International Journal of Psychophysiology 80 (2011) 166–170

Contents lists available at ScienceDirect

International Journal of Psychophysiology

journal homepage: www.elsevier.com/locate/ijpsycho

Short Communication

Emotional reactivity in nonsuicidal self-injury: Divergence between self-report and startle measures

Catherine R. Glenn [a,*], Terry D. Blumenthal [b], E. David Klonsky [c], Greg Hajcak [a]

[a] Department of Psychology, Stony Brook University, United States
[b] Department of Psychology, Wake Forest University, United States
[c] Department of Psychology, University of British Columbia, Canada

ARTICLE INFO

Article history:
Received 13 September 2010
Received in revised form 2 February 2011
Accepted 26 February 2011
Available online 3 March 2011

Keywords:
Nonsuicidal self-injury
Deliberate self-harm
Emotional reactivity
Startle reflex
Affective modulation

ABSTRACT

The current study examined emotional reactivity in nonsuicidal self-injurers and noninjuring controls using self-report (the Emotional Reactivity Scale: ERS) and psychophysiological measures (the startle reflex was measured during and after the presentation of IAPS images). Self-injurers reported greater emotional reactivity on the ERS, but did not exhibit differences in startle modulation during or after picture viewing compared to controls. Results suggest a divergence between self-report and psychophysiological measures of emotion in NSSI.

1. Introduction

Nonsuicidal self-injury (NSSI; e.g., skin-cutting and burning) refers to the deliberate injury of body tissue without suicidal intent (Klonsky and Glenn, 2009; Whitlock et al., 2006). NSSI has become a significant public health problem occurring in up to 14–15% of adolescents (Ross and Heath, 2002) and 17% of college students (Whitlock et al., 2006). Although NSSI can serve multiple purposes, it most often functions to reduce negative emotional experience (Klonsky, 2007): intense negative emotional states appear to precede engagement in NSSI (Nock et al., 2009), and decreases in negative affect following NSSI predict lifetime frequency of the behavior (Klonsky, 2007). Given that NSSI most often serves an emotion regulation function, it is not surprising that individuals who self-injure report more frequent and intense emotions (Klonsky et al., 2003; Nock et al., 2008), and greater difficulty dealing with unpleasant emotions (Gratz and Roemer, 2008; Heath et al., 2008; Nock, 2009).

Despite the mounting evidence of heightened negative emotionality in NSSI, most studies have not assessed physiological measures sensitive to emotion, or the convergence between multiple measures of emotion in NSSI. One study found that self-injurers are characterized by increased skin conductance compared to noninjurers during stressful tasks (Nock and Mendes, 2008). However, skin conductance measures arousal but does not distinguish between pleasant and unpleasant emotional states. Given the prominent role of negative emotionality in NSSI, this work might be supplemented by biological markers of emotional processing that are sensitive to negative valence.

In addition, it is important to consider how an emotional response may vary over time. Davidson (1998) articulated multiple aspects of emotional responding (i.e., affective chronometry) which could be abnormal among individuals who engage in NSSI. Specifically, the current study focuses on the possibility that individuals who engage in NSSI may differ in terms of reactivity (i.e., the magnitude of response to an emotional stimulus) and/or delayed recovery (i.e., less reduction in reactivity following an emotional challenge). Understanding whether individuals who engage in NSSI are characterized by heightened reactivity or delayed recovery, or both, may help explain the intense negative emotionality reported by those who self-injure.

The current study evaluated these aspects of affective chronometry in NSSI using a multimethod approach. First, we utilized a self-report instrument that assesses multiple aspects of emotionality: the Emotional Reactivity Scale (ERS; Nock et al., 2008). The ERS is a validated self-report measure of emotional reactivity that has been found to mediate the relationship between psychopathology and self-injurious thoughts and behaviors (Nock et al., 2008).

Second, we examined emotionality in NSSI using a psychophysiological measure that is sensitive to emotional valence, and has been used extensively to measure emotional processing in relation to psychopathologies characterized by negative emotionality (see reviews: Grillon and Baas, 2003; Vaidyanathan et al., 2009): the defensive startle reflex. In humans, the startle reflex is most often measured by the

* Corresponding author at: Department of Psychology, Stony Brook University, Stony Brook, New York, 11794-2500, United States. Tel.: +1 757 536 0333; fax: +1 631 632 7876.
E-mail address: cassie.glenn@gmail.com (C.R. Glenn).

