

# Differences in emotion modulation using cognitive reappraisal in individuals with and without suicidal ideation: An ERP study

Anastacia Y. Kudinova<sup>1</sup>, Max Owens<sup>1</sup>, Katie L. Burkhouse<sup>1</sup>,  
Kenneth M. Barretto<sup>1</sup>, George A. Bonanno<sup>2</sup>, and Brandon E. Gibb<sup>1</sup>

<sup>1</sup>Department of Psychology, Binghamton University (SUNY), Binghamton, NY, USA

<sup>2</sup>Teachers College, Columbia University, New York, NY, USA

(Received 7 November 2014; accepted 29 March 2015)

Difficulties in emotion regulation have been associated with increased suicidal thoughts and behaviours. The majority of studies have examined self-reported use of emotion regulation strategies. In contrast, the current study focused on a direct measure of individuals' ability to use a specific emotion regulation strategy, cognitive reappraisal, using the late positive potential (LPP), an event-related potential component that reflects attention to emotional stimuli. Specifically, the cognitive reappraisal ability of 33 undergraduate students was assessed via an image-viewing task during which the participants had to passively view, increase or reduce their emotions in response to looking at neutral, positive or dysphoric images. We found that participants with a history of suicidal ideation (SI) had significantly higher LPP when asked to reduce negative emotion in response to dysphoric images, compared to individuals with no history of SI. These findings suggest that difficulties with using cognitive reappraisal, specifically to decrease negative affect, might be linked to suicide risk.

**Keywords:** Emotion regulation; Cognitive reappraisal; Suicidal ideation; Event-related potentials; Late positive potential.

Suicide is the second leading cause of death for 15- to 34-year-olds in the USA (Centers for Disease Control and Prevention, 2014). Globally, more than 800,000 people die by suicide every year (WHO, 2014). Identifying the risk factors for suicidal thoughts and behaviours is critical for suicide prevention. Previous research suggests that, along with well-known factors including depression and past suicidal behaviours (Brown, Beck, Steer, & Grisham, 2000), difficulties with

emotion regulation might increase the risk for suicide attempts (Rajappa, Gallagher, & Miranda, 2011; Wagner & Zimmerman, 2006). Specifically, the self-reported use of maladaptive emotion regulation strategies was associated with suicidal ideation (SI) and attempts (Pisani et al., 2013). A key limitation of existing research on the link between emotion regulation and suicidal thoughts and behaviours, however, is that it has focused almost exclusively on self-reported use of emotion

---

Correspondence should be addressed to: Anastacia Y. Kudinova, MA, Department of Psychology, Binghamton University (SUNY), Binghamton, NY 13902-6000, USA. E-mail: [akudino1@binghamton.edu](mailto:akudino1@binghamton.edu)

regulation strategies and studies providing a direct measure of emotion regulation abilities are rare. This type of investigation is important because studies that directly examined emotion regulation ability via empirical paradigms show its critical involvement in adjustment to stressors (e.g., Bonanno, Papa, Lalande, Westphal, & Coifman, 2004) and development of depressive symptoms (e.g., Troy, Wilhelm, Shallcross, & Mauss, 2010), both of which constitute established suicide risks (Joiner et al., 2007).

One of the most researched ways to regulate emotions is cognitive reappraisal, an antecedent-focused strategy that involves cognitive re-framing of emotional stimuli in a way that augments the intensity, length and/or expression of an emotion (Gross & John, 2003). Cognitive theories of emotion suggest that individuals' emotional reactions to an event arise in response to their appraisal of the situation (Beck, 1983; Folkman & Lazarus, 1985) and developing the ability to flexibly modify the appraisals is at the core of many therapeutic interventions (e.g., Beck, 1983). Extensive research has been conducted on the habitual use of cognitive reappraisal and the results suggest that self-reported more frequent use of cognitive reappraisal is associated with better overall well-being and interpersonal functioning (Gross & John, 2003). However, the frequency of use might not be synonymous with the actual level of mastery of this emotion regulation strategy. The ability to effectively employ cognitive reappraisal, for instance, has been shown to constitute a different construct from its chronic use (Troy et al., 2010). The main aim of the current study was to use an experimental paradigm combined with neurophysiological measures to directly assess individuals' ability to use cognitive reappraisal to both decrease and increase emotions evoked by neutral, dysphoric and positive images.

