# Brooding, Inattention, and Impulsivity as Predictors of Adolescent Suicidal Ideation

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## Abstract

Although suicide remains a leading cause of death for adolescents, risk factors beyond diagnoses and suicide attempt history remain unclear. We examined whether cognitive style and temperament impact risk for an early, yet still clinically relevant and distressing, form of suicidality: active suicidal ideation. We used binary logistic regression to test whether brooding, inattention, and impulsivity predicted significantly increased risk for suicidal ideation in a sample of 134 twins, 46 of whom endorsed active suicidal ideation (*i.e.,* probands), as well as probands' cotwins and matched controls. When comparing probands with controls and controlling for depression diagnoses, brooding (B=0.73, Odds Ratio [OR]=2.07, p=0.021), inattention (B=1.09, OR=2.98, p<0.001), and impulsivity (B=0.91, OR=2.47, p=0.001) differentiated probands from controls, individually. We compared probands with their cotwins using the same approach, which allowed us to account for variance in suicidal ideation risk related to twins' shared, familial characteristics (*e.g.,* prenatal environment, neighborhood); inattention was the only significant predictor of suicidal ideation risk (B=0.66, OR=1.93, p=0.020). We then fit a logistic regression model that included all three predictors. Only inattention predicted significantly increased likelihood of suicidal ideation in proband versus controls and proband versus cotwin comparisons (B=0.88, OR=2.40, p=0.024 and B=0.67, OR=1.96, p=0.045, respectively). These results highlight the potential utility of examining novel, more proximal risk factors for suicidal ideation in addition to more established distal factors, like suicide attempt history and psychiatric diagnoses.

## Keywords

suicidal ideation; suicide; brooding; inattention; impulsivity

## Introduction

Adolescent suicide rates have increased by 25 percent in the last 15 years, making suicide the second leading cause of death for individuals between the ages of 10 and 19 (Sullivan, Annest, Simon, Luo, Dahlberg, & Centers for Disease Control and Prevention [CDC],

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2015). Each year, approximately one in seven adolescents seriously considers completing suicide or creates a suicide plan (Annest et al., 2015). Despite climbing rates of suicide, relevant risk factors beyond psychiatric diagnoses, family history of suicidal behavior, and demographic characteristics are poorly understood; however, an understanding of additional factors that increase suicide risk concurrently and/or longitudinally could provide invaluable insight into the development of suicidal behavior (Nock, Green, Hwang, McLaughlin, Sampson, Zaslavsky, & Kessler, 2013; Nock, Borges, Bromet, Alonso, Angermeyer, Beautrais, Bruffaerts, Chiu, Girolamo, Gluzman, Graaf, Gureje, Haro, Huang, Karam, Kessler, Lepine, Levinson, Medina-Mora, Ono, Posada-Villa, & Williams, 2008; Brent, Bridge, Johnson, & Connolly, 1996).

The prevailing conceptualization of suicidal behavior is a continuum ranging from suicidal ideation to suicide completion (Smith, Alloy, & Abramson, 2006). Examining predictors of less severe forms of suicidal behavior (*e.g.,* suicidal ideation) is essential to understanding the full developmental trajectory leading to completed suicide. Suicidal ideation is uniquely associated with suicide attempt, even when controlling for depression severity (Lewinsohn, Rohde, & Seeley, 1996). Additionally, 88 percent of suicide attempts are preceded by suicidal ideation, making it a critical marker of risk for more severe forms of suicidal behavior (Lewinsohn et al., 1996). Aside from prior suicidal behavior, suicidal ideation is the best predictor of subsequent suicide attempts and completion, but suicidal ideation generally does not lead to suicide attempts, especially in the absence of a specific plan (Prinstein, Nock, Simon, Aikins, Cheah, & Spirito, 2008; Nock et al., 2008). Examining risk factors for suicidal ideation may be one way to gain a clearer understanding of which individuals might benefit most from therapeutic interventions.

Given the strength with which suicidal ideation predicts more severe suicidal behavior, understanding how other factors, such as cognitive style and temperament traits (*e.g.,* brooding, inattention, and impulsivity), influence risk for thoughts about suicide becomes crucial. Psychopathology, including suicidal ideation, exists within the context of each individual's characteristics (Tackett, 2006). Thus, prediction of clinically relevant outcomes, such as suicidal ideation, can be enhanced by examining how these other temperament or cognitive factors influence suicidal ideation. Brooding, inattention, and impulsivity are rarely examined as risk factors for suicidal ideation outside of specific mental health diagnoses; however, several studies (reviewed below) do suggest that further examination of these predictors might be fruitful.

### Brooding and suicidal ideation risk

A tendency toward negative, ruminative thought patterns may increase risk for suicidal ideation by precluding effective problem-solving and mood regulation (Lyubomirsky & Nolen-Hoeksema, 1995). Additionally, Williams, Barnhofer, Crane, & Beck (2005) found that interpersonal problem-solving abilities of individuals with a history of depression and suicidality could not be distinguished from those of controls who had not experienced depression or suicidality prior to a mood challenge (*e.g.,* reading sad statements, listening to music that had a sad tone); however, previously depressed and suicidal individuals showed

diminished problem-solving following a mood challenge, potentially because of the excessive focus on negative thoughts about the self, triggered by low mood.

Based on factor analyses conducted by Treynor, Gonzalez, & Nolen-Hoeksema (2003), rumination is commonly separated into two subtypes: brooding (*i.e.,* "a passive comparison of one's current situation to some unachieved standard") and reflection (*i.e.,* "a purposeful turning inward to engage in cognitive problem solving to alleviate one's depressive symptoms"). Findings regarding the link between reflection and depression vary, but brooding is consistently associated with negative affect and depression across ages and reporters (Moberly & Watkins, 2008). Brooding also predicts suicidal ideation in adult community samples when both passive and active forms of suicidal ideation are combined (Miranda & Nolen-Hoeksema, 2007). Relatedly, rumination predicts both the duration and severity of young adults' suicidal ideation (Smith et al., 2006); however, the specific relation of brooding to suicidal ideation in the general adolescent population is unclear, making this potential association crucial to understand.