0167-8760/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpsycho.2011.02.016

eyeblink response, an initial and rapid protective behavior. The startle reflex is largest when individuals are viewing unpleasant stimuli and smallest when viewing pleasant stimuli (Bradley et al., 1990; Vrana et al., 1988).

Moreover, studies have assessed startle responding both during and after picture presentation (i.e., in the postpicture period). Although some studies suggest little to no affective modulation of startle following picture offset (Bradley et al., 1993; Dichter et al., 2002), Schupp et al. (1997) found a significant, yet weaker, affective modulation pattern after picture offset (also see Dillon and LaBar, 2005). Jackson et al. (2003) suggest that less startle potentiation after aversive picture offset may indicate greater emotional recovery and automatic return to baseline.

The current study utilized a multimethod approach to study emotional reactivity in NSSI, including a self-report instrument of emotional reactivity and a startle paradigm, similar to Jackson et al. (2003; also see Larson et al., 2007), to examine defensive reactivity during and after picture viewing. A young adult sample is particularly relevant because rates of NSSI are disproportionately high in this population (Whitlock et al., 2006). Based on existing research indicating increased negative emotionality in NSSI (Gratz and Roemer, 2008; Heath et al., 2008; Nock and Mendes, 2008), we hypothesized that self-injurers would report greater emotional reactivity on the ERS and would exhibit greater emotional reactivity during unpleasant picture viewing, and would maintain this greater startle potentiation in the postpicture period compared to controls.

2. Methods

2.1. Participants

Participants were 78 young adults from a college population: 41 self-injurers (73.2% female; M age = 19.98 years, SD = 1.99; 51.2% Caucasian) and 37 noninjuring controls (62.2% female; M age = 19.56 years, SD = 1.69; 56.8% Caucasian). The self-injuring sample was recruited from a larger study on NSSI (for initial recruitment, demographic, and clinical details, see Glenn and Klonsky, 2010). Approximately 63% of the self-injuring sample engaged in some form of NSSI during the previous 12 months, and half had engaged in two or more NSSI methods. The most common behaviors (assessed with the ISAS; see Self-report measures section) were banging/hitting self (performed by 46.9% of the sample, M frequency = 18.67, SD = 38.28, *Range* 1 to 150), and cutting (performed by 43.8% of the sample, M frequency = 12.36, SD = 15.87, *Range* 1 to 59). The most common NSSI functions were affect regulation (endorsed by 95.1% of self-injurers, M = 1.85, SD = .85), interpersonal boundaries (endorsed by 92.7%, M = 2.05, SD = 1.24), and self-punishment (endorsed by 90.2%, M = 2.49, SD = 1.27).

2.2. Stimuli and presentation

Participants viewed 54 images (18 unpleasant, 18 neutral, and 18 pleasant) from the International Affective Picture System (IAPS; Lang et al., 2005).[1] IAPS images were randomly presented for 8 s, in color on a 19-inch monitor set to a resolution of 1024 × 768 pixels, using PSYLAB 8 software (Contact Precision Instruments; Cambridge, MA). Stimuli viewing distance was 25 in. and each stimulus occupied approximately 27° of visual angle vertically and 33° of visual angle horizontally. Auditory startle probes, consisting of 50 ms, 105 dB bursts of white noise with near instantaneous rise time, were presented binaurally through headphones. Startle probes were produced with a noise/tone generator (Contact Precision Instruments; Cambridge, MA).

2.3. Self-report measures

The frequency and functions of nonsuicidal self-injury (NSSI) were measured using the Inventory of Statements about Self-Injury (ISAS), a reliable and valid measure of NSSI (Klonsky and Glenn, 2009; Klonsky and Olino, 2008). The ISAS measures the frequency of 12 NSSI behaviors (e.g., cutting and burning), as well as 13 functions of NSSI (e.g., affect regulation and peer bonding). In addition, a brief structured interview was used to confirm a history of NSSI.

