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Individual differences in reappraisal ability: Links to reappraisal frequency, well-being, and cognitive control

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ABSTRACT

Reappraisal is generally viewed as an adaptive emotion regulation strategy. Reappraisal frequency has been associated with greater well-being, and reappraisal ability is thought to be composed of several crucial cognitive control processes. However, the relationships among reappraisal ability, reappraisal frequency, well-being, and various cognitive control processes have not yet been determined. In this study, we experimentally examined individual differences in reappraisal ability (RA), and also assessed reappraisal frequency, well-being, and several cognitive control processes. We observed a positive relationship between RA, reappraisal frequency, and well-being. RA was also related positively to working memory capacity and set-shifting costs, and marginally related to abstract reasoning. These findings have important implications for understanding the cognitive components and affective outcomes of RA.

1. Introduction

Functionalist approaches emphasize the adaptive role played by emotions in many important situations (Clark & Watson, 1994). However, there are also times when emotions must be regulated. Research on emotion regulation has distinguished among emotion regulation strategies, finding that some are more effective than others (Gross & Thompson, 2007). In fact, the over-use of maladaptive strategies and the under-use of adaptive strategies are thought to underlie several common mood and anxiety disorders (Campbell-Sills & Barlow, 2007).

One generally adaptive emotion regulation strategy is cognitive reappraisal, which involves changing the meaning of a potentially emotion-eliciting situation in order to alter the emotion that follows. Reappraisal appears to be effective, is widely used in everyday life, and is closely related to skills taught in interventions for mood and anxiety disorders (Giuliani & Gross, 2009). For these reasons, reappraisal has been a common target of observational and experimental research (Gross, 1998; Gross & John, 2003; Kalisch, 2009).

Observational studies have demonstrated that the frequency with which one uses reappraisal relates to lower levels of trait negative affect and clinical symptoms, and higher levels of trait positive affect and well-being (Gross & John, 2003). In parallel, experimental studies have shown that instructed reappraisal reliably decreases self-reported negative affect (Gross, 1998), peripheral psychophysiology (Jackson, Malmstadt, Larson, & Davidson, 2000; Ray, McRae, Ochsner, & Gross, 2010), and activation in neural regions associated with emotion generation, such as the amygdala (Kalisch, 2009; Ochsner & Gross, 2008).

Multiple studies have demonstrated that those who use reappraisal frequently in everyday life report greater psychological well-being (Gross & John, 2003; Nezlek & Kuppens, 2008). However, it is unclear whether reappraisal frequency relates to reappraisal ability (RA, defined as the ability to actually execute cognitive reappraisal successfully). It is also unclear whether individual differences in RA also show a positive relationship with well-being. It is reasonable to hypothesize that those who have greater RA are able to successfully decrease their negative affect in everyday life, and therefore enjoy lower levels of negative affect, greater amounts of positive affect, and greater life satisfaction. Indeed, one previous study reports that reappraisal ability protects against depressive symptoms at high levels of stress (Troy, Wilhelm, Shallcross, & Mauss, 2010). Therefore, it is possible that well-being (low negative affect, high positive affect and greater life satisfaction) may be associated with RA.

Like any complex activity requiring cognitive control, reappraisal is thought to rely upon a range of cognitive control abilities (Ochsner & Gross, 2005). This idea is propagated by the common interpretation that the neural regions engaged during reappraisal

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are at least partially overlapping with those that are involved in cognitive control more broadly (Kalisch, 2009; Ochsner & Gross, 2005). Empirical investigations of cognitive control processes demonstrate that there are different types of cognitive control processes. These are most commonly categorized as working memory, set-shifting, and response inhibition. Individual differences in these different types of cognitive control are partially overlapping, but separable (Miyake, Friedman, Emerson, Witzki, Howerter & Wager, 2000). In addition to the commonly studied cognitive control tasks of working memory, set-shifting, and response inhibition, there is reason to believe that verbal ability may play a role in RA. Previous work examining another emotion regulation strategy, expressive suppression, has demonstrated that suppression ability is related to verbal ability, but not to other cognitive abilities (Gyurak, Goodkind, Kramer, Miller, & Levenson, 2011). When individuals generate an alternative narrative about a picture or event to reappraise, it seems likely that they need to bring and keep the automatic appraisal of a negative situation to mind (working memory), decrease the salience of that appraisal (inhibition), generate alternate interpretations (working memory manipulation and verbal ability), identify and engage the reinterpretation that is most appropriate (selection amongst alternatives, set-shifting), keep that new appraisal in mind (working memory maintenance), and keep track of the success of regulation (monitoring; Ochsner & Gross, 2008).

