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The Relationship of Self-reported Executive Functioning to Suicide Ideation and Attempts: Findings from a Large U.S.-based Online Sample

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An increasing number of studies demonstrate that individuals with a history of suicidality exhibit impaired executive functioning abilities. The current study examines whether these differences are linked to suicidal thoughts or suicidal acts—a crucial distinction given that most people who think about suicide will not act on their thoughts. A large online sample of U.S. participants with a history of suicide ideation (n = 197), suicide attempts (n = 166), and no suicidality (n = 180) completed self-report measures assessing executive functioning, suicide ideation and attempts; in addition, depression, self-efficacy, and history of drug abuse and brain injury were assessed as potential covariates. Individuals with recent suicide attempts reported significantly worse executive functioning than ideators. This difference was not accounted for by depression, self-efficacy, history of drug abuse or brain injury. Self-reported executive functioning may represent an important short-term risk factor for suicide attempts.

Keywords executive functioning, risk factors for suicide, suicide, suicide prevention, suicide risk

Suicide attempts are a leading cause of global mortality and a significant public health problem. Reports by the World Health Organization estimate that over 80,000 people die by suicide each year, more than in all armed conflicts worldwide (World Health Organization, 1999, 2014). For each death by suicide, it estimated that over 20 non-fatal suicide attempts are made (Crosby, Cheltenham, & Sacks, 1999; Goldsmith, Pellmar, Kleinman, & Bunney, 2002), which often result in severe injury and disability. Suicide attempts also have a devastating impact on individuals' families and communities and represent a substantial economic burden to societies. Specifically, across the United States and Canada alone, suicide attempts are estimated to account for over $53 billion in lost productivity and medical costs each year (Centers for Disease Control and Prevention, 2015; SmartRisk, 2009). It is therefore crucial to better understand the risk factors associated with suicidality in order to predict and prevent suicide attempts.

Large scale epidemiological studies have repeatedly demonstrated that mental

health conditions such as mood, anxiety, and substance disorders represent significant risk factors for suicidality (Nock, Hwang, Sampson, & Kessler, 2010). Indeed, this notion is strengthened by findings from psychological autopsy studies that more than 90% of those who died by suicide met criteria for one or more psychiatric disorders at the time of their attempt (Arsenault-Lapierre, Kim, & Turecki, 2004; Bertolote & Fleischmann, 2002). However, a careful review of this literature suggests that while mental health conditions are strongly predictive of suicidal thoughts, they only weakly predict suicidal acts among those reporting suicidal thoughts (Kessler, Borges, & Walters, 1999; May & Klonsky, 2016; Nock et al., 2010). This distinction is important given that approximately only a third of individuals who think about suicide will act on their thoughts (Angst, Angst, Gerber-Werder, & Gamma, 2005; Beck, Brown, Steer, Dahlsgaard, & Grisham, 1999; Borges et al., 2010). Such findings suggest that the transition from suicidal thoughts to suicidal acts may involve different mechanisms than the development of suicidal thoughts (Klonsky & May, 2014). Identifying the factors that distinguish those who act on their suicidal thoughts from those that do not could significantly improve suicide prevention efforts.

Neurocognitive abilities have been shown to strongly mediate the relationship between thoughts and behaviors (Mesulam, 1990) and therefore might be implicated in the transition from suicidal thoughts to suicidal acts. Early studies observed that individuals who attempted suicide experienced distorted cognitions (Shneidman, 1961), rigid and dichotomous thinking patterns (Neuringer, 1961, 1964), and impaired problem solving abilities (Levenson & Neuringer, 1971). These "higher-order" cognitions are often referred to as executive functioning abilities (Miller & Wallis, 2009; Strauss, Sherman, & Spreen, 2006; Zelazo, Carter, Reznick, & Frye, 1997), and have been repeatedly associated with neural pathways within the prefrontal cortex (Baddeley, 1992; Miller & Wallis, 2009). Recent neurocognitive and neuroimaging research findings suggest that individuals with a history of suicidality exhibit impaired performance on several performance-based executive functioning measures, such as the Iowa Gambling Task, Category Fluency, and the Stroop Test (Richard-Devantoy, Berlim, & Jollant, 2013), as well as differences in prefrontal cortical regions thought to support executive functioning abilities (Jollant, Lawrence, Olié, Guillaume, & Courtet, 2011).

