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The Influence of Ruminative Processing Mode on the Trajectory of Intrusive Memories Following a Negative Mood Induction

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Abstract

Background and Objectives: Rumination following an event, particularly in an abstract as opposed to concrete processing mode, is associated with increased intrusive memory frequency. However, the temporal trajectory of intrusive memories following abstract and concrete rumination remains unclear. We examined the association between processing mode and the frequency of intrusive memories over a six-hour time period following a negative mood induction.

Methods: One hundred and sixteen community participants watched a video sequence designed to induce negative mood. Participants were then randomised into condition (abstract, concrete or distraction) and completed a verbally mediated task designed to induce the respective processing mode. Participants then completed hourly ratings of rumination and intrusive memories about the video after leaving the laboratory.

Results: Negative mood and intrusive memories were reliably induced. There were no differences in the frequency of intrusive memories between the abstract and concrete conditions. In contrast, participants in the distraction condition reported significantly more sensory intrusive memories than either ruminative condition. Three classes were found among participants following the video (intrusion free, rapid remitters, slow remitters). Condition was not predictive of class membership.

Limitations: It cannot be ruled out that the differences between rumination and distraction conditions were due to task differences.

Conclusions: In contrast to previous findings, our results suggest that any form of rumination about an event (whether in an abstract or concrete mode) may temporarily result in fewer intrusive memories in comparison to distraction. Processing mode does not appear to predict particular trajectories of intrusions following a mood induction.

Keywords: rumination, processing mode, abstract, concrete, intrusive memory, depression

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Introduction

Intrusive memories (intrusions) are defined as the involuntary and spontaneous recollection of an autobiographical event (Brewin, Christodoulides & Hutchinson, 1996). Intrusions are a diagnostic feature of PTSD and have been extensively studied in this disorder (McNally, 2006). Considerable overlap has been found in the prevalence and characteristics of intrusive memories in depression and PTSD (Newby and Moulds, 2011) suggesting that intrusions may play an equally significant role in depression. Yet there has been sparse research conducted in this area, with no existing theoretical models which account for the role of intrusive memories in depression. Furthermore, intrusive memories in PTSD and depression differ in key features, namely their content and conditions of encoding (Krans, Pearson, Maier & Moulds, 2016).Unlike in PTSD, the events featured in intrusive memories in depression are not exclusively traumatic or fear based and can be provoked by a broader range of experiences. For example, an individual with depression may experience intrusive memories related to a relationship breakdown or work and/or financial difficulties. These differences highlight the need to investigate the unique mechanisms involved in the development and maintenance of intrusive memories in depression.

One key mechanism found to be associated with intrusive memories following emotional events is rumination. Cumulative results from cross-sectional, analogue and clinical studies have found that rumination following a sad or traumatic event results in greater emotional reactivity, as well as increased frequency of intrusive memories in comparison to no rumination (Zetsche, Ehring and Ehlers, 2009; Kubota, Nixon and Chen, 2015; Kvavilashvili& Schlagman, 2011). These findings suggest that verbal processing about an emotional event (in the form of rumination) may trigger intrusive memories about that event, which may prolong emotional distress and worsen depression and PTSD symptoms.

Yet while some studies show a strong relationship between rumination and intrusive memories, overall the evidence is mixed, with some studies showing no such relationship (Ehring, Szeimies and Schaffrick, 2009; Marks, Franklin & Zoellner, 2018). Processing Mode Theory (PMT; Watkins & Teasdale,

2004) provides an explanation for this discrepancy by attributing the maladaptive function of rumination to the *processing style*, rather than *content* of thoughts. PMT proposes that information can be processed in rumination through two distinct modes, abstract analytic (AA) or concrete experiential (CE). The concrete experiential (CE) mode consists of re-experiencing the sensory features of a memory including one's emotional state and physical sensations. In contrast, the abstract analytic mode (AA) implies conceptually thinking about a situation based on its general causes, consequences and importance. Thus it is possible that discrepant findings could be attributed to differences in processing modes adopted by participants in previous studies.

Emerging experimental studies have found the AA processing mode maladaptive as it leads to increased intrusive memory formation, in comparison to the CE mode. White & Wild (2016) examined the influence of abstract or concrete processing mode on intrusive memories following an analogue trauma. They found that participants in the concrete condition reported significantly less emotional reactivity to the film clips, fewer intrusive memories, and had significantly lower Impact of Event Scale – Revised (IES-R; Weiss & Marmar, 1996) scores than those in the abstract condition, despite controlling for changes in affect.

Furthermore, Watkins (2004) manipulated participants processing mode following a failure task designed to induce negative mood. Participants in the abstract condition reported significantly more IES-R intrusions and avoidance scores than participants in the concrete condition. These findings suggest that the mode of processing during rumination, as opposed to rumination per se, may be causally related to the development of intrusive memories following analogue traumatic or negative event.

In addition to the mode of processing, the degree to which intrusions are sensory based may also be of clinical importance. Intrusions experienced with heightened sensory features, as opposed to thought-based intrusions, predominate in clinical presentations and are thought to reflect that successful emotional processing of an event has not taken place (Williams & Moulds, 2010). There is a need to further understand how processing modes, such as AA and CE ruminative styles, relate to sensory based intrusions in particular.

There also remains a lack of clarity regarding the trajectories of intrusions following emotional events. There is significant variability in the timeframe that intrusive memories are assessed across studies, from 5-minute periods following experimental procedures (Ehring et al., 2009) to up to 3 months (Sundermann Hauschildt, & Ehlers, 2013). Given that intrusions are a common response to emotional stimuli which naturally subside in healthy individuals (Galatzer-Levy, Brown, Henn-Haase et al., 2013) – often within hours (Brewin, 2010) – there is a need to better understand the course of intrusions following such tasks and especially, whether the trajectory of decline differs according to the adopted mode of processing. This is particularly important for understanding clinical presentations where intrusions tend to persist over time (Marks, Franklin & Zoellner, 2018).

In contrast to examining the frequency of intrusions at a single timepoint in the minutes following an analogue distressing event, examining the trajectory of intrusions at multiple time points, their sensory and verbal characteristics, and factors that influence their persistence over time, may be more relevant when making inferences with respect to intrusions following real-world events. Conceivably, there might be two classes of individuals so far as the trajectory of intrusions is concerned: people at a low-level of risk for clinical disorders, for whom intrusions subside in the first few hours following an emotional event, and people at risk of clinical disorders, for whom intrusions persist.

