated in the natural environment, experimenter-rated outcome or self-reported success was used.

## Information Sources

The following electronic databases were searched: PsycINFO, PsycARTICLES, EMBASE and MEDLINE. These databases were searched from the beginning of the database until 21st April, 2015. Reference lists of the articles retrieved and review articles (Bell & D'Zurilla, 2009; Lyubomirsky & Tkach, 2004;

Nolen-Hoeksema, Wisco & Lyubomirsky, 2008; Smith & Alloy, 2009; Thoma, Friedmann & Suchan, 2013; Watkins, 2008; Whitmer & Gotlib, 2013) were also examined for relevant articles. Google Scholar was searched for articles citing key publications within the articles retrieved (i.e. Donaldson & Lam, 2004; Lyubomirsky et al., 1999; Watkins & Baracaia, 2002).

**Search**

Titles and abstracts in all databases were searched using ruminat* OR brood* OR reflection OR repetitive thought OR repetitive negative thought OR repetitive thinking OR repetitive negative thinking OR defensive pessimism; combined using AND with the following terms problem solv* OR problem-solv* OR social problem* OR means end* OR means-end* OR meps OR interpersonal problem* OR sps.

**Study Selection**

Titles and abstracts of all articles identified were initially screened to see if they met the eligibility criteria. Relevant articles were then read in full and again assessed against the eligibility criteria. A randomly selected 10% of the studies read in full were then assessed against the eligibility criteria by an independent clinical researcher. No difficulties were experienced gaining access to full texts of relevant articles and all relevant articles were written in English.

**Data Extraction**

The author (GBD) extracted the following data from all studies (a) The number of participants per condition and level of depression; (b) The design of the study, whether trait and/or state rumination was manipulated or measured, the type of state

rumination manipulation and any measure of rumination used; (c) The type of SPS task used and any outcome measures of task performance; (d) The main outcome from the study.

### Risk of Bias

All studies were assessed for risk of bias at the individual study level. The Cochrane Collaboration Tool for Assessing Risk of Bias (Higgins et al., 2011) was used for experimental studies. Correlational studies were also assessed in relation to selection, performance, measurement and attrition biases. Selective reporting across studies was used to assess risk of bias across studies.

## Results

### Study Selection

The screening and selection of studies is described in Figure 1. After being read in full, 35 studies were excluded for focusing on cognitive processes other than SPS (e.g. comprehension, learning, memory etc.), seven studies were excluded for not including a SPS task (i.e. only requiring participants to self-report their SPS ability rather than complete an SPS task) and seven studies were excluded for failing to manipulate state rumination or measure trait rumination. This left 14 studies that were included in the review. The independent researcher who assessed 10% of studies against the eligibility criteria agreed with all inclusion and exclusion decisions.

**Study Characteristics**

The characteristics of the 14 studies reviewed are included in Table 1. Participants were undergraduate or graduate students in seven of the studies. Six studies used patients who were clinically depressed or had been in the past and four of these studies also included nondepressed participants from the general population. One study recruited dysphoric and nondysphoric postnatal mothers from the general population. The included studies involved 1054 participants. Sample size ranged from 12 to 22 participants per condition in the experimentally designed studies and from 24 to 183 overall in correlational studies.

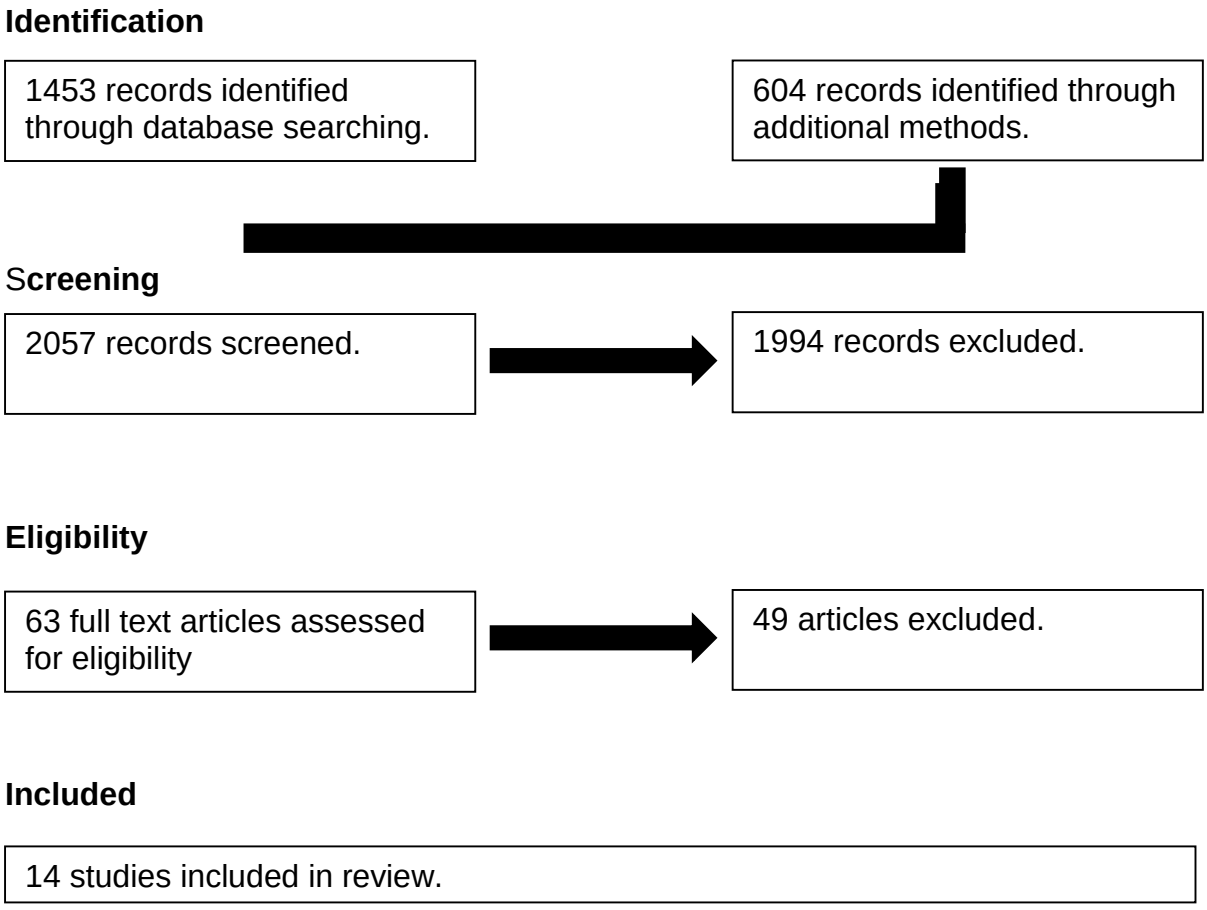


*Figure 1.* Search strategy and process of identification, screening, eligibility and inclusion for the review.

State rumination was manipulated and effects were compared to another condition in nine studies. The remaining five studies measured trait rumination and used a correlational design. Three studies both manipulated state rumination and measured trait rumination.

Twelve of the studies assessed SPS using the MEPS, two studies used diary records of actual SPS difficulties and one experiment from Lyubormirsky et al. (1999) required participants to construct solutions in response to actual SPS difficulties they faced. Eleven studies measured SPS performance on the MEPS using solution effectiveness and eight studies used either number of relevant means or proportion of solutions that were relevant means.

**Risk of Bias**

Table 1 provides risk of bias assessments for each individual study and includes information about possible sources of bias. Risk of bias was judged to be low or unclear for 13 out of 14 studies. Potential selection bias due to lack of information about randomisation of participants to conditions, potential reporting bias following lack of details about outcomes and potential detection bias due to lack of information about blinding of coders were the primary reasons for judgments of unclear risk of bias. O'Mahen, Boyd and Gashe (2015) was given a high risk of bias due to indications that participants guessed at the purpose of the task.

Table 1.

*Study characteristics, outcomes and risk of bias of studies included in the review.*

| Study | Expt & N | Participants and Design | Task and performance measures | Main outcome | Risk of Bias and Excluded Experiments |
|---|---|---|---|---|---|
| | | | Experimental Studies | | |
| Donaldson & Lam (2004) | 72 | Depressed patients and nondepressed from general population.<br>Trait R measured using RSQ-R.<br>2 (Depressed vs Nondepressed) × 2 (State R vs Distraction) | MEPS.<br>Solution effectiveness pre- and post-rumination or distraction. | Depressed State R larger drop in score than other conditions.<br>Trait R –ve correlation with score at Time 1 in depressed conditions. | Risk of Bias: Low. |
| Kao, Dritschel & Astell (2006) | 60 | Undergraduates.<br>2 (Dysphoric vs Nondysphoric) × 2 (State R vs Distraction) | MEPS.<br>Solution effectiveness and number of relevant means. | Dysphoric State R lower effectiveness than other conditions.<br>No difference number of mean solutions. | Risk of Bias: Low. |
| Lyubomirsky & Nolen-Hoeksema (1995) | Expt 3<br>69 | Undergraduates.<br>2 (Dysphoric vs Nondysphoric) × 2 (State R vs Distraction) | MEPS.<br>Solution effectiveness and proportion of solutions that were model solutions. | Dysphoric State R lower effectiveness and lower proportion of model solutions than other conditions. | Risk of Bias: Low.<br><br>Expts 1 and 2 excluded, did not include a SPS task. |
| Lyubomirsky, Tucker, Caldwell & Berg (1999) | Expt1<br>90 | Undergraduates.<br>2 (Dysphoric vs Nondysphoric) × 2 (State R vs Distraction) | Participants identified actual problems and generated solutions to them.<br>Rated effectiveness of solutions. | No difference in participants or coders ratings of solution effectiveness. | No information about randomisation provided.<br><br>Risk of Bias: Unclear.<br>Expt 2 excluded, did not include a SPS task. |

| | | | | | |
|---|---|---|---|---|---|
| Lyubomirsky, Tucker, Caldwell & Berg (1999) | Expt3 51 | Undergraduates.<br>2 (Dysphoric vs Nondysphoric) × 2 (State R vs Distraction) | Problem solutions task from Expt 1.<br>MEPS.<br>Solution effectiveness and proportion of solutions that were model solutions.<br>External ratings of expressed thoughts. | Dysphoric State R lower effectiveness and fewer model solutions than other conditions.<br>Rated negative tone, problem focus, self-criticism, self-blame –ve correlation with MEPS effectiveness. Rated confidence, perceived control +ve correlation MEPS effectiveness. | |
| O'Mahen, Boyd & Gashe (2015) | 59 | Postnatal mothers from general population.<br>2 (Dysphoric vs Nondysphoric) × 2 (State R vs Distraction) | Postnatal parenting MEPS.<br>Solution effectiveness and number of relevant means. | Dysphoric State R fewer relevant means than other conditions. | Reported attributions of participants indicated participants guessed at the purpose of the task.<br>Solution effectiveness not reported.<br>Risk of Bias: High. |
| Sanders & Lam (2010) | 60 | General population.<br>Trait R measured using RSQ-R.<br>2 (Recovered depressed vs Never depressed) × 2 (State R vs Mindfulness) | MEPS.<br>Solution effectiveness pre- and post-rumination induction. | Trait R +ve correlation with effectiveness in mindfulness conditions but not in State R conditions. | Risk of Bias: Low. |
| Watkins & Baracaia (2002) | 84 | Depressed patients, recovered depressed and nondepressed from general population.<br>Trait R measured using RSQ-R.<br>3 (Depressed vs Recovered vs Nondepressed) × 3 (State R vs Process R vs Control) | MEPS.<br>Rumination questions used during problem solving.<br>Solution effectiveness and number of relevant means. | Depressed. State R < Process R (Number means).<br>Recovered depressed. State R < Process R (Number means & effectiveness).<br>No effects in nondepressed. | RSQ-R results not reported.<br><br>Risk of Bias: Unclear. |

