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Preserving Integrity in the Face of Performance Threat: Self-Affirmation Enhances Neurophysiological Responsiveness to Errors

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Abstract

Self-affirmation produces large effects: Even a simple reminder of one's core values reduces defensiveness against threatening information. But how, exactly, does self-affirmation work? We explored this question by examining the impact of self-affirmation on neurophysiological responses to threatening events. We hypothesized that because self-affirmation increases openness to threat and enhances approachability of unfavorable feedback, it should augment attention and emotional receptivity to performance errors. We further hypothesized that this augmentation could be assessed directly, at the level of the brain. We measured self-affirmed and nonaffirmed participants' electrophysiological responses to making errors on a task. As we anticipated, self-affirmation elicited greater error responsiveness than did nonaffirmation, as indexed by the error-related negativity, a neural signal of error monitoring. Self-affirmed participants also performed better on the task than did nonaffirmed participants. We offer novel brain evidence that self-affirmation increases openness to threat and discuss the role of error detection in the link between self-affirmation and performance.

Keywords

self-esteem, threat

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Life is seasoned with failure. From the mistakes people make at work or school, to their missteps with friends, or blunders in romantic relationships, people are met with an abundance of information reminding them that they could be better than they are. When confronted with the stark reality of their shortcomings, individuals become motivated to preserve their self-worth. One way they might do so is to underscore alternative sources of their personal value. For instance, when faced with a threat to their athletic competence, they might remind themselves of their intellectual aptitude or strong family ties. This process of preserving self-worth minimizes the anxiety, stress, and defensiveness associated with threats to self-integrity while keeping individuals attuned to the possibility of self-improvement. But how, exactly, is this adaptive response to threat achieved? Although it is well documented that self-affirmation increases openness to threat, very few studies have addressed the basic mechanisms of this effect. In the current research, we examined the direct impact of self-affirmation on the neurophysiological reaction to integrity-threatening events.

Self-Affirmation Theory

Self-affirmation theory (Steele, 1988) proposes that individuals are motivated to protect the perceived integrity and worth of the self (D. K. Sherman & Cohen, 2006; D. K. Sherman & Hartson, 2011). Although self-integrity can vary across cultures, groups, and situations, it generally refers to the sense that one is a moral and socially suitable person (e.g., that one is intelligent, rational, competent, a good parent, a good American). When one's sense of self-goodness in an important life domain is undermined, self-integrity is threatened. Many responses to threats to self-integrity involve defensive psychological alterations aimed at denying, rejecting, or transforming the threat in order to restore self-worth (D. K. Sherman & Cohen, 2002; D. K. Sherman & Hartson, 2011). These defensive reactions might include self-serving attributions (Campbell & Sedikides, 1999), out-group

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derogation (Fein & Spencer, 1997), or overzealous beliefs (McGregor, Nash, & Inzlicht, 2009). However, because the function of defensiveness is to selectively attend to those aspects of a situation or event that support self-esteem and to reject threatening aspects, it distorts one's perception of reality and thereby undermines the ability to learn from the experience.

Of course, not every threatening situation produces biased perception and cognition. Threats to integrity can be managed in an adaptive way that not only promotes accurate responsiveness to threats but also preserves self-worth. Through self-affirmation, individuals can adapt to and learn from stressors, as well as maintain their sense of being competent, good, reliable, and the like. These self-affirmations typically involve the capacity to recall essential aspects of self and identity, which are independent of the threat itself and thereby invulnerable to it. So, whereas defensive behavior directly alters the meaning of threatening information, self-affirmation allows individuals to focus on domains of self-integrity unrelated to the evaluative implications of the immediate threat. By reaffirming integrity in this way, people can anchor their sense of self in their broader view of the self as good, and there is less need to defend against the threat. Rather, they can focus on the demands of the situation, setting aside the need to protect their ego.

Not surprisingly, this strategy affords substantial benefits in various domains. For instance, self-affirmation has been shown to increase the acceptance of threatening health information (Howell & Shepperd, 2012; D. A. K. Sherman, Nelson, & Steele, 2000), augment openness to counterattitudinal views (Cohen, Aronson, & Steele, 2000), reduce the racial achievement gap among African American students (Cohen, Garcia, Apfel, & Master, 2006), improve self-control (Schmeichel & Vohs, 2009), and even reduce the severity of the biological markers of stress (Creswell et al., 2005; D. K. Sherman, Bunyan, Creswell, & Jaremka, 2009). But how are these effects achieved? Although the behavioral outcomes of self-affirmation have been extensively examined, only a few studies have investigated their basic underlying mechanisms. In particular, past work has shown that self-affirmation reduces defensiveness by increasing implicit responsiveness and attentional bias toward self-relevant threat (Klein & Harris, 2009; van Koningsbruggen, Das, & Roskos-Ewoldsen, 2009).