A further question pertains to the interaction of processing mode and persistence of intrusions. An abstract processing mode may be associated with a persistently high course of intrusions in the hours following an emotional event in contrast to concrete processing. However, to the best of our knowledge, this has not been subject to systematic investigation. Moreover, the experimental literature on intrusive memories has largely assessed the occurrence of intrusive memories in a laboratory (e.g. Holmes & Bourne, 2008). Therefore, there is a need to examine intrusive memories using methods with greater ecological validity such as experience sampling. This may assist in more accurately understanding the factors that influence recovery or persistence of intrusive memories in real-world settings.

The aim of the present study was to examine whether the trajectory of intrusive memories differs between abstract or concrete ruminative processing mode, and a distraction control condition, over six hours following exposure to a negative mood induction. Our first hypothesis was that participants in an abstract processing condition would report more intrusive memories in total for the duration of the study compared to the participants in a concrete processing condition. Our second hypothesis was purely exploratory, where the influence of ruminative processing mode and other variables on the trajectory of intrusive memories would be examined across a 6-hour time period, following exposure to a negative mood induction.

Materials and Methods

This study was approved by the Human Research Ethics Advisory Panel at the University of Technology Sydney (approval no: ETH17-1481) and the hypotheses and analyses of the present study are subsumed within a broader study pre-registration with the Open Science Framework (osf.io/fc83w) on October 4, 2017. We note that our analysis approach has necessarily deviated in places from the pre-registered plan. Please see Supplementary Material 1 for a summary of where changes were made.

Participants

Participants (*N*=123) were recruited from the community via posters and online advertisements and phone screened for eligibility. Three were excluded (incompatible phone: *n* = 2, insufficient English: *n* = 1). The remaining 120 participants were invited to participate in the study and randomly allocated via an online randomisation generator (www.randomizer.org) into the abstract (n = 40), concrete (n = 40), or distraction condition (n = 40). Participants were reimbursed via a $30 online gift card.

Measures

Demographic variables were assessed via nine self-report items created for the present study. Questions pertained to participants' age, gender, relationship and socio- economic status, as well as history of diagnosed mental health condition. Please see supplementary materials 4 for the items of this questionnaire.

The Patient Health Questionnaire-9 (PHQ-9; Spitzer, Williams & Kroenke, 2001) is a nine-item scale which measures depression symptoms. Items are rated on a 0 to 3 scale (where 0 = not at all, 3 = nearly every day) and are summed to provide a total score ranging from 0 – 27, with scores of 5, 10, 15 and 20 representing mild, moderate, moderately severe and severe depression, respectively. The PHQ-9 has been found to have good criterion validity, construct validity, external validity and internal reliability with a Cronbach's alpha of 0.89 (Kroenke et al., 2001).

The Posttraumatic Stress Disorder Checklist-5 (PCL-5; Weathers, Litz, Keane, Palmieri, Marx & Schnurr, 2013) is a 20-item scale which assesses the 20 DSM-5 symptoms of PTSD. Responses range from 0 (not at all) to 4 (extremely) and are summed to provide a total score ranging from 0 – 80. Items of the PCL-5 are aligned with the DSM-5 (American Psychiatric Association, 2013) diagnostic criteria for PTSD. The PCL-5 was only administered to participants who endorsed a traumatic experience. We created a proxy diagnosis for PTSD based on the DSM-5 criteria from which analyses were derived. The PCL-5 has strong internal consistency (Cronbach's α= .94) and test-retest reliability (r =.82; Blevins et al., 2015).

The Patient-Reported Outcomes Measurement Information System Emotional Distress – Anxiety – Short Form (PROMIS; American Psychiatric Association, 2013) is a seven-item scale which assesses symptoms of anxiety. Responses range from one (never) to five (always) and are summed, with a score of 16, 20, and 28 indicating mild, moderate, and severe anxiety, respectively. The PROMIS has excellent internal consistency and a Cronbach's alpha of 0.93 (Pilkonis et al., 2011).

Rumination was assessed using the Action and Control Scale – Preoccupation Subscale (ACS-90, Kuhl, 1994). Participants were presented with 12 scenarios and were required to select either a ruminative response (e.g. "The thought that I lost keeps running through my mind", scored 1), or a non-ruminative response (e.g. "I can soon put losing out of my mind", cored 0), yielding an overall score from 0 (no preoccupation) to 12 (extreme rumination). The subscale has good reliability (Kuhl, 1994) and validity (Rholes et a., 1989). This scale was chosen as it is thought to measure rumination independent of processing mode, unlike other ruminative questionnaires (Nolen-Hoeksema & Morrow, 1991).

Worry was assessed using the 16-item Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990). Each item is rated on a five-point scale from one (not at all typical of me) to five (very typical of me). A total score is calculated by summing the first 11 items and the reverse-scores of the latter 5 items, with higher PSWQ scores reflecting greater levels of pathological worry. The PSWQ has high internal consistency and good test-retest reliability, with a Chronbach's alpha of .93 (Meyer et al., 1990).

A 16-item questionnaire titled 'Rumination and Intrusive Memory Questionnaire' was created for the present study and used to assess for the occurrence of intrusive memories and rumination following exposure to the sad film. This questionnaire contained items adapted from the Intrusive Memory Interview (IMI; Hackmann, Ehlers, Speckman & Clark, 2004) and Ruminative Response Style Questionnaire (RRS; Treynor, Gonzalez & Nolen-Hoeksema, 2003). Participants were asked whether or not they experienced an intrusive memory and asked to describe the memory in a single sentence. Participants also rated characteristics of the intrusive memory, including whether it was experienced as predominantly sensory or verbal. The results of analyses regarding the characteristics and qualitative features of the intrusive memories are beyond the scope of the current paper and will be reported elsewhere. Additionally, three items of the questionnaire pertained to whether participants ruminated about the memory and were rated on a scale of 0 (not at all) to 100 (very true). Higher scores indicated greater levels of rumination. The test-retest reliability of IMI has been found to range from r = .61 to r = .72 (Hackmann et al., 2004) and the RRS has been found to have acceptable construct validity and reliability with a Cronbach's alpha of .83 (Parola, Zendjidjian, Alessandrini et al., 2017).