### Inattention and suicidal ideation risk

Another risk factor that may predispose individuals to suicidal ideation is attention problems. Children with ADHD are 3.6 times more likely to attempt suicide than their same-age peers without ADHD, and a diagnosis of ADHD is associated with increased likelihood of completed suicide (Chronis-Tuscano, Molina, Pelham, Applegate, Dahlke, Overmyer, & Lahey, 2010; James, Lai, & Dahl, 2004). Moreover, a functional magnetic resonance imaging (fMRI) study comparing depressed adolescents to healthy controls revealed that the subset of depressed adolescents who had attempted suicide displayed increased activity in attention control circuitry in response to angry faces (Pan, Hassel, Segreti, Nau, Brent, & Phillips, 2013). Pan et al. (2013) contend that this increased brain activity suggests inefficient recruitment of attentional control circuitry in response to others' anger. This inefficient response pattern could lead to heightened processing of and focus on signs of others' disapproval, which is most likely a risk factor for suicide attempts (Pan et al., 2013). Despite evidence that attentional control issues increase risk for suicidality, attention problems and their relation to suicidal behavior are nearly always examined in the context an ADHD diagnosis. Consequently, how attention problems specifically, rather than the heterogeneous components of an ADHD diagnosis, relate to suicidal ideation remains unclear and crucial to investigate.

### Impulsivity and suicidal ideation risk

Impulsivity may also be a risk factor for suicidal ideation; however, very few studies address this topic. Difficulty with impulse control may reflect emotion regulation deficits, which translate into difficulty with managing reactions to interpersonal struggles and other forms of stress (Conner, Meldrum, Wieczorek, Duberstein, & Welte, 2004). An inability to cope effectively with these scenarios may increase the likelihood that an adolescent would contemplate suicide. Also, impulsivity may lead people to experience more emotionally painful scenarios, including embarrassment or interpersonal rejection, more frequently than non-impulsive individuals might (Witte, Merrill, Stellrecht, Bernert, Hollar, Schatschneider, & Joiner, 2008). Witte et al. (2008) suggest that accruing these emotionally painful

experiences over an extended period may produce feelings of isolation and hopelessness, both of which are related to suicidal ideation.

Additional information about how impulsivity relates to the specific outcome of suicidal ideation is lacking, but impulsivity is reliably associated with more severe forms of suicidal behavior. Among depressed adult inpatients, those who have attempted suicide report significantly higher levels of impulsivity than their counterparts who have not attempted suicide, even when controlling for demographic characteristics, antidepressant medication use, depression severity, and measures of psychopathology severity (Corruble, Damy, & Guelfi, 1999). Additionally, increased impulsivity is associated with younger age of suicide completion (McGirr, Renaud, Bureau, Seguin, Lesage, & Turecki, 2008). The lack of information about the plausible association between impulsivity and suicidal ideation and the consistency of evidence that impulsivity increases risk for suicide attempts and completion underscores the importance of exploring whether impulsivity relates in the same way to less severe, yet still highly clinically relevant, forms of suicidal behavior.

### Hypotheses

The goal of our study was to determine whether brooding, inattention, and impulsivity are associated with significantly increased risk for concurrent adolescent suicidal ideation using a cross-sectional design. These temperamental and cognitive style predictors are nearly always examined in the context of a diagnosis (e.g., depression) that is broadly related to risk for various forms of suicidality; however, we hypothesized that each of these three common and clinically relevant tendencies would predict suicidal ideation, even after controlling for a diagnosis of depression.

## Method

### Participants

The sample comprised 134 identical and fraternal twins (mean age=14.6 years) participating in one of two community-based longitudinal twin studies. One of the subsamples was wholly recruited from birth records, but part of this subsample was mildly enriched for psychopathology when the twins were 7 years old (*i.e.,* at least one member of the twin pair scored more than 1½ standard deviations above the mean level of parent-rated depression, anxiety, overanxiousness, oppositional defiance, aggression, conduct disorder, inattention, or impulsivity on the MacArthur Health and Behavior Questionnaire [Essex, Boyce, Goldstein, Armstrong, Kraemer, Kupfer, & MacArthur Assessment Battery Working Group, 2002]; cotwins of twins who met these criteria and low symptom twin pairs were also included [Schmidt, Van Hulle, Brooker, Meyer, Lemery-Chalfant, & Goldsmith, 2012]). The other subsample was recruited using birth records, mothers of twins groups, and advertisements, with no enrichment for symptoms. Twins were selected for follow-up assessments during adolescence based on prior participation during early and mid-childhood. Informed consent was obtained from all individual participants included in the study. The Institutional Review Board at the University of Wisconsin—Madison approved the protocol.

Twins completed a diagnostic interview assessing psychopathology based on criteria from the Diagnostic and Statistical Manual (DSM-IV); the diagnostic interviews (Diagnostic Interview Schedule for Children [Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000] or DISC Predictive scales Lucas, Zhang, Fisher, Shaffer, Regier, Narrow, Bourdon, Dulcan, Canino, Rubio-Stipec,Lahey, & Friman, 2001] also included a suicide risk assessment if a participant endorsed suicidal ideation. The rates of endorsement of suicidal ideation were similar between the partially selected (40 out of 1,140 [3.5%]) and unselected subsamples (6 out of 138 [4.3%]) samples. This consistency is unsurprising because recruitment for both studies took place more than 10 years prior to the twins' endorsement of suicidal ideation during follow-up phases.

The combined sample of probands, their twins, and matched controls was 53% female and 77.6% Caucasian, 13.3% Black, 3.7% Native American, and 1.5% Chinese (4.5% of ethnicity was missing or not reported). Family income was assessed using a numeric scale with categories ranging from $10,000 or less to over $200,000. The median family income in the sample was between $60,001 and $70,000. Approximately half of the participants' biological parents were married to each other (52.2 %).

