



The effect of an online mindfulness intervention on metacognitive regulatory processes and their association with phenomenological autobiographical memory components

Rachel Djabaeva

ABSTRACT

Identifying regulatory discrepancies can assist in distinguishing underlying difficulties in clinical affective disorders. The current research looked at the effect of a short online mindfulness intervention on metacognitive regulatory processes; reappraisal, suppression and rumination by comparing a mindfulness intervention group with a control group pre and post intervention. In addition, associations between those processes and phenomenological properties of autobiographical memory (AM) were examined between groups at post intervention. Results revealed significant differences between the groups at post intervention showing mindfulness had increased reappraisal and reduced rumination but had no effect on suppression. Significant associations were observed between metacognitive regulatory processes and AM components; reappraisal with linguistic, suppression with rehearsal and accuracy, and finally, rumination with remembering, linguistic and accuracy. These findings support the metacognitive model (Nelson & Naren, 1990) and link to the source monitoring framework (Johnson, 1988; Johnson, Hashtroudi & Lindsay, 1993) signifying that emotional experience is transferred through monitoring processes to the meta-level, of which mindfulness enhances through re-perceiving and adapting emotion regulation processes. This in turn, adapts patterns in the associations between metacognitive regulatory processes and autobiographical memory properties. The present research provides important implications for guiding future intervention.

KEY WORDS:	MINDFULNESS	METACOGNITION	EMOTION REGULATION	AUTOBIOGRAPHICAL MEMORY	ONLINE INTERVENTION
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Introduction

The metacognitive model (Nelson & Naren, 1990) proposes that mental representations interact between two levels; the meta-level and object-level. The object-level is where present and continuing experience is transferred through monitoring processes to the meta-level to perceive and appraise existing information and emotion (Mazzoni & Nelson, 2014; Fleming & Frith, 2014). Through regulatory processes the meta-level carries information for adjustment in behaviour to the object-level; hence emotions and thoughts become regulated (Fernandez-Duque et al., 2000; Kahan & Sullivan, 2012; Shea et al., 2014). A number of studies have focused on metacognition and mental health (Semerari et al., 2003; Dimaggio, 2011; Dimaggio & Lysaker, 2015), including post-traumatic stress disorder (Bennett & Wells, 2010; Lanius et al., 2010; Wells & Colbear, 2012; Lysaker et al., 2015), obsessive compulsive disorder (Grotte & Solem et al., 2015; Mavrogiorgou et al., 2016), schizophrenia (Lysaker et al., 2013), anxiety disorders (Yilmaz, Gencoz & Wells, 2011; Heiden, 2013) and depression (Gotlib & Joormann, 2010; Ladegaard & Lysaker et al., 2014; Solem et al., 2015).

Autobiographical memory is important for our sense of self and identity (Gardener, 2001; Conway, Singer & Tagini, 2004; Scoboria et al., 2014) and consists of episodic memory defined by three phenomenological components; self, autonoetic awareness, and subjective time (Tulving, 1985; Gardener, 2001; Conway et al., 2004). Accessing information requires activation of cognitive and metacognitive thinking (Daselaar et al., 2008; Greenberg & Knowlton, 2015) involving emotion (Talarico et al., 2004), sensory and narrative coherence (Rubin, Burt & Fifield, 2003; Rubin, Feldman & Beckham, 2004). From both cognitive and neurocognitive perspectives and including contemporary philosophical interpretations, the 'self' consists of two separate categories of self-awareness (Greenberg & Rubin, 2003): a minimal one absorbed on current momentary knowledge and linked to a sense of agency (Gardiner, 2001), and a narrative one consisting of an amalgamation of future planning, self-appraisal and episodic memory into an intelligible self-identity and coherent self (Gardiner, 2001; Greenberg & Rubin, 2003; Conway et al., 2004; Rubin, Dennis & Beckham, 2011). Research has identified difficulties in adapting autobiographical recall of an emotional nature in post-traumatic stress disorder (Rubin, Dennis & Beckham, 2011; Brown et al., 2014) and major depressive disorder (Wessel et al., 2001; King et al., 2010; Liu et al., 2013; Soderlund et al., 2014) which from the metacognitive perspective, would be due to impairments in emotion regulation at the meta-level.

A form of emotion regulation that is frequently encompassed by those with clinical affective disorders is the avoidance of experiencing emotion by suppressing intrusive thoughts and memories (Dalgleish & Yiend, 2006) however; this is a maladaptive strategy (Murakami et al., 2015). Rumination is another maladaptive approach which focuses recurrently on feelings of distress, consequences and causes (Nolen-Hoeksema et al., 2008; Arbutnott et al., 2015) and has been found to be a risk factor for disorders such as generalised anxiety disorder (Yang et al., 2014; Dar & Iqbal, 2015), post-traumatic stress disorder (Birrer & Michael, 2011; Roley et al., 2015), depression (Berman et al., 2011) including major depressive disorder (Yang et al., 2014; Brockmeyer et al., 2015) and obsessive compulsive disorder (Dar & Iqbal, 2015). Such disorders have also been associated with increased error-related

brain activity resulting in defective memory through faulty source monitoring (Weinberg, Olvet & Hajcak, 2010; Stern et al., 2010; Endrass et al., 2010) causing deficits in metacognitive regulation (Bennet & Wells, 2010; Wells et al., 2012), negative interpretations about situations, the self and future events (Nolen-Hoeksema, 1991; Murakami et al., 2015). Holland and Kensinger (2013) found that reappraisal modifies neural activity in autobiographical memory recall and that the amount of time this takes varies due to either down or up-regulating emotions. Once a memory generates emotion, reappraisal can reduce its impact by altering the interpretation of it which has greater efficacy in reducing stress (Keng et al., 2013).