However, no empirical investigations of RA have included the measurement of multiple cognitive control processes. To date, there is only one report of individual differences in cognitive control and reappraisal (Schmeichel, Volokhov, & Demaree, 2008). This study reports a negative relationship between one type of cognitive control, working memory capacity, and negative emotional responding during an instruction to decrease negative affect via reappraisal. However, this study was not able to measure RA as an individual difference in each participant. In addition, no other types of cognitive control were measured, and so it is unclear whether the relationship between reappraisal and working memory holds for other types of cognitive control processes, such as set-shifting, response inhibition and verbal ability.

The goal of the present study was to examine the relationship between individual differences in RA and reappraisal frequency, well-being, and multiple measures of cognitive control. We focused upon representative cognitive control measures that have been previously identified as overlapping and distinct contributors to cognitive control in the executive functioning literature, such as working memory, set-shifting and response inhibition (Miyake et al., 2000), and measures that have been used previously to examine relationships with other emotion regulation strategies, such as verbal and abstract reasoning ability (Gyurak et al., 2011). To assess the impact of social desirability on our predicted associations, we also assessed individual differences in social desirability. To assess the specificity of the relationships with reappraisal frequency, we also assessed the frequency of the use of another emotion regulation strategy, expressive suppression. We predicted that greater reappraisal ability would be associated with (a) greater reappraisal frequency, (b) greater well-being, and (c) several measures of cognitive control.

2. Methods

2.1. Participants

Participants were recruited from the San Francisco Bay Area via online bulletin board postings and paper fliers. Interested participants were screened by email and telephone. Inclusion criteria were: (a) between the ages of 18–36; (b) fluent in English; (c) free from psychotic symptoms; (d) high school degree or equivalent; and (e) no current substance abuse. One-hundred and one participants completed the tasks and questionnaires with valid responses (those who responded on at least 80% of the trials and for whom accuracy was above chance, indicating an earnest attempt at task completion). Of these, 12 participants were removed to due to missing data or outlying scores (*Z* score ±3 on at least one of the measures reported below). Therefore, 89 participants (37 men and 52 women) were included in the present study (ages 18–36, mean age = 25.1 S.D. = 5.0).[1] Of these, 39% of participants identified themselves as Caucasian, 25% as Asian, 8% as African-American, 6% as Hispanic, 10% stated that they were another unspecified ethnicity, and 12% declined to state their ethnicity. Education ranged from 12 to 21 years (mean = 15.7, S.D. = 2.3). Participants were paid for their time.

2.2. Procedure

Eligible participants were directed to a website where they completed measures of emotion regulation frequency, well-being, verbal ability, and abstract reasoning ability (described below). Several days later, participants completed laboratory sessions in small groups ranging from 1 to 4 people per session. Reappraisal ability, working memory, set-shifting and response inhibition were measured by tasks (described below) created and administered using the Eprime software package, and administered on Windows-based computers (all >1 GhZ processors with approximately 15″ monitors). Participants first completed the reappraisal task, then unrelated tasks, and then completed measures of working memory (operation span), set shifting (global/local), and response inhibition (Stroop). The experimenter unobtrusively monitored the session to ensure participants were on-task, to answer questions, and to begin each task in Eprime.