### Measures

**Brooding.—**The RSQ contains a 22-item scale assessing ruminative responses and an 11-item scale about distractive responses; the response scale ranges from 1 ("almost never") to 4 ("almost always"; Nolen-Hoeksema & Morrow, 1991). The rumination scale of the RSQ contains two main components after depression-confounded items are excluded: brooding (*e.g.,* "I think 'Why do I always react this way?'") and reflection (*e.g.,* "I write down what I am thinking about and analyze it"). Because reflection is considered a more neutral cognitive process and has mixed associations with depression, we focused on brooding, which is more hedonically negative and relates to depression more consistently (Burwell & Shirk, 2006). We formed a brooding composite by averaging the five item-level brooding scores and then standardizing this composite. 70.9% of participants had complete data from this measure. Internal consistency for brooding in our sample is acceptable and similar to estimates from prior studies (Cronbach's alpha = .80; Nolen-Hoeksema & Morrow, 1991). The RSQ has previously been used with adolescents and has good test-retest reliability and validity for predicting depression (Broderick & Korteland, 2004; Nolen-Hoeksema et al., 1994, Just & Alloy, 1997; Nolen-Hoeksema & Morrow, 1991).

**Inattention & Impulsivity.—**Inattention and impulsivity were self-reported by adolescents within one month of the diagnostic interview using the MacArthur Health and Behavior Questionnaire (HBQ), which assesses physical health and mental health symptoms, adaptation, and impairment (Essex et al., 2002). The HBQ response scale has six response options ranging from 1 to 7 (*i.e.,* no 4) and allows the participant to report whether a given behavior is "really like me" or whether the opposite of that behavior is "really like me" using the time frame of the past six months. The HBQ symptom scales are DSM-IV-based and assess inattention (*e.g.,* "I have a hard time paying attention"; 7 items) and impulsivity (*e.g.,* "In class, I interrupt and blurt out answers when it's not my turn"; 8 items) outside the context of a diagnosis. The HBQ has strong test-retest reliability and high

discriminant validity (Essex et al., 2002). The internal consistency estimates for the inattention and impulsivity scales are .84 and .86, respectively, in our sample; 91% of participants had complete HBQ data.

**Diagnostic Interviews.**—Depression diagnosis was derived from structured diagnostic interviews conducted by trained interviewers with all participants. Although two different diagnostic interviews were used, they are quite similar, and both are reliable, valid, and based on DSM-IV criteria (Lucas et al., 2001). Seventy-nine participants completed the DISC Predictive Scales, and 55 participants completed the Diagnostic Interview Schedule for Children (DISC; Version IV; Shaffer et al., 2000). The DISC Predictive Scales are derived from stem questions on the Diagnostic Interview Schedule for Children and accurately predict DISC diagnoses (Lucas et al., 2001). Diagnostic information from these interviews is presented in Table 1.

**Suicidal Ideation.**—Both the DISC and DPS include an item about suicidal ideation that asks respondents whether they have "thought seriously about killing [her/himself]"; however, the DPS assesses whether this has occurred in the past three months, while the DISC assesses whether it has occurred in the past year. Rates of suicidal ideation endorsement were 3% for DPS and 5% for DISC).

If suicidal ideation on the DISC or DPS was endorsed, following an IRB-approved procedure, we interrupted the interview to assess participants' suicidal ideation with a structured suicide risk assessment developed by study authors and other members of the research team. The risk assessment allowed us to ascertain whether an adolescent's suicidal ideation posed an imminent threat (*i.e.,* likely suicide attempt within 24 hours) to their safety, as well as whether they had a plan for completing suicide and the means to do so. We also assessed the degree of social support in the adolescent's life and any prior suicide attempts (see supplemental Appendix A).

## Data Analysis

We fit a series of logistic regression models to assess whether brooding, inattention, and impulsivity significantly increase the likelihood of presence of suicidal ideation. Participants completed questionnaires about impulsivity, inattention, and brooding in addition to the diagnostic interview and risk assessment, which allowed us to examine how these temperament and cognitive style variables alter risk for suicidal ideation concurrently. We controlled for depression diagnosis for theoretical and practical reasons. Theoretically, our interest is in risk factors independent of depression, and if associations between predictors and suicidal ideation are secondary to a depression diagnosis, then little motivation exists for examining these traits as predictors. Practically, while the DPS provides an accurate screen for DSM related disorders relative to the DISC (Lucas et al., 2001), the psychometric properties of DPS symptom counts relative to DISC symptom counts are unknown. Therefore, we controlled for depression diagnosis (rather than depressive symptoms).

We sought to distinguish three groups: the focal group of adolescents with suicidal ideation (*i.e.,* probands), cotwins of probands, and matched controls. Matched controls were selected from the full longitudinal twin sample ($N = 1,140$) based on their similarity to probands with

regard to sex, age, ethnicity, family income, and parents' marital status. If both members of a twin pair matched the proband, one member was selected at random. Logistic regression models (described below) that included probands and controls provided information about how brooding, inattention, and impulsivity impact individuals' likelihood of suicidal ideation when controlling for variance in suicidal ideation risk related to demographic characteristics shared by probands and controls.

Next, we repeated these analyses substituting probands' cotwins in place of matched controls. The two twin pairs in which both cotwins endorsed suicidal ideation were removed from these analyses. These models provided information about how brooding, inattention, and impulsivity affect risk for suicidal ideation while more stringently accounting for variance related to shared, familial characteristics. Probands share not only basic demographic characteristics, but also additional biological and environmental factors with their cotwins (*i.e.,* versus controls). This increased overlap of twins' traits and characteristics allowed us to control for more variance in suicidal ideation likelihood related to these unmeasured genetic and shared environmental factors (*e.g.,* prenatal environment, neighborhood, household, and parents' religious and political beliefs) than in the analyses comparing probands with matched controls. Thus, the difference between the probands and their unaffected cotwins arise from differences within families, and thus represent a subset of the whole range of risk factors.

