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Shorter communication

# Evidence for an emotion–cognition interaction in the statistical prediction of suicide attempts

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ABSTRACT

Suicidal behavior is a prevalent problem among adolescents and young adults. Although most theoretical models of suicide suggest that this behavior results from the interaction of different risk factors, most prior studies have tested only bivariate associations between individual risk factors and suicidal behaviors. The current study was designed to address this limitation by testing the effect of an emotion–cognition interaction on suicide attempts among youth. Specifically, we hypothesized that the interaction of emotion reactivity and problem-solving skills would statistically predict the probability of a recent suicide attempt among 87 adolescents and young adults. Results revealed a significant interaction, such that emotion reactivity was strongly associated with the probability of a suicide attempt among those with poor problem-solving skills, moderately associated among those with average problem-solving skills, and not significantly associated among those with good problem-solving skills. The next generation of studies on suicidal behavior should continue to examine how risk factors interact to predict this dangerous outcome.


Suicide is an alarming public health problem that ranks as the third leading cause of death among adolescents and young adults (Centers for Disease Control, 1981–2006). As such, there is an urgent need to reduce the prevalence of suicidal behavior among youth. An important first step in preventing suicide is increasing the understanding of how this dangerous behavior develops. Prior studies have identified individual correlates of suicidal behavior (e.g., suicide attempts), including the presence and accumulation of mental disorders (Nock, Hwang, Sampson, & Kessler, 2010; Nock et al., 2009), high emotion reactivity (Nock, Wedig, Holmberg, & Hooley, 2008), cognitive inflexibility (Neuringer, 1964), and impulsive-aggression (Mann, Waternaux, Haas, & Malone, 1999). Although each of these factors is associated with presence of suicide attempts among adolescents or adults, in isolation each factor provides only a limited understanding of how or why this behavior emerges.

Risk factors for suicidal behavior most likely do not exert entirely independent effects. Instead, the *interaction* of such factors may be most important in the development of suicidal behavior. The presence of interactions would help to explain why most adolescents with certain individual risk factors (e.g., high emotion reactivity) do not attempt suicide. That is, it is only in the presence of other key predictors that suicidal behavior occurs. Prior studies have demonstrated the importance of such interactions in the prediction of suicidal behavior (e.g., O'Connor, Rasmussen, & Hawton, 2010).

Theoretical models propose that emotion–cognition interactions, such as the interaction of high emotion reactivity and poor cognitive control, may lead to suicidal behavior. For example, escape models of suicide propose that people attempt to kill themselves because they: (1) experience high levels of emotional distress following challenging events that they find aversive and intolerable (e.g., high emotion reactivity) and (2) cannot generate and implement adaptive solutions or coping strategies (i.e., poor cognitive control); thus, they resort to suicide as a means of escaping their intolerable state (Baumeister, 1990; Linehan, 1993). Although this model of suicidal behavior is widely accepted, we are unaware of studies that have tested whether the proposed emotion–cognition interaction predicts suicidal behavior.

Even though emotion–cognition interactions have not been tested among suicide researchers, they have been examined in psychological science more broadly. Recent advances in developmental neuroscience suggest that emotional and cognitive factors often interact to facilitate adaptive functioning (Gray, 2004). If applied to the study of psychopathology, examining emotion–cognition interactions could provide insight into how maladaptive behaviors (e.g., suicide attempt) develop. Indeed, animal and human models suggest that emotion–cognition interactions may account for adolescent deficits in adaptive functioning due to developmental changes in emotion- and cognitive-related regions

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of the brain (e.g., Galvan et al., 2006; McCallum, Kim, & Richardson, 2010). Following suit, Steinberg (2007) proposed that high rates of adolescent risk-taking may result from the differential development of emotional and cognitive processes that characterize this period. That is, emotional processes develop at much faster rates than do cognitive-control processes, and this developmental lag may lead to adolescent maladaptive or risky behavior (Casey, Jones, & Hare, 2008; Galvan et al., 2006), such as suicidal behavior.