| | | | | | |
|---|---|---|---|---|---|
| Watkins & Moulds (2005) | 80 | Depressed patients and nondepressed from general population.<br>2 (Depressed vs Nondepressed) × 2 (State R concrete vs State R abstract) | MEPS.<br>Solution effectiveness and number of relevant means pre- and post-rumination or distraction. | Depressed. Concrete R increase in effectiveness but not in Abstract R. Concrete R more effective solutions than Abstract R.<br>No effects in nondepressed. | Risk of Bias: Low. |
| Yoon & Joormann (2012) | 51 | Undergraduates.<br>2 sequential manipulations. 2 (First: State R vs Distraction) × 2 (Second: State R vs Distraction) | MEPS.<br>Solution effectiveness and number of relevant means. | When State R first lower effectiveness and proportion of model solutions than when Distraction first. | No information about randomisation provided. No analysis of correlation between RSQ and performance reported.<br><br>Risk of Bias: Unclear. |
| | | <u>Cross sectional studies</u> | | | |
| Mori, Takano & Tanno (2015) | 39 | Undergraduates and graduates.<br>Trait R measured using RRQ. | Diary record of everyday problems.<br>Use of problem solving behaviours. | No interaction between self-rumination and problem solving behaviour. | Requirement to record problem behaviours and problems meant possible performance bias.<br><br>Risk of Bias: Unclear. |
| Noreen, Whyte & Dritschel (2015) | 86 | Undergraduates.<br>Trait R measured using RSQ-R. | MEPS.<br>Solution effectiveness and number of relevant means. | Depressed and high trait R –ve correlation with SPS score. | Risk of Bias: Low. |
| Raes, Hermans, Williams, Demyttenaere, Sabbe, Pieters & Eelen (2005) | 24 | Depressed patients.<br>Trait R measured using RSQ-R. | MEPS.<br>Solution effectiveness. | Trait R –ve correlation with effectiveness. | No information provided about blinding of coders.<br><br>Risk of Bias: Unclear. |

| | | | | | |
|---|---|---|---|---|---|
| Takano, Sakamoto & Tanno (2011) | Expt2<br>183 | Undergraduates.<br>Trait R measured using RRQ. | Recorded interpersonal negative events at 3 junctures. | Trait R +ve correlation with depressive symptoms following negative interpersonal events. | Risk of Bias: Low. |
| Yanes, Morse, Hsiao, Simms & Roberts (2012) | 46 | Depressed HIV patients.<br>Trait R measured using RSQ-R. | MEPS.<br>Solution effectiveness. | No correlation between Trait R and effectiveness. | No information provided about blinding of coders.<br>High attrition rate – 29%.<br><br>Risk of Bias: Unclear. |

*Note.* Expt = Experiment; MEPS = Means End Problem Solving task; Process R = Process Rumination; RRQ = Rumination-Reflection Questionnaire; RSQ-R = Response Styles Questionnaire – Ruminative Response Scale; SPS = Social Problem Solving; State R = State Rumination; Trait R = Trait Rumination.

## Results of Individual Studies

**Experimental studies.** Lyubomirsky and Nolen-Hoeksema (1995) conducted the prototype experimental study of state rumination and SPS. This used a 2 × 2 mixed design, the manipulated factor being state rumination versus distraction and the non-manipulated factor being dysphoric versus nondysphoric participants. Eight of the nine studies of the effects of state rumination in Table 1 adopted similar designs with the effects of rumination compared to another condition in at least two groups of participants where one group was either depressed, recovered depressed or dysphoric. Lyubomirsky and Nolen-Hoeksema (1995) found that, compared to the other three groups, the group of dysphoric participants who ruminated produced solutions on the MEPS that were rated lower in effectiveness and had a lower proportion of model solutions. Thus SPS was worse following rumination rather than distraction but only for dysphoric participants.

Lyubomirsky et al. (Experiment 3, 1999) replicated this design but also required participants to talk aloud while problem solving to provide an indication of the specific ruminative thoughts generated. Results suggested that rumination negatively affected SPS in dysphoric participants but not in nondysphoric participants. Expressed thoughts were analysed and this found that, across all groups, diminished negative tone, lower focus on one's problems and feelings, less self-criticism, increased self-confidence and perceived general control were all positively correlated with SPS using the MEPS.

In addition to the MEPS, Lyubomirsky et al. (Experiment 1, 1999) tested SPS using actual problems from participants' lives. They asked participants to identify problems in their own lives and construct solutions to them. External raters found no differences in problem severity or quality of solutions across the four conditions.

However, dysphoric participants in the ruminate condition rated their problems as more severe and less solvable and were less likely to implement solutions than participants in the other three groups. The judgement that problems were more severe and difficult to solve indicated that rumination can affect problem definition and formulation, the lower scores on the MEPS indicated that the generation of potential solutions and decision making was affected. Solution implementation, the final stage of SPS, also appeared to be affected by rumination. Thus, Lyubomirsky et al. provided evidence that rumination on dysphoric mood can affect all four components of SPS described by D'Zurilla and Goldfried (1971). However, neither of these studies used depressed participants thus limiting the generalisability of their findings.

This difficulty was addressed by Donaldson and Lam (2004) who gave patients with major depression and controls the MEPS before and after rumination or distraction. They found that SPS in depressed patients deteriorated following rumination, however, rumination did not affect SPS in the control group and SPS was not affected by distraction in either group. This pattern of results was repeated using the MEPS in dysphoric and nondysphoric undergraduates (Kao, Dritschell & Astell, 2006) and using an adapted MEPS with dysphoric and nondysphoric postnatal mothers (O'Mahen, Boyd & Gashe, 2015). Further evidence for the importance of current low mood in the relationship between rumination and SPS was provided by Sanders and Lam (2010) who gave the MEPS to recovered depressed or never depressed participants and did not find an effect of state rumination on SPS. The importance of proximity of rumination to low mood was illustrated by Yoon and Joorman (2012) who found that directly after a low mood induction, rumination followed by distraction degraded SPS more than distraction followed by rumination.

These studies provide little direct evidence of how to reduce the impact of rumination on SPS. This difficulty has been addressed by comparing alternative types of rumination. Watkins and Baracaia (2002) found that in depressed and recovered depressed participants shifting ruminative style with questions that focused on how to solve a problem improved performance on the MEPS relative to questions that focused on why there was a problem. No differences were found for nondepressed participants. Following on from this, Watkins and Moulds (2005) found that concrete self-focused rumination improved MEPS performance relative to abstract self-focused rumination in depressed participants but not in nondepressed participants.

Shifting ruminative focus to how to solve a problem appeared to improve problem definition, solution generation and decision making (Watkins & Baracaia, 2002). Further, the advantage of more concrete thinking is that it produces more detailed and elaborated descriptions of problems that are better suited to generating alternative solutions and guiding implementation (Watkins & Moulds, 2005). This suggests that autobiographical memory may play an important role in rumination and SPS. There is strong evidence that rumination leads to the recall of autobiographical memories that are overgeneral or lacking in specificity (Williams et al., 2007). The evidence from Watkins and Moulds suggests that overgeneral or abstract autobiographical memories will not support SPS as effectively as concrete autobiographical memories. Kao et al. (2006) tested autobiographical memory retrieval during SPS and found a nonsignificant trend for greater retrieval of overgeneral memories following rumination rather than distraction in dysphoric participants. They also found that across all participants there was a negative correlation between retrieval of overgeneral memories and SPS performance.

**Cross-sectional studies.** Raes et al. (2005) measured trait rumination, autobiographical memory specificity and MEPS in depressed patients. All three factors were correlated with each other and mediational analyses were consistent with the suggestion that reduced memory specificity acted as a pathway through which rumination negatively affected SPS. That is, reduced memory specificity limited the generation of solutions in SPS. However, the cross-sectional nature of the study means other causal pathways between the three factors are possible.

Noreen, Whyte and Dritschel (2015) also found that high trait rumination was associated with lower scores on the MEPS in an opportunity sample of undergraduates not selected according to mood. Prior to problem solving they asked participants to generate consequences of the problem being resolved or unresolved. Results suggested that the generation of unresolved consequences affected SPS for high ruminators. That is, problems were appraised as more severe and this restricted the ability of ruminators to generate effective solutions.

Yanes, Morse, Hsiao, Simms and Roberts (2012) did not find an association between trait rumination and MEPS scores in dysphoric HIV positive individuals. They did, however, report that perceived stress was more strongly associated with depressive symptoms for individuals with high memory specificity. Rumination mediated this association but SPS did not.

Three experimental studies of state rumination also measured trait rumination and MEPS. Donaldson and Lam (2004) found that high trait rumination was associated with poorer SPS in depressed patients but not in controls. There was also an interaction between state and trait rumination that revealed a negative association between high trait rumination and improvement in SPS following the distraction induction. Sanders and Lam (2010) also found an interaction between state and trait

rumination. This revealed that high trait rumination was associated with improvement in SPS in the mindfulness condition. Watkins and Baracaia (2002) did not report the results for trait rumination.

The only two studies not to use the MEPS investigated the role of trait rumination in SPS in everyday life. Takano, Sakomoto and Tanno (2011) found that trait rumination predicted a greater increase in negative affect after a person experienced a negative interpersonal event. Mori, Takano and Tanno (2015) found that, although trait self-reflection was associated with the use of effective problem solving behaviours in response to everyday stressful events, there was no significant relationship between trait self-rumination and use of effective problem solving behaviours. Neither study directly measured the outcome of SPS but inferred that greater levels of negative affect following negative events implied poorer SPS.

## Discussion

### Summary of Evidence

In comparison to another condition, such as distraction, eight out of nine experimental studies found an impairment in SPS performance following rumination or an improvement in SPS performance following an intervention that tried to alter ruminative thinking. This effect was only present for depressed or dysphoric participants. This is perhaps unsurprising given that the manipulation of rumination required participants to focus on their current feelings or physical sensations thus the manipulation will induce different processes in people according to their current mood. Four studies found cross-sectional data that high trait rumination was associated with poor SPS performance. These effects were found across samples of

depressed and nondepressed participants, however, there is a positive correlation between trait rumination and depression and studies did not control for depression when analysing trait rumination. Thus it is difficult to separate the effect of trait rumination from depression. Taken together these data offer strong support that for dysphoric or depressed individuals, rumination on low mood is associated with a depreciation in SPS performance.

Across the 14 studies there was evidence that rumination can affect all four stages of SPS described by D'Zurilla and Goldfried (1971). High state and trait rumination have both been associated with difficulties in problem definition and appraisal (Lyubomirsky et al. 1999; Takano et al., 2011) and Noreen et al. (2015) highlighted the importance of problem definition for SPS in high ruminators. Difficulties with the generation of potential solutions and decision making were both associated with rumination across the 12 studies that used the MEPS. Less investigated was the implementation of solutions. Lyubomirsky et al. (1999) provided some evidence from self-reports of intentions but there was no direct test of a relationship between rumination and the ability to implement solutions and verify solutions.

There was some evidence that overgeneral autobiographical memories mediated the effect of rumination on SPS (Watkins & Moulds, 2005, Raes et al., 2005). That is, rumination on low mood may activate overgeneral memories that do not support the specific requirements of a current problem solving situation. This builds on the well supported link between autobiographical memory and depression (Williams et al., 2007). Set against this were studies that did not find a clear association between rumination, autobiographical memory and SPS (Kao et al., 2006, Yanes et al., 2012). The inconsistency in findings and the range of different

SPS stages affected by rumination indicates that autobiographical memory is unlikely to be the sole mechanism by which rumination affects SPS.

**Limitations**

SPS was measured using the MEPS in all but two studies reviewed. This limits the generalisability of the findings as they may be specific to this particular measure. For example, solutions produced during the MEPS task were assessed by external raters. It is not possible to rule out some systematic bias in this subjective scoring process that is related to rumination (cf. D'Zurilla & Maydeu-Olivares, 1995). More generally, there are large differences between the laboratory based artificial problems in the MEPS and actual problems from everyday life that are meaningful to participants. For example, outside of the laboratory, extracognitive factors such as motivation may play a larger role in SPS (Nezu, 2004).

In common with most other manipulations of state rumination there was a lack of a no-intervention control condition in the studies reviewed (Watkins, 2008). Thus, it is difficult to identify whether any relative impairment in SPS was caused by a positive effect of the comparison condition, typically distraction, or a negative effect of rumination.