The twin-based data are likely to generalize to non-twins, as twins typically have the same risk for behavior and adjustment issues, including depression, generalized anxiety disorder, phobias, and panic disorder, as singletons (Rutter & Redshaw, 1991; Kendler & Gardner, 1998). Additionally, as noted above, both twins endorsed suicidal ideation in only two pairs, which suggests that environmental factors influence risk for suicidal ideation more than genetic factors.

In all analyses, we used p < .05 (two-tailed) as the criterion for significance, but we report precise p-values for all analyses.

### Missing data and multiple imputation

Due to the combination of longitudinal studies included in our sample, some participants were missing scores for certain predictor composites because of a priori data collection decisions about which questionnaires would be included in different phases of the studies. Nine percent of participants were missing inattention data, 9 percent were missing impulsivity data, and 29.1 percent were missing brooding data. To address missingness at the composite level for these predictors, we used multiple imputation in SPSS (IBM Corp.; iterative Markov chain Monte Carlo [MCMC] with fully conditional specification). Multiple imputation models included not only the variables with missing data, but also a set of relevant demographic variables (*e.g.,* sex, age; Gottschall, West, & Enders, 2012). Predicted values for missing data were created by regressing each variable on all other variables. This imputation process was repeated for 20 iterations. Results of logistic regression analyses were pooled across the 20 datasets.

# Results

## Suicidal Behavior

Following probands' endorsement of suicidal ideation, a senior staff member assessed their immediate safety by collecting additional information about events, thoughts, and behavior relevant to suicide risk. Based on this risk assessment, we classified all probands' risk of a suicide attempt or completion as non-imminent (*i.e.,* very low likelihood of suicide attempt or completion within 24 hours). When asked if they had a plan for killing themselves, 13 percent of probands replied affirmatively. Staff members also assessed the participant's intention to complete suicide; 21.7 percent stated the likelihood was essentially zero (*e.g.,* "never", "zero percent chance"), 45.7 percent said they were unlikely to kill themselves (*e.g.,* "not likely at all"), and 15.2 percent replied with uncertainty or a higher likelihood (*e.g.,* "5 out of 10", "I don't know").

We also assessed suicide attempt history and the degree of social support available to the participants. Nearly one-fifth (19.5%) of participants reported at least one prior suicide attempt, and 32.6 percent stated that they had not told anyone about their suicidal ideation. Additionally, although the risk assessment did not specifically assess participants' history of self-injurious behaviors, 19.6 percent of probands shared that they had engaged in self-harm at least once.

## Means, variability, and sex differences for the predictor variables

The means and standard deviations of the brooding, inattention, and impulsivity composites are listed in Table 2. Across probands, cotwins, and matched controls, mean levels of brooding and inattention did not vary significantly by sex; however, males were significantly more impulsive (Cohen's $d = 0.4$).

We also tested for sex differences in the three samples separately. Among probands and cotwins, no significant sex differences occurred in mean levels of brooding, inattention, or impulsivity although males were slightly more impulsive than females. Mean levels of impulsivity did vary significantly by sex among matched controls (p=0.048).

Perhaps no significant sex differences in brooding, inattention, or impulsivity among probands and cotwins occurred due to elevated symptom-related risk factors (Table 2). Probands had the highest levels of all three risk factors. Cotwins of probands exhibited values that were between those of probands and matched controls for all three predictors. For matched controls, who scored lowest on each risk factor, males scored higher on impulsivity, as expected. Matched controls did not display the expected sex difference of females reporting more brooding. This may be due to the age of the sample (average 14.6 years) because pronounced sex differences in brooding typically emerge around age 15 (Cox, Mezulis, & Hyde, 2010).

## Intercorrelations of the predictor variables

Next, we examined the correlations among brooding, inattention, impulsivity, and depression diagnosis. All three predictor variables (*i.e.,* brooding, inattention, impulsivity)

were significantly intercorrelated (Table 3). The correlation between brooding and inattention was .29 (p=0.005), and the correlation between brooding and impulsivity was .27 (p=0.008). As expected, the strongest correlation was between inattention and impulsivity (r=.70, p<0.001), which is unsurprising given that they frequently co-occur as symptoms of ADHD. However, differentiating inattention and impulsivity may help to subdivide diagnostic profiles in ways that relate meaningfully to patterns of depression comorbidity (Newcorn, Halperin, Jensen, Abikoff, Arnold, Cantwell, Conners, Elliott, Epstein, Greenhill, Hechtman, Hinshaw, Hoza, Kraemer, Pelham, Severe, Swanson, Wells, Wigal, & Vitiello, 2001). Depression diagnosis correlated significantly with inattention (r=0.24, p=0.009), but not with brooding or impulsivity.

### Brooding, inattention, and impulsivity as predictors of suicidal ideation (matched control analyses)

Using a binary logistic regression model controlling depression diagnosis, we tested brooding as a predictor of suicidal ideation when comparing 46 probands to 46 matched controls (Table 4). We did not control for sex in this set of analyses because controls were matched on proband sex. This model accounted for 28.2 percent of the variance (Nagelkerke $R^2$) in suicidal ideation status (*i.e.,* present or not) and correctly classified 65 percent of cases. For a one standard deviation (SD) increase in brooding, an adolescent's odds of endorsing suicidal ideation increased by a factor of 2.1 (B=0.73, p=0.021). Qualifying for a depression diagnosis increased an adolescent's odds of endorsing suicidal ideation by a factor of 13.7 (B=2.62, p=0.018) after controlling for brooding.

Next, we examined whether inattention predicts suicidal ideation when controlling for depression diagnosis in a subsample of 46 probands and 46 matched controls (Table 4). This model accounted for 37.8 percent of the variance (Nagelkerke $R^2$) in suicidal ideation status and correctly classified 70.6 percent of cases. For a one SD increase in inattention, an adolescent's likelihood of experiencing suicidal ideation increased by a factor of 3.0 (B=1.09; p<0.001). Adolescents who met criteria for major depressive disorder were 12.2 times more likely to experience suicidal ideation (B=2.50, p=0.025) after controlling for inattention.