Here, we propose that an emotion–cognition interaction of two known risk factors for suicidal behavior – high emotion reactivity and poor problem-solving skills – is associated with an increased probability of suicide attempt among adolescents. Prior research has demonstrated a relation between emotion reactivity – the degree to which one experiences strong negative emotion in response to a stressful event – and suicidal behavior among adolescents (Nock et al., 2008), as well as a relation between poor interpersonal problem-solving skills and the occurrence of suicidal behavior (Pollock & Williams, 2004). However, other types of problem-solving skills (e.g., financial, academic, work-related) also may statistically predict suicide attempts. Thus, we hypothesize that those who experience both intense emotional reactions *and* have a poor ability to solve problems will have a greater probability of a suicide attempt than those who have one or the other but not both. We tested the generality of this proposed effect by examining whether this interaction also statistically predicts engagement in risky behavior more broadly (i.e., nonsuicidal self-injury, violent behavior, alcohol and substance use), or whether the effect is specific to suicidal behavior.

## Method

### *Participants*

Participants were 87 adolescents and young adults (12–19 years old, $M = 17.03$, $SD = 1.91$) recruited for a laboratory-based study on self-injurious behavior. Advertisements were placed in local psychiatric clinics, on community bulletin boards, on the Internet, and in local newspapers calling for adolescents interested in participating "in a study aimed at understanding self-harm behaviors". Seven subjects did not complete all assessments and therefore were excluded from the analyses. Fifty six percent ($n = 49$) of the remaining 87 participants engaged in self-injurious behavior in the past year (suicidal and nonsuicidal), 29% ($n = 14$) of whom attempted suicide. Participants were mostly female (78.2%) and White (72.4%). Approximately 60% of participants met criteria for at least one DSM-IV disorder (total number of disorders $M = 1.32$, $SD = 1.66$), including mood disorders (31.0%), anxiety disorders (39.1%), substance use disorders (18.4%), disruptive behavior disorders (10.3%), and eating disorders (5.7%).

### *Procedure*

Participants who responded to advertisements traveled with their parents to Harvard University, where they were given a comprehensive description of the study and provided written informed consent/assent to participate. Participants were informed that their information would be kept confidential, unless study assessors learned that the adolescent, parent, or someone else was in danger of being harmed, in which case necessary precautions (e.g., informing parent, contacting a local hospital) would be undertaken. Participants also were informed that their participation was voluntary and could be withdrawn at any time; no participants refused to participate or withdrew from the study.

The Harvard University institutional review board approved all measures and procedures. Measures were administered during one assessment session in a psychology laboratory. All measures administered to the adolescent were done in the absence of the parent to increase the likelihood of honest responding. One Ph.D. level clinical psychologist (MKN), two predoctoral clinical psychology graduate students, and two post-baccalaureate research assistants administered assessments; all assessors were highly trained prior to data collection, audio- and video-taped during each assessment, and closely supervised. At completion of the study, all participants were debriefed, assessed for risk, and paid $100 for their participation.

### *Measures*

#### *Emotion reactivity*

Emotion reactivity was assessed using the Emotion Reactivity Scale (ERS; Nock et al., 2008), a 21-item self-report measure of emotion reactivity (e.g., "I tend to get emotional very easily," "When I experience emotions, I feel them very strongly/intensely," "When I am angry/upset, it takes me much longer than most people to calm down"). Participants rate items on a 0–4 Likert scale (0 = "not at all like me" to 4 = "completely like me"). This measure has been shown to have strong internal consistency ($\alpha = 0.94$) as well as good construct and criterion-related validity (Nock et al., 2008).

#### *Problem-solving skills*

Problem-solving skills were evaluated using the Delis–Kaplan Executive Function Systems Tower Task (DKEFS; Delis, Kramer, Kaplan, & Holdnack, 2004), which is a well-established neuropsychological test of executive functioning skills. The DKEFS Tower Task and other tower tasks (e.g., Tower of Hanoi, Tower of London) have demonstrated good validity (Sullivan, Riccio, & Castillo, 2009) and are frequently used as measures of problem-solving ability (Kaller, Rahm, Spreer, Mader, & Unterrainer, 2008; Unterrainer, Kaller, Halsband, & Rahm, 2006; Yochim, Baldo, Kane, & Delis, 2009). Tower tasks are not merely measures of intelligence but of problem-solving skills and planning ability more specifically, as demonstrated in the current study ($r = .27$ verbal IQ; $r = .23$ nonverbal IQ) and in other studies examining real-world functioning (e.g., Unterrainer et al., 2006). For example, Unterrainer et al. (2006) found that chess and non-chess players differed in problem-solving abilities (as measured by a tower task) but did not differ in level of fluid intelligence or verbal/visuospatial working memory.