2.3. Measures

2.3.1. Laboratory assessment of RA

Reappraisal ability was assessed using a task based on those used by our group in behavioral, psychophysiological, and neuroimaging contexts (McRae, Hughes, Chopra, Gabrieli, Gross, & Ochsner, 2010; Ochsner et al., 2004; Ray et al., 2010). This task measures RA by computing for each participant the average magnitude of reduction in negative affect in response to matched negative images during an instruction to reappraise compared to an instruction to respond naturally. Negative and neutral pictures were selected from the international affective pictures system (IAPS; Lang, Bradley, & Cuthbert, 2001).[2] Participants were instructed by a series of screens to follow an instruction that appeared before each picture (paired with a colored frame around the picture) to indicate what they were to do during that picture. Green frames were paired with the instruction "Look," and participants were told to "allow yourself to continue to feel whatever it was you were feeling previously about the picture, as you naturally would". Blue frames were paired with the instruction, "Decrease," and participants were told to try to tell themselves something that makes them feel less negative. An example trial of each type was presented to the participant, including examples of acceptable reappraisals for the decrease instruction, such as imagining ways the situation could im-

[1] Four participants had missing data on one or more measures, and participants were excluded for outlying scores on the following measures: operation span (3), abstract reasoning (2), verbal ability (1), negative affect (1), reappraisal frequency (1).

[2] Negative pictures were chosen for normative valence ratings less than 2.5 (*M* = 1.95, S.D. = 0.29), and had mean normative arousal ratings of 6.20 (S.D. = 0.58). Neutral pictures were selected for mean valence ratings of between 4.5 and 6.5 (*M* = 5.05, S.D. = 0.28), and had mean normative arousal ratings of 2.95 (S.D. = 0.40).

prove for the better, or identifying aspects of the situation that are not be as bad as they seem.

During the task, participants completed 15 trials of each type (look instruction with neutral picture, look instruction with negative picture, decrease instruction with negative picture).[3] Each trial consisted of: the pseudo-randomly ordered instruction word (2 s); the photo with a colored frame as a reminder of the instruction (7 s); a response to the question ‘‘How negative do you feel?’’ on a 9-point scale, with 1 labeled as ‘‘not at all,’’ 5 labeled ‘‘somewhat,’’ and 9 labeled ‘‘very negative’’ (4 s) and an inter-trial interval, a screen that read, ‘‘Relax’’ (7 s). Responses to the rating of negative affect were averaged for each of the experimental conditions. RA was calculated as the difference between the average rating of negative affect for the ‘‘Look Negative’’ condition and the ‘‘Decrease Negative’’ condition.

2.3.2. Frequency of reappraisal and suppression

Frequency of reappraisal and suppression use in everyday life were assessed with the Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). The reappraisal frequency scale includes 6 items such as ‘‘I control my emotions by changing the way I think about the situation I'm in.’’ The suppression frequency scale includes 4 items, such as ‘‘I control my emotions by not expressing them.’’ Alpha reliabilities were .78 and .77 for the reappraisal and suppression scales, respectively.

2.3.3. Well-being

Well-being was assessed with a composite score derived from typical levels of positive and negative affect, as well as life satisfaction. Typical levels of positive and of negative affect were assessed with the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). For each scale, participants report the extent they felt certain states over the past few weeks on 10 items, including ‘‘enthusiastic’’ and ‘‘proud,’’ for the positive scale (alpha = .88) and ‘‘hostile’’ or ‘‘irritable,’’ for the negative scale (alpha = .83). The Satisfaction with Life Scale (Diener, Emmons, Larsen, & Griffin, 1985) is a 5-item scale which includes items such as ‘‘In most ways, my life is ideal.’’ Alpha reliability was .90. The well-being measure was computed following Diener, as (positive affect − negative affect) plus life satisfaction (Diener, Suh, Lucas, & Smith, 1999; Lucas, Diener, & Suh, 1996).[4]

2.3.4. Verbal ability and abstract reasoning

Verbal ability and abstract reasoning scores were obtained from a self-administered cognitive test first developed by Shipley (1940; Zachary, 1991). This instrument was designed to be a brief and reliable self-administered measure of general intelligence, with scales that measure more specific constructs. The verbal ability scale has 40 multiple-choice items in which the participant chooses from four response options to identify the word with the closest meaning to the target word for that item. The abstract reasoning scale has 20 multiple-choice items in which the participant chooses from four response options to complete a logical sequence of numbers, letters or words. Higher scores on these subscales indicate higher levels of functioning in these domains.