Procedure

Please see Figure 1 for a graphical depiction of the study procedure. Participants provided informed consent and were then directed to complete self-report measures. Participants also provided ratings of their mood (sadness, happiness and calmness) on a Visual Analogue Scale (VAS; range 0-100) as a mood

induction check at four timepoints throughout the course of the study (immediately before and after the film clip, after the processing mode manipulation or distraction task, and after the self-rating questions) .

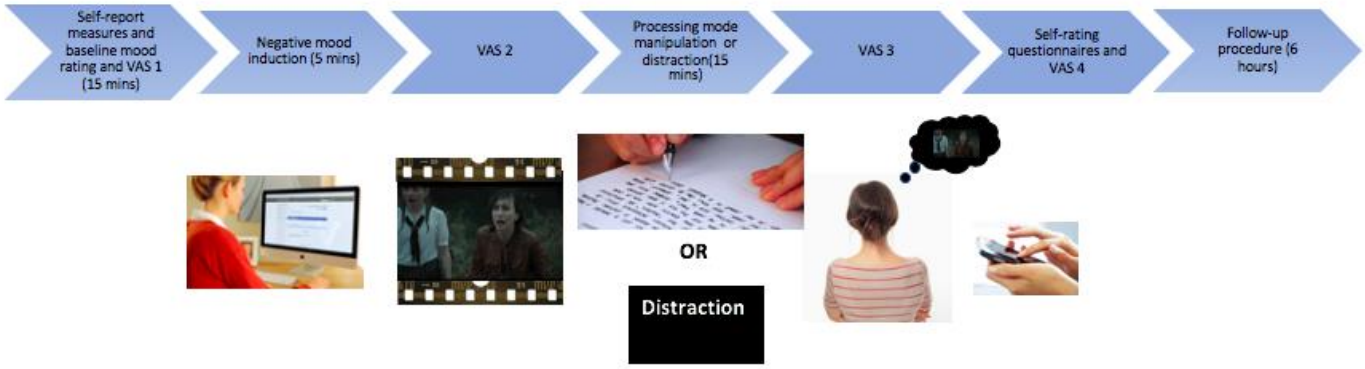

Figure 1. Study Procedure

Negative Mood induction

Participants then watched a 5-minute video sequence taken from the 2008 film 'The Boy in the Striped Pyjamas' directed by Mark Herman (Miramax). The video depicts the death of a boy while his parents attempt to save him. This mood induction is similar to the commonly used 'trauma-film paradigm' (Holmes and Bourne, 2008) with the exception that the film clip was designed to elicit sad mood rather than a fear or stress based reaction. As such, in contrast to traumatic material used in the trauma-film paradigm, the current film clip contained no violent or graphic scenes. Additionally, this clip has been found to reliably induce sad mood, in contrast to a fear or stress reaction (Schaefer, Nils, Sanchez, & Philippot, 2010).

Processing Mode Induction

Participants were then instructed to write an essay for 15 minutes about the scene they had watched in either an abstract or concrete manner. The instructions for the abstract condition were 'Please write about the general causes and the general consequences of the event in the film. Write about what this event means about the world and the people in the film clip'. In contrast, the instructions for the concrete

condition were 'Please write about the moment-to-moment experience of watching the film clip. Write about the emotions, thoughts and physical sensations you experienced while watching the film clip'. These instructions were very similar to the processing mode induction used by Watkins and Teasdale (2004) and Williams and Moulds (2007) and were chosen as they differentiate the conditions based on their experiential awareness on sensory information which is the variable proposed distinguish the modes of processing and determine whether successful emotional processing occurs (Teasdale, 1999).

Participants in the distraction condition were administered 28 distraction statements of the standard Nolen-Hoeksema and Morrow (1993) distraction induction. The instructions for this condition were 'For the next few minutes, try your best to focus your attention on each of the ideas on the following pages. Read each item slowly and silently to yourself. As you read the items, use your imagination and concentration to focus your mind on each of the ideas. Spend a few moments visualising and concentrating on each item (please see Supplementary Materials 2 for the items of the distraction condition).

The experimenter and an independent rater, blind to condition assignment, coded essays for causal and sensory words, to obtain a measure of inter-rater reliability. There was a 93% agreement between the coders as to the assigned processing mode of participants. Discrepancies were resolved through discussion. The results of the interrater analysis are $\kappa = 0.218$, $p < 0.001$ (95% CI 3.77, 8.23) indicating fair agreement (Landis & Koch, 1977). Participants were then provided with definitions of abstract and concrete processing and were asked to self-rate the extent to which their thinking about the film clip could be was consistent with each processing style on a scale of 1 (not at all) to 5 (very much).

Experience Sampling

Participants then downloaded the Metricwire mobile app (www.metricwire.com) and then left the laboratory. They then received a notification on their smartphone every hour for a period of six hours, directing them to complete the 'Rumination and Intrusive Memory Questionnaire' on the Metricwire app which assessed for the presence and frequency of intrusive memories and rumination about the film clip over the past hour. Please see the items of this questionnaire below:

1. In the past 30 minutes, have you experienced any spontaneous memories of the film clip from 'The Boy in the Striped Pyjamas', [yes/no with the following questions contingent on a "yes" response]
2. How many times did you experience this type of memory?
3. In a single sentence, describe what you remembered.
4. How long did the memory last?
5. How distressing did you find the memory?
6. When you experienced this memory, how uncontrollable was it?
7. How much did the memory interfere with what you were doing at the time?
8. Was the experience of the memory more like a thought or a sensory experience (i.e. contain any visual, olfactory, tactile component)?
9. Was the memory from a first-person or observer's visual perspective?
10. How vivid was the memory?
11. When you experienced the memory, how much did it feel like it was happening now compared to happening in the past?
12. To what extent did you feel the following emotions during the memory: sad (0 = not at all, 100 = very much) happy (0 = not at all, 100 = very much)
13. I find that my mind goes over the film clip again and again (0 = not at all – 100 = very true)
14. I find that thoughts about the film clip come to my mind over and over throughout the day (0 = not at all – 100 = very true)
15. I can't stop thinking about the film clip (0 = not at all – 100 = very true)

Data Screening and Analysis

Descriptive data analyses, one-way ANOVAs to identify between-condition differences in participant characteristics, and repeated measures t-tests to confirm that the mood induction and processing mode manipulations were effective, were conducted on SPSS version 25.

