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Effects of mindfulness, reappraisal, and suppression on sad mood and cognitive resources

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Abstract

The present study investigated the relative effects of mindfulness, reappraisal and suppression in reducing sadness, and the extent to which implementation of these strategies affects cognitive resources in a laboratory context. A total of 171 Singaporean undergraduate participants were randomly assigned to receive brief training in mindfulness, reappraisal, or suppression prior to undergoing a sad mood induction. Individual adherence to Asian cultural values was assessed as a potential moderator of strategy effectiveness. Participants rated their mood and completed a Color-Word Stroop task before and after mood regulation instructions. Analyses using multi-level modelling showed that the suppression condition caused less robust declines in sadness over time compared to mindfulness. There was also a nonsignificant trend in which mindfulness was associated with greater sadness recovery compared to reappraisal. Suppression resulted in lower average sadness compared to mindfulness among those high on Asian cultural values, but not those low on Asian cultural values. Both mindfulness and reappraisal buffered against increases in Stroop interference from pre-to post-regulation compared to suppression. The findings highlight the advantage of mindfulness as a strategy effective not only in the regulation of sad mood, but also in the preservation of cognitive resources in the context of mood regulation.

Keywords

Mindfulness; Reappraisal; Suppression; Sad mood; Cognitive resources; Asian cultural values

1. Introduction

Emotion regulation (ER) is a process through which individuals modify the expression and experience of their emotions (Gross, 1998). Disruptions in ER have been found to underlie a broad range of psychopathology, such as mood and anxiety disorders (Broderick & Metz, 2009; Goldin & Gross, 2010; Roemer et al., 2009). Specific strategies to achieve ER may be adaptive or maladaptive in different contexts. Two commonly examined strategies are reappraisal and suppression. Considered as an element of cognitive behavior therapy (CBT),

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reappraisal is frequently taught as a strategy to help patients re-interpret the meaning of emotion-inducing situations to reduce their emotional impact on them (Hofmann & Asmundson, 2008). Suppression, on the other hand, refers to attempts to inhibit both the external expression and internal experience of emotion (Dunn, Billotti, Murphy, & Dalgleish, 2009).

An additional ER strategy is mindfulness. Key to “third wave” behavioral therapies that emphasize present moment awareness, acceptance, and experiential change strategies as key elements of treatment (Hayes, Follette, & Linehan, 2004), mindfulness is taught as a practice to facilitate greater awareness and acceptance of one’s emotions. Mindfulness is commonly defined as the ability to pay attention to experiences in the present moment in an intentional, open, and nonjudgmental manner (Kabat-Zinn, 1994). There is a need to better understand the functions and effects of mindfulness compared to other established intervention techniques or regulation strategies.

To date, several studies have compared the effects of mindfulness or related processes to those of other strategies in regulating emotions. Studies examining the effects of acceptance (a subcomponent of mindfulness) have found a benefit for acceptance over suppression in lowering subjective anxiety (Braams, Blechert, Boden, & Gross, 2012; Levitt, Brown, Orsillo, & Barlow, 2004) and physiological arousal (Dunn et al., 2009; Hofmann, Heering, Sawyer, & Asnaani, 2009; but see Szasz, Szentagotai, & Hofmann, 2011; Hofmann et al., 2009). In one study, suppression was found to be more effective than acceptance in lowering subjective fear (Dunn et al., 2009), although it should be noted that in this study, instructions to suppress one’s emotions also included suggestions to reappraise emotion-inducing stimuli. There is further evidence that acceptance instructions promote quicker recovery of negative emotions compared to suppression (Liverant, Brown, Barlow & Roemer., 2008), which is consistent with past research that demonstrated paradoxical increases in unwanted experience or physiological arousal as a result of suppression (Gross, 1998; Wegner & Zanakos, 1994). When compared with reappraisal, acceptance was either equally (Hofmann et al., 2009; Wolgast, Lundh, & Viborg, 2011) or less effective (Szasz et al., 2011) in lowering anxiety, anger, or distress in response to lab-induced stressors.

A related line of research has also examined the effects of experimentally-induced mindfulness, which typically involves instructions to regulate one’s attention (with breath as a common anchor of attention) as well as acknowledge and accept experiences that arise moment-by-moment without judgment. Brief mindfulness exercise has been shown to be more effective than rumination or no instruction in alleviating subjective distress in healthy university students (Broderick, 2005), previously depressed individuals (Singer & Dobson, 2007), and currently depressed individuals (Huffziger & Kuehner, 2009). Brief mindfulness training has also been demonstrated to be superior to worry or control inductions in reducing emotional reactivity and down-regulating negative affect in non-clinical populations (Arch & Craske, 2006; Erisman & Roemer, 2010). A recent study (Keng, Robins, Smoski, Dagenbach, & Leary, 2013) found that both mindfulness and reappraisal instructions were equally effective in reducing sad mood in a sample of mildly depressed adults. It is unknown however the extent to which the findings generalize to healthy populations, as well as the

relative effects of experimentally-induced mindfulness versus other known strategies, such as suppression.

