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Differential Effects of Executive Functioning on Suicide Attempts

Cynthia Z. Burton, B.A., **Lea Vella, M.P.H.**, **Jennifer A. Weller, Ph.D.**, and **Elizabeth W. Twamley, Ph.D.**
San Diego State University/University of California, San Diego Joint Doctoral Program in Clinical Psychology, San Diego, CA; the Maricopa Integrated Health System/District Medical Group, Phoenix, AZ; University of California, San Diego, Department of Psychiatry, San Diego, CA; the VA San Diego Healthcare System, San Diego, CA, and the VA Center of Excellence for Stress and Mental Health, San Diego, CA

Abstract

Suicide is common among individuals with psychiatric illness; executive functioning may be associated with suicide risk. The authors examined demographic, clinical, and executive-functioning variables in suicide ideators and suicide attempters, hypothesizing that attempters would demonstrate poorer executive-functioning skills. Seventy-seven participants with psychiatric illness completed a neuropsychological battery while hospitalized or residing in crisis-houses after expressing suicidal ideation (N=40) or making a suicide attempt (N=37). Logistic regression predicted suicide Ideator versus suicide Attempter status; suicide Attempters exhibited poorer inhibition but better problem-solving ability than suicide Ideators. Suicide attempt risk may be associated with better problem-solving skills, but worse inhibitory control.

More than 30,000 Americans commit suicide every year, highlighting the need for improved evaluation and prevention of suicidal behavior.[1] Although the base rate for suicide among psychiatric patients is low, about 90% of people who do commit suicide have a psychiatric illness.[2] Previous research indicates that people diagnosed with schizophrenia, affective disorders, and personality disorders are 10 times more likely to commit suicide than those in the general population.[3] Neurocognitive functions, such as planning ability, impulsivity, and other executive skills could contribute to the risk of suicidal thinking and behavior. In an effort to better understand the association between mental illness and suicidal behavior, recent studies have focused on cognitive abilities as potential moderating factors. We will consider the emerging literature on neurocognition and suicide against a backdrop of neurobiological and neuroimaging research establishing a strong connection between cerebral function and suicidal behavior. It has long been known from postmortem studies that suicide completers have decreased levels of serotonin or its main metabolite, 5-hydroxyindoleacetic acid (5-HIAA).[4,5] Lower 5-HIAA in cerebrospinal fluid is also associated with suicidality and suicide attempts among patients with depression[5] and other psychiatric illnesses, including schizophrenia and personality disorders.[4] There are also indications that suicidality is associated with smaller brain volumes in orbitofrontal cortex and anterior corpus callosum[6,7] and with lower perfusion of the medial prefrontal and subgenual areas and ventral tegmentum.[8] Abnormalities such as these have been

Send correspondence to Elizabeth W. Twamley, Ph.D., Department of Psychiatry, University of California, San Diego, 140 Arbor Dr. #0851, San Diego, CA 92103; etwamley@ucsd.edu..

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hypothesized to contribute to impaired impulse-control and decision-making, which directly relate to executive functioning and suicidal behavior.

Executive functions appear particularly susceptible to impairment in psychiatric populations, particularly among individuals with bipolar disorder, borderline personality disorder, depression, and psychotic disorders.[9–13] Executive functions include 1) reasoning and problem-solving; 2) planning, strategizing, and organizing behavior; 3) switching and cognitive flexibility; 4) monitoring and adjusting one's own performance; and 5) inhibiting inappropriate behavior. Prefrontal areas of the brain, which are responsible for the evaluation of changing alternatives and the execution of plans, are often implicated in executive tasks.[14] Most executive functions are linked to the dorsolateral prefrontal cortex, whereas response inhibition is associated with the orbitofrontal region.[15]

Recent neuropsychological research suggests that suicide attempters do, in fact, show deficits in executive functioning, which could contribute to suicidality. For example, Keilp and colleagues[16] found that depressed, high-lethality suicide attempters performed worse than nonpatients on several neuropsychological measures, and also performed significantly worse than low-lethality attempters on tests of executive functioning. A follow-up study concluded that impaired attention was related to suicidal behavior beyond what could be explained by depression alone.[17] Furthermore, several studies have suggested that decision-making and impulsivity are associated with suicide attempts, to the extent that impulsivity may increase the risk of suicidal behavior but may dampen the planning required to cause death.[18–21]