The neurophysiological measure that we focused on is the late positive potential (LPP), which is an event-related potential (ERP) component that exhibits higher amplitude during the processing of emotional images (Bernat, Cadwallader, Seo, Vizuela, & Patrick, 2011; Schupp et al., 2000). Moreover, this waveform has been shown to

respond to emotion regulation processes (Moser, Hajcak, Bukay, & Simons, 2006). For instance, verbal descriptions of emotionally valenced images, as well as framing category, have been shown to modulate LPP amplitude (e.g., Hajcak, MacNamara, & Olvet, 2010). Additionally, Bernat et al. (2011) found that LPP was higher when participants were asked to enhance or suppress their emotional response to valenced stimuli than when they passively viewed those images. Therefore, the current study used modulation in LPP as a physiological index of cognitive emotion regulation. The aim of the study was to pull apart the components of cognitive emotion regulation by instruction (view passively, increase, decrease) and valence (neutral, positive, dysphoric), similar to Bernat et al. (2011), and examine which components were associated with participants' histories of SI. We hypothesised that individuals with a history of SI history would exhibit deficits in the ability to reduce physiological responses (LPP amplitude) to dysphoric images compared to individuals with no SI history.

## METHOD

### Participants

A total of 40 undergraduate students participated in the study for credit. Seven participants were excluded due to the lack of useable ERP data. The demographics for the remaining 33 participants are presented in Table 1.

### Measures

Participants' history of SI and depression was assessed via an interview using questions based on the depression and suicidality modules of the Mini-International Neuropsychiatric Interview (M.I.N.I.; Sheehan et al., 1998). The M.I.N.I. is a widely used psychiatric interview with good psychometric properties (Sheehan et al., 1998). Individuals were assigned to the SI ( $n = 10$ ) or no SI ( $n = 23$ ) groups based on the lifetime presence of recurrent suicidal thoughts.

Participants' current mood was assessed via the Visual Analogue Mood Scale (VAMS; Folstein &

Table 1. Descriptive statistics for the study sample

	Total (n = 33)	No SI (n = 23)	History of SI (n = 10)	F/ $\chi^2$
Age ( <i>M</i> , <i>SD</i> )	19.76 (2.12)	20.22 (2.31)	18.70 (1.06)	3.89
Ethnicity (% Caucasian)	43.8	34.8	66.7	2.67
Sex (% female)	69.7	60.9	90	2.8
VAMS sadness ( <i>M</i> , <i>SD</i> )	29.20 (16.50)	26.23 (17.76)	36.04 (10.97)	2.60
VAMS anxiety ( <i>M</i> , <i>SD</i> )	22.23 (30.25)	18.81 (31.10)	30.08 (28.12)	0.97

Note: None of the *p* values for *F*/ $\chi^2$  tests were significant.  
VAMS, Visual Analogue Mood Scale.

Luria, 1973). Specifically, participants were presented with two 100 mm lines, one of which was anchored at one end with “very happy” and at the other end with “very sad” while the other one was anchored with “very calm” on one end and with “very anxious” on the other end. They were asked to indicate their current mood by drawing a mark on the line. Current levels of sadness and anxiety were calculated by measuring the distance from the left end of the line to the mark.

Participants then completed an emotion regulation task. For this task, participants viewed a series of images, one at a time, from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999). The stimuli consisted of 12 dysphoric, 12 positive, and 12 neutral, colour images.<sup>1</sup> The task was divided into three blocks: (1) view normally, (2) increase the intensity of the emotion evoked by the image and (3) decrease the intensity of the emotion evoked. The instructions for the cognitive reappraisal computer task were adapted from Ochsner et al. (2004). The full reappraisal instructions are provided in the Appendix. For passive-viewing trials, the participants were asked to view pictures and respond as they normally would. For the increase/reduce trials, the participants were asked to use either one of the two strategies described by Ochsner et al. (self-focused and situation focused). For instance, to reduce negative emotions, the participants were instructed to either take a perspective of a detached observer with no personal

connections to individuals in an image (self-focused) or think about the positive aspects of a negative image (situation focused). After going through the instructions, the participants went through practice trials during which they practiced using cognitive reappraisal by sharing the thoughts they used to modulate their emotions in response to emotionally valenced images with experimenter.