The total number of studies was not large and five experimental studies had 15 participants or fewer per condition thus limiting the conclusions that could be drawn.

**Conclusions**

When dysphoric or depressed individuals ruminate on their low mood this can impair subsequent SPS in comparison to nondysphoric individuals who ruminate or

individuals who distract themselves. In depressed or dysphoric individuals rumination appears to affect problem definition, the generation of solutions and decision making. There is some evidence that rumination also affects solution implementation. The activation of overgeneral autobiographical memories may be a mechanism by which rumination impairs these component processes of SPS. Future research is needed to investigate the effect of rumination on the component processes of SPS outside the laboratory.

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## Appendix A. Instructions for authors for Cognition and Emotion

### Manuscript preparation

### 1. General guidelines

- This journal accepts full articles, brief reports, and Registered Reports of Replication (RRR) studies. The Journal also considers theoretical papers and literature reviews as long as these form a major contribution to our understanding of the interplay between emotion and cognition.
- Manuscripts are accepted in English. British English spelling and punctuation are preferred. Please use double quotation marks, except where “a quotation is ‘within’ a quotation”. Long quotations of 40 words or more should be indented with quotation marks.
- **Full Articles:** A full article will not exceed 8000 words including references, but excluding tables, captions, footnotes and endnotes. Manuscripts that greatly exceed this will be critically reviewed with respect to length. Authors should include a word count with their manuscript.
- **Brief Reports:** Manuscripts that describe the findings of one experiment should typically be submitted as a Brief Report. The main text of a brief report should contain no more than 4000 words and should include a maximum of 2 tables or figures and 25 references.
- **Registered Reports of Replication (RRR) Studies**: Registered Replication Reports are manuscripts describing the findings of a study designed to directly or conceptually replicate empirical findings published previously.

Unlike the more conventional process where a full report of empirical research is submitted for peer review, RRRs can be considered as proposals for empirical research, which are evaluated on their merit prior to the data being collected. For information on how to prepare Registered Reports of Replication (RRR) submissions see: http://explore.tandfonline.com/page/beh/pcem-registered-reports-of-replication-studies/pcem-rrr-instructions-for-authors.

- The style and format of the typescripts should conform to the specifications given in the *Publication Manual of the American Psychological Association* (6th ed.).
- All parts of the manuscript should be double-spaced, with margins of at least one inch on all sides. Number manuscript pages consecutively throughout the paper.
- Manuscripts should be compiled in the following order: title page; abstract; keywords; main text; acknowledgements; references; appendices (as appropriate); table(s) with caption(s) (on individual pages); figure caption(s) (as a list).
- **Title page** . This should contain only:

  (1) the title of the paper and a shortened version of the title suitable for the running header (not exceeding 40 character spaces)

  (2) the name, affiliation, email address, postal address and telephone number of all authors (please identify the corresponding author);

  (3) funding and grant-awarding body acknowledgements.
- **It is a condition of submission that authors fully disclose details of their data collection and data analysis.** Upon submission, authors will be

required to confirm that they adhere to the following statement, and should include this or a similar statement in the methods section: “We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study".

- Abstracts of 100-150 words are required for all manuscripts submitted.
- Each manuscript should have to 5 keywords.
- Search engine optimization (SEO) is a means of making your article more visible to anyone who might be looking for it. Please consult our guidance here.
- Section headings should be concise and should not contain numbering.
- All authors of a manuscript should include their full names, affiliations, postal addresses, telephone numbers and email addresses on the title page of the manuscript. One author should be identified as the corresponding author. Please give the affiliation where the research was conducted. If any of the named co-authors moves affiliation during the peer review process, the new affiliation can be given as a footnote. Please note that no changes to affiliation can be made after the manuscript is accepted. Please note that the postal and email address of the corresponding author will normally be displayed in the article PDF and the online article.
- All persons who have a reasonable claim to authorship must be named in the manuscript as co-authors; the corresponding author must be authorized by all co-authors to act as an agent on their behalf in all matters pertaining to publication of the manuscript, and the order of names should be agreed by all authors.
- Biographical notes on contributors are not required for this journal.

- Please supply all details required by any funding and grant-awarding bodies as an Acknowledgement on the title page of the manuscript, in a separate paragraph, as follows:
    - *For single agency grants:* "This work was supported by the [Funding Agency] under Grant [number xxxx]."
    - *For multiple agency grants:* "This work was supported by the [Funding Agency 1] under Grant [number xxxx]; [Funding Agency 2] under Grant [number xxxx]; and [Funding Agency 3] under Grant [number xxxx]."
- Authors must also incorporate a Disclosure Statement which will acknowledge any financial interest or benefit they have arising from the direct applications of their research.
- **Tables** should be kept to the minimum. Each table should be typed double spaced on a separate page, giving the heading, e.g., "Table 2", in Arabic numerals, followed by the legend, followed by the table. Make sure that appropriate units are given. Instructions for placing the table should be given in parentheses in the text, e.g., "(Table 2 about here)".
- **Results** of statistical tests should be given in the following form:

  "... results showed an effect of group, $F$ (2, 21) = 13.74, $MSE$ = 451.98, $p$ < .001, but there was no effect of repeated trials, $F$ (5, 105) = 1.44, $MSE$ = 17.70, and no interaction, $F$ (10, 105) = 1.34, $MSE$ = 17.70."

  Other tests should be reported in a similar manner to the above example of an $F$ -ratio. For a fuller explanation of statistical presentation, see the *APA Publication Manual.*
- **Abbreviations** that are specific to a particular manuscript or to a very specific area of research should be avoided, and authors will be asked to spell out in

full any such abbreviations throughout the text. Standard abbreviations such as RT for reaction time, SOA for stimulus onset asynchrony or other standard abbreviations that will be readily understood by readers of the journal are acceptable. Experimental conditions should be named in full, except in tables and figures.

- **Footnotes** should be avoided unless absolutely necessary. Essential footnotes should be indicated by superscript figures in the text and collected on a separate page at the end of the manuscript.
- For all manuscripts non-discriminatory language is mandatory. Sexist or racist terms must not be used.
- Authors must adhere to SI units. Units are not italicised.
- When using a word which is or is asserted to be a proprietary term or trade mark, authors must use the symbol ® or TM.
- Authors must not embed equations or image files within their manuscript

**2. Style guidelines**

- Description of the Journal's reference style.
- Guide to using mathematical scripts and equations.

**3. Figures**

- Please provide the highest quality figure format possible. Please be sure that all imported scanned material is scanned at the appropriate resolution: 1200 dpi for line art, 600 dpi for grayscale and 300 dpi for colour.
- Figures must be saved separate to text. Please do not embed figures in the manuscript file.

- Files should be saved as one of the following formats: TIFF (tagged image file format), PostScript or EPS (encapsulated PostScript), and should contain all the necessary font information and the source file of the application (e.g. CorelDraw/Mac, CorelDraw/PC).
- All figures must be numbered in the order in which they appear in the manuscript (e.g. Figure 1, Figure 2). In multi-part figures, each part should be labelled (e.g. Figure 1(a), Figure 1(b)).
- Figure captions must be saved separately, as part of the file containing the complete text of the manuscript, and numbered correspondingly.
- The filename for a graphic should be descriptive of the graphic, e.g. Figure1, Figure2a.

**SCHOOL OF PSYCHOLOGY**

**DOCTORATE IN CLINICAL PSYCHOLOGY**

EMPIRICAL PAPER

# Rumination and Time Allocation across Tasks


| | |
|---|---|
| Trainee Name: | **Geoffrey Duggan** |
| Primary Research Supervisor: | **Dr Nick Moberly**<br>Senior Lecturer, Mood Disorders Centre |
| Secondary Research Supervisor: | **Professor Ed Watkins**<br>Professor of Experimental and Applied Clinical Psychology, Mood Disorders Centre |
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## Abstract

Background and Objectives: Rumination may contribute to depression by impairing the most effective allocation of time across activities. An experiment tested the role of rumination in time allocation across tasks.

Methods: State rumination was manipulated by cueing an unresolved goal in one condition (32 participants) and cueing a resolved goal in another condition (32 participants). Trait rumination and depressive symptoms were also measured. All participants completed two word generation tasks and allocated a fixed overall time budget between the tasks by interleaving between them.

Results: No difference was found in task performance or time allocation following the manipulation of state rumination. Self-reported rumination did not differ between conditions throughout the experimental task. Differences in time allocation behaviour were associated with trait rumination.

Limitations: Use of a non-clinical population and tasks that are unrepresentative of everyday problem solving limited the generalisability of the results and may have limited the effect of the state rumination manipulation on task performance.

Conclusions: The absence of a difference in self-reported rumination throughout the task suggests that either the word generation task reduced levels of rumination or that the level of rumination induced did not have a large effect on the cognitive processes required to complete the word generation task.

## Introduction

Depressive 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). Response styles theory suggests that depressive rumination is a response style to low mood (Nolen-Hoeksema, 1991, 2000). As such it is a measurable trait and there is strong evidence that rumination contributes to the onset and maintenance of depression (Nolen-Hoeksema, 1991, 2000; Watkins, 2008).

An alternative control theory approach characterises rumination as simply conscious thought directed towards a given object for an extended period of time that recurs in the absence of environmental contexts that require this thought (Martin & Tesser, 1989, 1996, 2006). Within control theory, people are conceptualised as organisations of self-regulating feedback systems (Carver & Scheier, 1998). Martin and Tesser (1996) suggest that rumination plays an important role in this self-regulation and, rather than being classed as a trait, rumination is conceived of as a response to perceived insufficient progress towards a goal. Individuals continue to ruminate until they perceive they have made sufficient progress towards the goal, attain the goal or give up on the goal (see also Kuhl, 1985). Importantly, rumination can be both adaptive and maladaptive – helping individuals to attain goals or leading to perseveration on unachievable or hard-to-achieve goals. In depression, rumination is often characterised by unconstructive perseveration on hard-to-achieve goals meaning that it serves to perpetuate rather than reduce difficulties (Martin & Tesser, 1996).

Ultimately, response styles theory and control theory are not necessarily inconsistent and this study draws on both accounts to examine the role of rumination when managing goal directed behaviour across multiple goals. Although rumination can adaptively increase an individual's focus on an important goal (Calhoun, Cann, Tedeschi & McMillan, 2000), Martin and Tesser (2006) note that individuals typically pursue multiple goals simultaneously, and that the pursuit of some goals may conflict with the pursuit of other goals. Rumination to facilitate progress towards one goal may interfere with the attainment of progress towards another goal (Pyszczynski & Greenberg, 1987). Further, rumination about one goal may also interfere with the overall process of regulating resources (time, effort) across multiple goals. The potential significance of these properties of rumination can be understood through a behavioural description of depression.

**Rumination and the Behavioural Model of Depression**

Early behavioural models of depression attribute the symptomatic changes in mood to a decrease in response-contingent reinforcement for nondepressive behaviour (Ferster, 1973; Lewinsohn, 1974; Skinner, 1953). Positively reinforced healthy behaviour decreases in depression due to a reduction in the availability of reinforcing stimuli, the ability to obtain reinforcement and an increased frequency of punishment (Hopko, Lejuez, Ruggiero & Eifert, 2003; Lewinsohn, 1974). Assuming that individuals have discretion over their exposure to positively reinforcing stimuli, this account suggests that the way that individuals allocate time across tasks will affect their depressive symptoms. Allocating time to tasks that provide more positively reinforcing events will reduce depressive mood. This insight underpins the

effectiveness of the behavioural activation approach to depression (Dimidjian et al., 2006; Mazzucchelli, Kane & Rees, 2009).