The aforementioned research findings further our understanding of the relationship of executive functioning to suicidality, yet several factors limit the contribution of these studies to the literature. First, the majority of these are limited in that they compare patients with suicide attempts to patient populations some of whom have no history of suicide ideation. Since virtually all suicide attempters also experience suicide ideation (Brezo et al., 2007; Garofalo, Wolf, Wissow, Woods, & Goodman, 1999), it remains unclear whether differences between these groups are attributable to a history of suicide attempt, suicide ideation, or both. Second, executive functioning is almost exclusively assessed using performance-based measures. However, perhaps counterintuitively, emerging research suggests that self-report measures of executive functioning outperform performance-based measures in predicting real-world outcomes such as clinical group status (Manchester, Priestley, & Jackson, 2004), adaptive functioning, and behavioral adjustment (Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002), occupational problems (Barkley & Murphy, 2010), and antisocial activities (Barkley & Murphy, 2011). Self-report measures could therefore meaningfully inform the relationship of executive

functioning to suicidal thoughts and suicidal acts. Lastly, the existing literature on the relationship between executive functioning and suicidality is limited by the small samples sizes used in the individual studies which limit the generalizability of their findings.

The present study was designed to address these limitations and further clarify the relationship of executive functioning to suicidal thoughts and suicidal acts. Specifically, this study used two validated multidimensional self-report measures of executive functioning with large samples of individuals with a history of suicide thoughts, suicidal acts, and nonsuicidal participants from the United States. In addition, measures assessing self-efficacy, depression symptomatology, history of brain injury, and drug abuse were included to determine whether associations between executive functioning and suicide ideation or attempts might be better accounted for by these covariates.

METHODS

Procedure

Participants were recruited from Amazon's Mechanical Turk (MTurk) between December 2014 and January 2015. MTurk is an online platform that allows researchers to recruit large numbers of participants for research studies, which is especially useful when recruiting participants with low-base rate experiences (such as suicide ideation and suicide attempts). Studies have demonstrated that MTurk participants are more demographically diverse than undergraduate populations (Buhrmester, Kwang, & Gosling, 2011) and clinically similar to the general population (Shapiro, Chandler, & Mueller, 2013). Furthermore, and perhaps most importantly, MTurk participants have been found to provide high-quality data equal to data collected in laboratory settings (Buhrmester et al., 2011; Crump, McDonnell, & Gureckis, 2013; Goodman, Cryder, & Cheema, 2013; Paolacci, Chandler, & Stern, 2010).

No demographic restrictions (age, gender, ethnicity, marital status, or education) were used to select participants for this study. Participation in this study was however restricted to individuals with an MTurk account (collectively known as "workers") who reside in the United States and who have obtained at least a 90% accuracy rating in completing 100 or more Human Intelligence Tasks (HITs) on the MTurk platform. Amazon defines a HIT as "a single, self-contained task that a Worker can work on, submit an answer, and collect a reward for completing" (Amazon, 2016). Participants were first presented with an electronic consent form to review prior to participating in the study. Participants could select whether they consented to participate in the study by checking the "I consent" box at the bottom of the consent form. Participants who consented to participate in the study completed the study in two parts. First, participants were invited to complete a brief online survey estimated to take 1 to 3 minutes to complete and were paid $0.15 for participating. This survey included questions from the Youth Risk Behavior Survey–Suicide Screening Questionnaire (YRBS; Grunbaum et al., 2002; Kolbe, Kann, & Collins, 1993). Answers on this measure was used to divide participants into one of three groups: participants with a lifetime history of suicide attempts (Attempters), participants with a lifetime history of suicide ideation but no history of attempts (Ideators), and participants with no lifetime history of suicide ideation or suicide attempts (Nonsuicidal).

Participants that successfully completed the brief survey were invited to complete a longer 1-hour survey for an additional $2.00 payment. Recruitment to this survey was limited to 215 participants

for each of the three participant groups. Once the quota for a group was met, recruitment for that group was closed. Participants who consented to participate in the longer survey completed several measures including the Behavioral Rating Inventory of Executive Functions–Adult version (BRIEF-A; Roth, Isquith, & Gioia, 2005), the Frontal Systems Behavior Scale (FrSBe; Grace & Malloy, 2001), the Generalized Self-Efficacy Scale (GSES; Schwarzer & Jerusalem, 1995) scale, the Alabama Brief Screening for Possible Brain Injury (ABSPBI), the 10-item version of the Drug Abuse Screening Test (DAST-10; Skinner, 1982), the Depression, Anxiety, and Stress Scale (DASS-42; Lovibond & Lovibond, 1995), and several demographic questions. Descriptions of these measures are provided below. Due to a technical error age was not measured in this survey. However, we obtained approval from the Behavioral Research Ethics Board (BREB) of the University of British Columbia for an immediate follow-up and were able to assess 82.3% of the sample's age.