In the study presented here, we aimed to take these cognitive findings a step further by investigating neurophysiological responsiveness to self-threat. We suggest that the attentiveness to threat that characterizes self-affirmation should be reflected in complementary threat awareness at the level of the brain.

Neurophysiological Responding to Self-Integrity Threat

Just as an academic failure can threaten one's identity as a student, the commission of errors on a performance task is likely to induce threat to perceptions of personal efficacy. Indeed, research in affective neuroscience suggests that individuals demonstrate distinct neurophysiological responses to performance errors, which are perceived to be arousing and threatening (Hajcak & Foti, 2008; Hajcak, McDonald, & Simons, 2003).

One of the best known neural correlates of performance error is the error-related negativity (ERN; Gehring, Goss, Coles, Meyer, & Donchin, 1993). The ERN is a pronounced negative deflection on the electroencephalogram (EEG) that occurs within 100 ms of making an error on a task and is thought to be generated by the anterior cingulate cortex (ACC; Dehaene, Posner, & Tucker, 1994). Holroyd and Coles (2002) suggested that the ERN reflects an error-detection system that serves reinforcement learning; when people make errors, dopaminergic neurons in the midbrain that project to the ACC temporarily cease firing, which results in an ERN. According to this view, the ERN reflects a discrepancy between an expected outcome (e.g., a correct response) and an actual outcome (e.g., an incorrect response; see also Yeung, Botvinick, & Cohen, 2004).

Another view of the ERN links it with motivational and affective responses to errors (Inzlicht & Al-Khindi, 2012; Luu, Collins, & Tucker, 2000) and indicates the possibility that it may partially reflect a "distress signal" when performance is worse than expected (Bartholow et al., 2005, p. 41). This perspective suggests that ERN magnitude is associated with the value placed on errors and that increased motivation or task engagement in response to self-regulation failures elicits larger ERNs (Legault & Inzlicht, in press). Despite their differences, both views of the ERN suggest that it signals the monitoring of performance, which serves to increase attention, cognitive control, and readiness for action (Weinberg, Riesel, & Hajcak, in press).

Self-Affirmation and the ERN

Much like the ERN, self-affirmation attunes people to self-relevant threat in the service of promoting adaptive responding. Given that performance errors are a type of self-relevant threat, we expected that self-affirmation should increase emotional responsiveness to performance error, as demonstrated by an increased ERN. Supporting this idea, past work has shown that self-affirmed individuals are more likely to attend to and accept their mistakes and flaws than are defensive individuals (Hodgins et al., 2010; D. K. Sherman & Cohen, 2006). Moreover, because self-affirmation assuages any ego-protective alarm and allows people to attend to the demands of the task at hand, we also expected it would bolster task performance. Conversely, compared with self-affirmed individuals, nonaffirmed individuals are more likely to reject or dismiss personal threat (e.g., D. A. K. Sherman et al., 2000), and such defensiveness is related to the ignoring of personal errors (Hodgins et al., 2010); therefore, we expected that undermining self-affirmation would promote defensiveness and thus reduce error sensitivity. These negative consequences should be evinced by a blunted ERN, as well as reduced performance. Thus, in a novel examination of the neuroaffective underpinnings of self-affirmation, we assessed people's neurophysiological reactions to performance errors in order to test the protective effect of self-affirmation on threat defensiveness at the level of the brain.

Method

Participants

Thirty-eight introductory psychology students at the University of Toronto Scarborough participated for course credit. Three participants were excluded because of equipment malfunction, leaving a final sample of 35 (21 females, 14 males; mean age = 19.4 years, *SD* = 2.2).