Put another way, the behavioural model of depression suggests that the choice between more and less rewarding activities plays an important role in depression (see also Brunstein, 1993). Rumination facilitates progress towards goals and helps select between goals or tasks (Martin & Tesser, 1989, 2006), thus rumination may have an important effect on the allocation of time to more and less rewarding activities. That is, constructive rumination that reduces the perceived discrepancy between the current state and the goal state will provide positive reinforcement in the form of progress towards goals and engagement in activity. Conversely, unconstructive rumination will lead to repeated exposure to unsuccessful attempts to increase progress towards goals. Furthermore, there is evidence that the process of rumination places demands on executive functioning and depletes working memory resources (Whitmer & Gotlib, 2013). These resources are required to allocate time between more and less rewarding activities. Thus, just as depressive rumination is associated with poorer problem solving (Lyubormirsky, Tucker, Caldwell & Berg, 1999) and concentration (Lyubomrisky, Kasri & Zehm, 2003), unconstructive rumination may also inhibit the ability to allocate time to the most rewarding activity. In short, rumination may limit exposure to positively reinforcing events by producing perseveration on unachievable goals or by expending cognitive resources that could be used to effectively allocate time across activities.

Evidence that depressive rumination can affect the allocation of time across tasks was provided by van Randenborgh, Hüffmeier, LeMoult and Joormann (2010). In one experiment they divided participants into groups of high and low trait

ruminators and in another experiment they manipulated state rumination. In both experiments they gave participants solvable and unsolvable anagrams and measured time taken to abandon the unsolvable anagrams. Both trait and state rumination led to longer times to give up the unsolvable anagrams. This result suggests that rumination can lead to greater task perseveration even when the goal is unattainable.

**Time Allocation across Tasks**

Like Martin and Tesser (1996; 2006), Carver and Scheier (1998; Carver, 2003, 2006) draw on control theory (Powers, 1973) to describe a model for regulating effort across multiple different goals. Goals are pursued by assessing where one is relative to the goal and taking steps to reduce the discrepancy. A criterion of expected rate of progress is set for each goal and temporarily moving ahead or falling behind this criterion is a determinant of shifts among multiple goals. Recent empirical work has supported the model by showing that unexpectedly low progress towards a goal led participants to increase subsequent effort towards that goal (Fulford, Johnson, Llabre & Carver, 2010).

The present study operationalised effort as “time spent on task” and followed on from Fulford et al. (2010) by applying a paradigm from Payne, Duggan and Neth (2007) that enabled direct measurement of the rate of progress on a particular task. This enabled a quantitative characterisation of the strategies implemented by individuals to manage performance across tasks. Further, it supported an analysis of the impact of rumination on the management of performance across different tasks. This included the effect of rumination upon (a) the overall allocation of time to different tasks and (b) the shifts between goals in response to changes in rate of

progress over time. In this study the management of performance across tasks was studied as the allocation of time across tasks.

The paradigm used here from Payne et al. (2007) required participants to allocate time across an easy and a hard letter set in a word generation task. The rate at which participants generated words provided a measure of the rate of progress on each task. An important statistic was “giving-up time” which was the length of time between the final generation of a word and the decision to switch task. A bimodal distribution of giving-up times in Payne et al. (see also Hutchinson, Wilke & Todd, 2008) indicated that a significant proportion of task switches directly followed the accomplishment of a subgoal. In these instances individuals did not switch task until they had achieved a subgoal. If rumination leads to greater task perseveration (van Randenborgh et al., 2010) then rumination may also lead to a higher proportion of tasks switches taking place immediately after subgoal completion. Using the data from Payne et al. this translates to a higher proportion of giving-up times that are less than six seconds.

In this experiment, state rumination was manipulated by cueing resolved or unresolved goals. This manipulation was chosen because the effects of the manipulation were known to be maintained across a subsequent cognitive task (Roberts, Watkins & Wills, 2013) and the manipulation is directly derived from control theory. Roberts et al. (2013) found that unresolved goals led to higher levels of rumination than resolved goals and that strategy selection on a sustained attention response task was affected by rumination such that ruminators took longer to respond but were more accurate. Roberts et al. also found that the effect of state rumination was moderated by trait rumination, such that the manipulation of state rumination induced greater levels of rumination for individuals high in trait rumination

than those low in trait rumination. This is consistent with evidence from experience sampling that individuals high in trait rumination also experienced greater frequency of state rumination (Moberly & Watkins, 2008). Moreover, trait rumination and depressive symptoms have been found to moderate the effect of state rumination on social problem solving (Donaldson & Lam, 2004; Sanders & Lam, 2010). Therefore, both trait rumination and depressive symptoms were measured and their interaction with state rumination was analysed. It was predicted that trait rumination and depressive symptoms would moderate the effect of state rumination on time allocation such that state rumination would impair time allocation to a greater extent for individuals with high levels of trait rumination and depressive symptoms.

In summary, the relationship between rumination and depression is complex (Watkins, 2008). This experiment focuses on the role of time allocation in relation to both variables. Following the behavioural model of depression (Lewinsohn, 1974), it is suggested that allocating time to enable exposure to positively reinforcing events will lead to a reduction in depressive symptoms. Rumination is proposed to impair time allocation across tasks by causing individuals to dwell on unachievable goals (van Randenborgh et al., 2010) and reducing cognitive resources that could have been used to optimise time allocation (Whitmer & Gotlib, 2013). This in turn may contribute to less allocation of time to positively reinforcing events – thus maintaining depression.

It was predicted that cueing an unresolved goal would stimulate higher levels of rumination than cueing a resolved goal and this rumination would degrade individuals' allocation of time across the two word generation tasks. It was also predicted that following rumination on an unresolved goal rather than a resolved goal there would be fewer switches between tasks, more time spent on the hard task and

a higher proportion of giving-up times that are less than six seconds. Following Keogh, Moore, Duggan, Payne and Eccleston (2013) post-task judgements of performance were also recorded and it was predicted that the effect of rumination on task performance would be replicated for post-task judgements of performance.

## Method

### Design

State rumination was manipulated using the goal cueing task from Roberts et al. (2013). Thirty two participants were allocated to each goal condition. Goal condition, trait rumination and depressive symptoms were variables included in the regression analysis. The key dependent variables were taken from the word generation task. They were time on hard task, number of switches and giving-up time.

### Participants

Participants were 12 male and 52 female undergraduate students from the University of Exeter. All participants were native English speakers and received course credit for taking part in the experiment. Participants' age ranged from 18-43 years ($M$ = 20.16, $SD$ = 4.71). Participants were randomly allocated to one of two groups each comprising 32 participants. There were 6 male participants in each group and the groups did not significantly differ in age ($t$ < 1). The study was approved by the University of Exeter, Ethics Approval Committee, study number 2014/513.

## Materials and Measures

**Patient Health Questionnaire (PHQ-9; Spitzer, Kroenke & Williams, 1999).** The PHQ-9 assesses the presence of nine depressive symptoms over the preceding two weeks using 9 items (e.g. feeling tired or having little energy) that are each rated on a scale from 0 (not at all) to 3 (every day), with higher scores indicating a greater frequency of days that the symptom has bothered them (range 0-27). The PHQ-9 has good construct validity (Martin, Rief, Klaiberg & Braehler, 2006) and a high sensitivity to change in outcomes (Löwe, Kroenke, Herzog & Gräfe, 2004). The PHQ-8 omits the suicidal ideation item from the PHQ-9 and was used as the experimenter had not completed the training for managing a suicidal response. It has been shown to have good criterion validity (McGuire, Strine, Allen, Anderson & Mokdad, 2009; Pinto-Meza, Serrano-Blanco, Penarrubia & Haro, 2005) and construct validity (Martin et al., 2006; McGuire et al., 2009). Reliability was calculated from the data in this experiment and found adequate internal consistency ($\alpha$ = .76).

**Response Styles Questionnaire – Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991).** The RRS assesses the extent to which individuals respond to depressed mood by focusing on self, symptoms and on the causes and consequences of their mood (trait rumination) using 22 items (e.g. think about how alone you feel) that individuals rate as to whether this is something they generally do on a scale from 1 (almost never) to 4 (almost always), with higher scores indicating a greater trait tendency to depressive rumination (range 22-88). The RRS has high internal consistency, acceptable construct validity, and good test-retest reliability (Nolen-Hoeksema & Morrow, 1991; Treynor, Gonzalez & Nolen-

Hoeksema, 2003). Reliability was calculated from the data in this experiment and found adequate internal consistency ($\alpha$ = .91).

**Visual-analogue scales.** Visual-analogue 7-point scales were used to assess current levels of sadness, tension, self-focus and rumination on a particular goal. The scales ranged from 1 (very happy, very calm, not at all focused on myself, not at all thinking about it) to 7 (very sad, very tense, extremely focused on myself, thinking about it extremely often). The rumination scale included a brief summary of the goal that participants had identified during the goal-cueing task and asked participants how often they had been thinking about that goal in the last three minutes. (See Appendix A for full listing of scales.) Previous research indicates that visual analogue scales of this format can reliably detect changes in mood tension and self-focus (Roberts et al., 2013; Watkins & Teasdale, 2001, 2004).

**Goal cueing task.** The goal cueing task was taken from Roberts et al. (2013). In the unresolved condition participants were instructed to focus for 10 minutes on an ongoing or unresolved concern that they have been repeatedly thinking about in the last week. In the resolved condition participants focused on a concern that had troubled them in the past but was now resolved. Roberts et al. (2013) found this task elicited greater levels of rumination about the identified goal in the unresolved goal condition relative to the resolved goal condition. Prior to focusing on the goal, in both conditions participants rated their identified goal on scales of 0-10 for its importance, how much it bothered them now, how much it bothered them at its worse, how much they'd been thinking about it over the last week, how long it had been a difficulty and how much it related to more general concerns that they had. The full protocol for the task is given in Appendix B.

**Word generation task.** The word generation task was taken from Payne et al. (2007). Participants were given two sequences of letters and asked to generate as many words as possible using those letters. The “Easy” letter sequence was “L N A O I E T” which contains 53 words and the “Hard” letter sequence was “E S I F L C E” which contains 23 words (see Payne et al., 2007; for calculation of the potential word maximum for each letter sequence). Task instructions explained that words had to be between two and seven letters in length, could not use the same letter twice, could not use letters from more than one letter sequence and were not allowed to be proper nouns or acronyms. Participants were told they could switch between the letter sequences as much or as little as they wanted but their aim should be to maximise the total number of words generated in the 600 seconds provided (see Appendix C for complete list of instructions). Data from Payne et al. (2007) indicated that the optimal allocation of time was to spend approximately 25% of time on the Hard task.

Materials were presented on laptop computer with mouse using a bespoke program written using Microsoft Visual Studio. Following instruction, participants practiced the task using two different letter sequences until they understood the task. The experimental task was initiated by clicking on a button labelled “Start” at the top left of the screen. After the start button had been clicked on, a timer box below the Start button counted down from 600 to 0, in 1 second intervals. Two buttons labelled “Sequence 1” and “Sequence 2” were horizontally aligned at the top of the screen. Participants clicked on either sequence button to display a letter sequence in a box across the middle of the screen beneath the sequence buttons. At the start of the task the Easy and Hard letter sequences were randomly allocated to different sequence buttons for each participant. At the bottom of the screen were a textbox

and a button labelled “Enter”. Participants entered each word they generated by typing into the textbox and then clicking Enter, this cleared the textbox in preparation for the next word. No external feedback was given on the number of words entered or whether they were legitimate words. The program ended when the timer reached zero.

At 200, 400 and 600 seconds participants were interrupted by the program and asked to complete the sadness and rumination visual analogue scales before they returned to the word generation task at the same juncture. The timer for the word generation task stopped while the scales were completed.

Time on hard task was measured using the total number of seconds when the “Hard” letter sequence was visible. Number of switches was the number of times participants clicked on the opposite letter sequence from the one currently selected. Giving-up time was measured from the last time the “Enter” button was clicked when there were letters in the textbox until the button for the alternative letter sequence was clicked. Thus, it recorded the time between the last generation of a word during a task visit and the decision to switch task. For visits to a task when no words were generated giving-up time was equal to the length of the task visit. Mean giving-up time for each task was then calculated for each participant by averaging across all attempts to generate words from that task. The proportion of giving up times that were less than 6 seconds was calculated within each task, for each participant.