The DKEFS Tower Task requires that the participant move five disks of varying size across three pegs so that disks are moved onto a designated peg and stacked according to size in the least number of moves possible. A move-accuracy ratio (total moves made by participant divided by minimum number of moves needed to complete the task) was calculated to assess the level of problem-solving skills (Delis et al., 2004).

#### *Suicidal behavior*

Presence of suicidal behavior was assessed using the Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock, Holmberg, Photos, & Michel, 2007), a commonly-used structured clinical interview (e.g., Heilbron & Prinstein, 2010; Walsh, 2007; Washburn, Juzwin, Styer, & Aldridge, 2010). The SITBI assesses characteristics of self-injurious thoughts and behaviors, including suicidal thoughts, plans, gestures, and attempts, as well as nonsuicidal thoughts and behaviors. Participants report on presence, frequency, lethality, and functions of each of these thoughts and behaviors. In the current study, answers to the following items were dichotomized to assess past-year presence of suicidal behavior: "Have you ever made an actual attempt to kill yourself in which you had at least some intent to die?" and "How many times

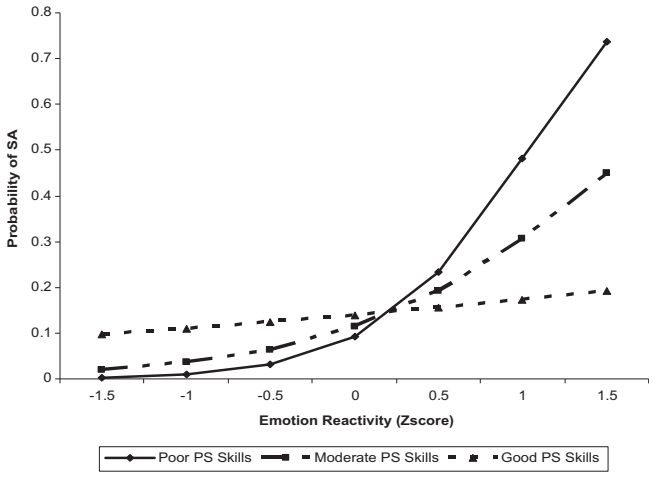


**Fig. 1.** Association between emotion reactivity and the probability of a suicide attempt among those with poor, moderate, and good problem-solving skills. Note: SA = suicide attempt, PS = problem-solving.

have you done this in the past year?" This measure has good interrater reliability (average $\kappa = 0.99$), test-retest reliability (average $\kappa = 0.70$), and construct validity (Nock et al., 2007).

*Other risky behaviors*

The presence of past-year nonsuicidal self-injury (NSSI) was evaluated with the SITBI (Nock et al., 2007). Violent behavior was evaluated using the Violent Thoughts and Behaviors Interview (VTBI), a structured clinical interview similar to the SITBI that assesses characteristics of violent thoughts and behaviors, including non-homicidal violent thoughts, plans, gestures, and attempts. In the current study, answers to the following items were dichotomized to determine past-year presence of violent behavior: "Have you ever done something to purposefully hurt someone else without wanting to kill him/her?" and "How many times have you done this in the past year?" The presence of a current diagnosis of substance- or alcohol-use disorders was assessed with the Kiddie-Schedule for Affective Disorders and Schizophrenia – Present and Lifetime Version (K-SADS-PL; Kaufman et al., 1997). The K-SADS-PL is a commonly-used semi-structured diagnostic interview that assesses current and lifetime history of psychiatric disorders. Two research assistants and two predoctoral clinical psychology graduate students were trained and supervised by the third author and demonstrated good interrater reliability across all diagnoses (average $\kappa = 0.93$) for the 20 randomly selected video-taped interviews.