Self-reported emotional reactivity was measured using the Emotional Reactivity Scale (ERS; Nock et al., 2008), which contains 21 items that assess three areas of emotional reactivity: emotional *sensitivity* (e.g., "I tend to get emotional very easily"; 8 items: total scale 0–32), emotional *arousal/intensity* (e.g., "I experience emotions very strongly"; 10 items: total scale 0–40), and emotional *persistence* (e.g., "When I am angry/upset, it takes me longer than most people to calm down"; 3 items: total scale 0–12).

Participants provided valence and arousal ratings of the IAPS pictures, after the startle task, using the Self-Assessment Manikin (SAM; Lang, 1980): (a) valence — rated from 1 = *extremely pleasant* to 9 = *extremely unpleasant*, and (b) arousal — rated from 1 = *extremely aroused* to 9 = *extremely calm.*

2.4. Procedure

All participants were tested individually in a sound-attenuated enclosure. An initial 4-trial habituation phase was used to reduce extreme startle responses from the first few trials. During the actual experiment, startle probes were presented randomly either during (6 pleasant, 6 neutral, and 6 unpleasant) or after (6 pleasant, 6 neutral, and 6 unpleasant) picture presentation; to decrease startle predictability, no startle probes were presented on the other 18 trials. Intertrial intervals ranged from 12 to 14 s; there were no specific instructions for the intertrial intervals.

Startle probes during picture presentation (used to quantify reactivity) were presented randomly between 4 and 6 s after picture onset in order to approximate peak startle magnitude based on work by Bradley et al. (1993). Based on previous studies, startle probes were presented randomly between 4 and 6 s after picture offset to measure recovery (Bradley et al., 1993; Dillon and LaBar, 2005; Schupp et al., 1997). IAPS images were grouped into 6 blocks of 9 images, so that each block included 3 images from each picture category and from each startle timing category. Following the startle task, participants completed the self-report measures.

2.5. Physiological data recording, reduction, and analysis

Startle-elicited EMG activity was recorded using a PSYLAB Stand Alone Monitor (SAM) Unit and an attached BioAmplifier system (Contact Precision Instruments; Cambridge, MA). Consistent with startle guidelines (see Blumenthal et al., 2005), two electrodes, 4 mm diameter Ag–AgCl filled with electrode gel (TD-40; Mansfield R & D), were positioned beneath the left eye over the orbicularis oculi muscle approximately 25 mm apart. A third electrode was placed on the forehead to serve as an isolated ground. EMG activity was sampled at 1000 Hz and filtered between 30 and 500 Hz. EMG responses were rectified in a window 200 ms wide, beginning 50 ms before the onset of the startle probe. To smooth out sharp peaks, a 6-point running average was applied to the rectified data. Startle amplitude was expressed as the difference between the average of the EMG data in the 50 ms window prior to the startle probe and the maximum in the 150 ms post-probe window. Data for each participant was then examined on each trial. Trials where the baseline included excessive

[1] The following images were selected from the International Affective Picture System (IAPS; Lang et al., 2005): pleasant — 1463, 1710, 1811, 2070, 2080, 2092, 2165, 2311, 2340, 4180, 4460, 4651, 4659, 4660, 4669, 4810, 7325, and 8461; neutral — 2320, 2570, 2580, 2870, 5390, 5410, 5532, 5534, 5731, 7009, 7010, 7025, 7041, 7140, 7175, 7224, 7235, and 7550; and unpleasant — 1050, 1300, 3261, 3500, 3530, 6230, 6250, 6313, 6510, 6560, 6571, 9250, 9253, 9400, 9405, 9410, 9420, and 9433.

Table 1
Mean startle magnitude (μV) for the self-injuring and noninjuring control groups during and after picture presentation.