The order of block presentation was randomised across participants and each block contained 36 trials. Each trial began with a reminder of the block instructions (“view passively”, “increase” or “reduce”), which appeared on the screen for 1000 ms before each trial. Following this, a fixation cross was presented on the screen for 1000 ms. Images appeared 500 ms after the offset of the fixation cross and remained on the screen for 3000 ms. The inter-stimulus interval randomly varied between 1750 and 2250 ms.

During the task, continuous electroencephalogram (EEG) was recorded using a custom cap and the BioSemi ActiveTwoBio system (Amsterdam, the Netherlands). The EEG was digitised at 64-bit resolution with a sampling rate of 512 Hz. Recordings were taken from 34 scalp electrodes based on the 10/20 system. The electrooculogram was recorded from four facial electrodes. Offline analysis was performed using the Matlab extension, EEGLAB (Delorme & Makeig, 2004) and the EEGLAB plug-in, ERPLAB (Lopez-Calderon & Luck, 2014). All data were re-referenced to the average of the left and right

<sup>1</sup> The following IAPS images were used: dysphoric—2141, 2205, 2276, 2455, 2700, 2703, 2799, 2900, 3230, 9220, 9421 and 9530; positive—1340, 2091, 2165, 2208, 2224, 2299, 2339, 2340, 2501, 4599, 4700 and 8461; and neutral—2038, 2102, 2393, 2397, 2745, 2850, 5500, 5731, 7009, 7041, 7080 and 7185.

mastoid electrodes and band-pass filtered with cut-offs of 0.1 Hz and 80 Hz, as previously described (e.g., Dunning & Hajcak, 2009). EEG data were processed using both artefact rejection and correction. First, large and stereotypical ocular components were identified and removed using independent component analysis scalp maps (e.g., eye blinks project mainly from frontal regions; Jung et al., 2001). Artefact detection and rejection was then conducted on epoched uncorrected data files to identify and remove trials containing blinks and large eye movements at the time of stimulus presentation. Epochs with large artefacts (greater than 100  $\mu\text{V}$ ) were excluded from analysis. As noted above, seven subjects were excluded from the analyses for exceeding the artefact rejection threshold (40%). Of these subjects, two were from the SI group and five were from the no SI group. For the remaining 33 subjects, the number of included trials did not differ significantly between the SI and no SI groups ( $M = 33.40$ ;  $M = 32.26$ ). The interval from  $-200\text{ms}$  to  $0\text{ ms}$  served as the baseline for ERPs. Previous literature suggests that LPP is maximal at centro-parietal sites (Schupp et al., 2000). Therefore, LPP was defined as the average activity 400–1000 ms following stimulus onset and was calculated by pooling across four centro-parietal locations along the midline (Pz, Cz, CP1 and CP2).

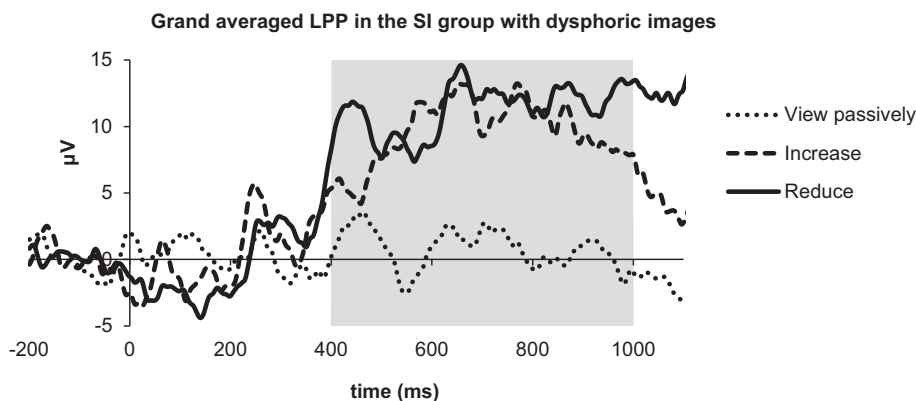
Analyses were conducted using SPSS (Version 22) General Linear Model software (Armonk, NY). Since Mauchli's test of sphericity was not violated in any of the analyses and the lowest  $\epsilon_{GG}$  was 0.92, Greenhouse-Geisser correction was not applied to  $p$  values associated with multiple  $df$  comparisons.