Precautionary measures were implemented to ensure the quality of the data collected. Participation in both surveys was limited to one response per IP address and one response per MTurk participant (as outlined by Peer, Paolacci, Chandler, & Mueller, 2012) to limit the same participant from completing either survey more than once. Furthermore, before beginning the surveys, participants had to complete a "captcha" or "reverse Turing test" to verify that participants were human and not automated programs (bots). To ensure that participants were accurately responding to the study's measures, a variety of attention checking questions (requiring participants to select a particular response or provide a response to a question with only one possible correct answer) were embedded within each survey measure. Lastly, the three validity scales in the BRIEF-A were used to exclude participants endorsing highly infrequent, inconsistent, and overly negative responses. Participants who failed to meet any of these requirements were excluded from analyses.

Since this study aimed to recruit participants with a history of suicide ideation and attempts, there was an increased risk that some of the participants might be in acute psychological distress or might experience unpleasant emotions as a result of reflecting on their past experiences. To address these possibilities, throughout both surveys participants were provided with a link to a 24-hour crisis line number and online crisis chat service. Participants were also provided with an extensive list of mental health resource at the end of the surveys. At the end of the longer survey, participants completed a positive mood induction task where they were asked to rank five strengths or values that are important to them and select positive coping strategies they use when feeling stressed or upset. Ethical approval for this study was obtained from the Behavioral Research Ethics Board of the University of British Columbia.

Participants

A total of 2,905 attempts to access the brief survey were made. Of these, 450 attempts were identified as duplicate attempts, 19 did not correctly complete the verification captcha, 10 did not complete the screening questionnaire, and 19 were not automatically detected as duplicates and completed the questionnaire twice but their first response set was kept, leaving a total of 2,407 unique participants. Of these, 808 were invited to complete the longer survey, 134 declined this offer, 17 accepted the offer but did not provide consent, 1 did not complete the captcha, 29 did not complete the entire survey, 50 participants failed one or more attention-checking questions, and 34 flagged one or

TABLE 1. **Demographic Information for All Participants ($n = 543$)***

Age ($n = 447$)	**Mean 34.6** *N*	**SD 11.5** %
Sex		
Male	243	44.8
Female	300	55.2
Race/ethnicity		
African	24	4.4
East-Asian	46	8.5
European/Caucasian	422	77.7
Indian/South Asian	3	0.6
Latin-American/Hispanic	20	3.7
Middle Eastern	4	0.7
Native American	8	1.5
Other	16	2.9
Sexual orientation		
Straight (heterosexual)	430	79.2
Bisexual	72	13.3
Gay (homosexual)	27	5.0
Questioning	6	1.1
Other	8	1.5
Marital status		
Single	292	53.8
Married/common-law	170	31.3
Divorced/separated	60	11.0
Widowed	9	1.7
Other	12	2.2
Highest level of education		
Some high school	3	0.6
High school graduate/GED	47	8.7
Some college or university	225	41.4
College or university graduate	176	32.4
Some graduate or professional school after college	29	5.3
Master's degree	54	9.9
Doctoral degree	9	1.7
	N	%
Yearly household income		
Less than $5,000	26	4.8
$5,000–$9,999	20	3.7
$10,000–$19,999	68	12.5
$20,000–$29,999	93	17.1
$30,000–$39,999	70	12.9
$40,000–$49,999	72	13.3
$50,000–$59,999	46	8.5
$60,000–$74,999	42	7.7
$75,000–$99,999	52	9.6
More than $100,000	35	6.4
Do not wish to answer	19	3.5

Note. *Due to a technical error, a question asking participants their age was not administered in the initial battery. However, BREB approval was obtained for an immediate follow-up which was completed by 447 participants, or 82.3% of the sample.

more of the embedded BRIEF-A validity scales, leaving 543 participants that completed the longer survey. The mean age of these participants was 34.6 (SD = 11.5), 55.2% identified as female, and over half (53.8%) reported their marital status as single. Additional demographic information is presented in Table 1.