	Startle during picture presentation			Startle after picture presentation		
	M (*SEM*)			*M* (*SEM*)		
	Pleasant	Neutral	Unpleasant	Pleasant	Neutral	Unpleasant
Self-injury	37.62 (3.93)	41.55 (3.84)	44.78 (3.76)	41.37 (3.95)	43.93 (3.98)	43.56 (3.93)
Control	41.72 (3.63)	45.19 (3.94)	47.21 (3.42)	44.86 (3.88)	45.67 (4.00)	46.49 (3.99)

artifacts were excluded; trials where there was no perceptible eyeblink response were scored as zeros and included in the overall averages. For each participant, startle magnitudes were examined both in terms of raw data, and were also converted to T-scores to reduce between-subject variability (i.e., reducing the influence of outliers). Group analyses were statistically evaluated through repeated measures ANOVA with the Greenhouse–Geisser correction applied. Effects of NSSI were examined using a 2 (group: self-injurers, controls) × 2 (startle timing: during, after) × 3 (picture type: pleasant, neutral, and unpleasant) mixed model repeated measures ANOVA. Significant interactions and main effects were followed by post hoc comparisons as appropriate.

3. Results

3.1. Self-report emotional reactivity

On the Emotional Reactivity Scale, self-injurers reported significantly greater emotional *sensitivity* (M [SD] = 16.48 [9.73] vs. M [SD] = 10.09 [9.22]; t[76] = 2.97, p = .004), *arousal/intensity* (M [SD] = 12.44 [6.11] vs. M [SD] = 7.86 [6.27]; t[76] = 3.26, p = .002), and emotional *persistence* (M [SD] = 6.71 [4.20] vs. M [SD] = 4.03 [3.55]; t[76] = 3.04, p = .003) compared to noninjuring controls.

3.2. Valence and arousal ratings

Participants rated pleasant images as more positively valenced than both neutral (t[77] = 11.96, p < .001) and unpleasant images (t[77] = 24.26, p < .001), and unpleasant images as more negatively valenced than neutral images (t[77] = 25.22, p < .001). Both pleasant and unpleasant images were rated higher in arousal than neutral images (t[77] = 18.81, p < .001 and t[77] = 19.99, p < .001, respectively). In addition, unpleasant images were rated higher in arousal than pleasant images (t[77] = 8.14, p < .001). There were no differences between self-injurers and controls on valence or arousal ratings for any of the picture types (ps ranged from .51 to .90).

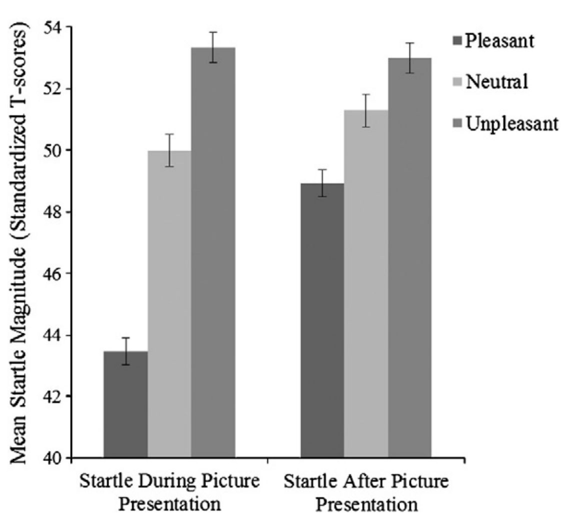

Fig. 1. Mean startle magnitude (standardized T-scores) during picture presentation and after picture presentation collapsing across self-injuring and control groups. Error bars indicate standard errors of means.

3.3. Startle results

Raw data was used to make between-groups comparisons. Startle magnitude did not differ overall between the self-injuring and noninjuring groups (F[1, 76] < 1). In addition, all 2- and 3-way interactions involving group did not reach significance (all Fs < 1).[2] In order to illustrate the main study findings, Table 1 displays the mean startle magnitude (μV) for the self-injurers and controls during and after picture presentation.

Since there were no between-groups differences, T-scored data was used to further examine within-subject effects of picture type and startle probe delay collapsing across the self-injuring and noninjuring groups (see Fig. 1). In the overall sample, startle magnitude was larger after picture presentation than during (F[1, 76] = 6.14, p = .015), and varied as a function of picture type (F[2, 76] = 20.57, p < .001); however, this was qualified by a significant interaction between picture type and startle timing (F[2, 76] = 4.10, p = .019). The significant startle timing X picture type interaction was followed by two one-way ANOVA examining the effect of picture type both during and after picture presentation.