## Procedure

Upon arrival at the laboratory, participants were asked to provide informed consent and were then administered the questions about SI history. Following this, participants completed demographics questionnaires and were then connected to EEG recording equipment via electrodes and completed the aforementioned emotion regulation task. The university's institutional review board approved this project.

## RESULTS

To test our primary hypothesis, we conducted a 2 (Suicidal Ideation: yes, no)  $\times$  3 (Instruction: view passively, increase, reduce)  $\times$  3 (Valence: dysphoric, positive, neutral) repeated measures analysis of variance (ANOVA) with LPP amplitude serving as the dependent variable. We found significant main effects for Instruction,  $F(2,62) = 3.22$ ,  $p = .047$ ,  $\eta_p^2 = .09$ , and Valence,  $F(2,62) = 15.62$ ,  $p < .0001$ ,  $\eta_p^2 = .33$ , as well as a significant SI  $\times$  Instruction  $\times$  Valence interaction,  $F(4,124) = 3.01$ ,  $p = .02$ ,  $\eta_p^2 = .09$ . Examining the form of the Instruction main effect, we found that participants had a significantly smaller LPP when they were asked to passively view the images ( $M = 2.73$ ) than when they were asked to either increase ( $M = 5.45$ ) or decrease ( $M = 4.68$ ) their emotions, with the latter two conditions not differing significantly. Examining the form of the Valence main effect, we found that participants had a significantly smaller LPP while viewing neutral images ( $M = 0.60$ ) than when viewing dysphoric ( $M = 5.83$ ) or positive ( $M = 6.43$ ) images, with the latter two not differing significantly. Next, to examine the form of the SI  $\times$  Instruction  $\times$  Valence interaction, we examined the SI  $\times$  Instruction interaction separately within each Valence. We found that the SI  $\times$  Instruction interaction was significant for dysphoric stimuli,  $F(2,62) = 7.63$ ,  $p < .001$ ,  $\eta_p^2 = .20$ , but not positive,  $F(2,62) = 0.30$ ,  $p = .74$ ,  $\eta_p^2 = .01$ , or neutral stimuli,  $F(2,60) = 1.20$ ,  $p = .32$ ,  $\eta_p^2 = .04$ . Next, we examined differences in LPP magnitude across the three instruction conditions for dysphoric stimuli within each group separately. Within the SI group, we found a significant main effect of Instruction,  $F(2,18) = 7.50$ ,  $p = .004$ ,  $\eta_p^2 = .45$ , which post hoc tests revealed was driven by a smaller LPP in the view passively condition than in the increase,  $F(1,9) = 6.88$ ,  $p = .03$ ,  $\eta_p^2 = .43$ , or reduce conditions,  $F(1,9) = 15.72$ ,  $p = .003$ ,  $\eta_p^2 = .64$ , with the latter two instruction conditions not differing significantly,  $F(1,9) = 1.04$ ,  $p = .34$ ,  $\eta_p^2 = .10$  (Figure 1). In contrast, within the no SI group, the main effect of Instruction was not significant,  $F(2,44) = 1.57$ ,  $p = .219$ ,  $\eta_p^2 = .07$ , indicating that

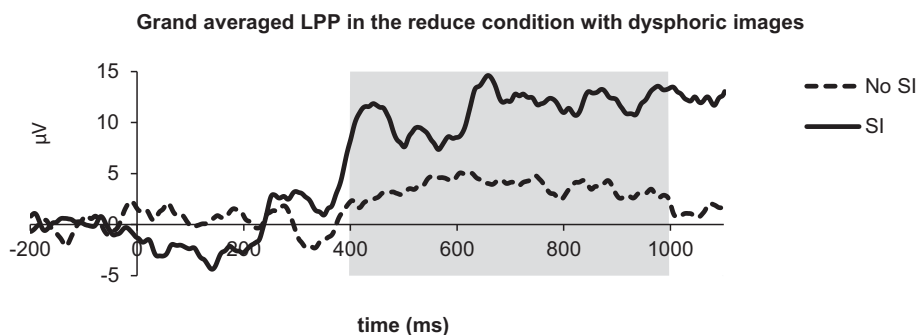


**Figure 1.** Grand averaged ERPs in the view passively, increase and reduce conditions elicited by dysphoric images at centro-parietal recording sites (Pz, Cz, CP1 and CP2). Highlighted area represents the time window for analyses (400–1000 ms). LPP was significantly higher in the increase ( $p = .03$ ) and reduce conditions ( $p = .003$ ), compared to view passively condition in response to dysphoric images.