To test the first hypothesis, that the participants in the abstract condition will report a greater total number of intrusions than participants in the concrete condition, a generalized linear model (GLM) was estimated to predict the total number of reported intrusions (across all post-induction assessment points). Given that the total number of intrusions can be considered to be a count variable, a Negative Binomial Log-Link function was used for the analysis. We first estimated the model with processing mode entered as a dummy coded variable (Abstract vs other conditions and Concrete vs other conditions). Next, we re-ran the model by including the following key covariates: PHQ-9, PROMIS, PSWQ, ACS, and PCL-derived diagnosis.

To determine whether the trajectories of intrusions differ across the assessment points, a second stage of the analysis involved exploration of whether latent classes of the trajectory of intrusive memory frequencies could be determined. Mplus version 7.31 was used for these analyses. Latent class growth analysis (LCGA) divides the trajectories of groups of participants into mutually exclusive and exhaustive classes (Collins & Lanza, 2010), which are “latent” in that class membership is not directly observed or measures (O’Donnell et al., 2017). The number of classes is determined partly on the basis of theory (parsimony being favoured) and partly on the basis of a number of fit indices. The Akaike Information Criterion (AIC, Akaike, 1987) and Bayesian Information Criterion (BIC, Schmartz, 1978) are goodness of fit indices where lower values correspond to improved model fit. The Lo-Mendell Rubin Likelihood ratio test (LMRLRT; Lo. Mendell, & Rubin, 2001) provides a p- value which indicates if a model fits the data better than a model with fewer classes (Nylund, Asparouhov, & Muthen, 2007). The entropy values, which indicate the classification accuracy of a solution, are also reported with values close to one indicating relatively stronger class classification accuracy (Geiser, 2010).

All models included an intercept and slope term, and the number of random starts was set to 1000, and the number of iterations to 200. Consistent with the LCGA approach, all within class variances were set to zero (Jun & Wickrama, 2008). Once the number of trajectory classes was determined, most likely class membership of each participant was regressed upon intrusion frequency.

To determine which factors predicted the trajectory of intrusions for participants, once the number of trajectory classes and most likely class membership for each participant were determined through LCGA, a series of regression analyses were run to determine whether class membership was predicted by self-report measures, intrusive memory characteristics and condition.

Results

Sample Characteristics

Table 1 presents demographic, sample and clinical characteristics for each group. There were no significant differences between groups in terms of age (F (2, 113) = 1.02, $p < .05$) or gender ($\chi^2 = 3.02$, $df = 2$, $p<.05$). Furthermore, there were no significant differences between groups in terms of depression (F (2, 113) = .290, $df = 2$, $p<.05$), PTSD (F (2, 113) = .448, $df = 2$, $p<.05$), anxiety (F (2, 113) =.033, $df = 2$, $p<.05$), and worry (F (2, 113) = .506, $df = 2$, $p<.05$) scores. In contrast, participants in the concrete condition were found to have marginally higher trait rumination scores than either the abstract or distraction condition (F (2, 113) = 3.19, $df = 2$, $p =.045$).

The number of participants who responded during the follow-up procedure was 115 (100%), 109 (95%), 110 (96%), 105 (91%), 106 (92%), 100 (87%) and 110 (96%) each time point, respectively. Furthermore, 755 (94%) of all time points were responded to across the entire follow-up procedure.

Mood and Processing Mode Manipulation Checks

Mood induction check

A paired samples *t*-test revealed the negative mood induction had the intended effect of reducing the total sample's mood from pre to post induction ratings t (115) = -13.40, p<.001. Additionally, the mood

induction was found to significantly reduce happiness *t* (115) = 15.71, p<.001 and calmness ratings t (115_ = 2.14, p<.05 from pre to post induction.

In order to evaluate whether the sad mood induction had a differential effect between condition, a 2 (condition: abstract, concrete, distraction) x 2 (time: baseline-Time1, post-induction-Time 2) repeated measures ANOVA was calculated using sad mood as the dependent measure. As anticipated, there was a significant main effect of Time, F (2, 113) = 182.27, p<.001), revealing that participants ratings of negative mood significantly increased following exposure to the film clip. There were no other significant main effects or interactions, indicating that the response to the mood induction was similar across each of the processing mode induction groups (all *p's*>.05). Figure 2 depicts the persistence of participant's negative mood ratings throughout the course of the study.

Table 1. Demographic characteristics of participants in abstract, concrete and distraction conditions and values on the self-report instrument

	Total sample of participants (N =116)		Abstract condition (n=39)		Concrete condition (n=37)		Distraction condition (n=40)		χ^2 comparisons between participants in abstract, concrete and distraction condition		
	N	%‡	*n*	%‡	*n*	%‡	*n*	%‡	χ^2	*df*	*p*-value*
Gender											
Female	72	62.1	23	59	20	54.1	29	72.5	3.02	2	.221
Ethnicity											
Caucasian	33	28.4	13	33.3	11	29.7	9	22.5	1.182	2	.554
Aboriginal	1	.9	0	0	0	0	1	2.5	1.92	2	.384
Asian	37	31.9	14	35.9	12	32.4	11	27.5	.648	2	.723
European	12	103	2	5.1	6	16.2	4	10.0	2.53	2	.283
Middle Eastern	4	3.4	0	0	3	8.1	1	2.5	3.91	2	.141
Indian	25	21.6	6	15.4	5	13.5	14	35.0	6.57	2	.037
Relationship Status											
Currently in a married or defacto relationship	34	29.3	16	35.9	10	26.7	7	17.5	1.89	2	.389
Education											
High School	29	25.0	7	17.9	8	21.6	14	35.0	3.39	2	.183
TAFE	1	6.0	2	5.1	1	2.7	4	10.0	1.89	2	.389
Undergraduate	41	35.3	13	33.3	16	43.2	12	30.0	1.58	2	.454
Employment											