2.3.5. Laboratory assessment of working memory

We measured working memory by assessing accuracy for words recalled that were encoded while presented simultaneously with a demanding math task. To do this, we modified the operation span task (Miyake et al., 2000; Turner & Engle, 1989) and presented math equations paired with neutral or negative target words. This allowed us to test for associations between reappraisal ability and working memory capacity in a neutral context (as has been reported previously; Schmeichel et al., 2008) as well as working memory capacity in an emotional context (which to our knowledge has never been reported). To begin, the participant was presented with an instructions screen that informed the participant that they would respond to math equations by indicating whether the equation was true or false. Presented alongside each math equation was a target word that the participant had to keep in mind. The participant had to press ‘‘T’’ or ‘‘F’’ to indicate whether the math problem was true or false while taking note of all target words. At the end of a block of these trials, the participant would report back all of the target words presented throughout the last block of trials. Word type (neutral or negative) was consistent within blocks, which varied in length between 2 and 5 trials, and each block length was repeated three times before increasing by 1 trial (total of 12 blocks, composed of a total of 42 trials). Following previous uses of this task, operation span performance was the total number of words correctly recalled at the end of each block.

2.3.6. Laboratory assessment of set shifting

We measured set shifting ability by administering a standard global/local task (based on Hedden & Gabrieli, 2010). Instructions presented on the screen indicated that participants would be shown a series of big letters (H or S) made of smaller letters (H or S) and that the color of the figure would cue them as to which letter(s) to attend to (blue for big letter, green for small letters). Each stimulus was presented for 1500 ms, followed by a 1500 ms fixation cross (during which responses were allowed and collected). Participants completed this task for 142 trials, broken into blocks of 12 trials, 6 of which were characterized by non-switching (the color indicating which letters to attend to remained constant) and 6 of which were characterized by switching (the color indicating which letters to attend to alternated between indicating the global or local letters). Consistent with prior work (Miyake et al., 2000), reaction times for correct trials were trimmed to exclude those less than 200 ms, and to replace values over 2000 ms with 2000 ms. In addition, values outside 3 S.D. for each participants mean were replaced with the 3 S.D. value. RTs were averaged for all switch trials vs. all non-switch trials. A switch cost metric was computed by subtracting the average RTs for the non-switch blocks from the switch blocks.

2.3.7. Laboratory assessment of response inhibition

We measured response inhibition by administering a standard Stroop task (based on Hedden & Yoon, 2006). Instructions on the screen indicated that participants would be shown the color words blue, red, green and yellow, or non-words (*****) and that they were to press the color key that corresponds to the color of the font, NOT the name of the word (colored stickers were placed on the R, T, Y and U keys of the keyboard to represent blue, red, green and yellow respectively). They were also instructed that speed was important, and to respond as quickly as possible while still being accurate. No time restriction was placed on their response. They completed the task for a total of 144 trials, 72 of which were neutral (*****) trials, 60 of which were incongruent trials (color name and font color did not match) and 12 of which were congruent tri-

[3] In addition, another instruction condition was included in which red frames were paired with the instruction, ‘‘Increase,’’ and participants were asked to tell themselves something that makes them feel more negative about neutral pictures. Responses to the Increase instruction are not reported here, as the ability to use reappraisal to decrease negative affect has been most frequently studied, and is likely to have the most impact on emotional well-being in everyday life.

[4] Correlations with each component of this well-being measure indicated that the effects were largely driven by positive affect and life satisfaction. In fact, all correlations reported with our well-being composite measure hold true (p's < .05) for the positive affect and satisfaction with life measures, but no significant relationships are observed with negative affect (with the exception of a trend for a negative relationship between negative affect and working memory capacity, $r = -.18$, $p = .09$).

als (color name and font color did match). Consistent with prior work (Miyake et al., 2000), reaction times for correct trials were trimmed to exclude those less than 200 ms, and to replace values over 2000 ms with 2000 ms. In addition, values outside 3 S.D. for each participants mean were replaced with the 3 S.D. value. An inhibition score was calculated by subtracting the average RTs for the correct congruent trials from the correct incongruent trials.

2.3.8. Social desirability

We measured social desirability using the Marlowe-Crowne Social Desirability scale (MCSD; Crowne & Marlowe, 1960). This 33-item measure includes items such as, ‘‘I'm always willing to admit when I make a mistake.‘‘ Alpha reliability was .74.