We then evaluated impulsivity as a predictor of suicidal ideation in a model that also accounted for depression diagnosis and included 46 probands and 46 matched controls (Table 4). This model accounted for 34.2 percent of variation in suicidal ideation status and classified 73.3 percent of cases correctly. A one SD increase in adolescent impulsivity was associated with 2.5 times greater likelihood of experiencing suicidal ideation (B=0.91; p=0.001). Meeting criteria for major depressive disorder increased an adolescent's odds of having suicidal ideation by 16.3 times (B=2.79, p=0.012) after controlling for impulsivity.

### Combined temperamental and cognitive style predictors of suicidal ideation (matched control sample analyses)

Next, we fit a logistic regression model that included all three temperamental and cognitive style predictors for 46 probands and 46 matched controls (*i.e.,* brooding, inattention, impulsivity). We did not statistically control for cotwin sex or depression diagnosis because

cotwin sex was not significant in any prior model, and because depression would have exhibited too much collinearity with the combination of three relevant variables. A one SD increase in inattention increased suicidal ideation risk increased by a factor of 2.4 (B=0.88; p=0.024). Brooding (B=0.57; p=0.109) and impulsivity (B=0.26; p=0.478) did not relate significantly to risk for suicidal ideation after controlling for inattention and the other predictor (Table 4). On a post hoc basis, we did test whether adding depression diagnosis to this model altered our pattern of results. Doing so changed beta values minimally and did not influence the overall pattern of results.

### Brooding, inattention, and impulsivity as predictors of suicidal ideation (cotwin sample analyses)

Next, we ran a series of binary logistic regression models that included 42 probands and their 42 cotwins. These analyses sought to examine the role of within-family differences in predicting suicidal ideation. We removed two twin pairs in which both members endorsed suicidal ideation. We did control for cotwin sex in these analyses to adjust for opposite sex dizygotic twin pairs, which constituted 37.3% of the sample.

Using a binary logistic regression model controlling for cotwin sex and depression diagnosis, we tested brooding as a predictor of suicidal ideation (Table 5). This model accounted for 15.4% of the variance (Nagelkerke $R^2$) in suicidal ideation status and classified 65.1 percent of cases correctly. Brooding (B=0.49, p=0.108) was not associated with significantly increased odds of experiencing suicidal ideation. Cotwin sex (B=−0.46, p=0.337) and qualifying for a diagnosis of depression did not relate significantly to risk for suicidal ideation (B=1.14, p=0.125).

We then examined whether inattention predicts suicidal ideation when controlling for cotwin sex and depression diagnosis (Table 5). This model accounted for 18.8% of the variance (Nagelkerke $R^2$) in suicidal ideation and correctly classified 65.2 percent of cases. For a one SD increase in inattention, an adolescent's likelihood of experiencing suicidal ideation increased by a factor of 1.9 (B=0.66; p=0.020). Cotwin sex and meeting criteria for major depressive disorder did not predict risk for suicidal ideation ($B_{cotwin\ sex}$= −0.12, p=0.805; $B_{depression}$=0.93, p=0.219).

We then evaluated impulsivity as a predictor of suicidal ideation in a model that also accounted for sex and depression diagnosis (Table 5). This model accounted for 14.8 percent of variation in suicidal ideation and classified 60.8 percent of cases correctly. Increased impulsivity was not associated with greater likelihood of experiencing suicidal ideation (B=0.47, p=0.074). Neither cotwin sex nor meeting criteria for major depressive disorder predicted significantly increased risk for suicidal ideation ($B_{cotwin\ sex}$= −0.36, p=0.446; $B_{depression}$=1.32, p=0.062).

### Combined temperamental and cognitive style predictors of suicidal ideation (cotwin sample analyses)

We also fit a logistic regression model that included all three predictors for 42 probands and their 42 cotwins. As in previous analyses comparing probands with cotwins, we removed the two twin pairs in which both twins endorsed suicidal ideation. We did not statistically

control for cotwin sex (because it was not a significant predictor in the three models just described) or depression diagnosis. For every SD increase in inattention, adolescents' risk for suicidal ideation was 2.0 times greater (B=0.67; p=0.045). Neither brooding (B=0.46; p=0.139) nor impulsivity (B=0.051; p=0.877) was associated with significantly increased risk for suicidal ideation (Table 5). Again on a post hoc basis, we tested whether adding depression diagnosis to this model changed our findings. This was not the case; beta values changed only minimally.

### Examination of the impact of comorbid ADHD

We conducted post hoc analyses to test whether brooding, inattention, and impulsivity individually predicted suicidal ideation when controlling for ADHD diagnosis to determine whether the significance of our predictors was a reflection of adolescents' overall symptom severity. This was apparently not the case because our pattern of results remained unchanged when controlling for ADHD, with the exception of brooding becoming a significant predictor when comparing probands with their cotwins in addition to predicting increased risk in the comparison of probands with controls (B=0.61, OR=1.839, p=0.03). We attribute this difference to the construct of brooding overlapping less with ADHD, which may explain its decreased robustness in models controlling for depression.

## Discussion

We examined brooding, inattention, and impulsivity as risk factors for suicidal ideation during adolescence using a combined sample of probands who endorsed suicidal ideation, their cotwins, and matched controls. Comparison of probands to matched controls revealed that brooding, inattention, and impulsivity predicted increased likelihood of suicidal ideation, as did a diagnosis of depression. When probands were compared to their cotwins, only inattention was associated with significantly increased risk. Thus, two patterns in the results deserve interpretation: (1) the difference between findings with matched controls and cotwins, and (2) the power of inattention as a predictor across all analyses.

### Apparent rigor of the analyses using cotwins of probands as the contrast group

Fewer significant predictors emerge when probands are contrasted with cotwins than when they are compared with matched controls. Thus, the cotwin control method is more rigorous, presumably because it goes beyond relevant demographic controls to equate for biological and experiential processes that affect members of the same family in similar ways. If sufficient numbers of both monozygotic and dizygotic pairs had been available, then we would have parsed the within-family factors into genetic differences (in the dizygotic pairs) and environmental difference components. In our smaller sample, we combine the monozygotic and dizygotic pairs and leave genetic and environmental differences unanalyzed.