Currently employed full-time or part-time	60	51.5	25	64.1	15	40.5	20	50	4.29	2	.117
Diagnosed with a mental disorder	26	22.4	5	12.8	9	24.3	12	30	3.47	2	1.77
Anxiety Disorder	18	15.5	4	10.3	7	18.9	7	17.5	1.27	2	.530
Mood Disorder	13	11.3	4	10.3	2	5.4	5	12.5	.971	2	.615
Trauma Disorder	1	.9	0	0	1	2.7	0	0	2.15	2	.341
Eating Disorder	4	3.4	1	2.6	1	2.7	2	5.0	.443	2	.801
Psychotic Disorder	2	1.7	0	0	1	2.7	1	2.5	1.04	2	.596
Personality Disorder	2	1.7	1	2.6	1	2.7	0	0	1.07	2	.585
Sought mental health treatment in past	26	22.4	5	12.8	9	24.3	12	30.0	3.46	2	.177
Currently Experiencing mental disorder	11	9.5	2	5.1	6	16.2	3	7.5	3.67	2	.159

	Total sample of participants (*N*=116)		Abstract condition (*n*=39)		Concrete condition (*n*=37)		Distraction condition (*n*=40)		One-way ANOVA		
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	*F*	*df*	*p*
Age	26.30	6.98	26.03	6.51	27.59	6.61	25.38	7.71	1.018	2	.365
PHQ-9	4.95	4.18	4.67	3.19	4.81	3.96	5.35	5.17	.290	2	.749
PCL-5	36.44	12.77	36.14	12.22	34.44	11.59	38.21	14.29	.448	2	.641
PROMIS	16.41	5.95	16.46	5.28	16.57	6.02	16.23	6.60	.033	2	.967
ACS	5.79	1.77	5.26	1.60	6.24	1.71	5.90	1.88	3.19	2	.045
PSWQ	66.49	19.25	68.95	18.63	64.68	18.04	65.78	21.01	.506	2	.604

Chi-square results compare the proportions of participants who have and have not searched for health information online in the preceding three months.

‡ Not all percentages add up to 100 percent due to rounding.

* No p-values were significant after correction for multiple comparisons (Bonferroni comparisons)

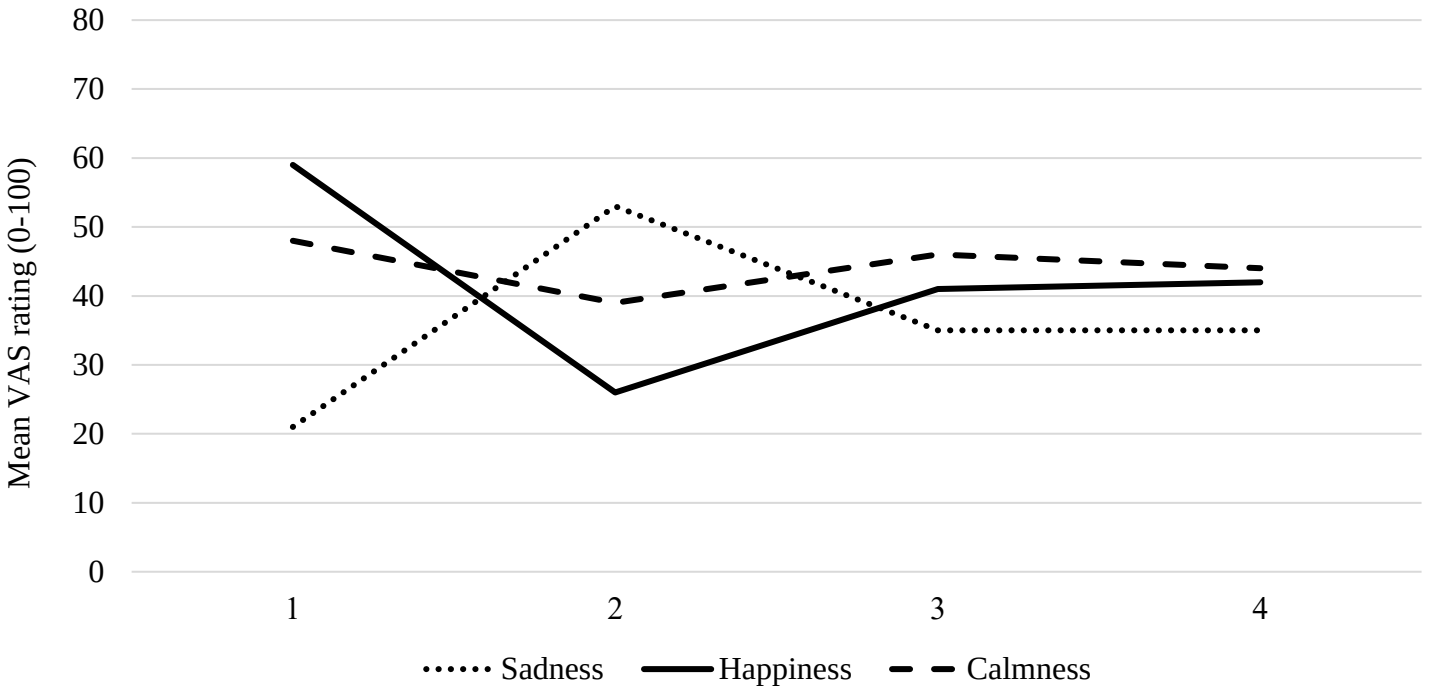

Figure 2. VAS ratings for current sadness, happiness, and calmness during the study.

Processing mode manipulation check

Results of a paired samples *t*-test revealed, as anticipated, the abstract condition produced more causal words than the concrete condition t (115) = 2.03, p<.05, (abstract condition: M = 3.72, SD = 4.26, concrete condition: M = 1.83, SD = 1.56). Additionally, as expected, the concrete condition produced more sensory words than the abstract condition t (115) = -3.46, p<.001 (abstract condition: M = 3.07, SD = 3.28, concrete condition: M = 7.74, SD = 6.28).