Other studies, however, have shown contradictory findings. Westheide and colleagues,[22] for instance, found that executive dysfunction was evident only in recent attempters who still had suicidal ideation at the time of assessment. A study comparing depressed patients with and without suicidal ideation showed that those with ideation performed significantly worse on some measures of reasoning and flexibility, but not on a test of inhibition.[14] Other analyses have yielded no significant relationships between neuropsychological performance and measures of suicidality in patients with depression and psychotic disorders, leading some to hypothesize that suicidality is a separate domain that is distinct from psychiatric symptomatology and neurocognitive performance.[23,24]

Furthermore, a small number of studies have demonstrated that individuals with a history of suicidality perform *better* on some measures of cognition than do those without suicidality. For example, Nangle and colleagues[25] reported that participants with at least one lifetime suicide attempt performed better than did nonattempters on measures of attention and verbal fluency, suggesting that better executive-related ability is associated with greater ability to formulate plans and initiate goal-directed behavior (i.e., the suicide attempt). Similarly, another study demonstrated that those with a lifetime history of suicidality outperformed participants with no history of suicidality on multiple neuropsychological measures, including tests of executive function.[26] After controlling for hopelessness, however, neuropsychological measures did not predict either current or lifetime suicidality, suggesting that hopelessness, rather than cognition, should be targeted for intervention. Given such conflicting results over a wide range of clinical diagnoses and methodologies, further research is warranted to clarify the nature of neurocognitive impairments in suicidal psychiatric patients.

The present study was designed to examine the role of executive functioning in individuals with psychiatric illness receiving acute care for either a recent suicide attempt or severe suicidal ideation. We included suicide Attempters and suicide nonattempters (Ideators) to enable comparisons between those who think about suicide *and* make an attempt versus

those who think about suicide but *do not* make an attempt and instead access psychiatric care. Because of the diffuse neuropsychological impairment common in severe mental illness,[9,11,12,27,28] we hypothesized that 1) participants would demonstrate impairment in executive function at a group level; and 2) suicide Attempters would show greater impairment than suicide Ideators.

METHOD

Participants

Participants included 77 individuals (37 Attempters and 40 Ideators) with psychiatric illness recruited from 1) the Maricopa Integrated Health System Psychiatric Inpatient Unit in Phoenix, AZ, (N=35); 2) the University of California, San Diego, CA, Inpatient Psychiatric Unit (N=2), or 3) San Diego, CA, Community Research Foundation Short Term Acute Residential Treatment Centers (N=40). All participants met the following inclusion criteria; they were 1) between the ages of 18 and 60; 2) currently receiving treatment for either a suicide attempt or suicidal ideation; 3) diagnosed with major depressive disorder, bipolar affective disorder, borderline personality disorder, or a primary psychotic disorder (schizophrenia or schizoaffective disorder); and 4) their primary language was English. Potential participants were excluded if they had a history of epilepsy, dementia, mental retardation, or traumatic brain injury with loss of consciousness greater than 30 minutes. The study was IRB-approved, and we obtained informed consent after participants received a complete description of the study.

Procedure

After hospitalization or crisis-house admission, each patient's diagnosis was determined by the treating psychiatrist and treatment team, and suicidal ideation and behavior were confirmed via chart review. Patients who met the inclusion criteria were invited to participate by a treating clinician and provided written informed consent to a research assistant. Participants first gave a brief history of their life circumstances and history of suicidality, then completed a 1-hr. neuropsychological battery. After assessment, each test was scored according to published norms.

Measures

American National Adult Reading Test (ANART; estimated premorbid IQ): *premorbid intellectual functioning.*[29]

The Delay=Go Computer Task (G.C. Pluck, personal communication, June 9, 2002; total early starts): *sustained attention and inhibitory control.*

Trail-Making Test, Parts A and B (completion time *T* score): *processing speed and cognitive flexibility.*[30]

The Controlled Oral Word-Association Test (CO-WAT; FAS total *T* score; Animals total *T* score): verbal problem-solving and verbal processing speed.[31]

The Stroop Test (interference condition, total correct *T* score): *response inhibition, impulsivity.*[32]

The Wisconsin Card-Sorting Test (WCST-64; Total Errors *T* score): reasoning, problem-solving, self-monitoring, and switching.[33]