Several other measures of task performance were also recorded although they were less central to the hypotheses around time allocation. All word repetitions and nonwords that were entered were summed to calculate the number of errors each participant made. Following Payne et al. (2007), nonwords were defined as any letter sequence that was not one of the pre-identified words. Number of items

generated on each task was calculated for each participant by subtracting the number of errors for that task from the total number of words entered.

**Post-task judgements of task performance.** Questions about task performance and visual analogue scales were used to assess self-rated task performance after the task had been completed. Participants were asked to judge the number of words generated in both easy and hard tasks, the time spent on the hard task and the number of switches between tasks. Scales tested difficulty of generating words on each task and amount of attention focused on the task. They ranged from 1 (very easy, very little) to 7 (very hard, I was extremely focused). These measures were adapted from Berka et al. (2007) and Keogh et al. (2013). The questions about task performance and scales are given in Appendix D.

## Procedure

Participants read the information sheet and then consented to take part in the experiment. They then completed the PHQ-8, RRS and visual analogue scales for sadness, tension and self-focus. This was followed by the instructions and practice for the word generation task and then the goal cueing task. Sadness, tension and self-focus visual analogue scales were completed for a second time as well as the rumination visual analogue scale. Participants then completed the word generation task which was immediately followed by the post-task judgements of task performance. They were then debriefed and completed a short positive mood induction task to limit post-experiment rumination.

## Results

Dependent measures were calculated for each participant and these scores were then used to calculate means and standard deviations across participants in the unresolved goal condition and the resolved goal condition. Any participant score ±3.29 *Z*-scores from the mean for that condition was categorised as an outlier. One score from the unresolved condition post-task judgement of number of switches met this criterion. This was replaced by the next highest score from that condition. No other univariate outliers were identified. No multivariate outliers for the predictive variables used in the regressions were identified.

### Participant Characteristics

Scores for the participant scales administered and the ratings for the goal focused on during the goal cueing task are given in Table 1. Means and standard deviations are given for the resolved and unresolved goal conditions. There were no significant differences between the resolved and unresolved goal conditions on the number of depressive symptoms reported or on trait rumination.

Participants reported more thoughts in the past week about the unresolved goal than the resolved goal, $t$ (62) = 19.71, $p < .001$, $\eta_p^2 = .86$. The unresolved goal condition were also currently more bothered by thoughts about the goal than the resolved goal condition, $t$ (62) = 14.83, $p < .001$, $\eta_p^2 = .78$. There were no other significant differences between the goals selected in the resolved and unresolved goal conditions. Therefore, the goals did not differ in their perceived severity or nature but the unresolved goals bothered participants more than the resolved goals. This pattern of significance was as predicted and replicated Roberts et al. (2013).

Table 1.

*Means and standard deviations for depressive symptoms, trait rumination and ratings of goal cued in both unresolved and resolved goal conditions.*

| | Unresolved | | Resolved | |
|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* |
| Depressive symptoms (PHQ-8) | 6.06 | 4.00 | 4.81 | 3.37 |
| Trait Rumination (RRS) | 47.41 | 10.98 | 43.06 | 12.69 |
| Goal importance | 8.56 | 1.16 | 8.00 | 1.95 |
| Bothered now by goal | 6.69 | 1.69 | 1.06 | 1.32 |
| Bothered by goal at worst | 9.28 | 1.11 | 9.09 | .86 |
| Thoughts of goal in the last week | 6.94 | 1.61 | .56 | .88 |
| Goal duration | 4.66 | 2.32 | 5.06 | 2.63 |
| Relation to general concerns | 5.47 | 2.24 | 4.69 | 2.95 |

**Mood and Self-focus Pre- and Post-Goal Cueing Manipulation**

Table 2 includes descriptive statistics for mood and self-focus before and after the goal cueing manipulation in both conditions. Sadness, tension and self-focus were compared before and after the manipulation with 2 (Condition: unresolved goal, resolved goal) × 2 (Time: pre-goal manipulation, post-goal manipulation) mixed ANOVAs with repeated measures on the second factor.

Table 2.

*Means and standard deviations for mood, tension and self-focus pre- and post-goal cueing manipulation*

| | Pre-Manipulation | | | | Post-Manipulation | | | |
|---|---|---|---|---|---|---|---|---|
| | Unresolved | | Resolved | | Unresolved | | Resolved | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Sadness | 3.19 | 1.18 | 2.97 | 1.00 | 4.59 | .98 | 3.50 | 1.11 |
| Tension | 3.34 | 1.18 | 3.50 | 1.37 | 4.22 | 1.58 | 3.34 | 1.26 |
| Self-focus | 4.59 | 1.13 | 4.38 | 1.36 | 4.94 | 1.56 | 5.06 | 1.41 |

There was a main effect of time with participants reporting feeling sadder after the manipulation, $F$ (1, 62) = 46.73, $p$ < .001, $\eta_p^2$ = .43 and a main effect of condition with participants sadder in the unresolved goal condition, $F$ (1, 62) = 8.40, $p$ < .01, $\eta_p^2$ = .12 but with both secondary to a Time × Condition interaction, $F$ (1, 62) = 9.53, $p$ < .01, $\eta_p^2$ = .13. Simple effects analysis indicated that the participants in the unresolved goal condition were sadder than those in the resolved goal condition after the manipulation, $F$ (1, 62) = 17.52, $p$ < .001, $\eta_p^2$ = .22 but there was no difference between conditions before the manipulation, $F$ (1, 62) = .64, $p$ = .43, $\eta_p^2$ = .01.

There was a marginal effect of Time on the amount of tension that participants felt, with more tension after the manipulation, $F$ (1, 62) = 3.83, $p$ = .055, $\eta_p^2$ = .06. There was no main effect of Condition, $F$ (1, 62) = 1.59, $p$ = .21, $\eta_p^2$ = .03, on tension but as expected there was a Time × Condition interaction, $F$ (1, 62) = 7.89, $p$ < .01, $\eta_p^2$ = .11. Analysis of simple effects found that participants reported more tension in the unresolved condition than the resolved condition after the manipulation, $F$ (1, 62) = 6.00, $p$ < .05, $\eta_p^2$ = .09, but there was no difference between the conditions before

the manipulation, $F$ (1, 62) = .24, $p$ = .63, $\eta_p^2$ = .00. Tension was higher after the manipulation in the unresolved goal condition, $F$ (1, 62) = 11.36, $p$ < .01, $\eta_p^2$ = .16, but there was no difference in tension from pre-goal to post-goal in the resolved goal condition $F$ (1, 62) = .43, $p$ = .52, $\eta_p^2$ = .01.

There was a main effect of Time on self-focus reflecting greater self-focus after the manipulation than before the manipulation, $F$ (1, 62) = 5.73, $p$ < .05, $\eta_p^2$ = .09. There was no effect of Condition on self-focus, $F$ (1, 62) = .03, $p$ =.86, $\eta_p^2$ = .00, and there was no interaction between Condition and Time, $F$ (1, 62) = .64, $p$ =.43, $\eta_p^2$ = .01.

Therefore, the goal manipulations differentially affected the level of tension and sadness across conditions and the level of self-focus was increased following the manipulation but not differentially across conditions.

**Mood and Rumination during the Word Generation Task**

Participant reported levels of sadness and rumination at four different time points were analysed as a manipulation check. It was expected that rumination would be greater in the unresolved condition and this would persist throughout the task. Results are given in figure 1 and a 2 (Condition: unresolved goal, resolved goal) × 4 (Time: 0s, 200s, 400s and 600s) mixed ANOVA with repeated measures on the second factor was conducted on self-reported sadness and rumination.

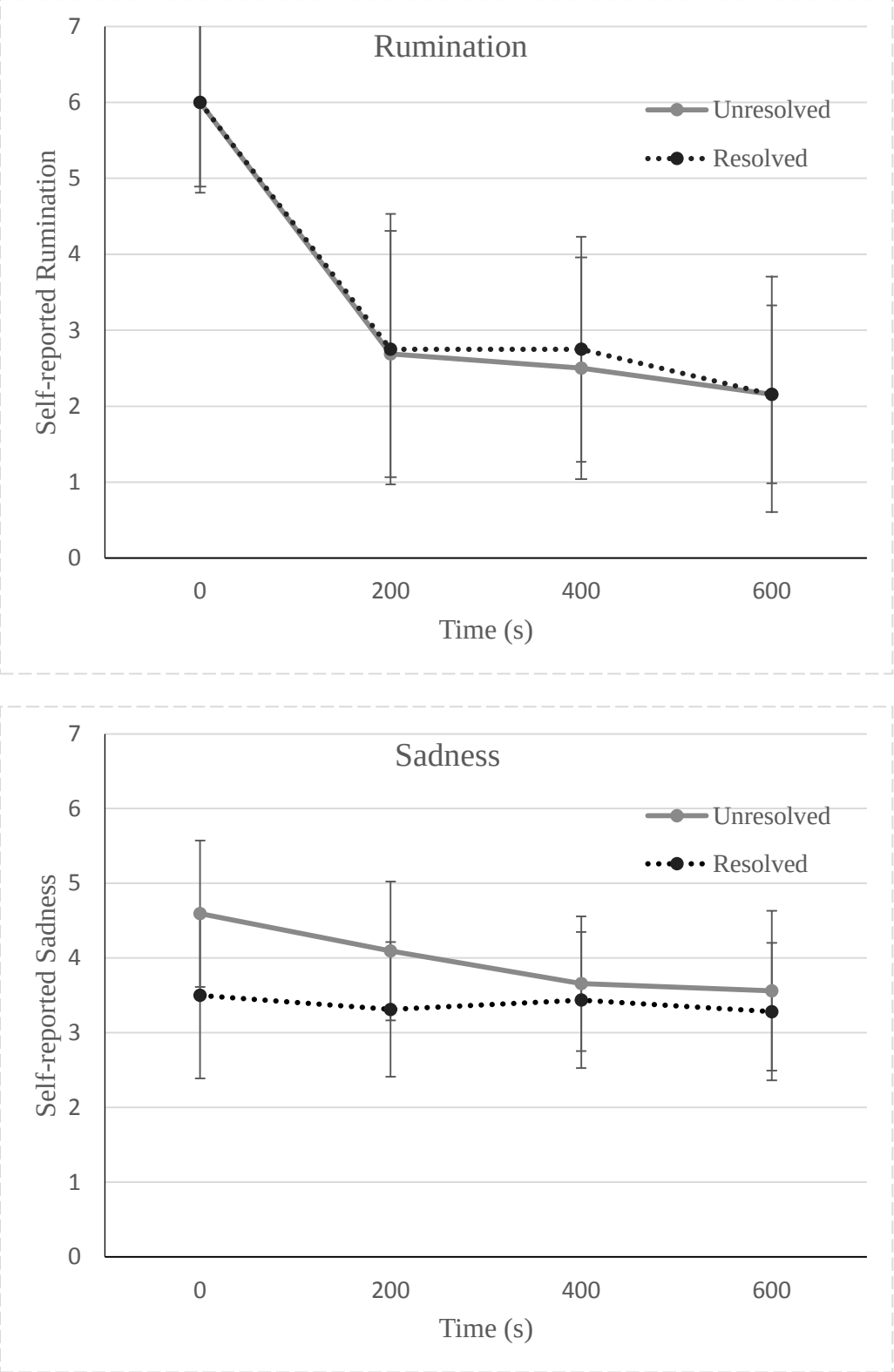


*Figure 1.* Mean self-reported rumination and sadness during the word generation task. Scores given for both the unresolved and resolved goal conditions. Error bars are standard deviations, longer error bar caps for unresolved goal condition.

