Executive Functions and Social Cognition in Highly Lethal Self-Injuring Patients With Borderline Personality Disorder
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CITATION
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Risk for potentially lethal self-injurious behavior in borderline personality disorder (BPD) may be associated with deficits in neuropsychological functions and social cognition. In particular, individuals with BPD engaging in more medically damaging self-injurious behaviors may have more severe executive function deficits and altered emotion perception as compared to patients engaging in less lethal acts. In the current study, 58 patients with BPD reporting a lifetime history of self-injurious behavior were administered neuropsychological measures of response inhibition, planning and problem-solving, and tests of facial emotion recognition and discrimination. Patients who engaged in more medically lethal self-injurious behaviors reported engaging in impulsive behaviors more frequently and displayed neuropsychological deficits in problem-solving and response inhibition. They were also less accurate in recognizing happy facial expressions and in discerning subtle differences in emotional intensity in sad facial expressions. These findings suggest that patients with BPD that engage in more physically damaging self-injurious behaviors may have greater difficulties with behavioral control and employ less efficient problem-solving strategies. Problems in facial emotion recognition and discrimination may contribute to interpersonal difficulties in patients with BPD who self-injure.

Keywords: borderline personality disorder, suicide, self-injury, execution function, social cognition

Self-injurious behavior, defined as deliberate physical harm to the self with or without suicidal intent, is a common feature of borderline personality disorder (BPD). Compared to the general population, individuals with BPD are 50 times more likely to complete suicide (Pompili, Girardi, Ruberto, & Tarelli, 2005), with rates of suicide completion in this patient group as high as 10% (Paris & Zweig-Frank, 2001). Self-injurious behavior is one of the strongest predictors of future suicide completion (Hamza, Stewart, & Willoughby, 2012), and while it is common to distinguish between self-injury with or without the intent to die (Hamza & Willoughby, 2013), research does not support a strong correspondence between the intent of self-injurious behavior and the physical damage resulting from the act (Hasley et al., 2008; Saptya et al., 2012). The medical lethality of self-injurious behavior can be assessed along a continuum ranging from minimal or no physical damage up to death (Beck, Beck, & Kovacs, 1975). Individuals with BPD that engage in more lethal self-injurious behaviors are more advanced in age, report more frequent suicide attempts, and describe themselves as more impulsive, aggressive, and sensitive to rejection (Soloff, Lis, Kelly, Cornelius, & Ulrich, 1994a; Soloff, White, & Diwadkar, 2014).

Whereas research on self-injury in individuals with BPD has focused almost exclusively on personality characteristics and comorbid psychiatric disorders, little research has examined potential cognitive vulnerabilities that may be associated with more lethal self-injurious behaviors. In patients with BPD, neuropsychological studies reveal a generalized cognitive deficit impacting multiple cognitive domains, although executive functions (i.e., higher-order cognitive abilities) such as response inhibition, planning, and problem-solving, appear to be the most significantly affected (for a review, see Ruocco, 2005).
Deficits in executive functioning and psychomotor speed have also been associated more broadly with suicidal behavior in other psychiatric groups (LeGris & van Reekum, 2006). Depressed patients with current suicidal ideation have been shown to have greater difficulties on measures of cognitive flexibility than patients without current suicidal ideation (Marzuk, Hartwell, Leon, & Portera, 2005). Several studies have also reported a range of executive function deficits in patients with a history of suicide attempt, including verbal fluency, working memory, risky decision-making, and response inhibition (Jollant et al., 2005; Raust et al., 2007; Richard-Devantoy, Berlin, & Jollant, 2014). Similarly, individuals engaging in nonsuicidal self-injury have demonstrated poorer response inhibition and working memory as compared to controls (Fikke, Melinder, & Landro, 2011; Franklin et al., 2010).

Only one study has evaluated the relationship of cognitive functioning to suicidal behavior in patients with BPD. LeGris, Links, van Reekum, Tannock, and Toplak (2012) administered neuropsychological tests of response inhibition, working memory, and risky decision-making to 42 women with BPD and found that only a measure of response inhibition (i.e., Stroop Color-Word Interference Test) was associated with a lifetime history of suicidal behavior. These findings, in conjunction with research on suicide risk in other psychiatric groups, suggest that cognitive deficits may place some individuals with BPD at an increased risk for self-injury, particularly when higher-order cognitive abilities involved in behavioral regulation are more significantly affected.

Deficits in social cognition (i.e., encoding, interpretation, and processing of information pertaining to other people) have also been identified as important contributing factors to self-injury. Studies of patients with mood disorders suggest that those with a history of suicide attempt may have greater difficulties recognizing facial displays of emotion (Richard-Devantoy, Guillaume, Olie, Courtet, & Jollant, 2013; Szanto et al., 2012). While individuals with BPD show pronounced difficulties recognizing angry, disgusted, and neutral facial expressions (Daros, Zakansan, & Ruocco, 2013) and subjectively magnify subtle expressions of sadness in faces (Daros, Uliaszek, & Ruocco, 2014), no research has examined the relationship of these social–cognitive deficits to self-injury. Given findings of emotion recognition deficits in mood disorder patients with a history of suicidality (Szanto et al., 2012), it may be that similar associations might exist in individuals with BPD which, in turn, may vary according to the medical lethality of self-injurious behaviors.