LPP magnitude did not differ significantly across instruction types for these participants. As another way of examining the significant SI  $\times$  Instruction interaction for dysphoric stimuli, we also examined SI group differences within each Valence type. In these analyses, we found that the SI group difference was specific to the reduce condition,  $t(31) = 2.33$ ,  $p = .03$ ,  $r_{\text{effect size}} = .12$  (Figure 2), and was not observed for instructions to increase,  $t(31) = .83$ ,  $p = .42$ ,  $r_{\text{effect size}} = .02$ , or passively view,  $t(31) = -1.54$ ,  $p = .13$ ,  $r_{\text{effect size}} = .07$ . As can be seen in Figure 2, individuals with a history of SI exhibited a larger LPP than individuals with no history of SI when they were asked to decrease their emotions in response to dysphoric images. Participants' average

LPP presented separately by group (SI, no SI), image valence, and instruction can be found in Table 2.

Finally, we conducted a number of follow up tests to determine if the effects were specific to participants' histories of SI rather than to current mood or past depression more broadly. First, in terms of current mood, we examined whether the SI group difference in LPP magnitude to dysphoric faces in the reduce condition would be maintained even when we statistically controlled for the influence of VAMS sadness and anxiety ratings. Even after statistically controlling for the influence of VAMS sadness and anxiety ratings, the SI group difference in LPP magnitude for



**Figure 2.** Grand averaged ERPs elicited by dysphoric images in the reduce condition at centro-parietal recording sites (Pz, Cz, CP1 and CP2). LPP was significantly higher in the reduce condition among individuals with a history of SI compared to those with no SI history ( $p = .03$ ).



Table 2. Means (and standard deviations) for participants' LPP, presented separately by group, valence and instruction

		View Passively	Increase	Reduce
No SI	Neutral	1.30 (6.95)	0.65 (7.13)	2.03 (5.12)
	Positive	3.60 (7.20)	8.10 (2.54)	6.43 (8.60)
	Dysphoric	6.34 (9.64)	5.70 (6.50)	2.80 (9.34)
SI	Neutral	-1.63 (5.90)	2.40 (5.14)	-1.15 (12.80)
	Positive	6.54 (11.52)	7.50 (7.62)	6.54 (12.60)
	Dysphoric	0.32 (11.80)	8.40 (12.30)	11.50 (11.00)

SI, History of Suicidal Ideation.

dysphoric stimuli in the reduce condition remained significant,  $F(1,30) = 6.60$ ,  $p = .02$ ,  $\eta_p^2 = .18$ . Second, we examined the impact of participants' history of major depressive disorder (MDD). Specifically, we repeated the above repeated measures ANOVA with both SI group and MDD history (yes, no) entered as between-subjects factors. In this analysis, the  $SI \times Instruction \times Valence$  interaction remained significant,  $F(2,116) = 2.58$ ,  $p = .04$ ,  $\eta_p^2 = .08$ , but none of the effects of MDD history was significant (lowest  $p = .06$ ). In addition, even after statistically controlling for the influence of MDD history, the SI group difference in LPP magnitude to dysphoric faces in the reduce condition remained significant,  $F(2,58) = 8.35$ ,  $p = .001$ ,  $\eta_p^2 = .22$ . Additionally, we ran a linear regression analysis with a difference index for dysphoric images [view passively - (increase + reduce/2)] used as the criterion variable and SI, MDD history and current sadness and anxiety entered as predictor variables. SI variable was entered in Step 1, with the rest of the predictor variables (MDD, current sadness and anxiety) entered in Step 2 of the regression analysis. We found that SI was significantly associated with the difference index for reactivity to dysphoric images,  $\beta = -13.04$ ,  $t = -3.06$ ,  $p = .005$ , when it was entered on its own into the model. Importantly, SI was the only significant predictor when the other variables were added to the model,  $\beta = -13.80$ ,  $t = -2.88$ ,  $p = .007$  (all other  $ps > .34$ ). Additionally, adding other variables failed to significantly improve the model ( $R^2 = 0.23$ ,  $F = 9.35$ ,  $p = .005$  for Step 1,  $R^2 = 0.03$ ,  $\Delta F = 0.41$ ,  $p = 0.75$  for Step 2). These results suggest that the

observed group differences in reactivity within the increase and reduce conditions compared to view passively condition were due to participants' histories of SI rather than to differences in current mood or history of MDD.