Before conducting statistical analyses, participants were first divided into one of three groups based on lifetime history of suicide ideation and suicide attempts. Of the 543 participants, 180 reported no lifetime history of suicide ideation or suicide attempts (Nonsuicidal), 197 reported a lifetime history of suicide ideation but no history of attempts (Ideators), and 166 participants reported a lifetime history of suicide attempts (Attempters). To examine whether results differed due to recency of ideation and attempts, participants were further subdivided into non-recent and recent groups based on whether their suicide ideation or suicide attempt occurred in the past 12-months. This resulted in 136 non-recent ideators, 61 recent ideators, 103 non-recent attempters, and 21 recent

attempters. 42 participants reported a recent history of suicide ideation and lifetime history of suicide attempts. Although these participants represent an important high-risk sample, conceptually it would be unclear whether differences between this group and others could be attributed to the presence of recent suicide ideation or their lifetime history of suicide attempts. As our study focused on disambiguating the relationship of executive functioning to suicide ideation and attempts, we excluded this subsample from analyses.

MEASURES

Measures of Executive Functioning

Behavior Rating Inventory of Executive Function–Adult Version. The Behavior Rating Inventory of Executive Function–Adult Version (BRIEF-A; Roth et al., 2005) is a 75-item self-report inventory used to assess perceived executive functioning. For each item, participants indicate on a scale from 1 (*Never*) to 3 (*Often*) the frequency they have experienced the described behavior. Higher scores indicate greater executive functioning impairment. The BRIEF includes one composite score and two indices comprised of nine individual clinical subscales The Behavioral Regulation Index (BRI) is created by combining four subscales including (1) Inhibit, (2) Shift, (3) Emotional Control, and (4) Self-Monitor. The Metacognition Index (MI) is composed of five subscales including (1) Initiate, (2) Working Memory, (3) Plan/Organize, (4) Task Monitor, and (5) Organization of Materials. The BRI and MI are combined to create the Global Executive Composite (GEC). The BRIEF-A includes three validity scales intended to measure infrequent (Infrequency Scale), inconsistent (Inconsistency Scale), and unusually negative (Negativity Scale) reporting.

The BRIEF-A has been shown to be sensitive to differences in executive functioning in an older-adult sample with mild cognitive impairment and cognitive complaints (Rabin et al., 2006). The BRIEF-A has also been used in adult samples with attention-deficit/hyperactivity disorder (ADHD; Stern, Pollak, Bonne, Malik, & Maeir, 2013), eating-disorders (Ciszewski, Francis, Mendella, Bissada, & Tasca, 2014), sexual disorders (Reid, Karim, McCrory, & Carpenter, 2010), and traumatic brain injury (TBI; Waid-Ebbs, Wen, Heaton, Donovan, & Velozo, 2012).

Internal consistency for the BRIEF-A clinical scales is good to excellent (ranging from .73 to .90; Ciszewski et al., 2014; Reid et al., 2010; Roth et al., 2005). Test-retest reliability ranged from .82 to .93 for the clinical subscales over a 4-week period (Roth et al., 2005). The BRIEF-A has been shown to strongly correlate with other measures of executive functioning including the Frontal Systems Behavior Scale (FrSBe; Grace & Malloy, 2001), Dysexecutive Questionnaire (DEX; Wilson, Alderman, Burgess, Emslie, & Evans, 1996), and the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, FitzGerald, & Parkes, 1982), demonstrating good convergent validity.

Frontal Systems Behavior Scale. The Frontal Systems Behavior Scale (FrSBe; Grace & Malloy, 2001) is a 46-item self-reported rating scale designed to assess behavior associated with damage to the frontal lobes. According to the manual, the FrSBe was designed to be (a) brief, reliable, and valid; (b) to assess adult behavior before and after frontal systems damage occurs; and (c) to permit multiple observers to provide behavior ratings (Grace & Malloy, 2001). For each of the 46 items, participants use a Likert-type scale to indicate their responses. Higher scores on the FrSBe reflect greater perceived impairment. The FrSBe yields a total score and three

subscale corresponding to the apathy, disinhibition, and executive functioning factor-analytically derived subscales (Niemeier, Perrin, Holcomb, Nersessova, & Rolston, 2013; Stout, Ready, Grace, Malloy, & Paulsen, 2003). The FrSBe includes normative information on men and women aged 18 to 95 with education ranging from 10 years to doctoral level (Grace, 2011).

The FrSBe total score as well as the individual subscales have demonstrated good–excellent internal reliability, with Cronbach's alpha ranging from 0.78 to 0.94 (Grace, 2011; Grace & Malloy, 2001; Velligan, Ritch, Sui, DiCocco, & Huntzinger, 2002), and good test-retest reliability (Velligan et al., 2002) with correlation values ranging from 0.65 to 0.78. Scores on the FrSBe have been shown to be significantly correlated to other measures of executive functioning including the BRIEF-A (Roth et al., 2005) and the Neuropsychiatric Inventory (NPI; Cummings et al., 1994; Norton, Malloy, & Salloway, 2001). The FrSBe has shown to predict instrumental activities of daily living (IADLs; Karzmark, Llanes, Tan, Deutsch, & Zeifert, 2012) and community integration (Reid-Arndt, Nehl, & Hinkebein, 2007) over and above neuropsychological tests of intelligence and executive functioning.