It has been accepted that mindfulness is an effective strategy for emotion regulation (Hayes & Feldman, 2004; Arch & Craske, 2006; Lalot, Delplanque & Sander, 2014; Murakami et al., 2015). Nelson, Stuart, Howard, and Crowley (1999) describe mindfulness as metacognitive as it encompasses a meta-level of attentiveness through monitoring at the object-level (Bishop et al., 2004; Garland et al., 2009). From this perspective, the construct of mindfulness is a form of awareness that involves the process of re-perceiving, decentering and a changing of cognition through different appraisals, which in turn, can accentuate self-focused attention through observation and monitoring (Kahan & Sullivan, 2012). In this sense, researchers argue against mindfulness as a trait, claiming it to be a metacognitive transitory state existing while mindful attention is continued (Bishop et al., 2004). This would assume that mindfulness is psychologically innate and with effective intervention can be accessed to improve coping approaches. Garland, Gaylord and Park (2009) suggest that it would be beneficial to understand the association between appraisal and reappraisal which comprises of an alteration in processes rather than in contents, and have proposed a hypothetical causal model that suggests mindfulness is utilized to activate positive reappraisal (Garland et al., 2009).

Troy, Shallcross, Davis and Mauss (2013; 2012) examined cognitive reappraisal in individuals that had received mindfulness based cognitive therapy (MBCT), which lead them to advocate mindfulness as a foundation for increased re-appraisal by focusing on the present moment, so thoughts and feelings become non-judgementally accepted. Other studies have looked at the effects of mindfulness and reappraisal in reducing sad mood (Keng et al., 2016) and Goldin and Gross's (2010) research found decreased rumination levels after a mindfulness-based stress reduction program. In addition, there is emergent evidence that online mindfulness training is as effective and manageable as the standard eight week training programmes involved with a therapist (Gluck & Maercker, 2011; Morledge, Alexandre & Fox, 2013).

In terms of the association between emotion regulation and autobiographical memory, evidence shows that rumination produces recurrent retrievals of negative memories (Lyubomirsky et al., 1998; Williams & Moulds, 2010). Alternatively, suppression of the emotion related to negative memories can inevitably lead to increased intrusion of the suppressed emotion or memory (Dalgleish & Yiend, 2006), particularly in those suffering with PTSD (Catarino et al., 2015). However, the interaction between emotion regulation and AM requires more attention, specifically the interrelation among the different types of processes (Pasupathi & Cartensen, 2003; Holland & Kensinger, 2010). After looking at the effect of a brief mindfulness

intervention on positive and negative valenced stimuli, Alberts and Thewissen (2011) suggest memory processes may be a likely function fundamental to the link between mindfulness and subjective well-being (Keng et al., 2011).

The primary aim of the current research is to examine the effect of a short term online mindfulness intervention on metacognitive self-regulation processes; reappraisal, suppression and rumination. In addition to this, the research wanted to investigate any significant adaptations in associations between metacognitive regulation processes and phenomenological components of autobiographical memory. The aim of the present research is to offer interpretation of changes in patterns of correlations of phenomenological properties of autobiographical memory and metacognitive regulation processes; reappraisal, suppression and rumination after an online mindfulness intervention.

It was firstly hypothesised that individuals in the intervention condition would experience a significant increase in reappraisal from pre to post intervention. Secondly, significant decreases in suppression were hypothesised from pre to post intervention for those in the mindfulness condition. Thirdly, it was hypothesised that individuals in the mindfulness condition would experience a significant decrease in rumination levels pre to post intervention. Finally, the current research examined differences in strengths of associations between metacognitive regulatory processes and phenomenological properties of autobiographical memory between the two groups post-intervention.

Methodology

Design

The trial compared an intervention group (mindfulness) with a control group (study skills) using a 2 x 2 mixed factor design where the independent between subjects factor was intervention with two levels (mindfulness vs study skills) and the independent within-subjects factor was assessment time with two levels (pre vs post intervention). The dependent variables were metacognitive regulation scores of reappraisal and suppression rated on the Gross and John (2003) self-report emotion regulation questionnaire (ERQ) and rumination scores rated on the Nolen-Hoeksema and Morrow (1991) rumination response scales (RRS), (see materials section for scale item descriptions).

To investigate post-intervention differences between both conditions in the strength of association between metacognitive regulation processes (ERQ and RRS) and phenomenological properties rated on the Rubin et al., (2003) autobiographical memory questionnaire (AMQ), Pearson's correlation co-efficient analyses were conducted.

Participants

Twenty six healthy non-clinical undergraduate students (Female = 18, Male = 8) between the ages of 20 and 61 ($M = 28.88$, $SD = 10.40$) volunteered for the study via a participation pool advertisement at Manchester Metropolitan University (Appendix A). Participants were assigned into two equal groups (mindfulness = 13 vs control =

13) on a random basis. A power analysis calculated using G*power 3.1.9 (Faul et al., 2009) determined that a minimum sample size of 22 participants were needed.¹

Materials

Individuals in each condition were provided a link to an online information sheet providing an overview of the study related to their condition (mindfulness or study skills) which requested them to click a consent box in order to participate in the study (Appendices B and C).