Apart from subjective affect, one important outcome of ER concerns the cognitive costs and advantages of different ER strategies. As emotions often arise in the context of pursuing important goals, an advantageous strategy would be one that maintains optimal cognitive performance and self-regulation (Richards & Gross, 2000). To date, research has suggested that mindfulness may be a cognitively efficient ER strategy. A study by Keng et al. (2013) found that mildly depressed participants who engaged in a mindfulness induction performed better on a Stroop task compared to those assigned to a reappraisal condition following a negative mood induction procedure. Reappraisal is also a relatively cognitively efficient strategy (when compared to suppression; Richards & Gross, 2000; Richards, Butler, & Gross, 2003), although it is associated with increased cognitive load when implemented as an online strategy (i.e., after an emotional situation begins to unfold; Sheppes & Meiran, 2008; Urry, van Reekum, Johnstone, & Davidson, 2009). The findings suggest that both mindfulness and reappraisal may have context-dependent cognitive advantages as well as costs. With regard to suppression, studies conducted in Western contexts have consistently demonstrated increased cognitive and physiological cost associated with use of the strategy (Dunn et al., 2009; Hofmann et al., 2009; Richards & Gross, 2000) compared to reappraisal or acceptance. No study has yet directly compared the cognitive costs of mindfulness, reappraisal, and suppression in the context of sad mood regulation in an Asian, non-clinical sample.

As suggested above, the adaptiveness of emotion regulation may vary based on contextual factors. One important but often neglected contextual variable is culture. As cultures shape and reinforce emotional responses differentially, they may influence the extent to which different ER strategies are valued and help individuals achieve desired goals (Kitayama, Markus, & Kurokawa, 2000; Matsumoto, 1990). One dimension of culture that has received some attention is endorsement of Asian cultural values, which emphasize interdependence, social harmony, emotion control, and hierarchy (Ford & Mauss, 2015; Kim, Atkinson, & Umemoto, 2001). In particular, research has investigated the role of Asian cultural values as a moderator of the effects of suppression. Whereas suppression is often used to promote self-protective purposes (especially in the context of social threats) in Western contexts, it may function to promote self-restraint and interpersonal harmony, which are highly valued in Asian cultures (Butler, Lee, & Gross, 2007). While suppression has largely been associated with maladaptive consequences in Western cultural contexts (Gross, 1998; Soto, Perez, Kim, Lee, & Minnick, 2011), there is evidence that use of the strategy is associated with less maladaptive psychological (Cheung & Park, 2010) and interpersonal outcomes (Butler et al., 2007) among individuals of Asian heritage or those adhering to Asian cultural values. As the majority of research on the association between culture and suppression is conducted in Western contexts, it is not known the extent to which the findings would be replicable in an Asian context, where endorsement of Asian cultural values is expected to be higher generally. Further, no research has yet explored whether adherence to Asian cultural values may differentially predict the effectiveness of ER strategies other than suppression, for example, mindfulness or reappraisal.

1.1. Specific aims and hypotheses

The present study aimed to compare the effects of mindfulness versus reappraisal and suppression on the regulation of sad mood in a nonclinical, Singaporean undergraduate sample. Based on past research, it was hypothesized that both mindfulness and reappraisal would be more effective than suppression in lowering sad mood. It was further predicted that mindfulness would result in the least depletion of cognitive resources, followed by reappraisal, and then suppression. A secondary goal of this study was to explore the potential role of Asian cultural values as a moderator of the effects of the three strategies, in particular suppression. We hypothesized that high endorsement of Asian values would predict more effective use of suppression, as reflected by greater reductions in sadness and less depletion of cognitive resources, relative to low endorsement of Asian values. It was an exploratory question whether Asian cultural values might also moderate the subjective and cognitive effects of mindfulness and reappraisal.

2. Methods

2.1. Participants

A total of 171 participants were recruited and randomly assigned to receive brief training in mindfulness (n = 57), reappraisal (n = 57), or suppression (n = 57). Inclusion criteria were 1) age between 18 and 55 and 2) proficient in English. Participants were recruited from National University of Singapore (NUS)'s Department of Psychology undergraduate research subject pool and the larger student community. This population was selected as it was expected that there would be a range of adherence to Asian cultural values in the sample. In particular, the student body consists of English-speaking students from a number of Asian cultural backgrounds, with a majority endorsing Chinese heritage. Participants received either course credits or twenty dollars for completing the study. The study was approved by NUS' Institutional Review Board.

2.2. Procedure

The study consisted of a 1.5-h experimental session. Following the completion of a battery of questionnaires, participants completed a baseline color word Stroop task. Participants were then randomized to the mindfulness, reappraisal or suppression condition, and listened to a pre-recorded audio instruction on the use of assigned strategy to cope with negative emotions. Each recording lasted approximately 10 min. The instructions for the mindfulness condition, adapted from Singer and Dobson (2007), emphasized registering thoughts and emotions as they are without judging them and included a mindfulness experiential exercise. Instructions for the reappraisal condition were adapted from Grisham, Flower, Williams & Moulds (2009) and Ray, Wilhelm & Gross (2008). Participants were trained to reframe the meaning of an emotional event to reduce its emotional impact and engaged in an exercise involving reappraising a hypothetical situation. Instructions for the suppression condition, adapted from Burns, Quartana & Bruehl (2007) and Feldner, Zvolensky, Stickle, Bonn-Miller and Feldner, Zvolensky, Stickle, Bonn-Miller, and Leen-Feldner (2006), emphasized suppressing both the experience and expression of emotions and included an exercise involving suppressing emotions in response to a hypothetical situation. After training, participants rated the perceived usefulness of their assigned technique.