Covariate Measures

Alabama Brief Screening for Probable Head Injury. The Alabama Brief Screening for Probable Head Injury (ABSPBI; Alabama Department of Rehabilitation Services, 2006a) is a brief screening instrument designed to determine if an individual has experienced a brain injury during the course of a domestic violence incident, or at any other time. Part one includes eight questions assessing a history of brain injury and acts as a gateway section. Participants respond to these questions by selecting either "Yes" or "No." Responding positively to any of the eight gateway questions in part one will result in participants completing part two of the ABSPBI which is includes a checklist of eleven common symptoms associated with head brain injury.

The ABSPBI was developed by the U.S. Department of Health and Human Services (2006) in collaboration with Dr. Mary Hibbert (Alabama Department of Rehabilitation Services, 2006b). Information regarding the psychometric properties of ABSPBI have yet to be published in peer-reviewed journals. For this study, a history of brain injury was determined if individuals endorsed one or events that are likely to result in brain damage (such as being hitting your head during a fall), losing consciousness, and having experienced one or more negative symptoms as a result of that event.

Depression Anxiety Stress Scale. The Depression Anxiety Stress Scale (DASS; Lovibond & Lovibond, 1995) is a 42-item measure used to assess symptoms of anxiety, depression, and stress during the last 7 days. For each question, participant indicate the degree to which each symptom applied to them on a scale from 0 (*did not apply to me at all*) to 3 (*Applied to me very much, or most of the time*). Fourteen questions per scale are combined to create scale total scores. Higher scores indicate more of the domain being measured. Cut-scores representing normal, mild, moderate, severe, and extremely severe symptomatology have been created for each scale using a large adult sample (Lovibond & Lovibond, 1995).

The DASS scales have excellent internal consistency reliability in both non-clinical (Antony, Bieling, Cox, Enns, & Swinson, 1998; Brown, Chorpita, Korotitsch, & Barlow, 1997; Lovibond & Lovibond, 1995) and clinical samples (Antony et al., 1998; Brown et al., 1997; Page, Hooke, & Morrison, 2007), as well

as good test-retest reliability (Brown et al., 1997). Studies using non-psychiatric and psychiatric samples have replicated the three-factor structure of the DASS scales (Antony et al., 1998; Brown et al., 1997; Crawford & Henry, 2003; Lovibond & Lovibond, 1995; Page et al., 2007) and found that the DASS scales correlates highly with legacy measures of depression, anxiety, and stress (Antony et al., 1998; Brown et al., 1997; Crawford & Henry, 2003; Lovibond & Lovibond, 1995; Page et al., 2007), demonstrating good-excellent convergence validity.

Drug Abuse Screening Test. A modified, 10-item version of the Drug Abuse Screening Test (Skinner, 1982) was used in this study. The DAST-10 is a self-report measure designed to assess drug-use severity in the previous 12 months. For each questions, participants indicate whether they have engaged in the specific behavior by selecting either "Yes" or "No." A total score is calculated by counting the number of positive responses on nine of the ten questions and one reverse-scored question. Higher scores indicate greater drug abuse. Recommended cut-scores reflecting severity of drug abuse have been developed with scores between 1–2 indicating low-level abuse, 3–5 moderate abuse, 6–8 substantial abuse, and 9–10 severe abuse. A cut score of 3 has been found to have .70–.84 sensitivity and .76–.80 specificity in diagnosing drug abuse disorders using the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV;* American Psychiatric Association, 2000; Cocco & Carey, 1998; Maisto, Carey, Carey, Gordon, & Gleason, 2000).

The DAST-10 has been found to have strong psychometric properties including good – excellent internal consistency (Carey, Carey, & Chandra, 2003; Cocco & Carey, 1998; McCabe & Teter, 2007) and good test-retest reliability (Cocco & Carey, 1998). Support for the unidimensional structure of the DAST-10 was found in one study (Carey et al., 2003) although an earlier study found a three-factor structure (Cocco & Carey, 1998). The DAST-10 has been used with samples of unselected undergraduate students (McCabe & Teter, 2007), psychiatric outpatients (Cocco & Carey, 1998), and adults with severe mental illness (Maisto et al., 2000).