Self-Report Questionnaires

The Emotion Regulation Questionnaire (ERQ; Gross & John, 2003)

The emotion regulation questionnaire (Gross & John, 2003) is a ten item questionnaire comprising of a six-item reappraisal subscale and a four-item suppression subscale designed to measure the propensity to regulate emotion through cognitive reappraisal and expressive suppression. Items on both subscales are rated on a seven point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The scale shows good internal reliability for each subscale with α coefficients of .79 and .73 for reappraisal and suppression respectively (Gross & John, 2003). For the purpose of the current research it was slightly adapted by asking individuals to rate the statements about their emotional life while in a learning environment (school, college or university), rather than asking them to rate the statements based on their emotional life in general as did the original Gross and John (2003) version. Copies of the original and adapted version can be found in appendix D and E.

The Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991)

The rumination response scale is a twenty-two item questionnaire designed to measure responses to mood focusing on the self, possible causes and implications. The RRS has high internal consistency with a Cronbach's alpha of .89 (Nolen-Hoeksema & Morrow, 1991). For the purpose of the current study the language was adapted to suit healthy non-clinical individuals within a learning context. Therefore, instead of using the word '*depressed*' this was changed to '*stressed*' as individuals within a learning context will relate to feeling stressed more than feeling depressed and it can be usual for individuals to not realise they may be feeling depressed therefore, the term '*feeling stressed*' is considered a more regular phrase of speech. The word '*sad*' was replaced with '*under pressure*' as it relates more to how individuals may feel within a learning context. Although students may feel sadness due to missing home, friends, relationships, or even over something that has happened in their lives while in the learning environment, the term feeling '*under pressure*' is more likely to be felt by a wider sample of individuals. The measures reflect the original scale in line with Nolen-Hoeksema and Morrow (1991) where the

¹ Using a significance alpha value of 0.5, power of .08 with a medium effect size (Cohen's $d = .5$.)

total score for the twenty-two items of the RRS were calculated, with higher scores representing higher levels of rumination while feeling a certain way; in this case; *stressed, down and under pressure*. A copy of the original ruminative response scale (Nolen-Hoeksema & Morrow, 1991) and the modified version are found in Appendices F and G.

Autobiographical Memory questionnaire (AMQ; Rubin et al., 2003)

The autobiographical memory questionnaire (Rubin, Schrauf & Greenberg, 2003) comprises of nineteen statements used to measure phenomenological components of autobiographical memory based on the sensory-perceptual episodic memory system (Conway, 2001). For the purpose of the present study and similar to previous studies (Berntsen, 2002; Bohanek, Fivush & Walker, 2005) phenomenological components of a nominated positive and negative memory were evaluated. All items were subjectively rated on a seven point scale with items (a) to (g) as; 1 = *not at all* to 7 = *as clearly as if it was happening right now*, items (h) to (m) as; 1 = *not at all* to 7 = *as much as any memory*, item (n) as; 1 = *100% imaginary* to 7 = *100% real*, item (o) as; 1 = *not at all* to 7 = *as often as any event in my life*, item (p) as; 1 = *not at all* to 7 = *completely* and item (s) as; 1 = *100% distorted* to 7 = *100% accurate*. The exception was item (q) which was rated on a three point scale based on *once, merged and continuous*, and item (r) which dated the memory. Finally, Rubin et al., (2003) suggested that the method of the AMQ allows for statements to be changed and that different wordings could benefit future research. On the basis of this, it was modified by adapting the language of the statements to suit healthy non-clinical individuals within a learning environment, yet statements remained of the same nature. A copy of the original (Rubin et al., 2003) and the modified version can be found in Appendices H and I.

Mindfulness Intervention

Permission was gained from Peter Morgan (2014) for use of the mindfulness audios which combined vital properties of mindfulness based stress reduction (MBSR) such as the body scan, sitting meditation and the mountain meditation, which were adapted versions taken from Kabat-Zinn (Kabat-Zinn, 1982). Week one consisted of the *Mindfulness of breath* and *Mountain meditation* (Total combined time: 13.43 mins), week two was *The Body Scan* (Total time; 23.12 mins) and week three was the *Breath, Sounds, Body, Thoughts and Emotions Meditation* (Total time: 19.00 mins). A copy of the instructions and a link to the audio recordings for each week can be found in the Appendices J - L.

Study Skills (Control Group)

Online audio recordings were freely available to download from the Palgrave Study Skills website (Palgrave, 2016). Week one was *Creative thinking* and *Tricks of the writers trade* (Total time: 12.73 mins), week two was *Exam Skills* and *Presentation Skills* (Total time: 14.28 mins) and week three was *Critical writing* and *Referencing* (Total time: 17.93 mins). A copy of the instructions, a link to the audio recordings can be found in Appendices M - O.

Procedure

Both groups of participants were informed that the study was about metacognitive processes and memory² and were given online instructions to complete three weekly sessions of listening to audio recordings at home³. In order to control for maximum engagement in both programmes, both groups were informed that all audios needed to be listened to in full and that the time spent on each recording was registered. If they were not fully engaged with the program their results were classed as invalid therefore, they could not continue further with the study or gain full points from the participation pool. Incorporated into one online questionnaire, the baseline measurements of the variables (ERQ, RRS and AMQ) were logged pre and post intervention for both conditions (mindfulness/study skills). For the AMQ, participants were instructed to recall one negative and one positive memory related to their time while in a learning environment (school, college or university) and asked to rate the phenomenological components of each memory. Consideration was taken to ensure the study skills programme was structurally comparable to the mindfulness programme in that audios were approximately the same amount of time to ensure that any changes in the mindfulness group could be specifically attributed to mindfulness training.