In the current study, patients with BPD reporting a lifetime history of self-injurious behavior were evaluated for the medical lethality of the single act resulting in the greatest physical damage. Participants were then classified as either high or low lethality patients according to conventions from prior research (Beck et al., 1975) and groups were compared on standardized measures of executive functioning and social cognition to determine whether high lethality patients showed greater deficits on neuropsychological tests of problem-solving, planning, and response inhibition, and more severe alterations in emotion perception. We hypothesized that high lethality patients would show more pronounced deficits in executive functioning and social cognition compared with low lethality patients. Specifically, we anticipated that high lethality patients would exhibit greater deficits in planning, problem-solving, and response inhibition, although analyses involving emotion recognition and discrimination were largely exploratory. The results of this study have potential to offer new insights into the role of neuropsychological and social–cognitive deficits as they pertain to lethality of self-injurious behaviors in patients with BPD.

**Method**

**Participant Characteristics**

Patients eligible for this study were required to meet criteria for current BPD based on the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*; American Psychiatric Association, 1994). They were recruited as part of two larger studies (a family study and a treatment study for self-injuring patients with BPD) incorporating neuropsychological and social cognition measures. To be included in the current study, participants were required to be 18–65 years old, fluent in English, capable to provide written informed consent, report at least one lifetime episode of self-injurious behavior, and have an estimated Full-Scale IQ ≥80 as determined by the Wechsler Test of Adult Reading (Wechsler, 2002). Exclusion criteria included the following: lifetime DSM-IV psychotic disorder or bipolar I disorder, lifetime eating disorder requiring hospitalization, or current or extensive history of alcohol or nonalcohol substance use disorder; history of significant head trauma (defined as ≥20 min loss of consciousness and/or >24 hr posttraumatic amnesia); developmental disorder (e.g., autism-spectrum disorder, Down’s syndrome); neurological illness (e.g., seizure disorder, encephalitis, stroke); serious physical illness (e.g., myocardial infarction, viral hepatitis, hypothyroidism); and significant manual, auditory, or hearing impairments. Participants were also required to provide a negative urine toxicology screen on the day that they completed neuropsychological testing.

Fifty-eight patients with BPD provided their written consent to participate in this research. All patients reported a lifetime history of self-injurious behavior. They were mostly female (89.7%) and primarily right-handed (89.7%) and with a mean age of 30.2 years (SD = 10.1). The ethnic composition of the sample classified according to 2011 Canadian census categories was as follows: White (72.4%), South Asian (6.9%), Black (3.4%), Latin American (1.7%), Chinese (1.7%), First Nations (1.7%), Japanese (1.7%), Southeast Asian (1.7%), and Other/Mixed (8.6%). The mean level of formal education for this sample was equivalent to two years of postsecondary school (14.1 years, SD = 2.1) and their IQ estimated from the Wechsler Test of Adult Reading (Wechsler, 2002) was in the average range, 109.1 (SD = 7.5). Nearly all patients reported a previous history of psychiatric treatment (94.7%), including inpatient hospitalization (78.9%) and outpatient consultation and/or treatment (87.7%). Patients reported having taken the following prescribed medications at least within three weeks prior to completing study procedures (either alone or in combination): sedatives (34.6%), stimulants (11.5%), anxiolytics (9.6%), antipsychotics (11.5%), antidepressants (58.5%), and mood stabilizers (11.5%).

Each patient’s single most medically damaging self-injurious behavior was coded on the Self-Harm Lethality Scale. Ingesting substances with sedative effects (n = 24) and cutting (n = 24) were the most frequently reported means of self-injury, followed
by ingesting substances without sedative effects ($n = 5$), hanging ($n = 3$), and immolation ($n = 2$). Ingested substances with sedative effects included antipsychotics ($n = 4$), antidepressants ($n = 5$), benzodiazepines—sedative hypnotics ($n = 8$), gas-asphyxia ($n = 1$), nonpsychotropic prescription medications ($n = 3$), over-the-counter sedatives ($n = 1$), and anticonvulsants ($n = 1$). Substances without sedative effects were largely over-the-counter medications ($n = 3$). Two patients could not recall precisely what substances they ingested for each of sedating and nonsedating substance categories. High and low lethality groups did not significantly differ in their reported use of any class of prescription medications in the three weeks prior to testing ($\chi^2s \leq 1.88$, $p \leq 0.17$).

### Sampling Procedures
Participants for the family study were recruited using flyers placed in an outpatient clinic for patients with BPD at the Centre for Addiction & Mental Health (CAMH) in Toronto, Canada, and print and online classified advertisements soliciting the participation of adults with a previous diagnosis of BPD. Patients from the treatment study for self-injuring patients with BPD were recruited from the BPD Clinic at CAMH as well as through print and online classified advertisements. All diagnostic interviewing and neuropsychological testing was carried out in a quiet testing room in the Clinical Neurosciences Laboratory at the University of Toronto Scarborough. Participants were remunerated $55 for their completion of diagnostic and neuropsychological assessments in addition to roundtrip travel expenses to the University campus. The research protocol was approved by the Research Ethics Board at the Centre for Addiction and Mental Health and the Social Sciences, Humanities and Education Research Ethics Board at the University of Toronto.

### Measures
#### Diagnostic assessments.
Semistructured diagnostic interviews were administered by Master’s and doctoral level research assistants trained to reliably administer each of the measures and directly supervised by a licensed clinical psychologist (ACR). Narratives for each participant were prepared based on all of the available information obtained from diagnostic interviews and medical record reviews and then discussed in a best estimate diagnostic meeting (Klein, Ouimette, Kelly, Ferro, & Riso, 1994). The Structured Clinical Interview for DSM–IV Axis I Disorders—Patient Edition (SCID–IP; First, Spitzer, Gibbon, & Williams, 2002) was used to evaluate schizophrenia and other psychotic disorders, mood disorders, alcohol and nonalcohol substance use disorders, anxiety disorders, eating disorders, and somatoform disorders. Assessments of all 10 DSM–IV personality disorders were carried out using the Structured Interview for DSM–IV Personality (Pfohl, Blum, & Zimmerman, 1995).