Processing mode condition and total number of intrusions

The association between processing mode condition and the total number of intrusions across the six-hour post-film period was examined using a GLM with a negative binomial link function. The total number of intrusive memories experienced in the abstract (M= 4.63, SD= 3.83) concrete (M=4.68, SD=1.02) and distraction condition (M=5.88, SD=5.04). The difference in the *total* number of intrusions reported by participants in the abstract processing mode condition when compared with participants in the concrete and distraction conditions was not significant (B = -.24, SE = 0.25, p = 0.33). Likewise, the difference in the total

number of intrusions reported by participants in the concrete processing condition when compared to the abstract and distraction conditions was not significant (B = .23, SE = 0.25, p = 0.36). Thus, hypothesis 1 was not supported.

When the above GLM was re-run with the inclusion of key covariates (PHQ-9, PROMIS, PSWQ, ACS and PCL-derived diagnosis), neither abstract nor concrete processing mode condition were significant predictors of total intrusions across the six hour follow-up interval (all two-tailed p's > 0.05) and none of the covariates were significant independent predictors of total intrusions (all two tailed p's > 0.05).

An additional GLM with a negative binomial link was run with the total number of *sensory* intrusive memories as the dependent variable and condition (processing mode or distraction) as the IV. The total number of sensory intrusive memories experienced in the abstract (M= 0.77, SD= 1.02) concrete (M=0.70, SD=0.97) and distraction condition (M=1.30, SD=1.36). This revealed that the distraction condition was a significant predictor of total sensory intrusions across the six hour follow-up interval, such that participants in the distraction condition reported more intrusive sensory memories than participants in either rumination condition (B=.470, SE=.255, p=.065).

Post-task trajectories of intrusions

The results for the LCGA analyses are summarised in Table 2. The most optimal solution appeared to be three-classes on the basis that the lowest BIC value was for three classes (1666.14), the LMRLRT p-value was significant for three, but not four classes, and a three class solution appeared to be relatively parsimonious. The distribution of the sample across the three classes based on their most likely class membership was: 40 (34.5%), 40 (34.5%), and 36 (31.0%).

Table 2. Incremental fit statistics and classification accuracy for latent class growth model for intrusion frequency total scores (N = 116).

Number of classes	Loglikelihood	AIC	BIC	BIC_{ssa}	Entropy	LMRLRT	LMRLRT *p*-value
1	-885.60	1775.19	1780.70	1774.38	-	-	-
2	-829.06	1668.13	1681.90	1666.09	0.67	105.65	0.04
3	-814.05	1644.11	1666.14	1640.85	0.63	28.05	0.07
4	-806.99	1635.98	1666.27	1631.50	0.62	13.20	0.11
5	-802.00	1631.99	1670.54	1626.29	0.67	9.34	<0.01
6	-801.06	1636.11	1682.93	1629.19	0.65	6.22	0.04
7	-801.00	1642.00	1697.07	1633.85	0.64	1.93	0.19

AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; BIC_{ssa} = Sample size adjusted BIC; LMRLRT = Low-Mendell Rubin Likelihood ratio test.

Figure 3 illustrates the trajectories of intrusions across the six-hour post film period for participants based on their most likely class membership. The trajectories of participants in each of three classes could be described as rapid remitters (class 1; n = 40), slow remitters (class 3; n = 36), and (relatively) intrusion free (class 2; n = 40).

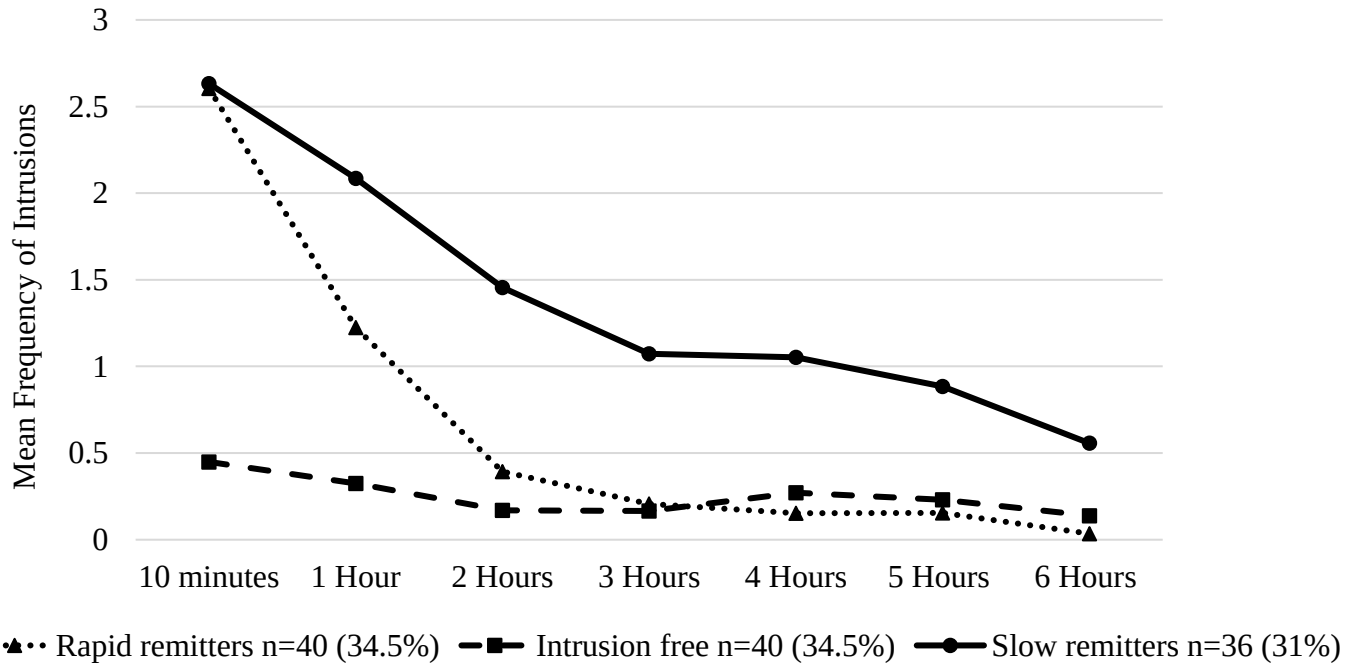

Figure 3. Trajectory of Intrusions over 6 hours

A central question of the current study pertains to whether participants could be expected to show differing trajectories of intrusions in the post-film period according to their assigned processing mode condition (Hypothesis 2). Table 3 summarises the correspondence between participants' processing mode assignment and their trajectory class membership.