3. Results

3.1. Manipulation check

Ratings of negative affect during the RA task indicated that participants were able to significantly decrease how negative they felt when reappraising (Look Negative mean = 6.12, S.D. = 1.50; Decrease Negative mean = 5.24, S.D. = 1.45); $t(88) = 7.66$, $p < .001$). Men and women did not differ on RA (all p's > .22). We also assessed whether our measure of RA was confounded with experimental demand by examining the relationship between RA and social desirability. Results from this analysis revealed no significant relationship ($r = -.16$, $p = .14$).

3.2. Reappraisal ability and frequency

We examined the relationship between reappraisal ability and frequency, using suppression frequency as a control for use of another emotion regulation strategy. We observed a positive correlation between RA and reappraisal frequency ($r = .24$, $p < .03$; Table 1). However, there was no significant relationship between RA and suppression frequency ($r = -.17$, $p = .11$). It is worth noting that both reappraisal frequency ($r = .27$, $p < .02$) and ability (see below) were positively associated with well-being, but no significant relationships were observed between reappraisal or suppression frequency and the cognitive control variables (absolute value of all r's < .12, p's > .31).

3.3. Reappraisal ability and well-being

We hypothesized a positive correlation between RA and well-being, which we observed ($r = .34$, $p < .001$; Table 1). Interestingly, there were no significant relationships between the measures of cognitive control and well-being (absolute value of all r's < .16, p's > .16).

3.4. Reappraisal ability and cognitive control

As expected, we replicated previous reports of an association between reappraisal and working memory capacity (operation span accuracy for all word types), $r = .26$, $p < .02$; Table 2). Similar to its relationship with operation span performance, RA was also related positively to reaction time costs due to shifting in the global/ local task ($r = .23$, $p < .03$). By contrast, RA was not significantly related to response inhibition as measured by the Stroop ($r = .003$, $p = .098$), verbal ability ($r = .034$, $p = .75$), and only marginally related to abstract reasoning ability ($r = .18$, $p = .09$). Furthermore, the relationships among working memory capacity, set shifting, verbal ability, and abstract reasoning were all substantial (r's between .31 and .47) compared with any of their relationships with RA (r's between .03 and .26), indicating that there is some overlap among cognitive control measures, but RA relates to only a subset of cognitive control measures.

Table 1
Pearson correlations among reappraisal ability, habitual regulation, and well-being.

	Reappraisal ability	Habitual regulation	
		Reappraisal frequency	Suppression frequency
Habitual regulation			
Reappraisal frequency	.24[b]	1	
Suppression frequency	−.17	−.07	1
Well-being	.34[c]	.27[b]	−.21[a]

Note: $N = 89$ except for expressive suppression ($N = 86$) and life satisfaction ($N = 87$). Regulation habits were measured by the reappraisal and suppression subscales of the Emotion Regulation Questionnaire. Well-being was assessed using a composite including z-scores of the positive affect scale minus the negative affect scale of the Positive and Negative Affect Schedule, plus the Satisfaction with Life Scale.
[a] Denotes trending p values at $.05 < p < .1$.
[b] Denotes significant p values at $p < .01$.
[c] Denotes significant p values at $p < .001$.

3.5. Secondary analyses

Comparing the neutral and emotional blocks of the operation span task, we observed a main effect of word type, showing greater memory for neutral than emotional words ($t(88) = 1.98$, $p = .05$). However, using a repeated measures GLM, we did not observe a significant interaction between the neutral/emotional content of the words and the relationship between accuracy and RA ($F = 0.23$, $p = .88$). Therefore, it appears that the relationship between RA and working memory capacity is unchanged when working memory capacity is measured in an emotional context.

We also examined accuracy on all three of our cognitive performance measures. We did not observe a relationship between RA and accuracy on the math portion of the operation span ($r = .048$, $p = .653$), or accuracy on the Stroop task ($r = .003$. $p = .98$). We did however, observe a positive relationship between RA and accuracy on the global local task ($r = .26$, $p < .04$).

4. Discussion

The present study focused upon the cognitive and affective individual differences associated with greater reappraisal ability (RA).

Table 2
Pearson correlations among reappraisal ability and cognitive control abilities.