#### Symptom rating scales.
Severity of current depressive symptomatology was measured using the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996). This self-report measure includes 21 items that correspond with DSM–IV criteria for a major depressive episode.

To evaluate impulsivity, the Barratt Impulsiveness Scale–11 (Stanford et al., 2009) was administered to all participants. This 30-item self-report questionnaire measures trait impulsivity in three primary domains: motor impulsiveness, or acting without thinking; attentional impulsiveness, which involves making quick decisions; and nonplanning impulsiveness, reflecting a lack of forethought (Barratt, 1985).

#### Self-Harm Lethality Scale.
The Self-Harm Lethality Scale was developed to assess the degree of medical lethality or damage resulting from suicide attempts and self-injurious behaviors (Beck et al., 1975). The rationale for its development centers upon findings that an individual’s intent to kill himself or herself is only minimally related to the medical damage resulting from the act (Beck et al., 1975). Eight forms of self-injurious behavior were assessed: substances with sedative effects, substances without sedative effects and other ingested substances, shooting, immolation, drowning, cutting, jumping, and hanging. Only the single lifetime act resulting in the most severe medical damage was rated on a scale ranging from zero (no medical damage) to eight (death). Based on prior work (Beck et al., 1975; Soloff, Fabio, Kelly, Malone, & Mann, 2005; Soloff et al., 2014), high lethality patients were identified according to a rating of four or greater on any one of the self-injurious behaviors rated on this scale as most medically damaging.

#### Neuropsychological measures.
Standard neuropsychological instruments assessing these cognitive abilities were employed in this study. Tests were administered according to directions described in the test manuals by bachelor’s and Master’s level research assistants trained to reliability on the measures by a clinical neuropsychologist (ACR). Full-Scale IQ was estimated using the Wechsler Test of Adult Reading based on normative data provided in the test manual (Wechsler, 2002).

The Victoria Symptom Validity Test (Slick, Hopp, Strauss, & Thompson, 1997) is a computerized two-alternative forced-choice performance validity measure that was used to exclude patients who did not adequately comply with neuropsychological procedures.

#### Response inhibition.
The Conners’ Continuous Performance Test—Second Edition (CPT-II; Conners, 2000) is a measure of visual attention that requires participants to monitor letters appearing on a computer screen over a period of 14 min and to press the space bar only for target letters (i.e., any letter except for X). This task provides two primary measures of response inhibition: commissions, representing failed attempts to control one’s manual motor response when presented with the letter X, and perseverations, which reflect the number of responses wherein response times to any stimuli are less than 100 ms, potentially reflecting an impulsive anticipatory response.

Additionally, the Color-Word Interference Test from the Delis–Kaplan Executive Function System (D–KEFS; Delis, Kaplan, & Kramer, 2001) was employed to measure response inhibition. This test requires examinees to control the automatic response to read words and instead name the color of the ink in which words are printed, more commonly referred to as the Stroop effect (Cohen, Dunbar, & McClelland, 1990). In the context of intact normal speed at naming colors, lower scores on the inhibition condition of this task reflect difficulties with verbal response control. Errors on basic naming of colors may also reflect response inhibition deficits (i.e., working quickly at the expense of problems with inhibiting incorrect responses) and/or perseverative responding (i.e., difficulty inhibiting a previous response, especially after having repeatedly generated the same response).
Planning and problem-solving. Tower tasks are neuropsychological measures commonly used to assess the executive functions of planning and problem-solving (for a review, see Ruocco et al., 2014). The D-KEFS Tower Test requires participants to build a series of towers of increasing complexity by moving five colored disks among three equal-sized pegs using as few moves as possible. The total achievement score provides a global measure of overall performance on this task that incorporates problem-solving accuracy and efficiency (i.e., the number of moves the participant needed to solve each item relative to the minimum number of moves possible on each item). Planning on this task is measured based on the length of time that respondents deliberated before completing their first move on each item. Impulsive individuals tend to complete their first move more quickly, possibly reflecting a failure to formulate a systematic strategy before beginning to build the towers. Problem-solving ability is measured according to a move-accuracy ratio, which represents the proportion of total moves made by an examinee across all items administered relative to the total number of minimum moves required to correctly build each tower. An elevated raw ratio score represents less efficient problem-solving as reflected by a relatively high number of excessive or haphazard moves, suggesting that the participant may have relied to some extent on a trial-and-error strategy.

Social cognition measures. The Penn Emotion Recognition and Emotion Discrimination tasks (Gur et al., 2002) are social-cognitive tasks that assess related yet distinct aspects of emotion perception. The Penn Emotion Recognition task examines the ability to identify four basic emotions (happiness, sadness, anger, and fear) and neutral expressions. On this computerized task, patients were presented with 40 successive faces and asked to quickly choose what emotion, if any, was displayed and to be as accurate as possible. On the Penn Emotion Discrimination task, patients were successively shown 40 pairs of faces. Each pair of faces were of the same person and the faces may or may not differ according to the intensity of the emotional expression. The difference in emotional intensity was subtle and computer-generated. The patient was asked to decide which face expressed the given emotion more intensely, or whether they displayed the same emotion more intensely, or whether they displayed the same emotion equally divided so that one of the faces in the pair was either more intensely happy or sad. To control for basic facial processing, including visual acuity and perception, the Benton Facial Recognition task was administered to all patients (Benton, Sivan, Hamsher, Vareny, & Spreen, 1983).