For sadness there was a main effect of Condition, which indicated that participants reported feeling more sad in the unresolved condition than the resolved goal condition, $F$ (1, 62) = 10.05, $p$ < .001, $\eta_p^2$ = .14. A main effect of Time indicated that participants reported less sadness as the task progressed, $F$ (3, 186) = 9.31, $p$ < .001, $\eta_p^2$ = .13. As expected the Condition × Time interaction was significant, $F$ (3, 186) = 5.55, $p$ < .01, $\eta_p^2$ = .08. Analysis of simple effects found that the unresolved condition was sadder than the resolved condition at the beginning of the task, $F$ (1, 62) = 17.52, $p$ < .001, $\eta_p^2$ = .22 and after 200s, $F$ (1, 62) = 11.74, $p$ < .01, $\eta_p^2$ = .16. There were no differences between conditions at 400s, $F$ (1, 62) = .93, $p$ = .34, $\eta_p^2$ = .02 and 600s, $F$ (1, 62) = 1.26, $p$ = .27, $\eta_p^2$ = .02. Sadness decreased over time in the unresolved condition, $F$ (3, 60) = 7.33, $p$ < .001, $\eta_p^2$ = .27 and there was no effect of Time on sadness in the resolved condition, $F$ (3, 60) = .59, $p$ = .45, $\eta_p^2$ = .02.

There was a main effect of Time on self-reported rumination, with rumination decreasing during the task, $F$ (3, 186) = 208.04, $p$ < .001, $\eta_p^2$ = .77. There was no effect of Condition on rumination, $F$ (3, 186) = .07, $p$ =.79, $\eta_p^2$ = .00 and no interaction between Condition and Time, $F$ (3, 186) = .02, $p$ =.89, $\eta_p^2$ = .00. Figure 1 shows a high score for rumination at the start of the word generation task in both conditions this was anticipated as participants had just completed the goal cueing manipulation that required them to think about the goal.

**Word Generation Task**

Table 3 includes measures of task performance during the word generation task and the post-task judgements of task performance. These measures are given for both unresolved and resolved conditions. A number of variables were not

normally distributed, where possible these were transformed using x = log (1 + x) prior to analysis. Any variables that still violated assumptions of normality following this transformation were analysed non-parametrically. Table 3 indicates which variables were transformed or analysed non-parametrically. Independent *t* tests between unresolved and resolved conditions were carried out on log (1 + number of switches), log (1 + post-task judgement of number of switches) and time on hard task. Mann-Whitney *U* tests between unresolved and resolved conditions were computed on post-task judgement of time on hard task and proportion of Hard task visits with a giving-up time of < 6s and proportion of Easy task visits with a giving-up time of < 6s. No differences were found on any of these analyses, *t* and *U* values are given in Table 3.

No predictions were made about the other measures in Table 3. The difference between unresolved and resolved goal conditions was also analysed for each of the remaining measures in Table 3 using independent *t* tests or Mann-Whitney *U* tests. A Bonferroni correction was applied to the alpha level for these analyses to account for making multiple comparisons (i.e. $\alpha$ = .05/10 = .005). None of these comparisons were significant, *t* and *U* values are given in Table 3.

Figure 1 indicates that at 200s there was still a difference in sadness between the two conditions thus all of the analyses were repeated using the first 200s of the word generation task and also using just the first visit to the Hard and Easy tasks. None of these analyses found any significant differences between unresolved and resolved goal conditions.

Table 3.

*Means and standard deviations for measures of task performance and post-task judgements for word generation task in unresolved and resolved goal conditions.*

| | Unresolved | | Resolved | | Difference |
|---|---|---|---|---|---|
| Task performance measures | *M* | *SD* | *M* | *SD* | |
| Number of task switches† | 9.13 | 3.69 | 10.09 | 4.88 | $t(62) = .62$ |
| Time on Hard task | 218.45 | 49.66 | 219.82 | 56.22 | $t(62) = .10$ |
| Number of items generated on Hard task | 10.25 | 3.59 | 10.59 | 4.28 | $t(62) = .35$ |
| Number of items generated on Easy task | 23.84 | 7.01 | 24.03 | 8.39 | $t(62) = .10$ |
| Giving-up time Hard task† | 20.92 | 8.97 | 22.25 | 14.91 | $t(62) = .06$ |
| Giving-up time Easy task† | 13.42 | 6.00 | 12.64 | 7.90 | $t(62) = .89$ |
| Proportion Hard task visits g-u time <6s‡ | .17 | .22 | .19 | .22 | $U = 468.00$ |
| Proportion Easy task visits g-u time <6s‡ | .37 | .26 | .32 | .29 | $U = 458.00$ |
| Number of errors† | 6.16 | 4.81 | 7.25 | 6.07 | $t(62) = .57$ |
| | | | | | |
| Post-task judgments of task performance | | | | | |
| Number of task switches† | 7.81 | 3.76 | 9.81 | 5.81 | $t(62) = 1.16$ |
| Time on Hard task‡ | 238.63 | 67.48 | 235.03 | 58.78 | $U = 493.00$ |
| Number of items generated on Hard task† | 12.12 | 6.18 | 12.03 | 8.46 | $t(62) = .50$ |
| Number of items generated on Easy task† | 17.13 | 8.84 | 18.09 | 10.79 | $t(62) = .20$ |
| Task difficulty Hard task‡ | 5.22 | 1.13 | 5.16 | 1.08 | $U = 508.50$ |
| Task difficulty Easy task‡ | 3.47 | 1.27 | 2.81 | 1.23 | $U = 353.50$ |
| Task attention‡ | 5.88 | .75 | 5.97 | .78 | $U = 476.50$ |

*† Transformed for analysis using x = log (1 + x). ‡ Analysed non-parametrically*.

*g-u time = giving-up time.*

**Moderating Effect of Trait Rumination and Depression**

Following Roberts et al. (2013) hierarchical regression was used to test whether trait rumination or depression moderated the effect of goal manipulation on task performance. Depression correlates highly with trait rumination so depression was also included in the regression to identify the contribution of trait rumination. The two dependent measures of primary theoretical interest were number of switches and time spent on hard task during the word generation task. Correlations between log (1 + number of switches), hard task time, log (1 + PHQ-8 score) and RRS score in each condition are given in Table 4. In both conditions the measures of depressive symptoms and trait rumination were positively correlated. There was a significant positive correlation between number of switches and depressive symptoms in the unresolved goal condition. There were no other significant correlations between number of switches and time on hard task and the measures of trait rumination and depression.

For the hierarchical regressions, goal condition (1 = unresolved goal; 0 = resolved goal), centred log (1 + PHQ8) scores (logPHQ8c) and centred RRS scores (RRSc) were entered in block 1. The interaction terms (goal condition × logPHQ8c; goal condition × RRSc; logPHQ8c × RRSc) were entered into block 2 of the regression and the 3-way interaction term (goal condition × logPHQ8c × RRSc) was entered into block 3. Two regressions were completed, one with time on hard task as the dependent variable and the other with log (1 + number of switches) as the dependent variable. Results from the regressions are given in Table 5.

Table 4.

*Correlations between measures of task performance and measures of depressive symptoms and trait rumination. Unresolved goal condition given above the line and resolved goal condition given below the line.*

| | RRS | Log(1+PHQ8) | Log(1+Number of switches) | Time on Hard task |
|---|---|---|---|---|
| RRS | - | .53** | -.06 | .01 |
| Log(1+PHQ8) | .62*** | - | .36* | -.24 |
| Log(1+Number of switches) | -.24 | .16 | - | -.27 |
| Time on Hard task | .34 | .10 | .24 | - |

** p < 05, ** p < 01, *** p < 001.*

The regressions found that when goal condition and PHQ8 scores were included in the regression, trait rumination predicted the time on hard task and the number of switches. That is, people who scored highly on trait rumination spent more time on the hard task and switched tasks fewer times during the word generation task. There were no other significant results or interactions between variables indicating that neither trait rumination nor depressive symptoms moderated the effect of goal condition upon either measure of task performance.

Table 5.

*Hierarchical regression analysing effect of trait rumination, depression and goal condition on time on hard task and number of switches.*

| | Time on Hard Task | | | Log (1 + Number of switches) | | |
|---|---|---|---|---|---|---|
| | *B* | *S.E.* | *β* | *B* | *S.E.* | *β* |
| *Step 1* | | | | | | |
| Condition | -3717.08 | 13125.78 | -.04 | -.02 | .05 | -.06 |
| logPHQ8c | 59273.65 | 33210.98 | .27 | -.22 | .12 | -.28 |
| RRSc | -1559.88* | 670.63 | -.36 | .005* | .002 | .33 |
| *Step 2* | | | | | | |
| Condition | -5136.62 | 12939.98 | -.05 | -.02 | .05 | -.06 |
| logPHQ8c | 37550.91 | 51562.15 | .17 | .01 | .18 | .02 |
| RRSc | -1707.83 | 919.98 | -.39 | .004 | .003 | .23 |
| Condition × logPHQ8c | 26077.64 | 66623.38 | .09 | -.37 | .24 | -.37 |
| Condition × RRSc | 499.69 | 1371.29 | .07 | .002 | .005 | .08 |
| logPHQ8c × RRSc | -4677.98 | 2509.21 | -.24 | 0 | .009 | -.003 |
| *Step 3* | | | | | | |
| Condition | 5635.97 | 14959.37 | .054 | -.02 | .05 | -.06 |
| logPHQ8c | 42436.26 | 51250.83 | .19 | .01 | .19 | .02 |
| RRSc | -1914.96* | 924.12 | -.44 | .004 | .003 | .23 |
| Condition × logPHQ8c | 18876.97 | 66267.28 | .064 | -.38 | .24 | -.37 |
| Condition × RRSc | 485.65 | 1359.89 | .07 | .002 | .005 | .08 |
| logPHQ8c × RRSc | -902.92 | 3667.67 | -.05 | 0 | .01 | .002 |
| Condition × logPHQ8c × RRSc | -6994.44 | 4992.35 | -.28 | -.001 | .02 | -.007 |

* = $p < .05$

Time on Hard task, Step 1, $F$ (3, 60) = 1.91, $p$ = .14, $R^2$ = .09; Step 2, $F$ (6, 57) = 1.84, $p$ = .11, $R^2$ = .16; Step 3, $F$ (7, 56) = 1.89, $p$ = .09, $R^2$ = .19.

Log (1 + Number of switches), Step 1, $F$ (3, 60) = 1.85, $p$ = .15, $R^2$ = .09; Step 2, $F$ (6, 57) = 1.41, $p$ = .23, $R^2$ = .13; Step 3, $F$ (7, 56) = 1.19, $p$ = .32, $R^2$ = .13.

## Discussion

Contrary to the hypotheses, no differences were found between unresolved and resolved goal conditions for any of the measures of task performance or time allocation. When goal condition, trait rumination and depressive symptoms were included within a hierarchical regression, there was some evidence that trait rumination was related to the allocation of time across tasks and the frequency with which people switch between tasks. That is, people high in trait rumination switched between tasks less frequently and allocated more time to difficult tasks than people low in trait rumination. Four explanations for the lack of differences between unresolved and resolved goal conditions are reviewed.

The first explanation is that the goal cueing manipulation did not affect state rumination. Table 2 outlines the effect of the manipulation on tension, self-focus and sadness. Following the manipulation there was a greater increase in tension and sadness for the unresolved goal condition than the resolved goal condition. The most directly comparable studies are Roberts et al. that used the same manipulation and found an effect of rumination on task performance and van Randenborgh et al.

(Experiment 2, 2010) that manipulated state rumination and found an effect on goal disengagement. Both studies found higher levels of sadness following the induction of state rumination (Roberts et al., $\eta_p^2$ = .60; van Randenborgh et al., $\eta_p^2$ = .12) but neither found a post-manipulation difference in sadness between conditions (Roberts et al., $\eta_p^2$ = .05; van Randenborgh et al., $F < 1$, effect size not reported). In contrast, the current experiment found increased sadness following the manipulation ($\eta_p^2$ = .43) and that the unresolved goal condition was sadder than the resolved condition immediately after the goal-cueing manipulation ($\eta_p^2$ = .22) and 200 seconds into the word generation task ($\eta_p^2$ = .16). In short, the state rumination manipulation in this experiment produced a larger difference in mood between conditions than in the two comparison studies.

The change in mood could be interpreted as indicating the effectiveness of the manipulation as rumination is associated with changes in mood (Nolen-Hoeksema, 1991). However, Figure 1 shows that there was no difference between conditions in rumination. The high level of self-reported rumination immediately after the goal cueing manipulation was unsurprising as participants had been explicitly instructed to ruminate on their identified goal. When tested during the word generation task, rumination on the goal was much lower and was equal across conditions. This contrasts with Roberts et al. who found sustained differences in rumination following the goal cueing manipulation although rumination was measured differently in their study. Van Randenborgh et al. did not measure self-reported rumination during their experiment.