Ethical Consideration

Ethical regulations were adhered to following the BPS guidelines (British Psychological Society, 2009) covering the subsequent themes of deception, risk factors, confidentiality, consent and debriefing and approval was authorised by the Manchester Metropolitan University. While mood can be altered by meditation and recall of autobiographical memories, the risk was considered to be low due to the online mindfulness intervention being varied in type and short term and the memories being recalled were within a learning context. In the (rare) case of emotional and personal issues surfacing relating to any memories recollected (within a learning environment), a list of useful contacts were provided for advice and counselling on the debrief page (Appendix P).

Results

Datasets and appropriate subscale items were evaluated using IBM SPSS Statistics 19.00 by calculating total scores at each assessment time (pre/post-intervention) for each group (control/mindfulness). Cronbach's alpha (α) coefficients were assessed for all scales in each group across trials to check internal reliability, which ranged from good (Cronbach's $\alpha = .71$) to acceptable (Cronbach's $\alpha = .76$) reliability (Nunally, 1978).

²This explanation was given rather than the full explanation (emotion regulation and autobiographical memory) in order to control for demand characteristics

³To control for extraneous variables, both groups were advised that they would gain maximum benefit from the program by listening to the recordings in a quiet environment with no distractions such as TV and mobile phones.

In line with previous research (Gross & John, 2003; Moore, Zoellner & Mollenholt, 2008), reliability coefficients were also denoted as acceptable for the subscale of the ERQ; reappraisal (Mindfulness: Cronbach's $\alpha = .85$, Control: Cronbach's $\alpha = .90$) and suppression (Mindfulness: Cronbach's $\alpha = .71$; Control: Cronbach's $\alpha = .85$).

The preliminary stage of the study was concerned with the effects of mindfulness on reappraisal, suppression and rumination therefore, unless otherwise stated, baseline measurements for the ERQ and RRS at week 1 are referred to as pre-intervention and the final (week 4) measurements are referred to as post-intervention. Following previous research, the scores calculated for each of the scale items on the ERQ-R, ERQ-S and RRS were analysed by 2 (Condition; control vs. mindfulness) between participants by 2 (Time; pre-intervention vs. post intervention) within participants mixed ANOVAs. A summary of the means and SDs for both groups (control/mindfulness) at each time (pre/post intervention) and overall scales are displayed in Table 1.

Table 1
Mean (SD) ratings for each scale; ERQ-R, ERQ-S and RRS, at time (pre and post-intervention) and condition (mindfulness vs control)

Scale	Intervention											
	Control ($n = 13$)				Mindfulness ($n = 13$)				Overall ($n = 26$)			
	Pre		Post		Pre		Post		Pre		Post	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Emotional Regulation												
Reappraisal	30.62	6.36	27.54	8.38	29.62	6.33	34.31	5.66	30.12	6.24	30.92	7.81
Suppression	18.85	5.37	17.00	5.10	17.54	5.46	16.62	5.39	18.19	5.34	16.81	5.15
Rumination												
Rumination	54.54	10.13	59.62	13.68	49.54	14.33	41.92	12.56	52.04	12.42	50.77	15.71

Hypothesis One: ERQ-Reappraisal

In terms of reappraisal levels there was no main effect for time, $F(1, 24) = .292$, $p = .59^4$, or condition, $F(1, 24) = 1.74$, $p = .20$, but there was a significant interaction, $F(1, 24) = 6.75$, $p = .02$. This interaction is illustrated in figure 1.

To determine the source of significance within the ANOVA, appropriate post hoc tests were conducted. Although there was a very slight decrease in reappraisal levels for the control group from pre to post-intervention⁵, paired sample t-tests confirmed this change was not significant⁶, $t(12) = 1.88$, $p = .08$, and while there was an increase in reappraisal levels in the mindfulness condition from pre to post-intervention, this change was also not significant, $t(12) = -1.87$, $p = .09$.

⁴Sphericity was assumed as Mauchly's test was not significant

⁵The explanation for this decrease is due to the time of year the research was undertaken; a busy time at university with exams and assignment deadlines would highly increase normal stress levels

⁶If the study was performed at a less stressful period at university, it is highly unlikely that reappraisal would have decreased in the control group.

Due to the trend toward increased reappraisal levels in the mindfulness condition independent t-tests were conducted and confirmed no difference (as expected) between the two conditions pre-intervention $t(24) = .40, p = .69$ but a significant difference between the two conditions post-intervention $t(24) = -2.41, p = .02$. This indicates that overall the two groups showed a significant difference post intervention, signifying that mindfulness had an effect on reappraisal levels.