	Reappraisal ability	Cognitive control abilities			
		O-span accuracy	Global local shift cost	Stroop cost	Abstract reasoning
Cognitive control abilities					
O-span accuracy	.26[b]	1			
Global local shift cost	.23[b]	.36[c]	1		
Stroop cost	−.01	.16	−.06	1	
Abstract reasoning	.18[a]	.38[c]	.31[b]	−.22[a]	1
Verbal ability	.03	.47[c]	.31[b]	−.04	.37[c]

Note: $N = 89$ except for global local ($N = 84$) and Stroop ($N = 81$). Cognitive abilities were measured by accurate recall on the operation span task, the shift minus stay reaction times on the global/local task, incongruent minus congruent reaction times on the Stroop, and the abstract reasoning and verbal measures developed by Shipley (1940).
[a] Denotes trending p values at $.05 < p < .1$.
[b] Denotes significant p values at $p < .01$.
[c] Denotes significant p values at $p < .001$.

We predicted that RA would be related to reappraisal frequency, well-being, and several types of cognitive control. We observed a positive relationship between reappraisal ability and frequency, as well as well-being, working memory capacity (neutral and emotional contexts), set-shifting costs, and a trend for a positive relationship with abstract reasoning ability. We did not observe significant relationships between RA and suppression frequency, response inhibition, or verbal ability. Below, we discuss the implications for the conceptualization of RA, its relationship to the previous literature on reappraisal frequency, well-being, and theoretical models of cognitive control.

4.1. Reappraisal ability and frequency

This study is the first to demonstrate an association between reappraisal ability and frequency. Reappraisal frequency has been previously related to positive affective outcomes, including lower amygdala activation in response to affective tasks (Drabant, McRae, Manuck, Hariri, & Gross, 2009) and lower levels of psychopathology (Gross & John, 2003). This clinical relevance has been used to justify further investigation of reappraisal *ability*, with the previously unsupported assumption that those who use reappraisal more frequently are also more capable reappraisers. It should be noted that the relationships observed here imply that reappraisal ability and frequency are related but not entirely overlapping constructs. This leaves open the possibility that some individuals use reappraisal quite frequently with little success, while others use it seldom, but it is a powerful tool when they do. Future work should identify the moderators that are associated with the strongest relationship between frequency and ability, which may be crucial in understanding the acquisition or improvement of reappraisal ability.

4.2. Reappraisal ability and well-being

One important contribution of this investigation of RA is that well-being (as measured by life satisfaction, positive and negative affect), which has been previously associated with reappraisal frequency (measured with self-report, as an individual difference; Gross & John, 2003), is related to reappraisal ability (measured experimentally, as a skill). It is notable that although RA relates to some cognitive control measures and well-being, there is no significant relationship between any type of cognitive control and well-being. Therefore, greater levels of some types of cognitive control may contribute to well-being through RA, but on their own are not related to greater well-being.

4.3. Reappraisal ability and cognitive control

Reappraisal is a complex, multi-step cognitive process (Ochsner & Gross, 2008). Like previous investigations of other emotion regulation strategies (Gyurak et al., 2011), we wanted to know which of several cognitive control processes are empirically related to reappraisal ability. One previous report established that working memory capacity as measured by two working memory tasks with neutral material was related to lower emotional responding during the instruction to reappraise (Schmeichel et al., 2008). However, this study used a between-subject design and therefore did not measure RA using a non-regulation baseline for each participant. We have replicated and extended this effect in the present study, by demonstrating that individual differences in RA are related to working memory capacity for both emotional and neutral material.

In addition, we also observed a relationship between RA and reaction time costs on a set-shifting task. At first blush, it may seem counterintuitive that RA would be positively related to the costs of set-shifting, as smaller shift costs are typically interpreted as more skillful performance. However, there is growing evidence that the shifting skills may not always be associated with adaptive outcome measures (Friedman, Haberstick, Willcutt, Miyake, Young, Corley, et al., 2007; Friedman, Miyake, Robinson, & Hewitt, in press). Indeed, the greater shift costs in our study were also associated with higher accuracy rates, and higher shifting costs were related positively to other cognitive measures as well. Therefore, we interpret performance on the shifting task to reflect the implementation of a cautious strategy, prioritizing accuracy over speed.