Table 3. Correspondence between participant processing mode allocation and trajectory class membership.

	Rapid remitters	Slow remitters	Intrusion free	Total per condition
Abstract processing condition	15 (38.5%)	9 (23.1%)	15 (38.5%)	39 (100%)
Concrete processing condition	15 (40.5%)	11 (29.7%)	11 (29.7%)	37 (100%)
Distraction condition	10 (25.0%)	16 (40.0%)	14 (35.0%)	40 (100%)
Total	40 (34.5%)	36 (31.0%)	40 (34.5%)	116 (100%)

10 mins 1 Hour. 2 Hours. 3 Hours 4 Hours 5 Hours. 6 Hours
Time after sad film

Multinomial regression analyses were then conducted to determine whether assigned processing mode was a significant predictor of trajectory class membership. Multinomial regression is an extension of logistic regression analysis for cases where the dependent variable is multicategorical (with more than two categories), consistent with the multicategorical nature of the estimated number of trajectory classes. Neither membership of the abstract processing mode condition (compared with either concrete or distraction), nor the concrete processing mode condition (compared with either abstract or distraction), were significantly associated with trajectory class membership (two-tailed p's > 0.05). In other words, processing mode did not predict whether a person was a member of the rapid remitter, slow remitter, or intrusion free trajectory classes.

Finally, we repeated the above multinomial regressions, but also included depressive symptoms (PHQ-9), anxiety symptoms (PROMIS), rumination (ACS), worry (PSWQ) and likely PTSD diagnosis (PCL diagnosis). The results are summarised in Table 4. None of these conceptually relevant covariates were significantly associated with post-film trajectory class membership (all two-tailed p-values > 0.05)

Table 4. Multinomial regression analysis predicting trajectory class membership.

1. Rapid remitters (1) vs slow remitters (0)

			95% CI for Exp(B)	
	B (SE)	Exp(B)	Lower	Upper
Intercept	0.92 (1.95)	-	-	-
PHQ-9	-0.09 (0.09)	0.92	0.77	1.09
PROMIS	0.02 (0.06)	1.02	0.90	1.15
ACS	0.15 (0.16)	1.16	0.84	1.60
PSWQ	0.00 (0.02)	1.00	0.96	1.03
Abstract processing mode	-1.07 (0.61)	0.34	0.10	1.14
Concrete processing mode	-0.73 (0.58)	0.48	0.15	1.49
Distraction processing mode (reference group)	-	-	-	-
PCL diagnosis	-0.27 (0.56)	0.76	0.25	2.28
No PCL diagnosis (reference group)	-	-	-	-

2. Intrusion free (1) vs slow remitters (0)

			95% CI for Exp(B)	
	B (SE)	Exp(B)	Lower	Upper
Intercept	0.31 (2.01)	-	-	-
PHQ-9	0.10 (0.09)	1.11	0.94	1.31
PROMIS	-0.06 (0.07)	0.94	0.82	1.07
ACS	0.19 (0.16)	1.21	0.88	1.67
PSWQ	0.00 (0.02)	1.00	0.96	1.03
Abstract processing mode	-0.86 (0.59)	0.15	0.13	1.35
Concrete processing mode	-0.11 (0.58)	0.90	0.29	2.81
Distraction processing mode (reference group)	-	-	-	-
PCL diagnosis	0.29 (0.58)	1.34	0.43	4.16
No PCL diagnosis (reference group)	-	-	-	-

ACS = Action and Control Scale – Preoccupation subscale; CI = Confidence Interval; PCL = Posttraumatic Symptom Checklist-5; PHQ-9 = Patient Health Questionnaire – 9; PROMIS = Patient-Reported Outcomes Measurement Information System – Emotional distress Anxiety Short Form.

Discussion

The aim of the present study was to determine whether the trajectory of intrusive memories varies by ruminative processing mode over six hours following exposure to a negative mood induction. It was firstly hypothesised that participants in the abstract condition would report more intrusive memories in total for the duration of the study compared to the participants in the concrete condition. Contrary to predictions, no difference was found in the total number of intrusive memories between participants in the abstract or concrete condition. In contrast, participants in the distraction condition, which was intended as a control,

reported more intrusive memories than either ruminative condition. This effect was only observed with respect to sensory, in contrast to verbal intrusive memories.

Our findings do not support those of previous studies which have found that abstract processing leads to increased intrusion formation than concrete processing (Watkins, 2004; Ehring & Ehlers, 2008; Maria et al., 2012; Scaich et al., 2013; White & Wild, 2016). In contrast, our findings accord with those of Williams and Moulds (2007) that mode of processing does not influence intrusion formation. This discrepancy may be attributed to methodological differences, including the use of self-referent intrusions (Watkins, 2004; White & Wild, 2016, Maria et al., 2012), or mood inductions which were highly graphic (Scaich et al., 2013). Additionally, the processing mode induction was arguably stronger in previous studies which administered essays at multiple time points and provided participants with training, practice and feedback in their assigned processing mode (Watkins 2004, White & Wild, 2016).

With regard to comparisons between distraction and the rumination-related processing modes, Ehring, Szeimies and Schaffrick (2009) was the only study to our knowledge that also included a distraction control group. Interestingly, this study also found that distraction lead to increased intrusive memory frequency in comparison to either abstract or concrete rumination. However, it is unclear whether the participants in the Ehring et al. study were instructed to report only sensory intrusions or those encompassing verbal and sensory characteristics. One explanation may be that the distraction condition served as a form of thought suppression, which has been shown to have the paradoxical rebound effect of causing upsetting memories to intrude more frequently (Dalgleish& Yiend, 2006). This may indicate that any form of processing of an emotional event, even rumination which has been viewed as maladaptive (Nolen-Hoeksema, 2000), may be more beneficial than no processing at all.