The analyses of task performance over the first 200 seconds did not find any difference between conditions and the self-report question asked participants whether they had been thinking about the goal over the last 3 minutes. Thus, there is

no evidence that the manipulation led to increased levels of rumination despite the changes in levels of sadness.

The second explanation is that factors specific to this experiment prevented state rumination from affecting task performance. The main difference between this study and Roberts et al., was the task used. They required participants to sustain attention to 1800 neutral words presented consecutively with a 900 ms intertrial interval. This task may have been less engaging or rewarding for participants than the word generation task. Engagement with the word generation task was reportedly at its highest at the start of the task as word generation has diminishing marginal returns. Thus, when participants were most likely to engage in rumination they were also generating the most words and thus receiving the most reinforcement. Thus task characteristics may have limited any rumination following the goal-cueing manipulation. In Roberts et al. rumination was sustained throughout the task whereas it reduced rapidly in this task, indicating the word generation may have been more effective at countering rumination.

The van Randenborgh et al. study examined goal disengagement from impossible anagram tasks. This task had many similarities with the word generation task, however, the experience of permanently abandoning an unsolved anagram is qualitatively different from temporarily switching to another task. The experience of failing to complete an anagram may have induced greater levels of rumination thus explaining the difference between conditions in task performance observed in van Randenborgh et al. that were not replicated here.

The third explanation is that changes in state rumination do not affect the allocation of time across tasks or task performance. The absence of evidence for any difference in rumination between conditions means it is difficult to make any

inferences about the relationship between rumination and time allocation. The experiment specific factors identified above do suggest that when engaged by a rewarding task non-dysphoric individuals are less likely to ruminate or to allow rumination to affect their time allocation. This absence of reported differences in rumination is noteworthy given that participants in the unresolved goal condition experienced lower mood for the first 200s than those in the resolved goal condition.

The final explanation is that although there was an important difference between the unresolved and resolved goal conditions the experiment lacked sufficient power to detect this difference. The effect size for the difference in sadness between conditions following the goal cueing manipulation was, $\eta_p^2$ = .22. If this is taken as an indication of the sort of effect sizes that might be present for other variables and assuming standard values for experimental power (.8) and $\alpha$ level (.05), a comparison between two independent samples would require 15 participants in each group to detect a difference with this effect size. The current experiment had 32 participants in each group. The mean effect size for a difference between conditions across all task performance measures was, $\eta_p^2$ = .16 in Roberts et al. and $\eta_p^2$ = .11 in van Randenborgh et al. The sample size per group needed to detect a difference was 22 participants and 33 participants respectively. Thus, the current experiment had sufficient power to detect effect sizes found in similar studies.

Mean effect size for the difference between conditions was $\eta^2$ = .004 when averaged across the key dependent measures (Time on Hard task, Number of switches, Proportion of Hard and Easy task visits with giving up time < 6s) and $\eta^2$ = .005 when averaged across all dependent measures in Table 3. These effect sizes were both below the threshold for a small effect size (Cohen, 1992). Therefore, the lack of significant differences between conditions appeared to reflect the small effect

size rather than a lack of experimental power to detect a theoretically interesting difference.

In summary, there was no evidence of any difference in state rumination between the unresolved and resolved goal conditions. There was a difference between conditions in sadness and Roberts et al. found differences in rumination using the same goal cueing manipulation. This suggests that either the word generation task reduced levels of rumination or that the level of rumination induced did not have a large effect on the cognitive processes required to complete the word generation task.

**Implications of Findings**

When variance due to goal condition and depressive symptoms was accounted for, participants high in trait rumination spent more time on the hard task and switched between tasks less frequently than participants low in trait rumination. This echoes the finding of van Randenborgh et al. and suggests that the process underlying the reluctance of high ruminators to abandon problems in their experiments, may have led to high trait ruminators switching less frequently between the hard and easy letter sequences in this experiment. Furthermore, the higher proportion of time spent on the hard task suggests that this difficulty in goal disengagement could lead to high trait ruminators allocating time to less rewarding tasks. This result provides some support for the idea that reducing the opportunities for positive reinforcement could be an important causal mechanism by which rumination leads to depression (Hopko, Lejuez, Ruggiero & Eifert, 2003). Also noteworthy is that trait rumination was associated with task performance measures

independently of depression, thus indicating trait rumination may be a distinct construct of relevance to time allocation independently of depression.

The importance of the trait rumination results should not be overstated. Table 4 indicates that the correlations between trait rumination and time on hard task and number of switches were not large or significant. There was also a positive correlation between number of switches and depressive symptoms in one group, which is inconsistent with the above account. Furthermore, this aspect of the design was correlational in nature and no interactions were found with the experimentally manipulated state rumination thus it is not possible to infer a causal relationship between trait rumination and time on hard task or number of switches. It is difficult to draw strong conclusions from the absence of an interaction between state and trait rumination as it is unclear about the effectiveness of the state rumination manipulation. Another difficulty in interpreting this interaction is the limited range of depressive symptoms and trait rumination scores in this sample.

Any discussion of a null result is inherently speculative. Nonetheless, if engagement in the word generation task counteracted any effect of rumination then this suggests that performance on tasks which are cognitively demanding and rewarding is less susceptible to rumination and such tasks could even act as effective distraction techniques in the short term.

**Limitations of the Study**

Rumination is a theoretically interesting construct in part because of its hypothesised role in depression. This study used a nondepressed population to study rumination which makes it difficult to generalize any conclusions to clinical populations. Not least because manipulations of rumination have been shown to

have different effects on nondepressed and depressed populations (Nolen-Hoeksema & Morrow, 1993). This may also partly explain the lack of difference between unresolved and resolved goal conditions. Although the state rumination manipulation focused on a real goal for the participants it is plausible that the participants found the ruminative processes induced less powerful than those experienced by a depressed population. Thus, performance on the word generation task would be more affected by cueing an unresolved goal for a depressed population than for the nondepressed population used in this experiment. The significant relationship between trait rumination and the key dependent variables supports this suggestion.

By providing participants with the freedom to select their time allocation strategies the paradigm moved a step closer to real world behaviour than more controlled studies of cognitive processing (e.g. Roberts et al., 2013). However, the lack of complexity and intrinsic meaning in the task limits the generalisability of any results outside the laboratory and to a clinical setting.

There is evidence that time perception is affected by low mood, such that people with depression underestimate the duration of time periods (Gil & Droit-Volet, 2009). This is particularly relevant as there was a difference between groups in negative mood following the manipulation. This could have led to a difference in time perception and thus time allocation. A limitation of the current study is that it does not investigate the effects of time perception upon the hypothesized differences in time allocation.

**Future Directions for Research**

One straightforward alteration to the current design would be to repeat the study using a depressed population. The more entrenched patterns of rumination in this population (Watkins & Nolen-Hoeksema, 2014) might mean any effects from the goal cueing manipulation are sustained throughout the word generation task. Similarly, investigating real world time allocation decisions would enable investigation of the effect of rumination on meaningful tasks where time allocation decisions have greater consequences.

A strength of the paradigm employed was that it provided a dynamic measure of task performance, thus had differences between conditions been observed, this would have enabled a characterisation of the changes in strategy. This potential was particularly relevant given that control theories (e.g. Carver & Scheier, 1998; Carver, 2003) of multiple task performance, mood and rumination make predictions based on rate of task progress but rarely provide objective measures of this rate. Future use of methods similar to that employed here would enable testing of these predictions. For example, Carver and Scheier (1998) proposed that when goal progress falls below some criterion then negative affect and effort increase, but when goal progress exceeds this criterion then positive affect increases and efforts decreases. Objectively measuring the rate of goal progress would enable these predictions to be empirically tested.

**Summary**

This experiment did not find a difference in task performance or time allocation following a manipulation of state rumination. Self-reported rumination did not differ between conditions throughout the experimental task. Differences in time allocation behaviour were associated with trait rumination. Future studies with

depressed populations may demonstrate an effect of state rumination on time allocation.

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## Appendix A. Visual Analogue Scales

Please rate on the following scales how you are feeling at the present moment

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Very happy | | | | | | Very sad |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Very calm | | | | | | Very tense |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all focused on myself | | | | | | Extremely focused on myself |

How often are you thinking about [INSERT IDENTIFIED CONCERN FROM GOAL CUEING TASK HERE]?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Not at all thinking about it | | | | | | Thinking about it extremely often |

## Appendix B. Goal cueing task protocol

1. *To begin with I would like you to rate your mood, level of tension, and self-focus at the present moment using these scales.* (Give rating scales).
2. **Rumination condition:**
    a. "*For the next ten minutes I am going to ask you to close your eyes and focus your attention on a problem and difficulty that is still unresolved and bothering you –so this is an ongoing and unresolved concern that has been repeatedly coming in to your mind over the past week and causing you to feel negative, sad, down or stressed.*

*When I ask you to begin, please close your eyes and dwell on this current problem or concern, in the way that you usually dwell on and ruminate about unresolved concerns, as intensely as you can, until I ask you to stop and to open your eyes.*

*Examples of the kind of difficulty that I would like you think about are...*(give example rumination topics)

*The problem or difficulty that you think about must be one that has been repeatedly troubling you recently and that you have not resolved, that is, it still bothers you and still comes repeatedly to mind.*

*Can you think of a problem or difficulty of this kind to think about?*

If no remind participant of examples and give them some time to think of a suitable topic. If yes proceed as follows:

*Would you mind telling me very briefly what the problem is?*

*Now I would like you to evaluate this difficulty using the following scales.*

(Give scales items are: how important it is to you (0-10), how much it bothers you now (0-10) and how much it did bother you at the time it was worst (0-10), how much you have been thinking about it over the last week (0-10), how long has this been a difficulty for you (0-10), and how much does this difficulty relate to more general concerns that you have (0-10). Ratings to be used to check the problem identified is appropriate.

If not an appropriate topic remind participant of the type of concern that we are interested in and the examples and give further time to try to identify a concern of this kind. If appropriate proceed as follows:

*Please close your eyes and dwell on this current problem or concern, in the way that you usually dwell on and ruminate about unresolved concerns, as intensely as you can, until I ask you to stop and to open your eyes.*

*Think about the problem and difficulty – what is it?*

*Focus on what about this problem/difficulty bothers and troubles you.*

*Think about what is important about this difficulty in terms of your personal goals.*

*Focus on how this problem reflects a lack of progress on important personal goals.*

*Think about how the problem/difficulty is still unresolved.*

*Concentrate on the aspects of the problem that reflect unfinished business*

*Focus on the aspects of the difficulty that repeatedly come to mind.*

*Think about any related concerns and unresolved issues that this problem reminds you of.*

*Please continue doing this until I come back".*

3. **Control condition:**

*a.* "*For the next few minutes I am going to ask you to close your eyes and focus your attention on a recent problem or difficulty that is now resolved and no longer bothering you –so this is an past and resolved difficulty that has not been coming in to your mind over the past week and no longer causes you to feel negative, sad, down or stressed. When I ask you to begin, please close your eyes and think about this past problem or concern, in the way that you usually think about resolved concerns, as intensely as you can, until I ask you to stop and to open your eyes.*

*Examples of the kind of difficulty that I would like you think about are...* (Give example control topics)

*The problem or difficulty that you think about must be one that has not been troubling you recently and that you have now resolved.*

*Can you think of a problem or difficulty of this kind to think about?*

If no remind participant of examples and give them some time to think of a suitable topic. If yes proceed as follows:

*Would you mind telling me very briefly what the problem was?*

*Now I would like you to evaluate this difficulty using the following scales.*

(Give scales items are: how important it is to you (0-10), how much it bothers you now (0-10) and how much it did bother you at the time it was worst (0-10), how much you have been thinking about it over the last week (0-10), how long has this been a difficulty for you (0-10), and how much does this difficulty relate to more general concerns that you have (0-10). Ratings to be used to check the problem identified is appropriate.