Statistical Methods

After high and low lethality patients were identified based on the Self-Harm Lethality Scale, groups were compared on demographic and clinical characteristics using between-subjects t tests, Fisher’s exact test, or Pearson chi-square. According to the Shapiro-Wilk Test, the majority of executive function and social cognition indices were not normally distributed. The nonparametric independent-samples Mann–Whitney U test examined differences between high and low lethality groups. Effect size measures were provided for relevant analyses (e.g., r, Cohen’s d, odds ratio, Cramer’s V). For neuropsychological measures, normative-referenced scores based on age were incorporated into analyses to control for within-group age-related differences in performances on these tasks. Ancillary analyses evaluated the relationship of depression severity and self-reported impulsiveness to performance on the executive function and social cognition measures to assess whether depressed mood may account for lower performances on the laboratory measures.

Results

Statistics and Data Analysis

Participant characteristics. Table 1 displays demographic and clinical characteristics of high and low lethality patients with BPD. Groups did not differ according to demographic variables (age, gender, education, estimated IQ) or clinical features (depressive symptoms, psychiatric diagnostic comorbidity, Global Assessment of Function ratings). The mean lethality rating across all self-injurious behaviors was 2.71 (SD = 1.79), with scores ranging from 0 to 7.

As previously indicated, high lethality patients were identified according to a rating of four or greater on any one of the self-injurious behaviors assessed (Beck et al., 1975; Soloff et al., 2005; Soloff et al., 2014). This procedure classified 18 patients (31%) as high lethality and 40 patients (69%) as low lethality self-injurers. Mean lethality severity ratings were 4.72 (SD = 1.02) and 1.80 (SD = 1.22) for high and low lethality patients, respectively, t(56) = 8.84, p < .001. On the Barratt Impulsiveness Scale, high lethality patients reported greater motor impulsiveness than low lethality patients, t(53) = 2.15, p = .04. Groups reported comparable attentional and nonplanning impulsiveness (p > .63 for each).

Response inhibition. Table 2 displays performances on executive function and social cognition measures for high and low lethality patients. Patient groups performed comparably on the DKEFS Color-Word Interference Test, although inspection of effect size differences suggested that high lethality patients showed subtle but not statistically significant difficulties on the inhibition condition of this task, potentially reflecting inefficiencies in response inhibition (Figure 1). Analysis of errors indicated that high lethality patients committed more color-naming errors than low lethality patients, U = 390, z = 2.01, p = .04, r = .28, reflecting possible difficulties with impulsivity or perseverative responding. Analysis of performances on the CPT revealed that groups did not significantly differ in terms of commissions, U = 359, z = 0.49, p = .62, r = .07, or perseverations, U = 391, z = 1.08, p = .28, r = .14.

Planning and problem-solving. On the DKEFS Tower Test, high lethality patients with BPD were poorer on a global index of overall performance on this task (Total Achievement score) as compared with low lethality patients, U = 168, z = −2.87, p = .004, r = .39. High lethality patients required more moves to solve items relative to the minimum number of moves required on each item, U = 212, z = −2.04, p = .04, r = .27, suggesting that they employed ineffective problem-solving strategies in constructing the towers compared to low lethality patients. Groups did not differ on measures of deliberation time, U = 385, z = −1.16, p = .25,
Table 1
Demographic and Clinical Characteristics of Low and High Lethality Patients