One of our salient findings was that the link between a depression diagnosis and suicidal ideation seems to be driven by biological and environmental factors that are shared by twins (*e.g.,* genetics, prenatal environment, family socioeconomic status, neighborhood and school environment, chaos in the home environment, insofar as they affect cotwins' similarly). This

is the inference supported by finding that depression diagnosis was a significant predictor in the proband vs. matched control analyses, but not in the proband vs. cotwin analysis. We note as a caution, however, that our design did not allow a direct statistical test for the *difference* in the predictive power of the depression diagnosis across the two methods of analysis. Still, depending on the research question, our results point to the power of cotwin controls, or more generally sibling controls, to unconfound predictors when they operate in family contexts.

## The robust predictive power of inattention

The only predictor that was significant across the four analytic approaches (single predictor with matched controls controlling for depression; single predictor with cotwin controls controlling for depression; multiple predictors with matched controls and with cotwins) was inattention. Given that inattention predicted risk for suicidal ideation more consistently than brooding or impulsivity, we must consider the meaning and implications of this robust prediction. Perhaps self-report inattention items (*e.g.,* "It's hard for me to work on one thing for a long time") included in our study predict suicide risk robustly because difficulty sustaining attention and the resultant interpersonal and educational struggles may damage adolescents' functioning, self-perception, or feelings of worth in ways that fuel suicidal ideation. Relatedly, the robust predictive power of inattention in our sample may corroborate the conclusion of Pan et al. (2013) that attentional control difficulties contribute to ineffective responses to others' anger significantly enough to increase risk for suicidal ideation.

It is also possible that inattention is a behavioral marker of neuropsychological factors related to risk for suicidal thoughts and behaviors. Cognitive control deficits (*e.g.,* attentional difficulties) are a potential endophenotype of depression, and fostering recognition and redirection of negative thought patterns is crucial for sustained improvement in symptoms (Trivedi & Greer, 2014; Webb, Dillon, Pechtel, Goer, Murray, Huys, Fava, McGrath, Weissman, Parsey, & Kurian, 2016; Halari, Simic, Pariante, Papadopoulos, Cleare, Brammer, Fombonne, & Rubia, 2008). It is possible that cognitive control difficulties among adolescents who report suicidal ideation may present as inattention and impede disengagement from suicidal thoughts. However, meta-analyses of cognitive control deficits among individuals with depression typically include patient samples and measures of attention that differ from those used with our community sample (*e.g.,* Trivedi & Greer, 2014; Webb, Dillon, Pechtel, Goer, Murray, Huys, Fava, McGrath, Weissman, Parsey, & Kurian, 2016).

Although adolescents who endorse suicidal thoughts may experience the attentional impairments that tend to accompany depression, they also seem to experience alterations in attention that are specifically associated with suicidality. Compared with adolescents who are not suicidal, but have symptoms of affective disorders, adolescents who have attempted suicide show impaired decision making and problem solving, such as worse overall performance on the Iowa Gambling Task, even when controlling for medication use, diagnostic status, and personality factors (Bridge, McBee-Strayer, Cannon, Sheftall, Reynolds, Campo, Pajer, Barbe, & Brent, 2013). Moreover, adolescents who have attempted

suicide display a failure to learn new contingencies that emerge during this task, suggesting difficulty with integrating new information into problem solving processes (Bridge et al., 2013). Although the directionality of these effects remains unclear, our findings provide support for conceptualizing inattention as a behavioral indicator of these neuropsychological alterations.

Alternatively, but perhaps somewhat less plausibly, inattention self-reported by adolescents might instead be a reflection of overall symptom severity or distress that is substantial enough to impair completion of daily activities. Because adolescents are not always completely aware of the nature and severity of their symptoms, they may notice the more concrete experience of having trouble completing tasks that could co-occur with a mixture of less well-defined symptoms. To address whether inattention is a proxy for overall symptom severity, we conducted separate post hoc analyses of how brooding, inattention, and impulsivity related to suicidal ideation risk when controlling for ADHD. Controlling for this diagnosis did not impact our pattern of results, with the exception of brooding predicting increased risk for suicidal ideation in the comparison of probands with cotwins (in addition to predicting increased risk in the comparison of probands with controls in prior analyses). The minimal changes in results when controlling for a diagnosis of ADHD are consistent with prior studies in which the link between ADHD and suicidal ideation was fully mediated by other comorbid conditions (Balazs, Miklósi, Keresztény, Dallos, Gádoros, 2014). Overall, the independent predictive power of brooding, inattention, and impulsivity suggest that more stable, temperament based traits relate more strongly to concurrent suicidal ideation risk than the specific diagnoses that we examined.

## Partial support for hypotheses about the link between brooding and impulsivity and suicidal ideation risk

Although neither brooding nor impulsivity predicted increased risk for suicidal ideation in analyses comparing probands to cotwins, both predictors were significant in comparisons of probands with controls. This pattern of significance indicates that brooding and impulsivity do significantly influence individuals' likelihood of experiencing suicidal ideation when controlling for variance in suicidal ideation risk attributable to demographic characteristics shared by probands and controls. Because these findings did not persist when comparing probands with their cotwins, the associations of brooding and impulsivity with suicidal ideation risk can be attributed more to factors that are shared by twins (*e.g.,* prenatal environment and neighborhood) than non-shared experiences. However, given the stringency of our inclusion criteria (*i.e.*, active ideation instead of more common passive ideation) and the relative rarity of twin pairs with at least one member reporting suicidal ideation in our full longitudinal sample, our power to detect these effects was not as high as might be desirable. The association of impulsivity, and potentially also brooding, with suicidal ideation risk might be significant when comparing probands with their cotwins in a larger sample.