## DISCUSSION

In this study, we examined differences in the ability to use cognitive reappraisal to modify emotional reactions to positive and negative stimuli among individuals with and without a history of SI. We found that individuals with a history of SI had the significantly larger LPP when they were asked to reduce their emotions via cognitive reappraisal specifically in response to dysphoric images compared to individuals with no SI history. Additionally, among individuals with SI history, LPP was significantly larger when participants were asked to increase or reduce their emotions in response to dysphoric images, compared to when they were asked to simply view the images passively. Individuals with no history of SI did not show any differential patterns of LPP magnitude to dysphoric images across instruction types. These findings were specific to SI history and were not due to the effects of current mood (sadness, anxiety) or MDD history. These findings reproduce previous research that found that LPP was increased in enhance and suppress conditions compared to passive-viewing condition (Bernat et al., 2011) and extend existing research by demonstrating that the pattern of LPP differences across valence and instruction may differ based on a person's history of SI. Moreover, these

findings add to existing research that suggests that emotion regulation plays an important role in suicidal thoughts and behaviours (e.g., Rajappa et al., 2011; Wagner & Zimmerman, 2006). Indeed, previous studies found that difficulties in emotion regulation, specifically perceived lack of strategies to respond to and recover from negative emotional experiences, was associated with increased risk for suicide attempts (Pisani et al., 2013). Conversely, teaching emotion regulation strategies to children improved mental health outcomes and reduced risk behaviours (Greenberg et al., 2003).

Additionally, the findings of the current study add to a rapidly growing body of literature that suggest that cognitive reappraisal use can impact neurophysiological activity assessed via LPP (e.g., Hajcak et al., 2010; Moser et al., 2006). Previous research showed that adults exhibited decreased LPP when responding to negative images with a more neutral interpretation, which might reflect reduction in the intensity of emotional responses (Hajcak et al., 2010). Moreover, children have been shown to generate smaller LPP in response to neutrally framed negative images (Dennis & Hajcak, 2009). In addition, a larger LPP in response to neutral interpretations of negative images was associated with poorer emotion regulation and greater mood symptoms reported by parents (Dennis & Hajcak, 2009). Therefore, LPP magnitude could potentially serve as a clinically meaningful neurophysiological marker of emotion regulation.

The strengths of this study include the use of direct electrophysiological measures to obtain estimates of the effectiveness of individuals' cognitive reappraisal ability, and the use of interviews to assess SI and depression history. Additionally, this is the first study, to our knowledge, that closely investigated the ability to use cognitive reappraisal to increase and decrease emotional experience in response to both positive and negative stimuli, as well as examined the association between these aspects of cognitive reappraisal and SI. The study also has some limitations that could be addressed by future research, including the focus on undergraduates, and future studies are needed to determine whether the findings will

generalise to clinical populations and to those with a history of suicide attempts (cf. Rajappa et al., 2011). Future research is also needed to determine whether these deficits in emotion regulation, specifically cognitive reappraisal, serve as a risk factor for future suicidal thoughts and behaviours. A relatively low number of trials per condition (12) may constitute another limitation, although previous research suggest that the inclusion of 12 trials corresponded to high internal consistency of LPP during emotion regulation tasks (e.g., Moran, Jendrusina, & Moser, 2013). In addition, the cross-sectional design of the current study precludes us from making any causal conclusions and future studies could examine the link between emotion regulation and SI prospectively. Finally, future research would benefit from larger sample sizes. For example, the lack of association between LPP and MDD history in our sample is surprising, given previous research showing that greater LPP for negative images in response to cognitive emotion regulation were associated with greater depressive and anxiety symptoms (e.g., Dennis & Hajcak, 2009). One possible explanation for these findings could be low statistical power to detect such associations in the current study due to smaller number of participants with a history of MDD. It is also possible, that SI history could have a larger effect on cognitive reappraisal ability, compared to MDD history, thus making this association to be more detectable even with limited power. Future studies with larger samples are needed to more definitively determine the impact of SI versus MDD history on reactivity to emotional stimuli. Despite these limitations, the findings of the current study extend previous research on the role of emotion regulation in suicide risk and suggest that the ability to effectively use cognitive reappraisal to reduce reactions to dysphoric stimuli may be a specific biomarker of risk that can be the focus of interventions designed to reduce risk for suicidal thoughts and behaviours.