Participants then underwent a mood induction procedure that involved simultaneous negative autobiographical recall and mood suggestive music ("Adagio-G Minor" composed by Albinoni, played at half speed). During the procedure, participants were given 10 min to write about three events that made them feel lonely, sad, rejected, or hurt, and then asked to recall these events as intensely as possible for 5 min. Participants rated their mood on a Visual Analogue Scale (VAS) pre- (T1) and post-induction (T2). Following induction, participants received instructions to apply their assigned strategy in coping with their mood. Music continued to play in the background at this time. Following Keng et al. (2013) and Singer and Dobson (2007), the mood regulation period lasted 5 min, during which participants were prompted to rate their mood on the VAS once every minute (T3 through T7). At the end of the mood regulation period, the music stopped and participants completed another Stroop task. Participants were then instructed to rate the extent to which they engaged in various ER strategies during the regulation period on an 8-point scale (0 = *not at all*; 7 = *very much*). The questions started with "to what extent where you trying to …", followed by "notice your thoughts and emotions as they are, in a nonjudgmental manner just now" (mindfulness), "change the way you think about the situations that you recalled just now" (reappraisal), or "suppress your thoughts and emotions just now" (suppression). To assess for potential experimenter bias across conditions, participants were also asked to rate (on a similar 8-point scale) the degree to which they perceived the experimenter to be enthusiastic and credible. Participants then underwent a positive mood induction, which involved watching a short, funny animal video clip to alleviate any remaining negative mood from the mood induction.

2.3. Measures and tasks

2.3.1. Demographic data form—The demographic data form recorded participants' sex, age, ethnicity, education background, employment and income, history of psychological disorders and treatment and prior experience to mindfulness.

2.3.2. State sadness—A VAS was used as a state measure of sadness. It consisted of a 0–100 scale with "neutral, no sadness" on one end and "sadness" on the other end of the scale. Participants were informed that 100 represents the saddest that they have ever felt, and were instructed to place a mark on the scale to indicate their degree of sadness. The VAS has been used in previous mood induction studies to assess changes in emotion (Singer & Dobson, 2007; Watkins, Teasdale, & Williams, 2003), and its results have been shown to be highly reproducible and sensitive to change (De Boer et al., 2004; Grant et al., 1999).

2.3.3. Asian Values Scale-revised (AVS-R)—The AVS-R is a psychometrically validated scale designed to measure adherence to Asian cultural values on the whole (Kim & Hong, 2004). The scale consists of 25-items and is rated on a 7-point Likert scale from 1 ("strongly disagree") to 7 ("strongly agree"). Higher scores on the AVS-R indicates greater adherence to Asian cultural values. The AVS-R was revised from the 36-item Asian Values Scale on the basis of the Rasch's model (Kim & Hong, 2004). In the current study, the AVS-R also showed an acceptable internal consistency of = 0.71.

2.3.4. Stroop task—A computer-based Color-Word Stroop task was administered to measure depletion of cognitive resources following the emotion regulation task (Chepenik, Cornew, & Farah, 2007). In each trial, participants were presented first with a 500 msec. fixation cross, followed immediately by a color word ("green", "blue", "red", "yellow"), or a control text ("xxxx") that appeared in red, blue, yellow, or green. The control text was presented in each of the four colors (congruent trial), whereas the color words always appeared in a color font other than their semantic meaning (incongruent trials). The ratio of control to incongruent trials was 1e3. The instructions required participants to say aloud as quickly and accurately as possible the color of the text. Trial order was randomized within 8-trial blocks. Stroop interference scores were calculated by dividing the difference between latencies for incongruent trials and control trials by the total latencies for both types of trials. Response times shorter than 150 ms and longer than 3000 ms were categorized as outliers and excluded from analyses (Sheppes & Meiran, 2008). Before the baseline trial, all participants completed a brief, 16-trial practice. A 160-trial test phase was administered for the baseline as well as post-regulation to measure changes in cognitive resources. The task was implemented in DirectRT with automatic scoring of vocal response latency.

2.4. Data analytic overview

Several analytic tools were applied to examine the impact of the experimental manipulation on our outcomes. First, we used repeated measures ANOVA to examine whether our experimental manipulations had the intended effect on sadness. Next, we used descriptive statistics and MANOVA to assess any baseline differences in the three groups and to verify adherence to our experimental protocol. Finally, we utilized multilevel regression models (with time points nested within participants) to examine the impact of experimental condition on sadness regulation and Stroop performance over time, as well as to examine whether Asian cultural values moderated the effects of condition on the trajectory of outcomes over time.

3. Results

3.1. Manipulation check

Thirty-three participants (19.3%) reported a mood shift of less than 1 point (1 cm on a 10 cm line) in response to the mood induction procedure. Following Keng et al. (2013), these participants were excluded from subsequent analyses. Groups did not differ significantly on the number of participants excluded on this basis (mindfulness = 14; reappraisal = 8; suppression = 11). Excluded participants did not differ from included participants on any demographic variables, except for age, $t(169) = 2.69$, $p = 0.008$, with the excluded participants ($M = 21$, $SD = 1.62$) being older than the included participants ($M = 20.19$, $SD = 1.45$). There was also a trend for the excluded participants ($M = 24.79$, $SD = 24.04$) to report higher levels of sadness at baseline compared to the included participants ($M = 16.94$, $SD = 18.45$), $t(169) = 2.06$, $p = 0.087$. A 3(group) × 2 (time, pre-vs. post-mood induction) ANOVA of sadness rating demonstrated a significant main effect of time, $F(1, 168) = 298.85$, $p < 0.001$, no main effect of group, and no interaction. Mean sadness ratings increased from 18.46 (SD = 19.82) to 52.68 (SD = 23.89) from pre-to post-mood induction.