## Implications and limitations

Although most research on suicidality focuses on psychiatric diagnoses as predictors of severe suicidal behavior (*e.g.,* Chronis-Tuscano et al., 2004), our findings underscore the

importance of examining proximal and continuous predictors. The ability of concurrent brooding, inattention, and impulsivity to predict a significant increase in risk for suicidal ideation independently of depression diagnoses suggests that increasing temporal proximity of predictors may be another way to increase the precision of risk prediction. Additionally, our findings highlight the value of using specific cognitive style and temperamental predictors, rather than or in addition to global diagnostic factors, to clarify risk for various forms of suicidality, including suicidal ideation.

The developmental implications of our findings deserve emphasis. Individuals who are, on average, 15 years old have not lived through much of the risk period for suicide and have not experienced risks for suicidal ideation and behavior that could occur later in adolescence and adulthood. Studies of individuals in early adulthood, mid-life, or older age might yield quite different results. Additionally, our analyses do not account for all possible pathways to suicidal ideation during adolescence. Although inattention was our most robust suicidal ideation predictor, 15% of probands reported inattention scores lower (*i.e.,* better attention) than the mean of the matched controls, which suggests a pathway to suicidal ideation that does not involve attention problems for that subset of probands. Collectively, these results suggest that other important developmental, risk, and protective factors influence risk for suicidal ideation.

Our findings hold implications for clinical work, particularly because brooding, inattention, and impulsivity are relatively common tendencies. Evidence suggesting a link between brooding, inattention, and impulsivity and increased risk for suicidal ideation could be used to augment how clinicians screen and treat clients at risk for suicidal ideation, assuming that our findings can be replicated. Because individuals who experience more brooding, inattention, and impulsivity are more likely to endorse active suicidal ideation, suicide risk assessment might extend beyond the common approach of only tracking typical presentations of depression or impairment (*e.g.,* school refusal or issues with/paucity of relationships). Adding relevant facets of temperament and cognitive style to suicidal ideation screening may help individuals who are not traditionally viewed as at-risk receive help before their distress worsens.

Furthermore, because inattention predicted increased risk for suicidal ideation in analyses that compared probands with their cotwins, even when controlling for depression and ADHD diagnoses, the inattention-suicidal ideation association may be driven by unique experiential factors that are independent of not only basic demographic factors, but also genetic and environmental factors shared by twins. The cotwin control analyses are stringent tests that could be used to inform clinical interventions for adolescents at risk for suicidal ideation. Although many existing treatment modalities target attention in some capacity, evidence from studies comparing effects of cognitive behavioral therapy (CBT) for depression to CBT augmented with cognitive control training suggests that specific training to strengthen selective attention and persistence yields significantly greater reductions in rumination and overall depression symptomology than CBT alone (Siegle, Ghinassi, & Thase, 2007). Although individuals who are depressed and those who have suicidal thoughts presumably have attentional biases toward different types of negative thoughts or feedback, cognitive control training may provide similar benefits to suicidal adolescents by improving

their ability to interrupt and redirect attentional biases underlying suicidal ideation. Additionally, the significance of the inattention-suicidal ideation link in the cotwin comparison suggests that unique environmental influences drive this association, so it may also be useful for interventions to help adolescents process distressing experiences that are unique to them (*i.e.,* not shared by their cotwin), such as bullying, accidents, illness, etc. while building coping and problem-solving skills.

Unlike inattention, brooding and impulsivity did not predict increased risk for suicidal ideation when probands were compared to their cotwins, but brooding and impulsivity may still be promising targets for clinical interventions. Although associations between brooding and impulsivity appear to be driven by biological and/or environmental factors common to twins, rather than twins' unique experiences, they are not necessarily any more difficult to target with a clinical intervention. Numerous clinical techniques ranging from building problem-solving skills to enhancing emotion regulation can help adolescents who are temperamentally prone to brooding or impulsivity cope with these tendencies and manage them effectively, which could significantly reduce distress and risk for suicidal ideation.

One feature of our study is that the analyses were focused on the prediction of suicidal ideation instead of the full spectrum of suicidality. The outcome of suicidal ideation was chosen a priori; we could not feasibly examine predictors of suicide attempts because the rate of reported suicide attempts in our sample was too low to warrant inclusion in analyses. Additionally, we are not aware of any completed suicides in our sample, which prevented us from exploring predictors of this outcome. The time frame of suicidal ideation varied by diagnostic assessments (*i.e.,* past 3 months for the DPS and past year for the DISC). The rate of endorsement of suicidal ideation on the DPS was 3 percent, while the rate of endorsement on the DISC was 5 percent, suggesting only minor differences in the sensitivities of these instruments. However, the relatively similar rates of endorsement despite the significant difference in time frame indicates that most instances of suicidal ideation disclosed by adolescents occurred in the 3 months prior to the interview.

Given that our data are cross-sectional, the plausibility of direction of effect being from inattention (or the other traits studied) to suicidal ideation, rather than from suicidal ideation inducing or exaggerating these traits rests on considerations aside from the study's design. Longitudinal data would aid inferences, but excluding confounding variables would remain an obstacle to causal inference. As mentioned above, the mean age of our sample was mid-adolescence, which excludes a significant portion of development and other potential periods of risk for suicidal ideation. Moreover, the nature of inattention requires more explication. Future work should parse the inattention domain carefully (*e.g.,* distinguish difficulty sustaining attention from sufficient attentional problems to impede completion of tasks) and examine external correlates of inattention measures.

Despite these limitations, our analyses provide valuable insight into rarely examined predictors of suicidal ideation among adolescents in a community sample. Most adolescent suicidality studies involve individuals who are hospitalized for a suicide attempt or those who have completed suicide. Examining less severe suicidality is an important step toward understanding the development of more severe forms of these behaviors.