Procedure

Participants were randomly assigned to either a self-affirmation or a nonaffirmation condition before completing a self-control task. In the *self-affirmation condition*, they were asked to rank six values (aesthetic, social, political, religious, economic, and theoretical values; Allport, Vernon, & Lindzey, 1960) from most important to least important. They were then given 5 min to write about why their highest-ranked value was important to them. In the *nonaffirmation condition*, participants were similarly asked to rank the six values, but they were then asked to write about why their highest-ranked value was not very important to them. This was done to undermine self-affirmation.[1]

Behavioral task. After the writing task, participants performed a go/no-go task. Stimuli consisted of the letter "M" (the *go* stimulus) and the letter "W" (the *no-go* stimulus). Participants were required to press a button on a box when the go stimulus appeared and to refrain from pressing the button when the no-go stimulus appeared. Each trial consisted of a fixation cross ("+") presented for 500 ms, followed by a go or no-go stimulus presented for 100 ms. The maximum time allowed for a response was 500 ms. The intertrial interval was 50 ms. To increase threat, we gave participants negative visual feedback for 500 ms ("Wrong!") if they committed an error. Participants completed six experimental blocks, each consisting of 40 go trials and 20 no-go trials.

Neurophysiological recording. Continuous EEG was recorded during the go/no-go task using a Lycra cap embedded with 32 tin electrodes. EEG was recorded at a sampling rate of 512 Hz using ASA acquisition software (Advanced Neuro Technology, Enschede, The Netherlands) with average-ear reference and forehead ground. Frequencies were digitally filtered off-line between 0.1 and 15 Hz (fast Fourier transform implemented, 24-dB zero-phase-shift Butterworth filter). The response epoch was defined as the period between 200 ms prior to and 800 ms subsequent to the button press. The EEG signal was baseline-corrected by subtracting the average voltage during the period 400 to 200 ms prior to the button press. Waves that exceeded threshold values of +50 and −50 μV were rejected. Each EEG signal was response-locked, and average waveforms for correct- and incorrect-response trials were created for each participant. These were averaged across participants within conditions to yield grand-average waveforms. The ERN was defined as the minimum deflection occurring at the frontocentral midline electrode FCz between 50 ms before and 150 ms after the key press (Hajcak & Foti, 2008).

Results

Task performance

A 2 (condition: self-affirmation vs. nonaffirmation) × 2 (response type: correct vs. incorrect) mixed-factor analysis of variance (ANOVA) with reaction time as the dependent measure showed that reaction time on incorrect-response trials (*M* = 147.58 ms, *SD* = 35.82) was significantly faster than reaction time on correct-response trials (*M* = 211.26 ms, *SD* = 33.77), $F(1, 33) = 196.01$, $p < .001$, $\eta_p^2 = .83$. The main effect of condition and the Condition × Response Interaction did not reach significance.

A 2 (condition: self-affirmation vs. nonaffirmation) × 2 (error type: commission vs. omission) mixed-factor ANOVA with error rate as the dependent measure revealed that participants in both conditions made significantly more errors of commission (*M* = 9.44%, *SD* = 8.42%) than errors of omission (*M* = 1.25%, *SD* = 1.82%), $F(1, 33) = 49.40$, $p < .001$, $\eta_p^2 = .55$. The Condition × Error Type interaction was significant, $F(1, 33) = 5.15$, $p < .03$, $\eta_p^2 = .11$. That is, participants in the self-affirmation condition made significantly fewer errors of commission (*M* = 6.99%, *SD* = 6.11%) than did those in the nonaffirmation condition (*M* = 12.41%, *SD* = 9.93%), $F(1, 33) = 4.71$, $p < .04$, $\eta_p^2 = .10$. This finding suggests that self-affirmation improved performance. There were no group differences for errors of omission (i.e., the error rates for self-affirmed and nonaffirmed participants were 1.27% and 1.23%, respectively), likely because of a floor effect.

ERN

To examine the effect of self-affirmation on ERN amplitude, we performed a 2 (condition: self-affirmation vs. nonaffirmation) × 2 (response type: incorrect vs. correct) mixed-factor ANOVA with waveform amplitude as the dependent measure. Unsurprisingly, there was a significant main effect of response type on waveform amplitude, $F(1, 33) = 29.30$, $p < .001$, $\eta_p^2 = .47$; errors generated larger ERNs (*M* = −7.13 μV, *SD* = 4.44) than did correct responses (*M* = −3.74 μV, *SD* = 2.60). This main effect, however, was qualified by a significant