Participants in the mindfulness, reappraisal and suppression conditions were considered adherent if they report a minimum score of 4 on a 7-point scale on their respective manipulation check question. Twenty (11.7%) of these participant were not adherent and excluded from subsequent analyses. Groups did not differ on the proportion of non-adherent participants. In addition, a small number of participants were not adherent to instructions in the Stroop task (n = 5, 2.9%) and were excluded from the subsequent analysis of the Stroop data. The proportion of participants excluded on this basis did not differ between the three conditions. This left a total sample size of 125 (mindfulness = 39, reappraisal = 43, suppression = 43) for analysis involving changes in sadness, and a sample size of 123 (mindfulness = 38, reappraisal = 43, suppression = 42) for analysis of the Stroop data.

A one-way MANOVA revealed significant between-group differences on self-reported use of the different ER strategies assessed (mindfulness, reappraisal, and suppression) during the regulation period, $F(6, 242) = 18.54$, $p < 0.001$. Follow-up univariate ANOVAS revealed significant between-group differences on use of these strategies. As expected, the reappraisal group reported significantly greater engagement in reappraisal (M = 5.14) than the mindfulness group (M = 4.00, $p < 0.01$) and the suppression group (M = 4.09, $p < 0.01$). As expected, mindfulness group reported significantly greater engagement in mindfulness (M = 5.33) than the reappraisal group (M = 4.61, $p < 0.01$) and the suppression group (M = 3.86, $p < 0.001$). As expected, the suppression group reported a significantly greater engagement in suppression (M = 5.34) than the mindfulness group (M = 2.26, $p < 0.001$) and the reappraisal group (M = 3.58, $p < 0.001$).

3.2. Baseline differences across conditions

Table 1 presents demographic and baseline characteristics for the three conditions. The sample's average age was 20.19 ($SD = 1.6$, range = 18–28). The majority of the sample (73.6%) was female. There were no group differences on any of the categorical variables (gender, ethnicity) in chi-square tests, or on the continuous variables (age, baseline sadness, baseline Stroop performance) in ANOVAs. There were no between-group differences on perceived levels of enthusiasm and credibility of the experimenter. The perceived usefulness of their assigned technique did not differ between groups, except for between the reappraisal and suppression groups ($p = 0.02$). The reappraisal group reported a greater level of perceived efficacy (M = 6.16, SD = 1.00) than the suppression group (M = 5.56, SD = 1.45). Given differential levels of perceived efficacy of strategy across these two conditions, further analyses examined whether perceived efficacy predicted the outcome variables in the study. The analyses showed that perceived efficacy was not a significant predictor of sadness ($p = 0.23$) or Stroop interference ($p = 0.18$). Further, inclusion of perceived efficacy as a covariate in models below did not substantively alter any result presented here.

3.3. Effects of condition on sadness regulation

In order to determine the effect of experimental condition on the trajectory of sadness across the five-minute regulation period, we fit a two-level regression model with regulation time point (T2 through T7) nested within individuals. This model predicted sadness at the current time point from covariates (gender and age), condition (coded as two dummy variables representing the contrasts between suppression and mindfulness and reappraisal and

mindfulness), time point (T2 through T7), and their interaction. This final interactive estimates the impact of experimental condition on the trajectory of sadness across the regulation period. A random effect of time was included based on a significant covariance parameter estimate, as well as a significant improvement in model fit with the inclusion of the random effect of time (based on a log likelihood ratio test). The intraclass correlation (ICC) for sadness was 0.43, indicating that 43% of the variance in sadness could be attributed to between-person factors. Equations from Snijders and Bosker (1999) and post-hoc power analysis indicated that the smallest effect sizes detectable (assuming 80% power, ICC of 0.43, a sample of 125 participants, and 6 repeated measures in each participant) was $d = 0.22$ for our primary hypothesis test (interaction between condition and time).

Results of the multilevel model predicting sadness from the interaction of condition and time are presented in Table 2 and depicted in Fig. 1. Age was associated with slightly lower sadness, whereas gender did not significantly predict sadness. As hypothesized, the suppression condition caused less robust declines in sadness over time compared to mindfulness ($p = 0.03$; $d = -0.19$), and there was a marginally significant trend ($p = 0.052$, $d = -0.21$) in which mindfulness resulted in more robust declines over time compared to reappraisal. Despite this positive effect of mindfulness (vs. suppression) on sadness, suppression was associated with significantly lower average sadness across the entire regulation period compared with mindfulness ($p = 0.002$, $d = -0.27$). Results of a similar model contrasting the effects of suppression and reappraisal on sadness over time revealed no significant differences in the trajectory of sadness over time between the two conditions, although suppression (vs. reappraisal) was associated with marginally lower mean levels of sadness across the regulation period (Estimate = 10.24, $SE = 5.30$, $t(117) = 1.93$, $p = 0.056$; $d = -0.30$).

Next, we examined whether individual differences in Asian cultural values (as measured using the AVS-R) moderated the influences of experimental condition and time on sadness. To do this, we built multilevel regression models similar to those described above, adding the main effects of Asian cultural values and all of the two- and three-way interactions of this trait with time and condition variables.