Generalized Self-Efficacy Scale. The Generalized Self-efficacy Scale (GSES; Schwarzer & Jerusalem, 1995) is a brief 10-item measure designed to assess "an optimistic self-belief" which is operationalized as the belief that one could cope with unexpected and potentially stressful life situations. We included the GSES as a proxy measure to assess participants' general negative reporting bias. We anticipated that participants with a negative reported bias would be more likely to endorse less optimistic self-beliefs. Assessing participant's reporting bias is important to examine, especially in using self-report measures, as observed group differences in executive functioning could be due to individuals' tendency to describe themselves more negatively. For each statement, participants select an answer ranging from 1 (*Not at all true*) to 4 (*Exactly true*). A single total score for the GSES is derived by combining the numeric value of each answer. A high score indicates greater perceived self-efficacy.

The GSES demonstrates good-excellent internal consistency reliability (Luszczynska, Scholz, & Schwarzer, 2005; Schwarzer, Mueller, & Greenglass, 1999), adequate-good test-retest reliability (Schwarzer et al., 1999), and a unidimensional construct (Schwarzer et al., 1999). The GSES has been translated to several languages (Schwarzer, Babler, & Kwiatek, 1997) and has been widely used in large samples in Europe, Asia, the Middle-East, North-America (Luszczynska, Gutiérrez-Doña, & Schwarzer, 2005; Luszczynska, Scholz et al., 2005), with online participants

(Schwarzer et al., 1999), individuals with medical conditions (Luszczynska, Scholz et al., 2005), as well as individuals with symptoms of anxiety and depression (Muris, 2002).

RESULTS

Descriptive statistics and internal consistency reliability (Cronbach's alpha) for each clinical measure are presented in Table 2.

TABLE 2. **Descriptive Statistics for Study Measures**

	Mean	SD	Cronbach's α
BRIEF-A			
Global executive composite	117.7	28.4	.97
Behavior Regulation Index (BRI)	49.2	12.4	.94
Inhibit	13.0	3.3	.76
Shift	10.2	3.0	.82
Emotional control	16.9	5.5	.94
Self-monitor	9.1	2.7	.82
Metacognition Index (MI)	68.4	17.6	.96
Initiate	14.3	4.1	.86
Working memory	13.3	3.9	.88
Plan/organize	16.8	4.7	.89
Task monitor	9.8	2.6	.81
Organization of materials	14.2	4.5	.91
DASS			
Depression scale total	13.4	12.5	.92
DAST-10			
Scale total	1.3	2.0	.81
FrSBe			
Apathy	35.9	9.8	.87
Disinhibition	30.6	8.1	.85
Executive dysfunction	39.2	10.2	.87
GSES			
Scale total	29.9	5.9	.93

Data Reduction

We entered the 12 subscales from the two self-report executive functioning measures (BRIEF-A and FrSBe) into an exploratory factor analysis (using principal axis factoring, promax rotation) to examine their structure. The Keiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = 0.93 ("superb" accoridng to Fields, 2009). Inspection of eigenvalue with scree plot indicated a clear one factor solution which accounted for 68.5% of the variance (eigenvalue = 8.2). No other factors yielded eigenvalues greater than 1. Therefore, the standardized scores for each of the executive functioning subscales were summed to create a single, composite executive functioning scale that was used for all subsequent analyses.

Direct Effects

Differences between lifetime, non-recent, and recent groups of attempters, ideators, and nonsuicidal participants were examined using the composite executive functioning scale. As shown in Table 3, moderate to large effect size differences were observed comparing Nonsuicidal participants to ideators and attempters within lifetime, non-recent, and recent groups (d range = 0.63–2.01). In contrast, comparing attempters to ideators within lifetime and non-recent groups revealed weak-small effect size ($d = 0.21$ and $d = 0.11$, respectively). However, a large effect size difference was obtained comparing recent attempters to recent ideators ($d = 0.98$) with recent attempters reporting much worse executive functioning than recent ideators.