#### Acknowledgements

We would like to thank Samantha Birk, Katie Champagne, Samantha Fradkin, Eric Funk and Samantha

Lowenkron for their help in conducting assessments for this project.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## REFERENCES

- Beck, A. T. (1983). Cognitive therapy of depression: New perspectives. In P. J. Clayton & J. E. Barnett (Eds.), *Treatment of depression: Old controversies and new approaches* (pp. 265–290). New York, NY: Raven Press.
- Bernat, E. M., Cadwallader, M., Seo, D., Vizueta, N., & Patrick, C. J. (2011). Effects of instructed emotion regulation on valence, arousal, and attentional measures of affective processing. *Developmental Neuropsychology, 36*, 493–518. doi:10.1080/87565641.2010.549881
- Bonanno, G. A., Papa, A., Lalande, K., Westphal, M., & Coifman, K. (2004). The importance of being flexible: The ability to both enhance and suppress emotional expression predicts long-term adjustment. *Psychological Science, 15*, 482–487. doi:10.1111/j.0956-7976.2004.00705.x
- Brown, G. K., Beck, A. T., Steer, R. A., & Grisham, J. R. (2000). Risk factors for suicide in psychiatric outpatients: A 20-year prospective study. *Journal of Consulting and Clinical Psychology, 68*, 371–377. doi:10.1037//0022-006X.68.3.371
- Centers for Disease Control and Prevention. (2014). National center for injury prevention and control. Web-based Injury Statistics Query and Reporting System (WISQARS). Retrieved from <http://www.cdc.gov/ncipc/wisqars>
- Delorme, A., & Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods, 134*(1), 9–21. doi:10.1016/j.jneumeth.2003.10.009
- Dennis, T. A., & Hajcak, G. (2009). The late positive potential: A neurophysiological marker for emotion regulation in children. *Journal of Child Psychology and Psychiatry, 50*, 1373–1383. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1111/j.1469-7610.2009.02168.x/full>
- Dunning, J. P., & Hajcak, G. (2009). See no evil: Directing visual attention within unpleasant images modulates the electrocortical response. *Psychophysiology, 46*(1), 28–33. doi:10.1111/j.1469-8986.2008.00723.x
- Folkman, S., & Lazarus, R. S. (1985). If it changes it must be a process: Study of emotion and coping during three stages of a college examination. *Journal of Personality and Social Psychology, 48*(1), 150–170. doi:10.1037/0022-3514.48.1.150
- Folstein, M. F., & Luria, R. (1973). Reliability, validity, and clinical application of the visual analogue mood scale. *Psychological Medicine, 3*, 479–486. doi:10.1017/S0033291700054283
- Greenberg, M. T., Weissberg, R. P., O'Brien, M. U., Zins, J. E., Fredericks, L., Resnik, H., & Elias, M. J. (2003). Enhancing school-based prevention and youth development through coordinated social, emotional, and academic learning. *American Psychologist, 58*, 466–474. doi:10.1037/0003-066X.58.6-7.466
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*, 348–362. doi:10.1037/0022-3514.85.2.348
- Hajcak, G., MacNamara, A., & Olvet, D. M. (2010). Event-related potentials, emotion, and emotion regulation: An integrative review. *Developmental Neuropsychology, 35*, 129–155. doi:10.1080/87565640903526504
- Joiner, T., Kalafat, J., Draper, J., Stokes, H., Knudson, M., Berman, A. L., & Mckee, R. (2007). Establishing standards for the assessment of suicide risk among callers to the national suicide prevention lifeline. *Suicide and Life-Threatening Behavior, 37*, 353–365. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1521/suli.2007.37.3.353/full>
- Jung, T.-P., Makeig, S., McKeown, M. J., Bell, A. J., Lee, T.-W., & Sejnowski, T. J. (2001). Imaging brain dynamics using independent component analysis. *Proceedings of the IEEE. Institute of Electrical and Electronics Engineers, 89*, 1107–1122. doi:10.1109/5.939827
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International affective picturesystem: Instruction manual and affective ratings*. Technical Report A-4. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.
- Lopez-Calderon, J., & Luck, S. J. (2014). ERPLAB: An open-source toolbox for the analysis of event-related potentials. *Frontiers in Human Neuroscience, 8*, 213. doi:10.3389/fnhum.2014.00213
- Moran, T. P., Jendrusina, A. A., & Moser, J. S. (2013). The psychometric properties of the late positive