Results for sadness are presented in Table 4. Although Asian cultural values did not significantly moderate the interactive effect of condition and time (i.e., did not alter the influence of mindfulness vs. suppression or reappraisal on the trajectory of changes in sadness), there was a significant two-way interactive effect of Asian cultural values and condition, in which the suppression condition reported lower average sadness than the mindfulness condition across the regulation period among individuals *high* (+1 SD) in Asian cultural values ($p < 0.05$). Both suppression and mindfulness conditions did not differ on average sadness individuals *low* (−1 SD) in Asian cultural values ($p > 0.05$). Condition effects over time among individuals high (+1 SD) and low (−1 SD) in Asian cultural values are depicted in Fig. 3. Of note, there was a non-significant trend for Asian cultural values to predict quicker recovery of sadness in the mindfulness condition versus the suppression condition ($p = 0.11$). Similar models comparing the influence of Asian cultural values on the contrast between suppression and reappraisal revealed no significant moderation by Asian cultural values.

3.4. Effects of condition on stroop interference

In order to examine the effect of condition on Stroop interference at baseline and following the sadness induction, we again used a multilevel regression model in which time points (T2, T7) were nested within individuals. Because there were only two observations per person, random effects of time were not possible, though a random intercept was included. The model predicted Stroop interference at each time point from age and gender as covariates, condition (category coded as the following two terms: the contrast between mindfulness and suppression, the contrast between mindfulness and reappraisal), dichotomous time point (T2, T7), and the interactions of category-coded condition with time. The ICC for sadness was 0.18, indicating that 18% of the variance in sadness could be attributed to between-person factors. Equations from Snijders and Bosker (1999) and post-hoc power analysis indicated that the smallest effect sizes detectable (assuming 80% power, ICC of 0.18, a sample of 123 participants, and 2 repeated measures in each participant) was $d = 0.36$ for our primary hypothesis test (interaction between condition and time). Results for the effects of condition and time on Stroop interference are reported in Table 3 and depicted in Fig. 2. Neither age nor gender were significantly associated with Stroop performance. There were no baseline differences in Stroop interference across the three conditions (as indicated by nonsignificant main effects of condition on the intercept (baseline scores) in the model). Consistent with hypotheses, individuals in the mindfulness condition had less increase in Stroop interference over time when compared to the suppression condition ($d = -0.36$). In addition, similar models comparing the suppression and reappraisal models indicated that reappraisal condition also had less robust increases in Stroop interference over time compared to the suppression condition (Estimate = −0.01, $SE = 0.004$, $t(115) = -2.02$, $p = 0.045$; $d = -0.27$). There was no significant difference in the effects of reappraisal and mindfulness over time on Stroop interference. Further, there was no significant correlation between changes on Stroop interference scores with either changes in sadness scores from pre-to post-regulation or sadness at post-regulation (all ps > 0.05), suggesting that the interference effect cannot be attributed to residual mood or differences in mood ratings across groups.

We next examined whether Asian cultural values moderated the effects of experimental condition on Stroop performance. Including the main and interactive effects of Asian values in the model predicting Stroop performance revealed no significant interactions of Asian cultural values with condition or time to predict Stroop interference (all p's > 0.05). Therefore, these results are not presented in tabular form.

4. Discussion

The present study examined the relative effects of mindfulness versus reappraisal and suppression on sad mood and cognitive resources in a Singaporean undergraduate sample. Compared to suppression, brief mindfulness training resulted in more rapid reductions in sad mood induced through negative autobiographical recall. Suppression however resulted in lower levels of average sadness across the mood regulation period, relative to mindfulness and reappraisal. Further, both mindfulness and reappraisal buffered against increases in Stroop interference from pre-to post-regulation compared to suppression. Moderation analyses showed that suppression resulted in lower levels of average sadness compared to

mindfulness among those high on Asian cultural values, but not those low on Asian cultural values.

The finding that mindfulness resulted in significantly quicker reductions in sadness compared to suppression is consistent with previous studies showing that brief acceptance training promotes recovery of negative affect (Alberts, Schneider, & Martjin, 2012; Greenberg & Meiran, 2014; Liverant et al, 2008). The fact that the suppression condition is characterized by an overall lower, and more blunted sadness response compared to mindfulness complicates the interpretation of this finding. On the one hand, this finding suggests that mindfulness is a more effective regulation strategy because it facilitates quicker mood recovery; on the other hand, it is arguably more advantageous if one is able to keep down negative emotions throughout the period of a stressor, despite experiencing a slower rate of mood recovery. We argue that the pattern of mood changes observed in the mindfulness condition represents a healthier trajectory of affect regulation: one that allows for the development and expression of sadness in a responsive and context appropriate manner (recall of negative autobiographical memory), as well as effective recovery of the emotion afterwards. This position is supported by findings from affect dynamics research, which showed that higher levels of emotion inertia (the extent to which one's emotions are resistant to change) are predictive of less adaptive psychological functioning (Koval, Kuppens, Allen, & Sheeber, 2012; Kuppens, Allen, & Sheeber, 2010). Notably, there was a trend for mindfulness to be associated with more rapid mood recovery compared to reappraisal, although the effect did not reach statistical significance.