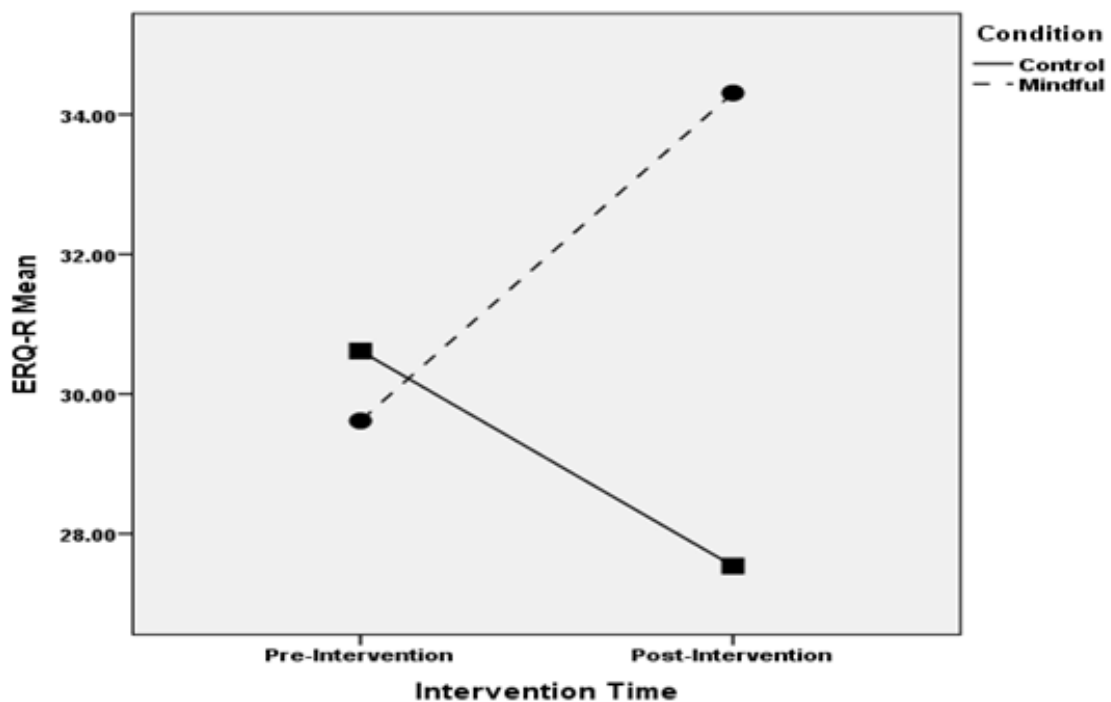


Figure 1: Interaction between intervention time (pre vs post) and condition (control vs mindfulness) for the ERQ-R

Hypothesis Two: ERQ-Suppression

In respect to suppression levels there was no significant main effect for time, $F(1, 24) = 1.67, p = .21$, or condition, $F(1, 24) = .22, p = .64$, and no significant interaction, $F(1, 24) = .19, p = .67$, which indicated that mindfulness had no effect on suppression.

Hypothesis Three - Rumination: RRS

In reference to rumination levels there was no main effect for assessment time $F(1, 24) = .17, p = .68$ but there was a significant main effect for condition $F(1, 24) = 8.2, p = .01$. However, this was qualified by a borderline significant interaction, $F(1, 24) = 4.28, p = .05$. This is illustrated in figure 2. Although there was a very slight increase in rumination levels for the control group from pre to post-intervention, paired sample t-tests confirmed this change was not significant, $t(12) = 1.99, p = .07$, and while there was a decrease in rumination in the mindfulness condition, this change was also not significant, $t(12) = -1.37, p = .20$. With a trend toward lower rumination scores in the mindfulness condition, independent t-tests were conducted confirming no significant difference between scores of the two conditions pre-intervention $t(24) = 1.03, p = .32$, but a significant difference post-intervention $t(24) = 3.44, p = .002$. This specifies that overall there was a significant difference between the two groups post-intervention, demonstrating that mindfulness had an effect on rumination.

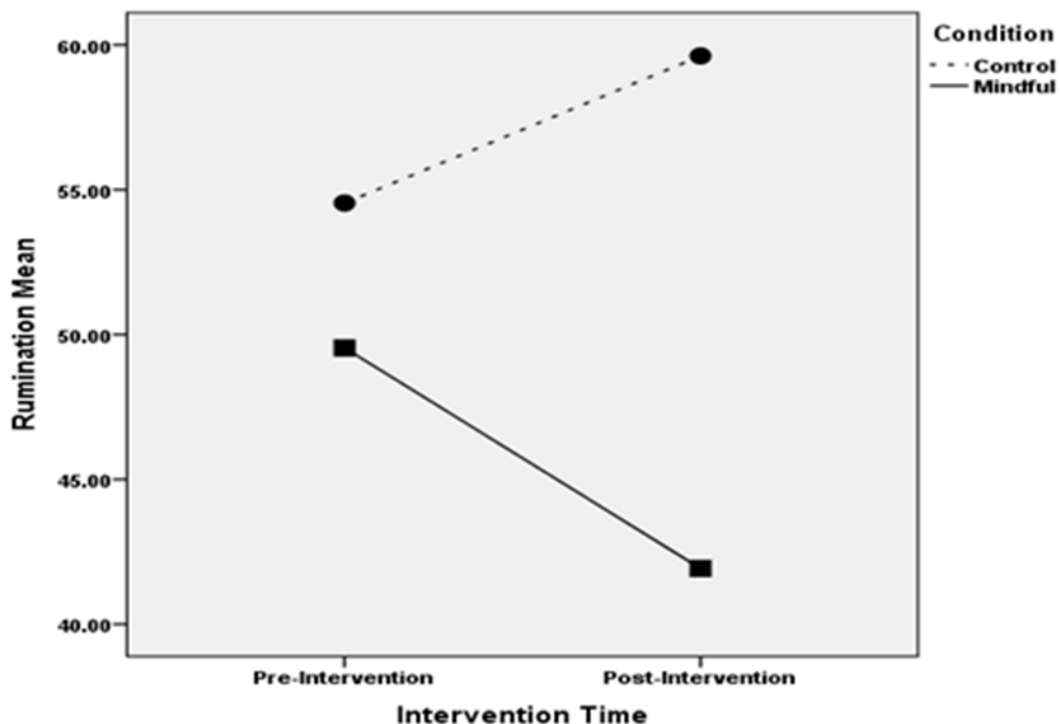


Figure 2: Interaction between intervention time (pre vs post) and condition (control vs mindfulness) for RRS scores