*Data analysis*

Preliminary analyses were conducted to assess bivariate associations among study variables. Next, the association between the interaction of emotion reactivity and problem-solving skills and the probability of a suicide attempt was tested using a logistic regression analysis. For the logistic regression analysis, emotion reactivity and problem-solving skills were entered into the first step (after standardizing), and the interaction of independent variables was entered into the second step, with presence of a recent suicide attempt as the dependent variable (logistic regression analyses transform dichotomous dependent variables into probabilities). Post-hoc probing analyses were conducted using recommended data analytic procedures (Aiken & West, 1991), and we graphed the results of the post-hoc probing regression analyses at low, medium, and high levels of problem-solving skills (Fig. 1). Final regression analyses were conducted to test whether the interaction between emotion reactivity and problem-solving skills statistically predicted the probability of other risky behaviors: past-year NSSI, past-year violent behavior, or any substance- or alcohol-use disorder.

**Table 1**
Hierarchical logistic regression analysis statistically predicting past-year suicide attempt status ($N = 87$).

| Variable | $B$ | SE | Wald | OR (95% CI) | $\chi^2$ | $R^2$ |
|---|---|---|---|---|---|---|
| Step 1 | | | | | $\chi^2_{(2)} = 9.28^*$ | 0.17 |
| Emotion reactivity | 1.02 | 0.38 | 7.22 | 2.78 (1.32–5.86)** | | |
| Problem-solving skills | −0.24 | 0.30 | 0.62 | 0.79 (0.44–1.42) | | |
| Step 2 | | | | | $\chi^2_{(3)} = 13.90^{**}$ | 0.25 |
| Interaction | −0.98 | 0.49 | 4.00 | 0.38 (0.15–0.98)* | | |

$^{**}p < 0.01$, $^{*}p < 0.05$.

## Results

*Preliminary analyses*

Results from $t$ tests and chi-square tests revealed that participants who had made a recent (past year) suicide attempt ($n = 14$) did not differ from non-attempters ($n = 73$) in age, sex, race, or presence of current psychiatric disorders ($ps = 0.08$–$0.83$), except for presence of a mood disorder ($\chi^2_{(1)} = 17.62$, $\Phi = 0.45$, $p < 0.05$) and number of psychiatric disorders ($t_{(85)} = -2.63$, $d = 0.75$, $p < 0.05$). Problem-solving skills were unrelated to either emotion reactivity ($r = 0.08$, *ns*) or presence of a recent suicide attempt ($r = -0.04$, *ns*). Emotion reactivity was moderately associated with presence of a suicide attempt ($r = 0.31$, $p < 0.01$), as has been shown in a prior study (Nock et al., 2008).

*Emotion–cognition interaction in the statistical prediction of a suicide attempt*

Consistent with our hypothesis, as shown in Fig. 1, the interaction between emotion reactivity and problem-solving skills significantly statistically predicted the probability of youth suicide attempts ($\chi^2_{(3)} = 13.90$, $p < 0.05$) (Table 1). Post-hoc probing revealed that emotion reactivity was strongly associated with the probability of a suicide attempt among those with poor problem-solving skills ($B = 2.22$, SE = 0.79, $p < 0.01$), moderately associated among those with moderate problem-solving skills ($B = 1.23$, SE = 0.43, $p < 0.01$), and not significantly associated among those with good problem-solving skills ($B = 0.26$, SE = 0.47, *ns*).

*Emotion–cognition interaction and other risky behaviors*

We then tested whether the interaction effect statistically predicts the probability of other risky behaviors. Results revealed that the interaction between emotion reactivity and problem-solving skills did not predict the probability of other risky behaviors either as a group ($B = 0.06$, SE = 0.32, Wald = 0.03, OR = 1.06, CI = 0.56–2.00, *ns*), or individually: NSSI ($B = 0.11$, SE = 0.30, Wald = 0.14, OR = 1.12, CI = 0.62–2.01, *ns*), violent behavior ($B = -0.67$, SE = 0.66, Wald = 1.02, OR = 0.51, CI = 0.14–1.87, *ns*), or substance- or alcohol-use disorder ($B = 0.11$, SE = 0.35, Wald = 0.10, OR = 1.12, CI = 0.56–2.22, *ns*).

## Discussion

The main finding of this study is that the interaction of emotional and cognitive factors statistically predicts the occurrence

of adolescent suicide attempts. More specifically, adolescents with both high emotion reactivity and poor problem-solving skills were at greatest risk for attempting to kill themselves than were those high on only one of these factors (Fig. 1). Results also demonstrated a bivariate association between emotion reactivity and the probability of a suicide attempt (as demonstrated by prior research; Nock et al., 2008) but not between problem solving and the probability of a suicide attempt. Prior studies on suicidal behavior generally have examined problem-solving skills within a social context. Therefore, the absence of such an association in the current study may be attributed to examination of non-social problem-solving skills, which represents a divergence from prior studies. Future studies should concurrently examine the effects of intrapersonal and interpersonal problem-solving skills on adolescent suicide attempts.