- potential during emotion processing and regulation. *Brain Research*, 1516, 66–75. doi:10.1016/j.brainres.2013.04.018
- Moser, J. S., Hajcak, G., Bukay, E., & Simons, R. F. (2006). Intentional modulation of emotional responding to unpleasant pictures: An ERP study. *Psychophysiology*, 43, 292–296. doi:10.1111/j.1469-8986.2006.00402.x
- Ochsner, K. N., Ray, R. D., Cooper, J. C., Robertson, E. R., Chopra, S., Gabrieli, J. D. E., & Gross, J. J. (2004). For better or for worse: Neural systems supporting the cognitive down- and up-regulation of negative emotion. *NeuroImage*, 23, 483–499. doi:10.1016/j.neuroimage.2004.06.030
- Pisani, A. R., Wyman, P. A., Petrova, M., Schmeelk-Cone, K., Goldston, D. B., Xia, Y., & Gould, M. S. (2013). Emotion regulation difficulties, youth-adult relationships, and suicide attempts among high school students in underserved communities. *Journal of Youth and Adolescence*, 42, 807–820. doi:10.1007/s10964-012-9884-2
- Rajappa, K., Gallagher, M., & Miranda, R. (2011). Emotion dysregulation and vulnerability to suicidal ideation and attempts. *Cognitive Therapy and Research*, 36, 833–839. doi:10.1007/s10608-011-9419-2
- Schupp, H. T., Cuthbert, B. N., Bradley, M. M., Cacioppo, J. T., Ito, T., & Lang, P. J. (2000). Affective picture processing: The late positive potential is modulated by motivational relevance. *Psychophysiology*, 37(2), 257–261. doi:10.1111/1469-8986.3720257
- Sheehan, D. V., Lecrubier Y., Sheehan K. H., Amorim, P., Janavs J., Weiller, E., ... Dunbar, G. C. (1998). The mini-international neuropsychiatric interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry*, 59, 34–57.
- Troy, A. S., Wilhelm, F. H., Shallcross, A. J., & Mauss, I. B. (2010). Seeing the silver lining: Cognitive reappraisal ability moderates the relationship between stress and depressive symptoms. *Emotion*, 10, 783–795. doi:10.1037/a0020262
- Wagner, B. M., & Zimmerman, J. H. (2006). Developmental influences on suicidality among adolescents: Cognitive, emotional, and neuroscience aspects. In T. E. Ellis (Ed.), *Cognition and suicide: Theory, research, and therapy* (pp. 287–308). Washington, DC: American Psychological Association, xviii, 409 pp.
- WHO. (2014). *Suicide factsheet*. Retrieved September 20, 2014, from <http://www.who.int/mediacentre/factsheets/fs398/en/>

## APPENDIX

The following instructions were displayed on the screen and given verbatim:

You will now see a series of images. Some of the pictures will be positive, some will be negative and some will be neutral. You will be looking at pictures for approximately 10 minutes. You need to look at these pictures normally, as you usually would, increase, or reduce the emotions you are feeling with your thoughts. You will be prompted with instructions before each image. The prompt “View passively” means that you just have to look at the image as you usually would. If you see the prompt “Increase”, try to amplify the intensity of the emotions you are feeling in response to the picture with your thoughts. For example, you can think of how the image may apply to you personally, or someone who is close to you. You can also concentrate on negative aspects in a sad image to increase negative emotions, or positive aspects of a happy image to increase positive emotions. If you see the prompt “Reduce”, try to decrease the intensity of the emotions you are feeling in response to the image. For example, you can take a perspective of a detached observer to feel less positive emotion when viewing a positive image. You can concentrate on positive aspects of a negative image to feel less negative emotion. Remember, the following prompts correspond to the instructions below:

View passively—look at the picture as you normally would.

Increase—think of the picture in a way that enhances the emotions you are feeling.

Reduce—think of the picture in a way that decreases the emotions you are feeling.