We did not find strong evidence of an influence of Asian cultural values on mood recovery across the three strategies. However, given the nonsignficant trend for Asian cultural values to predict quicker recovery of sad mood for the mindfulness condition versus the suppression condition, we cannot conclude with confidence that Asian cultural values do not influence the effectiveness of mindfulness as an ER strategy. On average, people with high Asian values who engaged in suppression (versus mindfulness) reported lower levels of sadness compared to those endorsing lower levels of Asian values. These findings mirrored those of the primary analyses involving the entire study sample. To some extent, the findings are consistent with research demonstrating the benefits of suppression among individuals identifying with Chinese culture or interdepenent self-constual (Huang, Leong, & Wagner, 1994; Le & Impett, 2013). However, as highlighted earlier, it is questionable the extent to which a more blunted emotional response necessarily reflects an adaptive ER style. This study is among the first to demonstrate the role of Asian cultural values in moderating the effects of mindfulness and suppression within an Asian context, and the findings warrant replication and further exploration in larger samples.

The finding that suppression resulted in significantly greater increases in Stroop interference compared to mindfulness and reappraisal corroborates other research demonstrating increased cognitive or physiological cost associated with use of suppression as an ER strategy (Alberts et al., 2012; Feldner et al., 2006; Gross, 1998; Hofmann et al., 2009). Even though participants in the suppression condition reported consistently lower levels of sadness compared to the other conditions, there is clearly a cognitive cost to it. This finding suggests that mindfulness and reappraisal are relatively cognitively efficient strategies, and is

consistent with theoretical and empirical accounts of mindfulness as a state of relaxed, open awareness that can help restore self-control resources (Friese, Messner, & Schaffner, 2012; Salmon et al., 2004) as well as studies demonstrating reduced cognitive load associated with reappraisal (Richards & Gross, 2000; Richards et al., 2003).

The comparison between mindfulness and reappraisal is interesting to note. Unlike Keng et al. (2013), who found that reappraisal resulted in greater cognitive depletion compared to mindfulness, the present study found no difference between the two strategies in their cognitive consequences. The difference in findings may be attributed to the fact that the present study recruited a non-clinical sample (as opposed to an analogue depressed sample in Keng et al.), who may have been more able to engage in reappraisal efficiently. These findings suggest that the degree of cognitive load associated with reappraisal may vary by the nature of population employing the strategy, with clinically more severe populations potentially finding the strategy to be more effortful or cognitively demanding compared to healthy populations (Keng et al., 2013). The findings overall point to the potential of mindfulness as an effective strategy in terms of not only facilitating mood recovery, but also preservation of cognitive resources, which has important implications for the treatment of emotional disorders in which cognitive deficits are an associated feature, such as depression (Levin, Heller, Mohanty, Herrington, & Miller, 2007; Ravnkilde et al., 2002) and anxiety (Eysenck, Derakshan, Santos, & Calvo, 2007). Future research should explore further the effects of mindfulness training on mood regulation as well as cognitive functioning post-regulation in the context of these disorders.

Several strengths of the study include recruitment of a relatively large sample size, use of a randomized experimental design, and control for experimenter effects and participants' adherence to manipulation instructions. Analyses exploring Asian cultural values as a moderator of the effects of the ER strategies add a unique cultural angle to this study. Several limitations should be high-lighted. First, the results of this laboratory study may not be generalizable to coping with negative situations in daily life. Future research should examine the effects of the ER strategies as they are naturally employed in daily life. The training instructions provided are also only an analogue of how the respective ER strategies are taught in the context of psychotherapy. Further, use of self-report methods to assess emotions and strategy adherence is subject to biases. Future research should examine the use and effects of the ER strategies using multiple modes of assessment (e.g., the think-a-loud procedure and psychophysiological measures). Lastly, the study recruited a predominantly Chinese, Singaporean undergraduate population, which limits the generalizability of the findings to other demographic groups as well as clinical populations.

The present study points to several directions for future research. Placed within the larger ER literature, the study sheds light on the importance of examining the role of context in modulating the effects of different ER strategies, consistent with recommendations by other researchers (Aldao, Nolen-Hoeksema & Schweizer, 2010). Both distal factors such as type of regulated emotion, the timing of an executed strategy, and nature of population (clinical vs. healthy populations), and proximal factors such as culture, may differentially influence the efficacy of an ER strategy. In particular, the study suggests that the effects of mindfulness and reappraisal may very well vary depending on the context in which they are

implemented. Beyond depletion of cognitive resources, future research should explore additional domains on which these strategies may exert differential effects (e.g., memory for emotional events). It would also be of value to assess the clinical or practical benefits of minimizing consumption of cognitive resources by a regulation strategy, for example, by examining the extent to which mindfulness and reappraisal results in better behavioral performance under conditions of heightened stress. Lastly, future studies should examine more closely the interaction between specific cultural values and the effects of various regulation strategies across settings. As Asian cultural values represent a broad set of different sub-values, it remains to be clarified specific sub-values that would have the most impact on the efficacy of a particular regulation strategy, and the mechanisms through which these values modulate the effects of the strategy.