An alternative explanation for the present findings is that rumination prevented individuals in both the abstract or concrete condition from immediately experiencing intrusive memories. It has been theorised that verbal-linguistic behaviour, such as rumination, dampens the refreshing function of imagery, causing images to disappear from awareness at a faster rate (Borkovec, Alcaine & Behar, 2004). Thus it is

conceivable that in contrast to individuals in the distraction condition, the rumination elicited in the abstract or concrete conditions temporarily interfered with the formation of intrusive images about the film. This explanation is consistent with results from a series of experiments conducted by Holmes and Colleagues (2008) which found that increases in verbal processing led to a reduction in intrusions following a trauma film paradigm.

Rumination is nevertheless linked with greater levels of distress and intrusive memory frequency in the months following emotional events (Ehring et al., 2009; Zetsche et al., 2009, Slofstra et al., 2017). This disparity may be reconciled by the proposition that while rumination may temporarily dampen intrusion frequency during encoding or the immediate aftermath of an event, it may perpetuate intrusions in the long term. By switching attention from imagery to rumination (a verbal-linguistic activity), individuals suppress autonomic arousal, which may negatively reinforce this behaviour. This may lead to the predominance of rumination as a maladaptive avoidance strategy for distressing internal stimuli (including emotions, memories and unpleasant physical sensations).

In the long term rumination may have a paradoxical effect of increasing intrusive memories if it prevents successful contextualisation and elaboration of memories (Ehlers & Clark, 2000). Persistently elevated intrusive memories may undermine one's perceived ability to cope and contribute to psychopathology (Hayes et al., 2013). Thus while both rumination conditions may have temporarily reduced intrusion frequency, this may have resulted in a delayed reaction whereby intrusions spiked after the six-hour assessment period. This explanation is plausible given that studies which have found an effect of rumination on intrusive memories did so one to seven days after experimental manipulations (Watkins, 2004, Maria et al., 2012, Scaich et al., 2013 and White & Wild, 2016).

The second hypothesis, that processing mode may predict the trajectory of intrusions in the hours following the negative mood induction, was exploratory. The findings indicated that three classes of individuals best described the inter-individual course of intrusions across the six-hour post induction interval: rapid remitters, slow remitters and (relatively) intrusion-free. Interestingly, a "persistently high

frequency" class was not identified, indicating perhaps that individuals at risk of clinical disorders may still experience an erosion of intrusion frequency over time, but perhaps not as rapidly as other groups.

Of particular note, is that processing mode was not predictive of trajectory class membership. Thus, while some studies have found processing mode to be predictive of intrusion frequency at specific time points following emotional events/mood inductions (Watkins 2004; White & Wild, 2016), processing mode does not appear to have value for predicting the *course* of intrusions across the immediate hours following an emotional event. Other variables may be better predictors of these trajectories, such as the activities which participants engage in during the post-induction period, with one speculative possibility being that cognitively taxing activities might contribute to a reduction in intrusions, albeit temporarily.

In this regard, a strength of our study was that we conducted an ecological assessment of intrusions following the mood induction – when participants were returning to their routine daily activities. The trajectories of intrusions after leaving the lab may thus have been quite different to those if participants had remained in the relatively artificial testing environment.

The present findings should be interpreted in light of several limitations. Firstly, despite use of the commonly used Nolen-Hoeksema distraction task (Williams & Moulds, 2007; Ehring, Szeimies & Schaffrick, 2009) it could be argued that differences in intrusion frequencies between this condition and the rumination conditions were a result of task differences. In contrast to the rumination conditions which involved essay writing, participants in the distraction condition were instructed to read and visualise items which may have inadvertently induced sensory processing, making individuals more susceptible to the formation of intrusive memories.

Secondly, it is unclear whether participants in the distraction condition adhered to these instructions, or alternatively engaged in rumination about the film in their habitual processing mode. Finally, although illustrative, our sample was relatively small for a latent class trajectory analysis which may explain the less than optimal differentiation of classes (entropy 0.67). We nevertheless note that these approaches can be

used with sample sizes as small as 100, particularly when there are more than four within-subject assessment occasions (Nagin, 2005).

Third, our manipulation of abstract processing emphasised a focus on the "general causes and general consequences" of the events of the film, rather than self-referential thinking, which is also conceptually related to rumination. However, we note that our manipulation appeared to successfully vary participants' rumination in line with the key distinguishing features of abstract vs concrete processing, and that the manipulation was consistent with that of other researchers who have sought to induce these modes (e.g., Scaich, Watkins, & Ehring, 2013; White & Wild, 2016). Our manipulation check, as used by Watkins (2004), also identified the key discriminating differences between abstract and concrete processing modes (i.e., causal vs sensory content). Nevertheless, further studies might aim to induce and identify key aspects of self-referent processing styles as they pertain to rumination.

Furthermore, while the present study focused on the implications of findings for depression, it is acknowledged that emotional responses evoked in response to our mood induction may also overlap with trauma responses (i.e. fear or horror). This overlap is mirrored in the complex emotional reactions to distressing events in real life, as is reflected in the rates of high comorbidity between depression and PTSD (Flory & Yehuda, 2015).

Future studies should include measures of sensory and verbal processing and experiential avoidance to confirm whether it is verbal-linguistic nature of rumination which precludes successful emotional processing as reflected by the persistence of intrusive memories. Additionally, these variables should be examined in the months following naturally occurring distressing events to clarify the relationship between these processes and isolate the most relevant variables involved in the maintenance of intrusive memories and development of depression. Such investigation may point towards areas of intervention to treat intrusive memories and rumination, such as imagery rescripting procedures whereby the focus of the intrusive memory is processed and updated (Brewin et al., 2009).

Conclusions

The findings of our study highlight the complex pattern of associations between processing modes and intrusive memories. While concrete and abstract processing modes were indistinguishable in their association with subsequent intrusions, engagement in rumination may provide a temporary benefit when compared to distraction for the experience of sensory intrusions in the hours following an upsetting event. To the best of our knowledge, ours is the first study to chart different trajectories of intrusions that individuals might experience during the post mood-induction phased. Further research should aim to confirm these trajectory classes and identify reliable predictors of the course of post-induction intrusions. Likewise, there is a need to further clarify the extent to which sensory compared with verbal processing modalities bear upon intrusions. Addressing these questions will likely contribute to enhanced psychological therapy interventions for depressed individuals, as well as for people who have recently experienced traumatic or upsetting events.

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