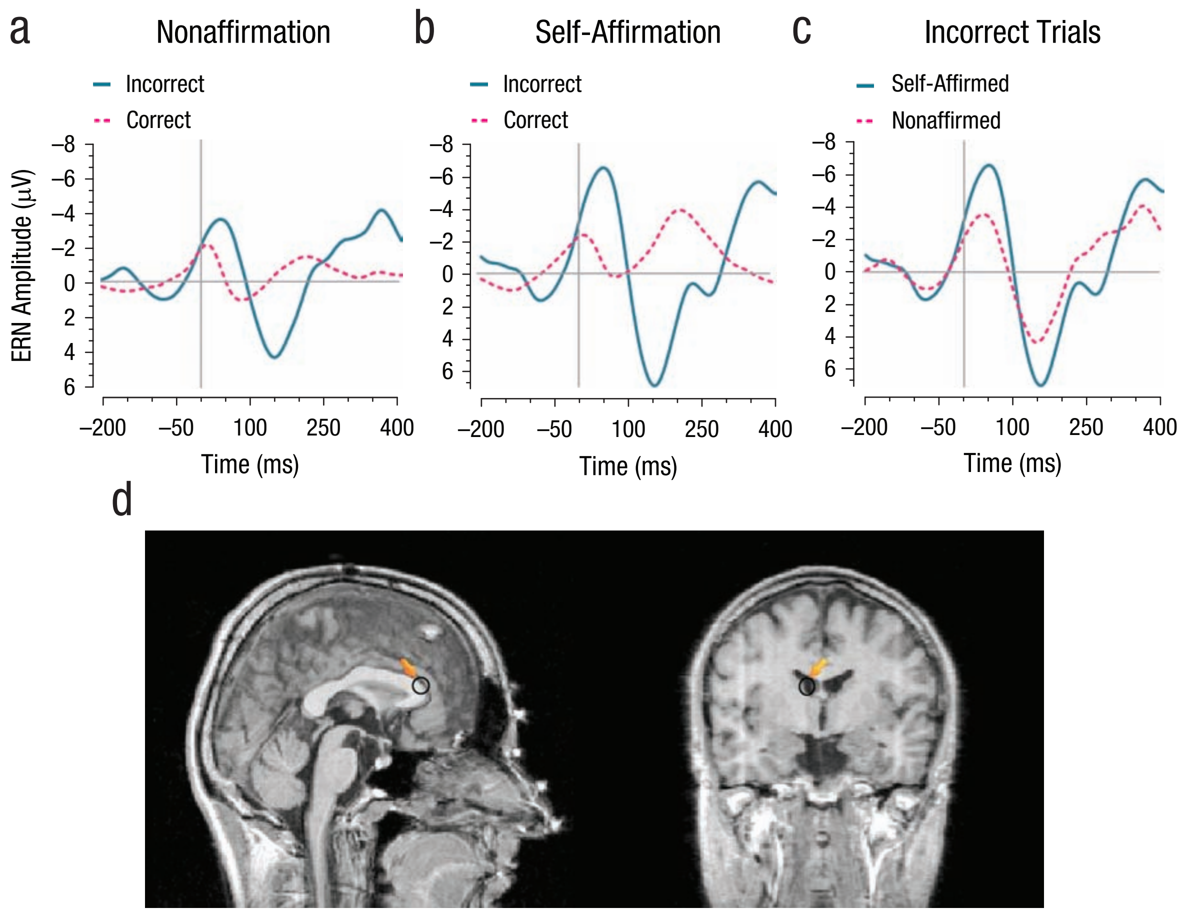

Fig. 1. Error-related negativity (ERN) amplitude and dipole source localization. Response-locked waveform amplitude at FCz following correct and incorrect responses on the go/no-go task is shown separately for participants in the (a) nonaffirmation and (b) self-affirmation conditions. The waveforms in (c) illustrate group differences in ERN amplitude (i.e., waveforms for incorrect-response trials only). The brain maps (d) show the results of dipole source localization, which identified the source of the ERN (indicated by the arrows) as being in an area approximately consistent with the anterior cingulate cortex.

interaction between condition and response type, $F(1, 33) = 7.11$, $p < .01$, $\eta_p^2 = .18$ (see Fig. 1).