Startle varied during picture presentation (F[2, 76] = 21.97, p < .001), and paired-samples t-tests confirmed that startle was attenuated during pleasant images compared to both neutral (t[77] = 4.28, p < .001) and unpleasant images (t[77] = 7.58, p < .001). In addition, startle was larger during unpleasant than neutral images (t[77] = 2.02, p = .047). Following picture presentation, startle again varied as a function of picture type (F[2, 76] = 3.52, p = .033). In the postpicture period, startle magnitude following unpleasant images was larger than that following pleasant images (t[77] = 2.92, p = .005). However, startle magnitude did not differ following pleasant and neutral images (t[77] = 1.58, p = .119), or following unpleasant and neutral images (t[77] = 1.04, p = .300).

To further examine differences during and after picture presentation, startle magnitude was compared between the picture viewing and postpicture periods for each picture type. Startle magnitude was comparable during and following unpleasant pictures (t[77] = .24, p = .824) and neutral pictures (t[77] = .83, p = .409). However, for pleasant pictures, startle magnitude was larger in the postpicture than during picture viewing (t[77] = 3.97, p < .001). These findings indicate that startle magnitude in response to both unpleasant and neutral pictures was equivalent during picture viewing and in the postpicture period; however, startle magnitude increased from the picture to postpicture period when there was no longer an appetitive foreground stimulus.[3]

[2] There were no differences in startle magnitude between past (i.e., no NSSI in previous 12 months) and current self-injurers (i.e., NSSI in the previous 12 months).

[3] Consistent with Nock et al. (2008), the ERS subscales were highly correlated (all rs above .78); therefore, only the total ERS scale was used in the following analyses. The total ERS scale was negatively associated with startle potentiation following unpleasant (compared to neutral) pictures (r = −.24, p = .035). That is, greater self-reported emotional reactivity was related to less potentiation following unpleasant images. All remaining correlations between the ERS and startle responding did not reach statistical significance (all ps > .05).

4. Discussion

The current study sought to examine emotional reactivity in nonsuicidal self-injury (NSSI) using self-report and psychophysiological measures of emotion. Self-report findings from the present study are consistent with previous research suggesting that individuals who engage in NSSI experience more negative emotionality and greater interference from this emotional distress than noninjuring controls (Gratz and Roemer, 2008; Heath et al., 2008). However, although self-injurers reported greater emotional reactivity, there were no differences in the affective modulation of startle during emotional picture viewing (assessing emotional reactivity) or after emotional picture offset (assessing emotional recovery) between self-injurers and noninjuring controls. The null startle results and divergence between self-report and psychophysiological measures of emotion are surprising given the robust self-report findings from this and previous studies on NSSI.

Although the startle findings do not support previous research on emotional abnormalities in NSSI, results do mirror previous null findings in startle responding in borderline personality disorder (BPD), a disorder closely associated with NSSI. A few studies have failed to find differences between patients with BPD and controls in baseline startle, prepulse inhibition of startle (Herpertz et al., 2000), and affective modulation of startle (Herpertz and Koetting, 2005). Both NSSI and BPD share features of increased negative emotionality and difficulty with emotion regulation (Clarkin and Posner, 2005; Klonsky et al., 2003). Thus, the failure in this and other studies to document emotional abnormalities in these conditions using peripheral psychophysiological measures is somewhat perplexing.

Despite the lack of group differences, findings from this study indicate that, across participants, affective modulation of startle was maintained, albeit weaker, after picture offset. These findings are in line with some previous research examining affective modulation of startle in the postpicture period (Dillon and LaBar, 2005; Schupp et al., 1997). However, previous studies have only reported affective modulation of startle in the postpicture period when participants were instructed to imagine the picture or to enhance their emotional experience. The current results, on the other hand, suggest that affective modulation of startle is evident after picture offset without direct instruction. Moreover, potentiation to aversive stimuli was comparable between the picture viewing and postpicture periods, whereas attenuation to appetitive stimuli was reduced in the postpicture period. These findings support the notion of a negativity bias in emotional recovery, or greater sensitivity to negative than positive stimuli in the postpicture period (Ito et al., 1998); however, the appetitive stimuli used in the current study were rated as less arousing than the aversive stimuli so these findings should be interpreted with caution. Collectively, the current results provide support for the notion that the startle reflex can be used to measure both emotional reactivity to, and recovery following, emotional stimuli.