<table>
<thead>
<tr>
<th></th>
<th>Low lethality patients (n = 40)</th>
<th>High lethality patients (n = 18)</th>
<th>Statistic</th>
<th>df</th>
<th>Sig. (2-tail)</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>29.63 (9.84)</td>
<td>31.33 (10.88)</td>
<td>(t = -0.59)</td>
<td>56</td>
<td>0.56</td>
<td>Cohen's (d = -0.16)</td>
</tr>
<tr>
<td>Years of education</td>
<td>14.45 (2.12)</td>
<td>13.28 (2.02)</td>
<td>(t = 1.97)</td>
<td>56</td>
<td>0.05</td>
<td>Cohen's (d = 0.57)</td>
</tr>
<tr>
<td>Female</td>
<td>90.00</td>
<td>88.90</td>
<td>FET</td>
<td>1.00</td>
<td>Odds ratio = 0.89</td>
<td></td>
</tr>
<tr>
<td>Right handed</td>
<td>92.50</td>
<td>83.30</td>
<td>(\chi^2(2) = 0.57)</td>
<td>0.48</td>
<td>Cramer's (V = 0.14)</td>
<td></td>
</tr>
<tr>
<td>White ethnicity</td>
<td>66.70</td>
<td>75.00</td>
<td>(\chi^2(8) = 6.51)</td>
<td>0.59</td>
<td>Cramer’s (V = 0.34)</td>
<td></td>
</tr>
<tr>
<td>WTAR predicted IQ</td>
<td>110.23 (6.27)</td>
<td>106.61 (9.30)</td>
<td>(t = 1.50)</td>
<td>24</td>
<td>0.15</td>
<td>Cohen’s (d = 0.46)</td>
</tr>
<tr>
<td>BIS attention</td>
<td>1.73 (0.50)</td>
<td>1.80 (0.57)</td>
<td>(t = -0.48)</td>
<td>53</td>
<td>0.63</td>
<td>Cohen’s (d = -0.13)</td>
</tr>
<tr>
<td>BIS motor</td>
<td>1.51 (0.43)</td>
<td>1.79 (0.49)</td>
<td>(t = -2.15)</td>
<td>50</td>
<td>0.04</td>
<td>Cohen’s (d = -0.61)</td>
</tr>
<tr>
<td>BIS non-planning</td>
<td>1.69 (0.45)</td>
<td>1.69 (0.44)</td>
<td>(t = 0.02)</td>
<td>52</td>
<td>0.99</td>
<td>Cohen’s (d = 0.00)</td>
</tr>
<tr>
<td>BDI total</td>
<td>29.27 (11.62)</td>
<td>30.89 (11.26)</td>
<td>(t = -0.49)</td>
<td>53</td>
<td>0.63</td>
<td>Cohen’s (d = -0.14)</td>
</tr>
<tr>
<td>GAF (prior month)</td>
<td>45.53 (5.87)</td>
<td>45.77 (5.51)</td>
<td>(t = -0.13)</td>
<td>43</td>
<td>0.90</td>
<td>Cohen’s (d = -0.04)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Low lethality patients (n = 40)</th>
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<th>Statistic</th>
<th>df</th>
<th>Sig. (2-tail)</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDD</td>
<td>46.90</td>
<td>46.20</td>
<td>FET</td>
<td>1.00</td>
<td>Odds ratio = 0.97</td>
<td></td>
</tr>
<tr>
<td>Past MDD</td>
<td>37.50</td>
<td>30.80</td>
<td>FET</td>
<td>0.74</td>
<td>Odds ratio = 0.65</td>
<td></td>
</tr>
<tr>
<td>Past alcohol abuse</td>
<td>12.50</td>
<td>23.10</td>
<td>FET</td>
<td>0.39</td>
<td>Odds ratio = 1.52</td>
<td></td>
</tr>
<tr>
<td>Past alcohol dependence</td>
<td>25.00</td>
<td>53.80</td>
<td>FET</td>
<td>0.09</td>
<td>Odds ratio = 1.71</td>
<td></td>
</tr>
<tr>
<td>Past substance abuse</td>
<td>3.10</td>
<td>7.70</td>
<td>FET</td>
<td>0.50</td>
<td>Odds ratio = 1.61</td>
<td></td>
</tr>
<tr>
<td>Past substance dependence</td>
<td>12.50</td>
<td>30.80</td>
<td>FET</td>
<td>0.20</td>
<td>Odds ratio = 1.68</td>
<td></td>
</tr>
<tr>
<td>Current PTSD</td>
<td>18.80</td>
<td>30.80</td>
<td>FET</td>
<td>0.44</td>
<td>Odds ratio = 1.48</td>
<td></td>
</tr>
<tr>
<td>Past PTSD</td>
<td>18.80</td>
<td>23.10</td>
<td>FET</td>
<td>0.70</td>
<td>Odds ratio = 1.23</td>
<td></td>
</tr>
</tbody>
</table>

Note. \(M = \) mean; \(SD = \) standard deviation; WTAR = Wechsler Test of Adult Reading (Wechsler, 2002); IQ = intelligence quotient; MDD = major depressive disorder; BIS = Barratt Impulsiveness Scale-11 (Patton & Stanford, 1995); GAF = Global Assessment of Function (Hall, 1995); PTSD = posttraumatic stress disorder; df = degrees of freedom; FET = Fisher’s exact test.

\(r = .16,\) or average time required to carry out each move while solving items, \(U = 361,\) \(z = -0.70,\) \(p = .48,\) \(r = .09.\)

**Emotion recognition.** On the Penn Emotion Recognition task, high lethality patients with BPD correctly identified fewer happy faces than low lethality patients (Figure 2), \(U = 91,\) \(z = -2.55,\) \(p = .01,\) \(r = .41,\) and they were not significantly slower in their response times to happy faces, \(U = 144,\) \(z = 0.46,\) \(p = .64,\) \(r = .07,\) suggesting that they did not trade accuracy for speed. High lethality patients tended to misinterpret happy faces as angry, \(U = 360,\) \(z = 2.26,\) \(p = .02,\) \(r = .30,\) although these analyses should be interpreted with caution because they are based only on a small number of errors in this direction (2.23% error rate across all participants). Groups did not differ in their recognition of neutral faces, \(U = 140,\) \(z = 0.35,\) \(p = .73,\) \(r = .06,\) or faces.

Table 2
Performance on Executive Function and Social Cognition Measures for Patients With Borderline Personality Disorder