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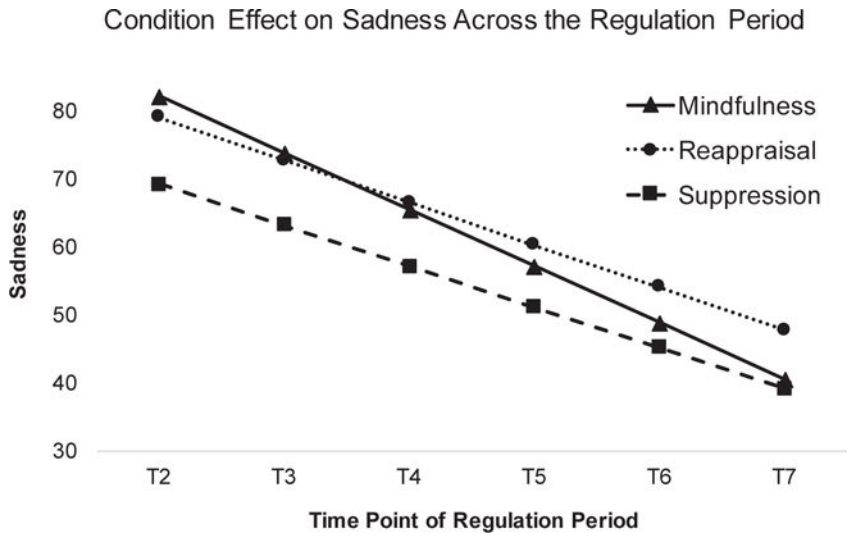

Fig. 1.

Model-based depiction of experimental condition effect on sadness across the regulation period.

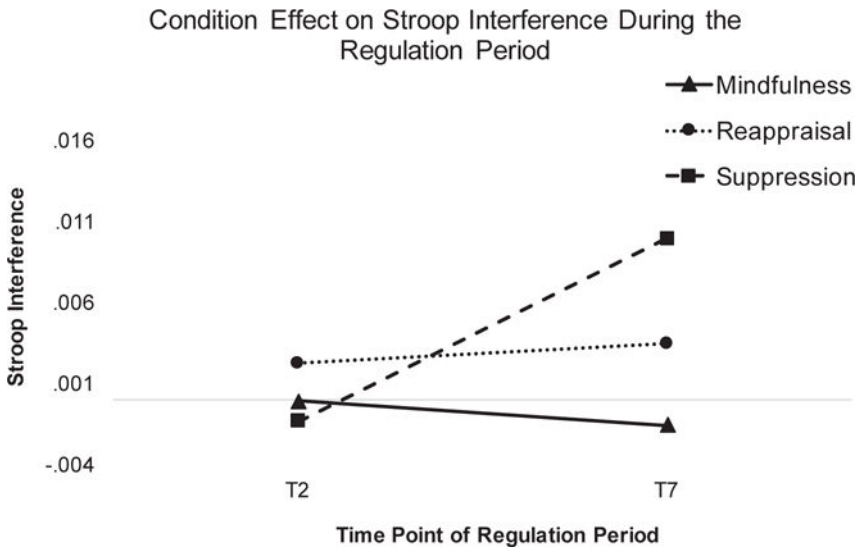

Fig. 2.
Model-based depiction of the effect of condition and time on Stroop interference.

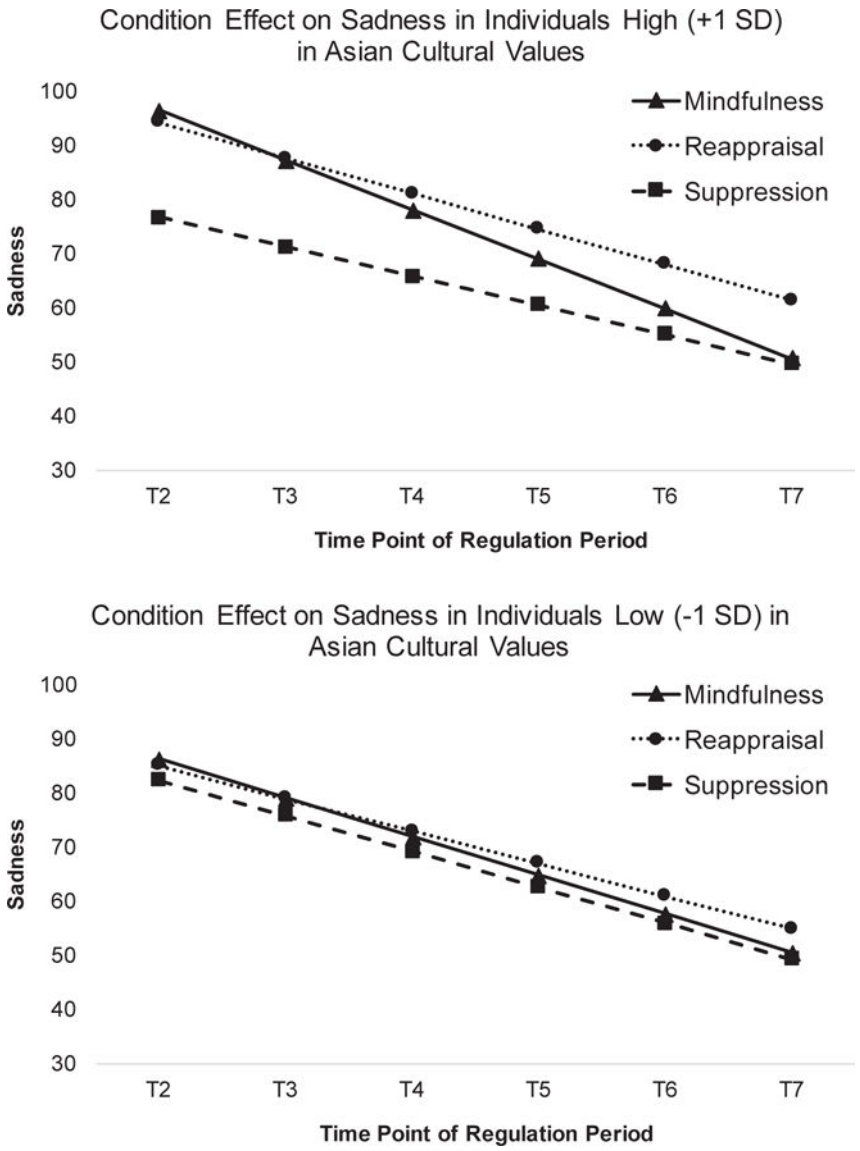

Fig. 3.