This study is the first to examine affective modulation of startle in NSSI and contributes to the growing literatures on emotion in NSSI as well as affective modulation of the startle reflex in the postpicture period. However, several important limitations deserve comment. First, findings suggest that the two components of emotional processing explored in the present study may not tap into emotionality differences central to NSSI. For instance, it is possible that reactivity to and initial recovery from an emotional challenge are equivalent in self-injurers and noninjurers. However, this interpretation seems unlikely given the robust self-report evidence to the contrary. Another possibility is that the standardized emotional images used in this study were not comparable to real-world emotional stimuli and therefore failed to elicit the emotion dysregulation in NSSI that occurs outside the laboratory. Perhaps more idiographic stimuli, such as negative feedback or other personally relevant information, would be useful for examining emotion regulation difficulties in NSSI. In addition, it may be possible that reactivity and recovery differences in NSSI may only emerge during a heightened emotional state (e.g., frustration). For instance, perhaps self-injurers would show differences in startle reactivity or recovery if a mood induction preceded the picture viewing task. Second, the sample was comprised of college student self-injurers; future research should examine affective modulation of startle in younger participants since NSSI often begins in early adolescence, and in self-injurers from clinical contexts who might exhibit more severe emotional problems. Third, the pleasant images were not rated as arousing as the unpleasant images. Although the postpicture startle pattern was not attributable to these arousal differences, future studies should make efforts to balance image arousal ratings. Finally, as mentioned above, participants were not given specific instructions during the postpicture period; therefore it is not clear what strategies participants may have been using to maintain or modulate their emotional experience after picture offset.

Acknowledgements

This study was supported in part by the Office of the Vice President for Research at Stony Brook University, and an NIH grant (MH08009601) awarded to E. David Klonsky, and a Psi Chi Graduate Research Grant and an NIH NRSA Predoctoral Fellowship Award to Catherine R. Glenn (F31-MH086197).