Metacognitive Regulation and Autobiographical Memory

The second part of the study wanted to determine whether there were any effects at post-intervention of associations between metacognitive regulation processes (reappraisal, suppression and rumination) and subjective properties of autobiographical memory. Due to practical constraints only four statements

representing recollection, linguistic, rehearsal and accuracy components are included however, these are considered to be a good representation of sensory perceptual knowledge of autobiographical memory and relevant to metacognitive monitoring and control processes (Conway, 2001; Scoboria, Talarico & Pascal, 2015). In addition, due to a small sample size it was not viable to test for correlational differences at pre and post intervention therefore, only the two conditions were analysed at post intervention using Pearson product-moment analysis. This is similar to previous correlational studies on AM such as by Boals and Schuettler (2011) although, claims on causality are unable to be made. While all components of the Rubin et al, (2003) study were included in the questionnaire, due to time constraints only AM components tested that showed a significant correlation with one or more of the regulatory processes (reappraisal, suppression and rumination) are reported. A summary is provided in Table 2.

Table 2
Summary of correlations between metacognitive regulation⁷ and autobiographical components of both conditions at post-intervention

Question		Control		Mindfulness	
		Positive	Negative	Positive	Negative
Remembering	ERQ-R	-.29	'.42	'.18	'.17
	ERQ-S	.08	-.08	-.39	-.26
	RRS	-.03	-.30	-.57*	-.49*
	<i>r</i>		.19		.85**
In Words	ERQ-R	.34	.37	-.50*	-.57*
	ERQ-S	-.33	-.29	-.32	-.09
	RRS	'-.54*	'-.72**	-.25	-.56*
	<i>r</i>		.74**		.58*
Rehearsal	ERQ-R	'.19	-.19	-.41	-.36
	ERQ-S	-.34	-.06	-.37	-.52*
	RRS	-.40	'.06	-.21	-.40
	<i>r</i>		.48*		.63*
Accuracy	ERQ-R	-.28	'.07	.29	-.02
	ERQ-S	'.29	-.21	-.55*	-.35
	RRS	-.10	'.12	-.55*	'-.51*
	<i>r</i>		.01		.70**

*. Correlation is significant at the 0.05 level (1-tailed); **. Correlation is significant at the 0.01 level (1-tailed).

⁷ERQ-R = Reappraisal, ERQ-S = Suppression, RRS = Rumination

Recollection (Remembering) with Rumination

In the mindfulness condition a negative association was observed between rumination and *remembering* (rather than just knowing) of positive ($r = -.57, n = 13, p = .02$) and negative memories ($r = -.49, n = 13, p = .05$). Thus lower rumination was associated with greater recollection (remembering) of both positive and negative memories in the mindfulness condition.

Linguistic (In Words) with Reappraisal and Rumination

In the mindfulness condition, a negative correlation existed between reappraisal and the retrieval of both positive ($r = -.50, n = 13, p = .04$), and negative memories recalled in words ($r = -.57, n = 13, p = .02$), compared to no association in the control group. Thus higher reporting of reappraisal appeared to be associated with lower reporting of both positive and negative memories recalled in words in the mindfulness condition. A negative correlation was observed in the control group between rumination and memories recalled in words of both positive ($r = -.54, n = 13, p = .03$), and negative memories ($r = -.72, n = 13, p = .00$), and in the mindfulness group there was a negative correlation between rumination and negative memories recalled in words ($r = -.56, n = 13, p = .02$) which was a weaker relationship than in the control group. This indicates that while rumination is associated with less retrieval of negative and positive memories recalled in words in the control group, it is only associated with less retrieval of negative memories recalled in words in the mindfulness condition and this association is somewhat reduced.

Rehearsal with Suppression

A negative correlation was found between suppression and negative memories that had been thought or talked about in the mindfulness group ($r = -.52, n = 13, p = .04$). This indicates that those in the mindfulness condition who had reported greater suppressing of emotion tended to talk or think about negative memories less after mindfulness training.

Accuracy with Suppression and Rumination

A negative correlation was found between suppression and reported accuracy of positive memories in the mindfulness group ($r = -.55, n = 13, p = .03$) indicating that those who reported lower suppression reported greater accuracy of positive memories. Rumination was also negatively correlated with reporting of accuracy for both positive ($r = -.55, n = 13, p = .03$) and negative memories ($r = -.55, n = 13, p = .04$) in the mindfulness group. Thus, it indicates that people who ruminate less tend to report more accuracy in both positive and negative memories in the mindfulness group.

Discussion

The current study aimed to assess the effect of a short online mindfulness intervention on metacognitive regulatory processes (reappraisal, suppression, rumination). The second part indirectly examined the relationships between the metacognitive strategies and subjective qualities of AM properties between the two conditions at post intervention.

Mindfulness and Reappraisal

In terms of reappraisal, the main finding from the present study supports the hypothesis that mindfulness enhances reappraisal. This effect is in line with Troy et al., (2013) who found that individuals who had received MBCT demonstrated higher cognitive reappraisal and also lends support to Garland et al., (2009) in that mindfulness is reciprocally interconnected and increases positive reappraisal. These results also further back up the metacognitive perspective on the role of mindfulness in positive reappraisal as first discussed in the introduction. The findings show a trend toward higher reappraisal after mindfulness training and even though there was not a significant main effect pre-post intervention this could be explained by the trend in the control group toward lowered reappraisal from pre to post-intervention. However, there were significant differences between the two groups at post intervention.