<table>
<thead>
<tr>
<th></th>
<th>Low lethality (n = 40)</th>
<th>High lethality (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive function measures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Performance Task: Commissions</td>
<td>(-0.52 (-1.10))</td>
<td>(-0.63 (-1.21))</td>
</tr>
<tr>
<td>Continuous Performance Task: Perseverations</td>
<td>(-0.29 (-1.04))</td>
<td>(-1.92 (-4.46))</td>
</tr>
<tr>
<td>Color Word Interference Test: Color Naming</td>
<td>(-0.25 (0.74))</td>
<td>(-0.26 (0.74))</td>
</tr>
<tr>
<td>Color Word Interference Test: Word Reading</td>
<td>(0.18 (0.72))</td>
<td>(0.25 (0.79))</td>
</tr>
<tr>
<td>Color Word Interference Test: Inhibition</td>
<td>(0.19 (1.15))</td>
<td>(-0.16 (0.85))</td>
</tr>
<tr>
<td>Tower Test: Total Achievement</td>
<td>(0.33 (0.73))</td>
<td>(-0.22 (0.66))</td>
</tr>
<tr>
<td>Tower Test: Mean First-Move Time</td>
<td>(0.24 (0.71))</td>
<td>(0.47 (0.50))</td>
</tr>
<tr>
<td>Tower Test: Time-Per-Move-Ratio</td>
<td>(-0.25 (1.08))</td>
<td>(0.12 (0.50))</td>
</tr>
<tr>
<td>Tower Test: Move Accuracy Ratio</td>
<td>(-0.17 (0.88))</td>
<td>(-0.67 (0.61))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social cognition measures</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fear recognition</td>
<td>(0.22 (0.73))</td>
<td>(-0.13 (1.56))</td>
</tr>
<tr>
<td>Happiness recognition</td>
<td>(0.37 (0.37))</td>
<td>(-0.45 (1.45))</td>
</tr>
<tr>
<td>Neutral recognition</td>
<td>(-0.36 (1.46))</td>
<td>(0.01 (0.87))</td>
</tr>
<tr>
<td>Sadness recognition</td>
<td>(0.05 (1.06))</td>
<td>(0.13 (0.86))</td>
</tr>
<tr>
<td>Anger recognition</td>
<td>(0.29 (0.96))</td>
<td>(0.40 (0.60))</td>
</tr>
<tr>
<td>Sadness discrimination</td>
<td>(0.23 (0.97))</td>
<td>(-0.83 (1.05))</td>
</tr>
<tr>
<td>Happiness discrimination</td>
<td>(0.42 (0.91))</td>
<td>(-0.25 (1.07))</td>
</tr>
</tbody>
</table>

Note. \(z\)-scores are normatively referenced with a mean of zero and standard deviation of \(\pm 1.\) Negative values denote poorer performance relative to normative data.
displaying sadness, $U = 131, z = 0.00, p = 1.00, r = .00$, fear, $U = 134, z = 0.11, p = .91, r = .02$, or anger, $U = 137, z = 0.21, p = .93, r = .03$.

**Emotion discrimination.** Compared to low lethality patients, high lethality patients showed greater difficulties on the Penn Emotion Discrimination task in discerning subtle differences in intensities of facial expressions of sadness, $U = 28, z = -2.26, p = .02, r = .46$, and these difficulties could not be attributed to quicker response times, $U = 64, z = 0.00, p = 1.00, r = .00$. Whereas all patients were more likely to incorrectly judge sad faces as displaying the same emotional expression (81%) versus expressing different emotional intensities (19%), $t(23) = 7.05, p < .001$, high lethality patients showed no systematic tendencies to incorrectly judge faces as the same, $U = 63, z = -0.06, p = .95, r = .01$, or different, $U = 65, z = 0.06, p = .95, r = .01$. High and low lethality groups did not differ in their discrimination of happy faces, $U = 78, z = 0.86, p = .39, r = .17$, or in their response latencies on happy faces, $U = 64, z = 0.00, p = 1.00, r = .00$.

**Ancillary Analyses**

Performance on the Inhibition condition of the DKEFS Color-Word Interference Test was significantly associated with depression severity, $r = -0.40, p = .003$ and nonplanning impulsiveness, $r = -0.42, p = .002$. Otherwise, no significant correlations were found between depression and impulsivity self-report measures and executive function test performance ($|r|'<s < 0.26, ps > .07$).

With regard to social cognition measures, higher motor and nonplanning impulsiveness were associated with lower accuracy in discriminating facial expressions of happiness ($|r|' s > -0.48, ps \leq .02$), whereas only motor impulsiveness was associated with less accurate discrimination of sadness, $r = -0.56, p = .005$. Additionally, higher nonplanning impulsiveness was linked to poorer recognition of angry facial expressions, $r = -0.36, p = .04$. Depression severity was not significantly correlated with any of the social cognition measures ($|r|' s \leq -0.36, ps \geq .09$).

**Discussion**

The current study investigated whether patients with BPD with a lifetime history of highly lethal self-injurious behaviors showed more pronounced deficits in executive functioning and social cognition as compared to patients engaging in less medically damaging acts. High and low lethality patients did not differ with regard to demographic characteristics, psychiatric diagnostic comorbidity, or clinical severity. On self-report measures, high lethality patients described more frequent impulsive behaviors than low lethality patients, and consistent with hypotheses, high lethality patients also showed greater deficits on neuropsychological indices of response inhibition and problem-solving. In addition, high lethality patients more frequently misidentified happy facial expressions and had greater difficulties discerning subtle differences in emotional intensity in sad facial expressions.

On the Barratt Impulsiveness Scale, high lethality patients subjectively reported engaging in more impulsive behaviors than low lethality patients, which was consistent with prior research on self-injuring patients with BPD (Claes, Van den Eynde, Guillaume, Vogels, & Audenaert, 2012). The current study extended these findings to indicate that patients with BPD enacting more medically damaging self-injurious behaviors reported even more frequent impulsive behaviors resulting from the urgency to act without thinking through the consequences of their actions. This contrasts with other forms of impulsive behaviors, namely, problems with attention and planning, which although elevated among self-injuring patients with BPD (Claes et al., 2012), were reported equally as frequently in the current study among high and low lethality patients. These findings, however, diverge from other research suggesting that individuals who attempt suicide without planning may not necessarily be more impulsive than those who plan their actions (Anestis, Soberay, Gutierrez, Hernández, & Joiner, 2014; Witte et al., 2008). Considering this research, the current findings may be more specific to patients with BPD who are more impulsive and may be more likely to act on the spur of the moment, perhaps to reduce the subjective intensity of aversive emotional experiences (Kleindienst et al., 2008). This trait may represent a unique behavioral phenotype signifying an increased risk for suicide even among self-injuring patients with BPD, although inferences cannot be made based on these data about the extent to which patients may deliberate, problem-solve, and impulsively act in reference to a given episode of self-injury.