Because the working memory task we used also has a dual task component, but is untimed, like the shifting task, it is possible that operation span performance is more related to individual differences in careful, accurate shifting than in working memory. In the present study we did not observe a significant relationship between RA and verbal ability, or response inhibition, and only a trend for the relationship between RA and abstract reasoning ability. Additionally, the relationships between the cognitive control measures were noticeably stronger than the relationship between RA and any of the cognitive control abilities, indicating that that reappraisal has less variance in common with most cognitive control measures than other cognitive control measures. Similar findings regarding the association of expressive suppression and verbal ability (Gyurak et al., 2011) indicate that different emotion regulation strategies may be specifically associated with different types of cognitive abilities.

4.4. Limitations and future directions

The present study outlines the cognitive and affective correlates of greater reappraisal ability, which enhances our understanding of the processes involved in successful reappraisal. Despite this contribution, the present report has some limitations.

First, because we went beyond questionnaire measures to assess reappraisal and several cognitive control abilities in the laboratory, we had a smaller sample than most investigations of personality and individual differences. However, despite our small sample, we replicated several effects that have been established in larger samples (Gross & John, 2003; Schmeichel et al., 2008). Therefore, we feel that we can interpret our results here with some confidence.

Second, our measure of RA was computed from self-reported negative affect scores, which may be vulnerable to experimental demand. However, it has been demonstrated in previous studies that decreases in self-reported negative affect during reappraisal as implemented in this experimental paradigm are paralleled by changes in peripheral physiology and activation of the amygdala, which are less susceptible to demand effects (Jackson et al., 2000; Ochsner, Bunge, Gross, & Gabrieli, 2002; Troy et al., 2010). In addition, in the present study, RA was not related to a measure of social desirability, which one might expect if strong demand effects were present.

Another potential concern is that because we measured RA by performance on a computerized task, associations between RA and the cognitive control measures could be due to common method variance. However, we observe significant relationships that cut across methodologies. For example, RA is the only performance-based measure that relates to reappraisal frequency and well-being. In addition, RA relates to some performance-based cognitive control measures (working memory and set-shifting), but not others (response inhibition), and there are significant relationships among cognitive control measures that are measured using performance and self-report. Our reappraisal task also included an increase negative condition to neutral pictures, which may have influenced performance during the decrease negative condition. However, we did not observe any significant relationships between individual differences on the increase negative condition and any of the cognitive control or well-being measures here.

Finally, it is important to bear in mind that because the data here are correlational, we were unable to test the direction of causality between RA and the other individual differences associated with it. There are strong theoretical reasons to believe that individual differences in working memory and set-shifting costs support reappraisal ability, while well-being follows from successful reappraisal use. Future work should test competing hypotheses regarding causality. For example, a testable alternative is that negative emotional responses occur during the measurement of cognitive control (i.e. stereotype threat, test anxiety, evaluative stress) that disrupt performance. Those who are better able to regulate these interfering emotional responses may attain higher scores on measures of working memory and other cognitive control tasks. In the long term, better performance on these measures may feedback to create less threat, anxiety and stress during measurement of these skills, which in turn causes even higher scores.

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Corrigendum

Corrigendum to "Individual differences in reappraisal ability: Links to reappraisal frequency, well-being, and cognitive control" [J. Res. Pers. 46 (2012) 2–7]

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The authors regret some errors were found in the article after publication. Word additions have been boldfaced. For word or number omissions, the sentence will appear in its correct form.

In Methods section, 2.3.5, (page 4), the next to last sentence should have read:

*Word type (neutral or negative) was **mixed** within blocks, which varied in length between 2 and 5 trials, and each block length was repeated three times before increasing by 1 trial (total of 12 blocks, composed of a total of 42 trials).*

In Secondary Analysis section, 3.5 (page 5), the first sentence should have read:

*Comparing the neutral and emotional **trials** of the operation span task, we observed a main effect of word type, showing greater memory for neutral than emotional words ($t(88) = 1.98$, $p = .05$).*

In Methods section, 2.3.1 (page 4), the last sentence of the first paragraph should have read:

An example trial of each type was presented to the participant, including examples of acceptable reappraisals for the decrease instruction, such as imagining ways the situation could improve for the better, or identifying aspects of the situation that are not as bad as they seem.

In Results section, 3.4 (page 5), the third sentence should have read:

By contrast, RA was not significantly related to response inhibition as measured by the Stroop ($r = .003$, $p = .98$).

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