The fact that the study was undertaken at an extremely busy period in university with numerous assignment deadlines and exams could inevitably mean that all the participants would have been under increased pressure and stress at this time. However the results suggest that mindfulness reduced the effect of this by increasing reappraisal because without, participants may have more than likely produced similar results to the control group of decreased reappraisal at this busy time. This supports Lalot, Delplanque and Sander (2014) in that mindfulness influences cognitive reappraisal which in turn leads to adaptive coping processes. In addition, these findings support the notion of the mindful coping model proposed by Garland (2007), in that individuals initiate adaptive coping responses by decentering into the mode of mindfulness - a metacognitive awareness, where individuals can then reappraise the given stressors in a positive manner by attributing new meaning. This is the first known study to test this hypothesis using a short online mindfulness intervention with successful results.

Mindfulness and Suppression

Similar to results of Hepburn et al., (2009), who found that MBCT did not reduce suppression, the current findings did not support the hypothesis that mindfulness would decrease suppression. Possible explanations for this perhaps fit with Murakami et al., (2015) in that both mindfulness and suppression regulate through different top-down modulation systems (Murakami et al., (2015). Therefore, while each strategy decreases amygdala reactions to emotional prompts at the prefrontal areas, the two differ in regulation pathways. However, Hepburn et al., (2009) suggest that variance effects on measures of suppression require more research.

Mindfulness and Rumination

As predicted, mindfulness decreased rumination levels and supports similar findings by Jain and Shapiro et al., (2007) and Shahrar et al., (2010) who found decreased rumination improved after mindfulness training. The present findings show a trend toward decreased rumination after mindfulness training and even though there was not a significant main effect pre to post-intervention this could be explained by the trend in the control group toward increased rumination from pre to post-intervention. Similar to the decreased reappraisal results in the control group, due to the current research being conducted at an extremely busy period in university it is highly inevitable that all participants would have been under increased pressure and stress at this time. This suggests that mindfulness was able to reduce the effect by decreasing rumination because without, participants may have produced similar results as the control group of increased rumination at this busy time. However, the current findings support the proposition of mindfulness being a non-goal-orientated mode of processing, thus thinking is moved away from ruminative goal-orientated processing as suggested by Teasdale, Segal and Williams, (2003). These results have important implications because they reveal a constructive property of mindfulness (Teasdale, Segal & Williams, 2003) that can impact processes evident amongst a range of anxiety conditions such as generalised anxiety disorder (GAD), obsessive compulsive disorder (OCD) and post-traumatic stress disorder (PTSD).

Metacognitive Regulation and Autobiographical Memory

While the present study does not provide a hypothesis on these correlations and results are considered preliminary, it is apparent that mindfulness intervention has changed the pattern of correlations as there are apparent significant differences in strength of the associations between the two conditions. Given the number of ABM measures used and the number of participants, these correlations are only tentative and suggest potentials for future innovative research.

Recollection (Remembering) with Rumination

The findings of the present study, found a negative relationship between rumination and recollection (*remembering*) of both positive and negative AMs in the mindfulness group compared to no relationship in the control group. Thus lower rumination scores (found in the ANOVA results) were associated with increased confidence in recollection (*remembering*) of both positive and negative memories after mindfulness training. Autobiographical memory entails source monitoring and research has shown that re-experiencing of perceptual based information is involved in remembering (Rubin, Schrauf & Greenberg, 2003; Rubin & Siegler, 2004) as opposed to familiarity which denotes a method of memory absent of detailed information.

In addition to this, rumination is linked with anxiety disorders such as generalised anxiety disorder (GAD) and obsessive compulsive disorder (OCD), which have both been associated with increased error-related brain activity, resulting in false memory owing to defective source monitoring (Weinberg, Olvet & Hajcak, 2010; Stern et al., 2010; Endrass et al., 2010). Since mindfulness has been found to increase the accuracy of source monitoring owing to improved attentiveness of subjective

experience, it reflects in the current results as a mediator for both rumination and the recollection of both positive and negative memories.

Linguistic component of AM with Reappraisal and Rumination

It would appear that reappraising emotion negatively influences the subjective quality of positive and negative AMs recalled *in words* after mindfulness training. From the perspective of the metacognitive model, the probability is that after mindfulness intervention, once the reappraisal of the emotion related to the AM reaches the meta-level it also conveys the memory for change to the object-level, hence the emotion becomes regulated (Bishop et al., 2004; Garland et al., 2009; Kahan & Sullivan, 2012), while at the same time the memory is recalled less *in words*.

Rumination is associated negatively with retrieval of negative and positive AMs recalled *in words* in the control group and this relationship appears to be altered in the mindfulness condition in that it is negatively associated only with negative AMs recalled *in words*. However, this association is reduced somewhat. In relation to the research discussed in the introduction on rumination and autobiographical memory where recurrent retrievals of negative memories lead to increased distress (Lyubomirsky et al., 1998; Williams & Moulds, 2010), it is conceivable, as with reappraisal, that mindfulness reduces the function of the linguistic component in negative memories while ruminating in order to reduce the effect of increased distress.

Rehearsal with Suppression

Suppression of emotion was associated with decreased reported *thinking or talking* about negative AMs after mindfulness training, whereas in the control group there was no relationship between the two. This is an interesting finding since it is known that suppression of emotion related to negative memories inevitably leads to increased intrusions of the suppressed emotion or memory (Dalgleish & Yiend, 2006), particularly in those suffering with PTSD (Catarino et al., 2015). In this case, of those who had taken part in the mindfulness intervention that still reported suppression of emotion (ANOVA results showed mindfulness had no effect on suppression), mindfulness had appeared to influence rehearsal of negative AMs in a way where participants did not think of them as frequently (even when suppressing emotion). This suggests that mindfulness may influence the function of rehearsal of negative AMs in those who suppress emotions to become a positive functional mechanism.