Model-based depiction of the three-way interaction of Asian cultural values, experimental condition, and time on sadness.

Table 1

Sample characteristics across conditions.

Variable	All Participants (n = 125)	Mindfulness (n = 39)	Reappraisal (n = 43)	Suppression (n = 43)
Female	73.6%	76.9%	65.1%	79.1%
Chinese	87.2%	84.6%	86.0%	90.7%
Never married	92.0%	84.6%	97.7%	93.0%
Not Employed	84.8%	89.7%	79.1%	86.0%
Previously in Therapy	0.0%	0.0%	0.0%	0.0%
Experience with Mindfulness	22.4%	28.2%	23.3%	16.3%
	M(SD)	**M(SD)**	**M(SD)**	**M(SD)**
Age	20.19 (1.6)	20.00(1.54)	20.47 (1.72)	20.09 (1.53)
AVS-R	96.28 (11.71)	98.26 (12.67)	94.65 (9.94)	96.12 (12.45)

Note. AVS-R = Asian Values Scale-Revised.

Table 2

Model predicting sadness across the regulation period from condition and time.

Parameter	**γ**	**SE**	**df**	**t Value**	**p Value**
Fixed Effects					
Intercept	122.29	30.58	117	4.00	0.00
Gender	5.14	4.13	117	1.24	0.22
Age	**−2.42** *	1.20	117	−2.02	0.04
Reappraisal vs. Mindfulness	−7.24	5.42	117	−1.34	0.18
Suppression vs. Mindfulness	**−17.48** **	5.42	117	−3.23	0.001
Dichotomous Time (Pre/Post)	**−8.32** ***	0.77	622	−10.78	<0.0001
(Reappraisal vs. Mindfulness) × Time	2.08	1.07	622	1.95	0.05
(Suppression vs. Mindfulness) × Time	**2.31** *	1.07	622	2.16	0.03
Covariance Parameters (Random Effects)					
	Estimate	SE			
Intercept	469.46 ***	77.48			
Time	17.91 ***	2.99			
Error	93.63 ***	5.92			

Note.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

Gamma values represent fixed effects estimates and are analogous to unstandardized beta in regression.

Table 3

Model predicting stroop interference from condition and dichotomous time.

Parameter	γ	SE	df	t Value	p Value
Fixed Effects					
Intercept	0.000	0.028	115	0.000	0.998
Gender	0.002	0.004	115	0.590	0.560
Age	0.000	0.001	115	0.150	0.879
Reappraisal vs. Mindfulness	0.002	0.004	115	0.540	0.592
Suppression vs. Mindfulness	−0.001	0.004	115	−0.300	0.764
Dichotomous Time (Pre/Post)	−0.002	0.004	115	−0.410	0.685
(Reappraisal vs. Mindfulness) × Time	0.003	0.005	115	0.530	0.598
(Suppression vs. Mindfulness) × Time	**0.013** *	0.005	115	2.500	0.014
Covariance Parameters (Random Effects)					
	Estimate	SE			
Intercept	0.00031 ***	0.000042			
Error	0.00035 ***	0.000048			

Note.

* $p < 0.05$,

* $p < 0.01$,

*** $p < 0.001$.

Gamma values represent fixed effects estimates and are analogous to unstandardized beta in regression.

Table 4

Model Predicting Sadness Across the Regulation Period from Asian cultural values, Condition, and Time.

Parameter	γ	SE	df	t Value	p Value
Fixed Effects					
Intercept	107.54	31.35	114	3.43	0.00
Gender	6.23	4.16	114	1.50	0.14
Age	−1.93	1.22	114	−1.59	0.12
AVS-R	7.08	3.65	114	1.94	0.054
Reappraisal vs. Mindfulness	−5.48	5.38	114	−1.02	0.31
Suppression vs. Mindfulness	**−16.10** **	5.36	114	−3.00	0.003
Linear Time	**−8.16** ***	0.78	619	−10.42	<0.0001
(Reappraisal vs. Mindfulness) × Time	1.87	1.08	619	1.73	0.08
(Suppression vs. Mindfulness) × Time	**2.15** *	1.07	619	2.00	0.046
AVS-R × (Reappraisal vs. Mindfulness)	−1.96	5.62	114	−0.35	0.73
AVS-R × (Suppression vs. Mindfulness)	**−11.20** *	5.03	114	−2.23	0.03
AVS-R × Time	−0.99	0.72	619	−1.38	0.17
AVS-R × (Reappraisal vs. Mindfulness) × Time	0.72	1.13	619	0.64	0.52
AVS-R × (Suppression vs. Mindfulness) × Time	1.61	1.00	619	1.61	0.11
Covariance Parameters (Random Effects)					
Intercept	446.54***	75.87			
Time	17.96***	3.04			
Error	93.64***	5.92			

Note.

* $p < 0.05$,

** $p < 0.01$,

*** $p < 0.001$.

Gamma values represent fixed effects estimates and are analogous to unstandardized beta in regression. AVS-R = Asian Values Scale-Revised.