Analysis of simple main effects revealed that, although the self-affirmation and nonaffirmation groups showed comparable waveform amplitudes on correct-response trials ($M = -4.06$ µV, $SD = 2.66$, and $M = -3.40$ µV, $SD = 2.57$, respectively; see Figs. 1a and 1b), self-affirmed participants displayed significantly higher waveform amplitude on incorrect-response trials ($M = -9.05$ µV, $SD = 5.23$) than did nonaffirmed participants ($M = -5.10$ µV, $SD = 2.09$), $F(1, 33) = 8.44$, $p < .01$, $\eta_p^2 = .20$; see Figures 1a, 1b, and 1c. Furthermore, this simple effect remained significant after controlling for rates of commission errors and omission errors and for reaction time, $F(1, 30) = 7.71$, $p < .01$, $\eta_p^2 = .20$. This suggests that self-affirmation enhanced the ERN, independently of any cognitive effect.

Dipole source localization (Fig. 1d) confirmed that the ERNs were generated in an area approximately consistent with the ACC. Pre-auricular-nasion coordinates of this area were as follows: $x = 0.1$ mm, $y = 0.1$ mm, $z = 60.0$ mm; dipole strength was 86.58 nAm. This source accounted for 86.6% of the variance of the signal.

Correlations between the ERN and performance

When we assessed the association between the two dependent variables, an interesting dissociation between self-affirmed and nonaffirmed participants emerged. That is, there was a stronger (negative) association between the ERN and performance (i.e., error rate) for the self-affirmed participants, $r(18) = .46$, $p = .06$, than for the nonaffirmed participants, $r(17) = .21$, $p = .40$. This finding suggests that self-affirmation enhanced ERN amplitude, which was related to task performance. Presumably, the increased receptivity to errors among affirmed individuals allowed them to better correct for their mistakes. In sum, our findings suggest that self-affirmation increased error responsiveness, including error-related distress, which allowed for adaptive adjustment in self-control.

Discussion

Our results reveal that self-affirmation improves performance and increases neuroaffective sensitivity to task errors. When people assert their core values, thereby affirming who they are, they become more emotionally responsive to lapses in performance and thus more receptive to the demands of the task at hand. In line with self-affirmation theory, this finding suggests that construal of the self in terms of one's broad values and self-concept reduces defensiveness against immediate threats to self-integrity (in this case, the commission of errors) and allows one to respond openly to the situation.

Our data are the first to indicate a direct neurophysiological link between self-affirmation and error monitoring. This finding complements and extends past work. Whereas van Koningsbruggen et al. (2009) showed that self-affirmation heightens implicit responsiveness to threat, we have provided direct neural evidence of this association by identifying a brain-mediated mechanism through which self-affirmation alerts people to the reality of self-relevant threats (i.e., their own errors). Following the recent finding that self-affirmation increases attentional bias toward threat (Klein & Harris, 2009), we suggest that such threat awareness improves functioning—including task performance—by boosting attention to sources of threat in order to inform future behavior. Self-affirmation, in other words, improves cognitive control because it orients people to their errors, thereby allowing them to improve their subsequent performance.

By revealing self-affirmation's neuroaffective impact, we have provided a possible explanation for its various positive effects. For instance, self-affirmation not only boosts performance in threatened domains (e.g., Martens, Johns, Greenberg, & Schimel, 2006) but also offsets the ill effects of depletion and boosts self-control (Schmeichel & Vohs, 2009). Given that depletion has been shown to lower the ERN (Inzlicht & Gutsell, 2007), our data complement and extend this past work by showing that self-affirmation may protect against depletion because it increases automatic detection of, and sensitivity to, errors. Moreover, in light of a recently observed link between intrinsic motivational engagement and error detection (Legault & Inzlicht, in press), we suggest the possibility that, by putting people in sync with that which is personally significant and meaningful, self-affirmation reduces defensiveness and energizes motivational engagement (thus mobilizing self-regulatory resources).

Finally, given the association between the ERN and negative affect (Inzlicht & Al-Khindi, 2012), the current results suggest that self-affirmation increases error-related distress. Although this might seem paradoxical at first, our data suggest that the type of negative affect fostered by self-affirmation is adaptive; that is, it orients people to their failings and thereby helps them improve. Indeed, when individuals are faced with negative or distressing personal information, self-affirmation seems to promote awareness and approach, rather than minimization and defense.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Note

1. Evidence from our lab (e.g., Al-Khindi, 2010) indicates that the error monitoring of participants given the type of nonaffirmation manipulation we used here does not differ from the error monitoring of true control participants who are not exposed to any affirmation or nonaffirmation information prior to EEG recording.

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