According to the research outlined in the introduction, this is feasible, since the core component of mindfulness is based on the non-judgmental observation of stimuli therefore, while suppressing a negative emotion related to a negative memory, the negative memory is able to be processed and viewed in a non-judgemental way which could result in less thinking (or intrusion) of it. This finding supports Alberts and Thewissen's (2011) suggestion of a possible mechanism whereby mindfulness may be a fundamental connection between memory processes (such as rehearsal) and subjective well-being.

Accuracy with Suppression and Rumination

In the mindfulness group, reported suppression was negatively associated with accuracy of positive memories but not in the control group. This is in line with

previous findings where suppression results in impaired memory (Richards & Gross, 2000). However it appeared that mindfulness has deteriorated this relationship. The greater people suppressed emotion the less accuracy they had in the memory. This would suggest that mindfulness does not improve accuracy of memory in those who use suppression to regulate emotions which could be due to the fact that mindfulness and suppression regulate through different top-down modulation systems (Murakami et al., (2015) and it is likely that the two are in conflict when being activated simultaneously, causing less accuracy in AMs due to this conflict.

Reported rumination was negatively associated with accuracy of both positive and negative memories only in the intervention group. Since mindfulness decreased rumination, it appeared that this resulted in a stronger relationship for reporting higher accuracy of both positive and negative memories but not in the control group. This finding is similar to the finding with the *remembering* (vs familiarity) component, in that mindfulness has been found to increase the accuracy of source monitoring owing to improved attentiveness of subjective experience, therefore, as with *remembering*, it reflects in the current results as a possible mediator for both rumination and accuracy of both positive and negative memories. There could be scope to explore the beneficial aspect mindfulness brings to source monitoring and the subjective autobiographical memory components in those suffering with disorders such as GAD, OCD and depression.

Limitations

Asking participants to retrieve memories could have the effect of experimenter bias as autobiographical memory belief and recollection would have been strong due to this (Scoboria & Talarico, 2013; Scoboria et al., 2014). Another potential limitation comes from the use of self-reported questionnaires which could present demand characteristics when instructing participants to respond to specific qualities of subjective experience, which could intensify the recounted occurrence of these qualities (Kahan & Sullivan, 2012). Future research could perhaps utilize a mixed method approach similar to that done by Keyworth et al., (2014).

A small sample size was used and consisted of students who were going through a very busy and stressful period at university which may have affected results in both groups owing to increased pressure of assignment deadlines and exam worry. Correspondingly, while efforts were made to fully instruct participants, there was no way to determine whether participants fully engaged or not, therefore future research could look at using a measure such as the Toronto Mindfulness Scale (Lau et al., 2006). In addition to this, further research could also incorporate measures of individual differences such as trait mindfulness by using the Five Facet Mindfulness questionnaire (Baer et al., 2006) or on personality types using the Big Five Inventory (BFI) to account for those with a predisposition to anxiousness or stress.

Implications of the current research

The findings of the present research provide scope into how online mindfulness-based interventions could be deliberated for adaptive coping styles and offers robust support for an online intervention program, reducing cost and increasing access.

This study also adds insight for neuropsychological researchers such as Opialla et al., (2015) who found shared neural circuits in mindful and reappraisal strategies. If mindfulness improves reappraisal by connecting into the processes that trigger reappraisal neural circuits, then perhaps by recognising different activations associated with mindfulness, reappraisal, rumination and AM components might provide a better understanding to the different processes in modification underlying psychotherapeutic interventions.

In addition, there are some important clinical and research implications on the strength of consideration of the relationships between metacognitive emotion regulation strategies and subjective AM components after mindfulness. Based on this influence on AM, it highlights a varying construction which could be of value to further studies. Perhaps by looking at the difference in these relationships at pre to post intervention could provide some interesting data to work from. In addition to this, the findings in this research can be of value to current metacognitive treatments such as metacognition-orientated psychotherapy, metacognitive interpersonal therapy, or mentalization-based treatment and assist psychotherapy research by considering the importance of the relationship between mindfulness, emotion regulation and autobiographical memory (Dimaggio et al., 2012).

The findings provide scope for future research within clinical populations suffering with emotional disorders such as depression, GAD or PTSD as they could be connected with deficits in both AM and emotion regulation abilities, of which there is no research to date examining the two together in those suffering with these disorders.

Conclusion

In sum, the main strength of the present research was in the use of using a control group to compare differences at pre to post intervention on the effect of mindfulness on metacognitive emotion regulation strategies, which is the first of its kind in relation to reappraisal, suppression and rumination together. Also, this is the first known study that has examined the relationship between metacognitive regulation on subjective autobiographical memory properties after an online mindfulness intervention.

The findings here are preliminary and need to be explored further; however there is great significance to these findings that can be extracted for further research using different methodological approaches.

The current research offers support to the metacognitive model (Nelson & Naren, 1990) and the mindful model (Garland, 2007) linking to the source monitoring framework (Johnson, 1988; Johnson, Hashtroudi & Lindsay, 1993). On this basis, it is evident that present and continuing experience is transferred through monitoring processes to the meta-level, and that mindfulness enhances the basis for re-perceiving and the adapting of emotion regulation processes, which in turn adapts correlational patterns between metacognitive regulatory processes and autobiographical memory components.

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