Possible Covariates

Several logistic regression analyses were performed to understand whether

TABLE 3. **Differences (Cohen's D and .95 Confidence Intervals) in Executive Functioning Within Lifetime, Non-Recent, and Recent Groups of Attempters, Ideators, and Nonsuicidal Participants**

	Nonsuicidal vs. ideators	Nonsuicidal vs. attempters	Ideators vs. attempters
Lifetime	0.74 (0.53–0.95)	0.91 (0.69–1.13)	0.21 (0.01–0.42)
Non-recent	0.63 (0.40–0.85)	0.65 (0.40–0.89)	0.11 (−0.15–0.37)
Recent	1.04 (0.74–1.35)	2.01 (1.51–2.50)	0.98 (0.46–1.50)

covariates might explain the ability of executive functioning to distinguish recent attempter vs. recent ideator groups. Results of these analyses are summarized in Table 4. First, to account for potential negative reporting bias, the GSES scale total score was added as a covariate to the model alongside the executive functioning scale. Results revealed that the executive functioning scale accounted for significant variance in group status ($p < .01$) over and above the GSES scale, which did not account for significant variance ($p = .21$). Second, to assess the potential role of depression as a covariate, the DASS depression scale was entered into a logistic regression model alongside the executive functioning scale. Results revealed that DASS depression did not meaningfully reduce the variance explained by the executive functioning scale and did not account for significant variance in group status ($p = .28$). Third, to assess the potential role of brain injury as a covariate, the ABSPBI

TABLE 4. **Logistic Regression Analyses Predicting Recent Attempter vs. Recent Ideator Group Status**

	β (SE)	Wald's χ^2	*df*	*p*	Model χ^2	Nagelkerke R^2
Executive functioning					13.64	.23
Executive functioning total score	0.11 (0.03)	11.20	1	<.001		
Constant	−1.94 (0.43)	20.89	1	<.001		
Negative reporting bias					15.25	.25
GSES total score	−.06 (0.04)	1.58	1	.21		
Executive functioning total score	.09 (0.04)	6.92	1	<.01		
Constant	−.37 (1.30)	0.08	1	.77		
Depression					14.85	0.24
DASS depression total score	−.03 (.03)	1.17	1	.28		
Executive functioning total score	.13 (.04)	11.16	1	<.001		
Constant	−1.36 (.67)	4.15	1	<.05		
Brain injury					13.82	0.23
ABSPBI brain injury criteria	−.25 (.57)	.19	1	.67		
Executive functioning total score	.11 (.03)	10.21	1	<.005		
Constant	−1.79 (.54)	11.06	1	<.001		
Drug abuse					17.37	0.28
DAST-10 total score	.18 (.09)	3.60	1	.06		
Executive functioning total score	.09 (.03)	7.14	1	<.01		
Constant	−2.29 (.48)	22.35	1	<.001		

brain injury criteria was entered into a model alongside the executive functioning scale. Results revealed that the ABSPBI brain injury criteria did not account for significant variance ($p = .67$), and did not meaningfully reduce variance explained by executive functioning. Fourth, to assess drug abuse history as a potential covariate, the DAST-10 scale was entered alongside the executive functioning scale. Results revealed that the DAST-10 scale did not account for significant variance ($p = .058$) and did not meaningfully reduce variance explained by executive functioning.

Finally, in order to better understand which of the aforementioned variables is most predictive of recent attempter vs. recent ideator group status, the ABSPBI brain injury criteria, DASS Depression scale, DAST-10, and GSES scale were entered into a forward method (LR) logistic regression model along with the executive functioning scale. This analysis determined that the executive functioning scale alone accounted for most of the variance in group status correctly classifying 76.8% of cases, $\beta(\mathrm{SE}) = .11(.03)$, Wald's $\chi^2 = 11.20$, $p < .001$, Model $\chi^2 = 13.64$, Nagelkerke $R^2 = .23$. No other variable significantly contributed to the model.

DISCUSSION

This study examined the relationship of self-reported executive functioning to history of suicide ideation and suicide attempts using a large online sample. We focused on executive functioning because of its importance in mediating thought-behavior relationships (Baddeley, 1992; Elliott, 2003; Strauss et al., 2006), and its potential for distinguishing those who have vs. those who have not acted on suicide thoughts.

All ideator and attempter groups reported worse executive functioning than the nonsuicidal group. However, lifetime ideators and lifetime attempters scored comparably on executive functioning. In contrast, comparing recent ideators to recent attempters revealed large differences in executive functioning, with recent attempters reporting greater executive functioning impairment. This relationship remained robust when accounting for participants' negative reporting, depression symptom severity, history of brain injury, and history of drug abuse. Taken together, the findings from this study suggest that executive functioning might be particularly impaired around the time that suicide attempts are made.