References

Blumenthal, T.D., Cuthbert, B.N., Filion, D.L., Hackley, S., Lipp, O.V., Van Boxtel, A., 2005. Committee report: guidelines for human startle eyeblink electromyographic studies. Psychophysiology 42, 1–15.
Bradley, M.M., Cuthbert, B.N., Lang, P.J., 1990. Startle reflex modification: emotion or attention? Psychophysiology 27, 513–522.
Bradley, M.M., Cuthbert, B.N., Lang, P.J., 1993. Pictures as prepulse: attention and emotion in startle modification. Psychophysiology 30, 541–545.
Clarkin, J.F., Posner, M., 2005. Defining the mechanisms of borderline personality disorder. Psychopathology 38, 56–63.
Davidson, R.J., 1998. Affective style and affective disorders: perspectives from affective neuroscience. Cogn. Emotion 12, 307–330.
Dichter, G.S., Tomarken, A.J., Baucom, B.R., 2002. Startle modulation before, during, and after exposure to emotional stimuli. Int. J. Psychophysiol. 43, 191–196.
Dillon, D.G., LaBar, K.S., 2005. Startle modulation during conscious emotion regulation is arousal-dependent. Behav. Neurosci. 119, 1118–1124.
Glenn, C.R., Klonsky, E.D., 2010. A multimethod analysis of impulsivity in non-suicidal self-injury. Pers. Disord. Theory Res. Treat. 1, 67–75.
Gratz, K.L., Roemer, L., 2008. The relationship between emotion dysregulation and deliberate self-harm among female undergraduate students at an urban commuter university. Cogn. Behav. Ther. 37, 14–25.
Grillon, C., Baas, J., 2003. A review of the modulation of the startle reflex by affective states and its application in psychiatry. Clin. Neurophysiol. 114, 1557–1579.
Heath, N.L., Toste, J.R., Nedecheva, T., Charlebois, A., 2008. An examination of nonsuicidal self-injury among college students. J. Ment. Health Couns. 30, 137–156.
Herpertz, S.C., Koetting, K., 2005. Startle response in inpatients with borderline personality disorder vs. healthy controls. J. Neural Transm. 112, 1097–1106.
Herpertz, S.C., Schwenger, U.B., Kunert, H.J., Lukas, G., Gretzer, U., Nutzmann, J., Schuerkens, A., Sass, H., 2000. Emotional responses in patients with borderline as compared with avoidant personality disorder. J. Pers. Disord. 14, 339–351.
Ito, T.A., Larsen, J.T., Smith, N.K., Cacioppo, J.T., 1998. Negative information weighs more heavily on the brain: the negativity bias in evaluative categorizations. J. Pers. Soc. Psychol. 75, 887–900.
Jackson, D.C., Mueller, C.J., Dolski, I., Dalton, K.M., Nitschke, J.B., Urry, H.L., Rosenkranz, M.A., Ryff, C.D., Singer, B.H., Davidson, R.J., 2003. Now you feel it, now you don't: frontal brain electrical asymmetry and individual differences in emotion regulation. Psychol. Sci. 14, 612–617.
Klonsky, E.D., 2007. The functions of deliberate self-injury: a review of the evidence. Clin. Psychol. Rev. 27, 226–239.
Klonsky, E.D., Glenn, C.R., 2009. Assessing the functions of non-suicidal self-injury: psychometric properties of the Inventory of Statements about Self-Injury (ISAS). J. Psychopathol. Behav. Assess. 31, 215–219.
Klonsky, E.D., Olino, T.M., 2008. Identifying clinically distinct subgroups of self-injurers among young adults: a latent class analysis. J. Consult. Clin. Psychol. 76, 22–27.
Klonsky, E.D., Oltmanns, T.F., Turkheimer, E., 2003. Deliberate self-harm in a nonclinical population: prevalence and psychological correlates. Am. J. Psychiatry 160, 1501–1508.
Lang, P.J., 1980. Behavioral treatment and bio-behavioral assessment: computer applications. In: Sidowski, J.B., Johnson, J.H., Williams, T.A. (Eds.), Technology in Mental Health Care Delivery Systems. Ablex, Norwood, NJ, pp. 119–137.
Lang, P.J., Bradley, M.M., Cuthbert, B.N., 2005. International affective picture system (IAPS): instruction manual and affective ratings. Technical Report A-6. The Center for Research in Psychophysiology, University of Florida.
Larson, C.L., Nitschke, J.B., Davidson, R.J., 2007. Common and distinct patterns of affective response in dimensions of anxiety and depression. Emotion 7, 182–191.

Nock, M.K., 2009. Why do people hurt themselves? New insights into the nature and function of self-injury. Curr. Dir. Psychol. Sci. 18, 78–83.
Nock, M.K., Mendes, W.B., 2008. Physiological arousal, distress tolerance, and social problem-solving deficits among adolescent self-injurers. J. Consult. Clin. Psychol. 76, 28–38.
Nock, M.K., Wedig, M.M., Holmberg, E.B., Hooley, J.M., 2008. The emotion reactivity scale: development, evaluation, and relation to self-injurious thoughts and behaviors. Behav. Ther. 39, 107–116.
Nock, M.K., Prinstein, M.J., Sterba, S.K., 2009. Revealing the form and function of self-injurious thoughts and behaviors: a real-time ecological assessment study among adolescents and young adults. J. Abnorm. Psychol. 118, 816–827.
Ross, S., Heath, N., 2002. A study of the frequency of self-mutilation in a community sample of adolescents. J. Youth Adolesc. 31, 67–77.
Schupp, H.T., Cuthbert, B.N., Bradley, M.M., Birbaumer, N., Lang, P.J., 1997. Probe P3 and blinks: two measures of affective startle modulation. Psychophysiology 34, 1–6.
Vaidyanathan, U., Patrick, C.J., Cuthbert, B.N., 2009. Linking dimensional models of internalizing psychopathology to neurobiological systems: affect-modulated startle as an indicator of fear and distress disorders and affiliated traits. Psychol. Bull. 135, 909–942.
Vrana, S.R., Spence, E.L., Lang, P.J., 1988. The startle probe response: a new measure of emotion? J. Abnorm. Psychol. 97, 487–491.
Whitlock, J., Eckenrode, J., Silverman, D., 2006. Self-injurious behaviors in a college population. Pediatrics 117, 1939–1948.