If not appropriate remind participant of the type of concern that we are interested in and the examples and give further time to try to identify a concern of this kind. If appropriate proceed as follows:

*Please close your eyes and think about this past problem or concern, in the way that you usually think about past resolved difficulties, as intensely as you can, until I ask you to stop and to open your eyes.*

*Think about the problem and difficulty – what was it?*

*Focus on what about this problem/difficulty bothered and troubled you in the past.*

*Think about what was important about this difficulty in terms of your personal goals.*

*Focus on how resolving this problem reflects progress on important personal goals.*

*Think about how the problem/difficulty is now resolved.*

*Concentrate on the aspects of the problem that are now finished and dealt with*

*Think about any other resolved difficulties that this problem reminds you of.*

*Please continue doing this until I come back".*

4. *"Thank you*.
5. *Now I would like you to rate your current mood, level of tension, and level of self-focus, and the extent to which the concern that you have been thinking about has been troubling you using these scales"*. (Give rating scales).

**Example rumination topics:**

An ongoing concern about an important relationship, which you feel that you should be managing better.

A recent negative event and its impact upon how you have been feeling over the past few weeks.

Concerns that you have failed to achieve a goal that is of personal importance to you.

Feeling that you disappoint someone who means a lot to you.

Feeling that you do not compare favorably to other people with respect to an area of functioning that is important to you.

**Example control topics:**

A concern that you would not achieve a goal that you have now succeeded in achieving.

A past dispute with someone who means a lot to you that has now been resolved and you now feel very positively about this relationship.

A situation or event that you had been finding stressful, but that you have now learned to manage well.

An area of functioning that is important to you, and which you previously felt you did not manage well, but that you now manage as well as other people.

A negative event that happened many years ago and that you have now come to terms with and are not troubled by.

## Appendix C. Instructions for word generation task

Instructions

Thank you for agreeing to take part in this experiment.

At the top of the screen there are 2 buttons: Sequence 1 and Sequence 2. Clicking on one of these buttons will cause a sequence of letters to be displayed in the box below. There is a different sequence of letters for each button.

Your task is to generate as many English words as possible of 2 letters or more using the letters displayed. Each word must only use letters from 1 of the sequences but you may switch between the letter sequences as much or as little as you like. Your goal is to generate as many words as possible in total.

After typing in a word you should press “Enter” to enter the word and clear the display.
You have 10 minutes (600 seconds) to generate as many different words as possible.

## Appendix D. Subjective Ratings of Task Performance

How many words do you think you generated for the letter sequence E S I F L C E?

_____

How many words do you think you generated for the letter sequence L N A I O E T?

_____

How much time (in seconds between 0-600) do you think you spent on the sequence E S I F L C E?

_____

How many times do you think you switched between the 2 letter sequences?

_____

How hard did you find it to generate words from the letter sequence E S I F L C E?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Very easy | | | | | | Very hard |

How hard did you find it to generate words from the letter sequence L N A I O E T?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Very easy | | | | | | Very hard |

How much attention did you focus on the task overall?

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| Very little | | | | | | I was extremely focused |

## Appendix E. Consent form

Participant Consent Form.

Study title: Subjective Experience and Spontaneous Thinking
Researcher: Geoffrey Duggan

1. I confirm that I have read and understood the participant information sheet for the above study.
2. I understand that my personal details will be kept secure and no identifiable details will be used as part of the research results.
3. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.
4. I agree to take part in the study.

Name _____
Date _____
Age _____
Gender _____

## Appendix F. Participant Information Sheet

### Participant Information Sheet: Subjective Experience and Spontaneous Thinking

You are being invited to take part in a research study by Geoffrey Duggan a trainee clinical psychologist. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please read the following information carefully. Ask Geoff if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

**What is the purpose of this research?**
In this study we are interested in examining subjective experience and spontaneous thinking processes in an experimental context. We are investigating the interaction between spontaneous thoughts and the decisions that people make when completing a cognitive task to see what might influence thoughts wandering away from the current task. We will also measure some cognitive and personality variables that might influence this interaction.

**Do I have to take part?**
It is up to you whether or not to take part. If you do decide to take part you will be given this information sheet to keep and asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without giving a reason.

**What if I do not wish to take part?**
Inform Geoff at any point during the task and if you are receiving course credit you will be given the full amount of credit and are free to leave.

**What do I have to do?**
You will be asked to complete some questions about your mood and the extent to which your mind wanders. You will then be asked to think about a concern you have recently had then you will be asked to complete a scrabble-like task which involves thinking up words from different sets of letters.

**How long will the study last?**
The study should last about an hour in total.

**Will my taking part in the study be kept confidential?**
All information which is collected about you during the course of the research will be kept strictly confidential. You will be identified by a code rather than a name.

**What will happen to the results of the research study?**
We aim to publish results of the study in a clinical psychology journal and present our findings at professional conferences. If you would like a summary of the results on completion or details of any publications and presentations please contact Geoffrey Duggan at the address below.

**What if I want to know more?**
Please email Geoffrey Duggan on gd268@exeter.ac.uk for more information.

Thank you for your time.

## Appendix G. 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 participant information sheet participants will be informed by email of the results of the study.

### Journal Publication

It is expected that the study will be submitted for publication with the Journal of Behaviour Therapy and Experimental Psychiatry.

### Presentation

In June 2015, 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.

## Appendix H. Response Styles Questionnaire – Ruminative Responses Scale

**Identification No:** **bold = brooding** underline = reflection

**Responses to Depression**

People think and do many different things when they feel down, sad or depressed. Please read each of the items below and indicate whether you never, sometimes, often, or 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.

| Almost Never | Sometimes | Often | 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 about how passive and unmotivated you feel |
| ☐ | ☐ | ☐ | ☐ | 6. Analyse recent events to try and understand why you are depressed |
| ☐ | ☐ | ☐ | ☐ | 7. Think about how you don't seem to feel anything anymore |
| ☐ | ☐ | ☐ | ☐ | 8. Think "Why can't I get going?" |
| ☐ | ☐ | ☐ | ☐ | **9. Think "Why do I always react this way?"** |
| ☐ | ☐ | ☐ | ☐ | 10. Go away by yourself and think about why you feel this way |
| ☐ | ☐ | ☐ | ☐ | 11. Write down what you are thinking and analyse it* |
| ☐ | ☐ | ☐ | ☐ | **12. Think about a recent situation, wishing it had gone better** |
| ☐ | ☐ | ☐ | ☐ | **13. Think "Why do I have problems other people don't have?"** |
| ☐ | ☐ | ☐ | ☐ | 14. Think about how sad you feel |

| Almost Never | Sometimes | Often | Almost Always | |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | 15. Think about all your shortcomings, failings, faults, mistakes |
| ☐ | ☐ | ☐ | ☐ | 16. Think about how you don't feel up to doing anything |
| ☐ | ☐ | ☐ | ☐ | 17. Analyse your personality to try to understand why you are depressed |
| ☐ | ☐ | ☐ | ☐ | 18. Go someplace alone to think about your feelings |
| ☐ | ☐ | ☐ | ☐ | 19. Think about how angry you are with yourself |
| ☐ | ☐ | ☐ | ☐ | 20. Listen to sad music |
| ☐ | ☐ | ☐ | ☐ | 21. Isolate yourself and think about the reasons why you feel sad* |
| ☐ | ☐ | ☐ | ☐ | 22. Try to understand yourself by focusing on your depressed mood |
| ☐ | ☐ | ☐ | ☐ | **23. Think "What am I doing to deserve this?"** |
| ☐ | ☐ | ☐ | ☐ | 24. Think "I won't be able to concentrate if I keep feeling this way". |
| ☐ | ☐ | ☐ | ☐ | **25. Think "Why can't I handle things better?"** |

**Thank you for filling in this questionnaire.**

* Whitmer & Gotlib (*Cog Ther Res, 35*, 99-107, 2011) advise replacing item 11 ('*write down…*') with item 21 '*isolate yourself and think about the reasons why you feel sad*' due to low communality with other reflection items. Due to poor factorial validity of the reflection subscale in depressed samples, they suggest using an 'intentional rumination' scale including three items: '*go away…*', '*go someplace alone*' and '*isolate yourself…*'); other items cross-loaded on the brooding subscale.

This version of the RRS combines the original 22-item version with the more recent version 22-version reported by Treynor et al 2003. Items common and unique to both versions are included such that the full range of RRS factors – e.g. reflection versus brooding (Treynor et al., 2003), introspection versus self-blame (Roberts et al., 2000) can be calculated.

Items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 are common to all versions

Items 20, 21, 22 are used in the original version and that analyzed by Roberts et al.

Items 23, 24, 25 are used in the more recent version used by Treynor et al.

Best practice is probably to calculate the total score for both versions.

A total score should be for 22-items i.e. a range from 22-88, with c. scores below 40 low rumination, 40-50 normal, 50-60 above normal, 60 plus in clinical range

N.B.: Whitmer & Gotlib (*Cog Ther Res, 35*, 99-107, 2011) advise replacing item 11 ('*write down…*') with item 21 '*isolate yourself and think about the reasons why you feel sad*' due to low communality with other reflection items. Due to poor factorial validity of the reflection subscale in depressed samples, they suggest using an 'intentional rumination' scale including three items: '*go away…*', '*go someplace alone*' and '*isolate yourself…*'); other items cross-loaded on the brooding subscale.

**Appendix I. Patient Health Questionnaire-8**

**Over the last 2 weeks, how often have you been bothered by any of the following problems?**

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

## Appendix J. Instructions for authors Journal of Behavior Therapy and Experimental Psychiatry.

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### NEW SUBMISSIONS

Submission to this journal proceeds totally online and you will be guided stepwise through the creation and uploading of your files. The system automatically converts your files to a single PDF file, which is used in the peer-review process.

As part of the Your Paper Your Way service, you may choose to submit your manuscript as a single file to be used in the refereeing process. This can be a PDF file or a Word document, in any format or lay-out that can be used by referees to evaluate your manuscript. It should contain high enough quality figures for refereeing. If you prefer to do so, you may still provide all or some of the source files at the initial submission. Please note that individual figure files larger than 10 MB must be uploaded separately.

### References

There are no strict requirements on reference formatting at submission. References can be in any style or format as long as the style is consistent. Where applicable, author(s) name(s), journal title/book title, chapter title/article title, year of publication, volume number/book chapter and the pagination must be present. Use of DOI is highly encouraged. The reference style used by the journal will be applied to the accepted article by Elsevier at the proof stage. Note that missing data will be highlighted at proof stage for the author to correct.

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There are no strict formatting requirements but all manuscripts must contain the essential elements needed to convey your manuscript, for example Abstract, Keywords, Introduction, Materials and Methods, Results, Conclusions, Artwork and Tables with Captions.

If your article includes any Videos and/or other Supplementary material, this should be included in your initial submission for peer review purposes.

Divide the article into clearly defined sections.

***Figures and tables embedded in text***

Please ensure the figures and the tables included in the single file are placed next to the relevant text in the manuscript, rather than at the bottom or the top of the file.

**REVISED SUBMISSIONS**

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Regardless of the file format of the original submission, at revision you must provide us with an editable file of the entire article. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. The electronic text should be prepared in a way very similar to that of conventional manuscripts (see also the Guide to Publishing with Elsevier: http://www.elsevier.com/guidepublication). See also the section on Electronic artwork.

To avoid unnecessary errors you are strongly advised to use the 'spell-check' and 'grammar-check' functions of your word processor.

**Article structure**

***Subdivision - numbered sections***

Divide your article into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2, ...), 1.2, etc. (the abstract is not included in

section numbering). Use this numbering also for internal cross-referencing: do not just refer to 'the text'. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

***Introduction***

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

***Material and methods***

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

***Results***

Results should be clear and concise.

***Discussion***

This should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

***Conclusions***

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

***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**

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A concise and factual abstract is required. The abstract should be structured, using the following headings: *Background and Objectives; Methods; Results; Limitations; Conclusions.* Maximum length is 250 words, including headings. 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.

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Collate acknowledgements, declaration of interest, and role of funding organizations 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.).

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