On neuropsychological tests of response inhibition, high lethality patients showed variable patterns of deficits (i.e., difficulties on some but not all measures of response inhibition), reflecting a

![Figure 1](image_url)  
**Figure 1.** Effect size differences contrasting high and low lethality self-injuring patients with borderline personality disorder on the Color-Word Interference Test. *Note.* Negative effect size values reflect worse performance for high lethality patients compared to low lethality patients. Error bars represent standard error.

![Figure 2](image_url)  
**Figure 2.** Facial emotion recognition for high and low lethality self-injuring patients with borderline personality disorder. *Note.* Negative effect size values reflect worse performance for high lethality patients compared to low lethality patients. Error bars represent standard error.
possible cognitive basis for their elevated subjective reports of impulsivity. Specifically, they committed more errors than low lethality patients on a timed measure of color naming, which could reflect difficulties with response inhibition as well as perseverative responding (Delis et al., 2001). On the interference condition of the Color-Word Interference Test, high lethality patients performed worse than low lethality patients (albeit not significantly), with a medium effect size difference favoring the latter. In the context of relatively equivalent trial completion times on color naming and word reading, reduced performance on the interference condition for high lethality patients suggests a selective deficit in inhibiting the more salient and automatic reading response, and is consistent with prior research on suicidal behavior and cognitive functioning in BPD (LeGris et al., 2012). Whereas more severe depressive symptoms was significantly associated with poorer inhibition performance on the interference condition, high and low lethality patients reported similar levels of depression, suggesting that depression severity could not account for these findings. Poorer inhibition performance, however, was correlated with greater non-planning impulsiveness, implicating a potential link between a performance-based measure of response inhibition and self-reported difficulties with thinking behaviors through before acting.

In contrast, high lethality patients performed comparably to low lethality patients on other neuropsychological indices of response inhibition, including commission errors and perseverative responses on the CPT. Discrepant patterns of deficits on indices of response inhibition between the Color-Word Interference Test and CPT for high lethality patients likely reflect deficits in relatively distinct underlying inhibitory processes, or in the same processes at different points in time (Khng & Lee, 2014). To disentangle the nature of these altered inhibitory processes, research incorporating neuroimaging could provide insights into localized patterns of cerebral dysfunction signifying distinct inhibitory functions (H. Rodrigo et al., 2014), which might also assist in elucidating the precise timing of alterations in these inhibitory processes (Ruch-sow et al., 2008) among high lethality patients. In conjunction with performance on the DKEFS Color-Word Interference Test, these findings suggest that high lethality patients may have more pronounced deficits on specific neuropsychological indices of response inhibition as compared with low lethality patients. These deficits could underlie self-reported difficulties with nonplanning impulsiveness which, in turn, may imply impaired behavioral control in those patients at an increased risk to engage in more medically dangerous self-injurious behaviors.

In addition to deficits in response inhibition, high lethality patients showed remarkable difficulties on a neuropsychological measure of problem-solving. Whereas high lethality patients delibera-\_tated for a similar length of time as low lethality patients before beginning to solve each problem, they employed a less efficient strategy on their way toward achieving an accurate solution. This pattern of performances suggests that patients enacting more medically damaging self-injurious behaviors generated a relatively high number of unnecessary or haphazard moves and likely relied to some extent on a trial-and-error approach (Delis et al., 2001). In contrast to prior research showing no significant association between a measure of risky decision-making and suicidal behavior in patients with BPD (LeGris et al., 2012), the current findings indicate that high lethality patients may show deficits in problem-solving that are independent of risk-taking behavior. These findings are consistent with research linking poor interpersonal and emotional problem-solving skills with self-injury in BPD (Kehrer & Linehan, 1996), while supporting the aims of psychotherapies intending to improve problem management in patients with this disorder (Blum et al., 2008; Linehan, 1993; Linehan, Heard, Clarkin, Marziali, & Munroe-Blum, 1992).

Considering that high lethality patients showed a combination of both poor response inhibition and inefficient problem-solving, these findings could have important implications for understanding what factors might predispose patients with BPD to engage in more medically damaging self-injurious behaviors. Indeed, it is conceivable that a convergence of problems with behavioral control and ineffective problem-solving capacity might increase the likelihood that patients will turn to more dangerous means of self-injury. For example, when high lethality patients experience high levels of emotional distress, they may have difficulty spontaneously generating—or they may consider only a small number of —alternative behaviors that function to reduce emotional arousal, impulsively selecting the first option that comes to mind (D’Zurilla & Nezu, 2010). When self-injury is a salient previously rewarded alternative behavior that effectively reduces aversive tension (Chapman, Gratz, & Brown, 2006), ineffective problem-solving may not only narrow the range of behaviors that patients may consider in response to an aversive emotional state, but inadequate response inhibition could cause patients to engage in more medically lethal behaviors since they fail to fully consider more adaptive alternative behaviors.