The emotion–cognition interaction effect found in the current study provides support for several theoretical models of suicidal behavior. For example, escape theories of suicide propose that people choose suicide as a means of ending their intolerable affect because they cannot generate more adaptive solutions. In support of such theories, results from the current study suggest that it is the combination of having poor problem-solving skills and high emotion reactivity that increases risk of attempting suicide. Future studies should test this interaction in the prediction of subsequent suicide attempts. Doing so would begin to tease apart the temporal associations among these constructs and provide further insight into the development of this behavior among adolescents.

Results of the current study also are consistent with theories in developmental neuroscience suggesting that emotion–cognition interactions potentially lead to maladaptive behavior among adolescents (Galvan et al., 2006; Steinberg, 2007). However, results also indicate that this emotion–cognition interaction did not statistically predict the presence of less direct and harmful risky behaviors (i.e., engagement in NSSI, violent behavior, alcohol and substance use). These findings are surprising in light of the aforementioned advances in developmental neuroscience but may be explained by the nature of the dependent variable. Suicidal behavior is the most direct and lethal behavior, whereas NSSI, violent behavior, and alcohol and substance use are less directly self-destructive and dangerous. Perhaps highly emotionally reactive adolescents who have poor problem-solving skills cannot generate adaptive (e.g., calling a friend) or even non-lethal maladaptive (e.g., alcohol abuse) solutions; thus, they resort to the most effective but lethal means (e.g., suicide) to escape their intolerable affective state.

Another possible explanation for why the current results did not demonstrate a relation between this emotion–cognition interaction and other less risky behaviors is that the type of emotion–cognition interaction tested may be associated with suicide attempts only. Perhaps the particular combination of high emotion reactivity and poor problem-solving skills leads to suicidal behavior, whereas other emotion–cognition interactions (e.g., high emotion reactivity and poor social communication skills) lead to other risky behaviors (e.g., NSSI, alcohol abuse, reckless driving). Future studies should examine the effects of different combinations of emotional and cognitive factors in the statistical prediction of suicidal behavior as well as other risk-taking behaviors.

### *Limitations and future directions*

These results should be interpreted in light of several limitations, which give rise to important future directions for this line of research. First, the current study was cross-sectional, precluding any causal inferences. Although it was hypothesized that having high emotion reactivity and poor problem-solving skills increases an adolescent's risk of choosing suicide as a means of escape, another possible interpretation of these results is that prior history of attempting suicide increases likelihood of developing high emotion reactivity and poor problem-solving skills. Future studies should test this interaction effect prospectively to elucidate the temporal relations among these constructs.

Second, the relatively small and homogeneous sample limits the generality of the current results to more diverse samples of varying ages, ethnicities, and genders. Replication of these results with larger, more heterogeneous samples is needed.

Finally, each independent and dependent factor was assessed using only one form of assessment. Future studies using multiple measurement methods would provide a stronger test of the proposed model. Further, although level of problem-solving skills was determined using a behavioral measure, emotion reactivity was assessed using retrospective self-report, which is a less objective means of assessment than a physiological measure of emotion reactivity (Schacter, 1999). Administering several methods of assessment, including objective measures, will provide a better understanding of how these factors interact to statistically predict this dangerous outcome.

### *Conclusion*

Evidence of an emotion–cognition interaction provides greater insight into the processes that may lead to suicidal behavior among adolescents. It also extends existing research on emotion–cognition interactions into the clinical domain and supports theoretical models of suicide. Finally, these findings may have important implications for future prevention and intervention efforts. Such efforts might consider enhancing child and adolescent problem-solving skills in addition to emotion regulation skills. Indeed, prior research has demonstrated that treatments aimed at enhancing problem-solving and emotion regulation skills can decrease the risk of suicidal behavior (Linehan et al., 2006). Future studies that examine the causal role of these factors and the effects of more complex interactions developmentally will produce a deeper understanding of why some adolescents attempt suicide and hopefully will reduce the prevalence of this dangerous behavior among our youth.

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