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## Conclusions

Our findings demonstrate that temperament traits and cognitive style can, independently of depression diagnoses, significantly impact risk for suicidal ideation during adolescence. Inattention emerged as a robust predictor of suicidal ideation across different methods of analysis. These results underscore the potential importance of incorporating aspects of adolescents' functioning that go beyond traditional symptom assessment when conceptualizing risk for suicidal ideation. Increasing our understanding of how specific and proximal risk factors, such as temperament traits and cognitive style, relate to adolescents' risk for suicidal ideation is an important step toward enhancing prediction of suicidal ideation and providing distressed adolescents with necessary resources and interventions earlier and more effectively.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgements

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**Table 1.**

Diagnostic information by group.

| | Probands (%) | Cotwins of Probands (%) | Matched Controls (%) |
|---|---|---|---|
| Major depressive disorder | 23.9 | 7.1 | 2.2 |
| Social anxiety disorder | 8.7 | 7.2 | 10.8 |
| Separation anxiety disorder | 15.2 | 7.2 | 2.2 |
| Agoraphobia | 13.1 | 9.5 | 4.4 |
| Panic disorder | 10.9 | 14.3 | 4.4 |
| Generalized anxiety disorder | 15.2 | 2.4 | 4.4 |
| Specific phobia | 26.1 | 21.4 | 17.4 |
| Obsessive-compulsive disorder | 19.6 | 7.2 | 6.7 |
| Post-traumatic stress disorder | 21.7 | 11.9 | 4.3 |
| Eating disorder (anorexia nervosa or bulimia nervosa) | 19.5 | 9.5 | 4.4 |
| Attention-deficit/hyperactivity disorder | 17.3 | 7.2 | 6.5 |
| Oppositional defiant disorder | 8.7 | 14.2 | 10.9 |
| Conduct disorder | 2.2 | 2.4 | 0 |
| Tic disorder | 0 | 0 | 2.2 |
| Selective mutism | 4.3 | 2.4 | 0 |
| Dysthymia | 0 | 2.4 | 0 |

*Note.* Diagnoses are based on Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) criteria.

**Table 2.**

Descriptive statistics for predictor variables

|  | Probands | | | Cotwins of probands | | | Matched controls | | |
|---|---|---|---|---|---|---|---|---|---|
|  | N | Mean | SD | N | Mean | SD | N | Mean | SD |
| Brooding | 30 | 0.42 | 0.83 | 27 | -0.01 | 1.11 | 38 | -0.33 | 0.94 |
| Inattention | 41 | 0.55 | 0.91 | 36 | -0.17 | 1.01 | 45 | -0.37 | 0.87 |
| Impulsivity | 41 | 0.46 | 1.04 | 36 | -0.07 | 0.94 | 45 | -0.36 | 0.85 |

*Note.* Composites are standardized. Ns reflect the number of individuals from each group with complete data.

**Table 3.**

Bivariate correlations between predictor variables.

|  | Brooding (standardized) | Inattention (standardized) | Impulsivity (standardized) | Depression diagnosis (dichotomous) |
|---|---|---|---|---|
| Brooding (standardized) | 1 (n=95) |  |  |  |
| Inattention (standardized) | 0.29 p=0.005 | 1 (n=122) |  |  |
| Impulsivity (standardized) | 0.27 p=0.008 | 0.70 p<.001 | 1 (n=122) |  |
| Depression diagnosis (dichotomous) | 0.19 p=.083 | 0.24 p=0.009 | 0.09 p=.317 | 1 (n=124) |

**Table 4.**

Logistic regression analyses of brooding, inattention, and impulsivity as predictors of suicidal ideation (matched control analyses)

| | Single predictor model | | | | Combined model | | | |
|---|---|---|---|---|---|---|---|---|
| | **B** | **Standard error** | **P-value** | **Likelihood of endorsing suicidal ideation increased by a factor of:** | **B** | **Standard error** | **P-value** | **Likelihood of endorsing suicidal ideation increased by a factor of:** |
| Brooding | 0.73 | 0.31 | 0.021 | 2.07 | 0.57 | 0.36 | 0.109 | n/a |
| Depression diagnosis | 2.62 | 1.11 | 0.018 | 13.72 | n/a | n/a | n/a | n/a |
| Inattention | 1.09 | 0.30 | <0.001 | 2.98 | 0.88 | 0.39 | 0.024 | 2.40 |
| Depression diagnosis | 2.50 | 1.12 | 0.025 | 12.22 | n/a | n/a | n/a | n/a |
| Impulsivity | 0.91 | 0.27 | 0.001 | 2.47 | 0.26 | 0.36 | 0.478 | n/a |
| Depression diagnosis | 2.79 | 1.11 | 0.012 | 16.29 | n/a | n/a | n/a | n/a |

*Note.* Depression was a control variable in the single predictor models, but not in the combined model. Brooding, inattention, and impulsivity composites are standardized.

**Table 5.**

Logistic regression analyses of brooding, inattention, and impulsivity as predictors of suicidal ideation (cotwin sample analyses)

| | Single predictor model | | | | Combined model | | | |
|---|---|---|---|---|---|---|---|---|
| | B | Standard error | P-value | Likelihood of endorsing suicidal ideation increased by a factor of: | B | Standard error | P-value | Likelihood of endorsing suicidal ideation increased by a factor of: |
| Brooding | 0.49 | 0.31 | 0.108 | n/a | 0.46 | 0.31 | 0.139 | n/a |
| Depression diagnosis | 1.14 | 0.74 | 0.125 | n/a | n/a | n/a | n/a | n/a |
| Cotwin sex | −0.46 | 0.48 | 0.337 | n/a | n/a | n/a | n/a | n/a |
| Inattention | 0.66 | 0.28 | 0.020 | 1.93 | 0.67 | 0.34 | 0.045 | 1.96 |
| Depression diagnosis | 0.93 | 0.76 | 0.219 | n/a | n/a | n/a | n/a | n/a |
| Cotwin sex | −0.12 | 0.50 | 0.805 | n/a | n/a | n/a | n/a | n/a |
| Impulsivity | 0.47 | 0.26 | 0.074 | n/a | 0.05 | 0.33 | 0.877 | n/a |
| Depression diagnosis | 1.32 | 0.71 | 0.062 | n/a | n/a | n/a | n/a | n/a |
| Cotwin sex | −0.36 | 0.47 | 0.446 | n/a | n/a | n/a | n/a | n/a |

*Note.* Depression and cotwin sex were control variables in the single predictor variables, but not in the combined model. Brooding, inattention, and impulsivity composites are standardized.