While interpersonal problems are especially prevalent among self-injuring patients with BPD (Berk, Jeglic, Brown, Henriques, & Beck, 2007; Brodsky, Groves, Oquendo, Mann, & Stanley, 2006), little is understood about social–cognitive abilities and their associations with suicide risk in this patient group. Indeed, motivations for self-injury in BPD frequently involve interpersonal themes and desires to reduce associated negative emotional states (Brodsky et al., 2006; Klonsky, 2007; Soloff, Lis, Kelly, Cornelius, & Ulrich, 1994b). Results from previous facial emotion recognition studies have been mixed. Despite this lack of consistency, patients with BPD have been shown to subjectively magnify subtle expressions of sadness in faces (Daros, Uliaszek, & Ruocco, 2014) and to have difficulties recognizing facial expressions of anger and disgust, as well as neutral faces (Daros et al., 2013). In the current study, high lethality patients had greater difficulties recognizing happy facial expressions, a finding that could not be attributed to mood-state-related biases in facial emotion recognition, given that patient groups did not differ in depressive symptom severity or diagnostic comorbidity with major depression. These difficulties recognizing happy facial expressions may reflect trait-like alterations in the perception of positive affect, which could have downstream consequences on patients’ mood states and the quality of their interpersonal interactions. In addition to misidentifying happy facial expressions, high lethality patients demonstrated difficulties in facial emotion discrimination. Specifically, they were less accurate than low lethality patients in discerning subtle differences in the intensities of facial expressions of sadness, although they showed no systematic biases toward overestimating or underestimating the intensity of one facial expression over another. These findings are partly consistent with research indicating that patients with BPD show altered perception of sadness in faces, subjectively magnifying the intensity of subtle
facial expressions of sadness (Daros et al., 2014). Additionally, higher self-reported nonplanning impulsiveness (but not depression severity) was associated with poorer discrimination of sad facial expressions. Taken together, these findings on tests of social cognition suggest that patients engaging in more medically damaging self-injurious behaviors may show alterations in the perception of both positive and negative affect in faces, the former associated with misidentification of the emotion and the latter potentially related to trait impulsiveness characterized by minimal deliberation before acting.

There are some limitations to consider while interpreting the results of the current study. First, other aspects of executive functioning (e.g., working memory, cognitive flexibility) were not directly evaluated in this study, in part because deficits in response inhibition, planning, and problem-solving are the most significantly affected cognitive domains in BPD (Ruocco, 2005; Ruocco, Laporte, Russell, Guttman, & Paris, 2012). What remains to be determined is whether high lethality patients show more pronounced deficits in these and other cognitive domains during an aversive emotional state, which could provide more direct information about the impact that specific cognitive deficits may have on mood-related impulsive self-injurious behaviors in patients with BPD. While negative affect was not assessed prior to testing in the current study, such assessments could provide important information on the emotional contexts of impulsive responding and inefficient problem-solving (Chapman, Dixon-Gordon, Layden, & Walters, 2010), as well as performances on social–cognitive measures. Second, facial emotion recognition and discrimination are two among a larger number of social–cognitive abilities that may be altered in patients with BPD. More research is needed to understand other aspects of social cognition that may place patients with BPD at an increased risk for engaging in more lethal self-injurious behaviors (e.g., difficulties with perspective taking and recognizing emotions from body language and voice intonation), and how these difficulties might contribute to interpersonal problems that might precipitate episodes of self-injury. Third, follow-up research may assist in identifying dysfunctions in specific inhibitory cognitive processes that may underlie more medically lethal self-injurious behaviors in patients with BPD. In conjunction with neuroimaging, future research may also help to extricate relatively distinct neural circuits involved in the regulation of behavior and emotion that may illuminate potential ways in which executive functions and social cognition interact in their relationship with self-injurious behavior in BPD (Ruocco, Amirthavasagam, Choi-Kain, & McMain, 2013; Silbersweig et al., 2007; Soloff et al., 2014). Fourth, while we did not evaluate the numbers of past suicide attempts or episodes of self-injury, instead opting to focus on the medical lethality of the most serious self-injurious behaviors, future research should investigate whether frequencies of these behaviors are related to executive processes and social cognition. Fifth, although not statistically significant, substance use disorders occurred somewhat more frequently among high lethality patients, which could reflect an underlying liability for impulse-spectrum disorders in this patient group. Further research should more extensively evaluate impulse control disorders among patients with BPD who engage in more medically damaging self-injurious behaviors and to evaluate their potential relevance to underlying neurocognitive vulnerabilities in BPD. Finally, recruitment of larger samples of self-injuring patients with BPD may improve statistical power when examining these and other components of executive function and social cognition in high and low lethality patients, and comparisons with other diagnostic groups (e.g., schizophrenia, bipolar disorder) may inform questions about the specificity of the current findings to BPD versus patients with other psychiatric diagnoses who engage in self-injurious behavior.

In summary, this study provides new evidence that patients with BPD who engage in more medically damaging self-injurious behaviors have more pronounced deficits than low lethality patients in response inhibition and problem-solving ability. These neurocognitive vulnerabilities may narrow the range of perceived alternative behaviors in which patients may engage as a means to reduce emotional distress, while also potentially making them more likely to enact more dangerous self-injurious behaviors by acting on the spur of the moment without considering the consequences of their actions. These neurocognitive deficits, in conjunction with difficulties perceiving both positive and negative affect in faces, may cause patients with BPD to engage in more lethal self-injurious behaviors, representing possible trait-like vulnerability markers that may place these patients at an increased risk for suicide. While preliminary, these findings provide new insights into the nature of neuropsychological and social–cognitive deficits in BPD, and highlight important executive function deficits and emotion perception alterations that may signify patients with BPD who are at an increased risk for engaging in more medically harmful self-injurious behaviors.

References


personality disorder. *Suicide and Life-Threatening Behavior*, 36, 313–322. http://dx.doi.org/10.1521/suli.2006.36.3.313