One interpretation is that impaired executive functioning represents a relatively short-term risk factor for suicide attempts. Executive functioning abilities such as planning, decision making, and self-monitoring are crucial for daily functioning and their impairment has been associated with an increased likelihood of engaging in high-risk and harmful behaviors (Brower & Price, 2001; Elliott, 2003; Grant, Contoreggi, & London, 2000; Pennington & Ozonoff, 1996). Furthermore, clinical studies using suicidal populations have demonstrated that suicide attempters exhibit greater impairment on several performance-based measures than both patient and health controls (Richard-Devantoy et al., 2013). Viewed in this context, individuals with both suicide ideation *and* impaired executive functioning might be at an elevated risk of attempting suicide due to their diminished ability to engage in protective cognitive strategies such as generating alternative coping strategies, accurately assessing the consequences of prospective behaviors, and inhibiting maladaptive emotional and behavioral responses.

Given the cross-sectional design of this study, a second possible interpretation of these findings is that recent attempters might be biased to view themselves negatively, perhaps even as a direct result of

having made an attempt, and thus be biased to report poor psychological and cognitive functioning. However, our covariate analyses address, and to some extent refute, this interpretation. The GSES, a measure of general self-efficacy, was included to capture general tendencies to report negatively about one's psychological characteristics, and we found that the association between recent suicide attempts and executive functioning remained robust even when controlling for GSES. Furthermore, the association remained robust when controlling for other covariates, namely depression, drug abuse, and brain injury. Although controlling for these covariates increases our confidence that there is a reliable and specific association between recent suicide attempts and impaired executive functioning, it remains possible that other covariates might have better accounted for the observed differences in executive functioning. Prospective longitudinal research examining the relationship of executive functioning to suicide ideation and suicide attempts is required to clarify whether these variables predict future suicide ideation or suicide attempts.

There are unfortunately few studies to compare our findings to since, to our knowledge, no other study has compared differences in self-reported executive functioning between suicide ideators and attempters. Loyo, Martínez-Velázquez, and Ramos-Loyo (2013) are the only study to assess self-reported executive functioning in a sample with a history of suicide attempts. This study found that suicide attempters with depression and anxiety reported worse executive functioning on several BRIEF-A scales compared to patient and healthy controls with no histories of suicide attempts. However, since their study did not include a group of participants with suicide ideation, it remains unclear whether the reported differences are due to a history of suicide attempts, suicide ideation, or both. Similarly, few studies have examined differences in executive functioning between suicide ideators and attempters using behavioral measures (Burton, Vella, Weller, & Twamley, 2011; Clark et al., 2011; Dombrovski et al., 2010, 2011). Examining these studies revealed no overlapping behavioral measures and inconsistent results. Our ability to compare the results of these studies with those ours is further limited by finding from a recent review suggesting minimal overlap between self-report and behavioral measures of executive functioning (Toplak, West, & Stanovich, 2013). Further research using self-report and behavioral measures of executive functioning with suicide ideators and attempters is therefore needed to better understand the relationship of these measures to suicide ideation and suicide attempt.

In addition to the cross-sectional nature of this study, three additional limitations deserve note. First, this study relied on self-report measures. Self-report measures are more susceptible to biased reporting, especially if participants are unwilling or unable to accurately report their experiences. It is difficult to integrate the results of this study with those of the existing literature since the vast majority of studies have almost exclusively measured executive functioning using performance-based measures, and existing research suggests that self-report and performance-based measures of executive functioning minimally overlap with one another (Barkley, 2012; Chaytor, Schmitter-Edgecombe, & Burr, 2006; Odhuba, van den Broek, & Johns, 2005; Strauss et al., 2006; Toplak et al., 2013). Future studies should incorporate both subjective and objective measures of executive functioning to more completely assess the relationship of executive functioning to suicide ideation and suicide attempts.

Second, the results of this study are limited by the small sample of recent

attempters. Although the small sample was expected given the generally low prevalence of past 12 month suicide attempts, caution is recommended in interpreting the results since a smaller sample limits the reliability and generalizability of the findings. Recruiting larger samples of recent attempters will help determine whether the findings from this study are unique due to the small sample of recent attempters recruited or whether they apply more broadly to individuals with a recent suicide attempt.

Lastly, the generalizability of our findings might be limited due to the characteristics of recruiting an online sample using MTurk. Although existing studies have found MTurk participants to be more demographically varied than undergraduate populations (Buhrmester et al., 2011) and clinically similar to non-online samples (Shapiro et al., 2013), this may limit the generalizability of our findings. For example, given that the average age of our participants was relatively young, our results may be more generalizability to younger, rather than older populations. Similarly, the majority of the participants reported a Caucasian ethnic background, a heterosexual sexual orientation, and being single at the time of study which may limit the generalizability of our findings to other, more diverse populations.

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The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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