Statistical Analysis

All variables were inspected for normality; number of lifetime suicide attempts and number of early starts on the Delay=Go Computer Task were skewed, and these data were analyzed using square-root-transformed variables. For the first hypothesis, mean neuropsychological performance for the entire sample was calculated. All *T* scores are scaled such that a score of 50 and a standard deviation (SD) of 10 characterize the normal population, where higher scores indicate better performance; *T* scores greater than 40 are considered average to above-average. *T* scores were not calculated for the Delay=Go Computer Task because norms for this test are not available, so raw scores were used for this test. For the second hypothesis, group differences on demographic, clinical, and neuropsychological variables were analyzed with *t*-tests and chi-square tests. Equal variances were not assumed for any *t* comparison in which Levene's test for equality of variances was significant. The final prediction model of suicide Attempter status was analyzed using logistic regression, in which all participants with complete data were included. We also performed a likelihood-ratio test to examine whether each block of demographic, clinical, and neuropsychological variables contributed significantly to the final model. Alpha for significance was set at 0.05, and all tests were two-tailed. Data were analyzed using PASW Statistics for Windows (Version 18). There were no significant diagnostic group differences on neuropsychological performance (oneway ANOVA; all ps ≥0.061), so the diagnostic groups were combined for all analyses.

RESULTS

Sample Characteristics

Demographic, clinical, and neuropsychological characteristics of the sample are presented in Table 1. Participants had a mean age of 37.5 years, and most had completed high school; about half were women, and one-quarter were of minority ethnicity. The majority of participants had a comorbid substance- or alcohol-use disorder, and, on average, participants had four previous suicide attempts.

Hypothesis 1—The first hypothesis was only partially supported: participants performed in the average range on all neuropsychological measures except the Stroop test, on which they were mildly impaired, as a group (Table 1).

Hypothesis 2—To examine differences between suicide Attempters and suicide Ideators, we first compared groups on demographic and clinical variables. Suicide Attempters were significantly more likely to be women, married, employed, and have a nonpsychotic diagnosis (Table 2). Groups did not differ on age, education, ethnic minority status, presence of substance-use disorder, or family history of completed suicide (all ps≥0.09; see Table 2).

Because the identified group differences would limit inferences about neuropsychological performance between Attempters and Ideators, we performed logistic-regression analyses, with demographic variables entered in Block 1, clinical variables entered in Block 2, and neuropsychological variables entered in Block 3 (Table 3). Likelihood-ratio tests showed that the block of demographic variables contributed significantly to the full model, as compared with the intercept-alone model (χ^2=18.73, df: 6, p=0.005), but the block of clinical variables did not (χ^2=6.15, df: 4, p=0.188). The third block of neuropsychological variables also contributed significantly to the full model (χ^2=26.47, df: 8, p=0.001).

Consistent with our second hypothesis, worse inhibition performance was associated with suicide Attempter group membership (Stroop Interference total correct *T* score; odds ratio (OR): 0.79, p=0.010), however, better problem-solving ability was also associated with the

Attempter group (WCST total-errors *T* score; OR: 1.22, p=0.007). Also, being married (OR: 9.01, p=0.042) or female (OR: 7.22, p=0.038) increased the odds of membership in the Attempter group. No other variables were significant predictors of group membership (all ps≥0.14; see Table 3).

DISCUSSION

To our knowledge, this is the first study to compare recent suicide attempters to recent suicide ideators, based on the concept that there may be subtle cognitive differences between those who consider suicide but do not act on their impulses and those who make a suicide attempt. To better pinpoint these hypothesized differences, we aimed to evaluate executive functioning in acute-care psychiatric patients with either a recent suicide attempt or recent suicide ideation. Contrary to our first hypothesis, participants in this study demonstrated various cognitive strengths; they performed in the average range on all measures except a measure of inhibition, on which they were mildly impaired. However, their *T* scores on the executive functioning tests were all at the low end of the average range. These data suggest that our participants' distribution of executive-function performances overlaps to some extent with that of the healthy individuals on whom these tests were normed. Consistent with previous research,[20,21] impairment in inhibition may be a specific risk factor for suicidal ideation and behavior.

Support for our second hypothesis was mixed: in a model controlling for demographic, clinical, and other neuropsychological variables, disinhibition was significantly associated with the suicide Attempter group, again suggesting that disinhibition may represent a dominant pathway to a suicide attempt. In fact, Mann and colleagues[2] asserted that prominent impulsivity and aggression are characteristics of people at risk for suicide, independent of psychiatric diagnosis. Contrary to our expectation, better problem-solving ability was also associated with the suicide Attempter group. This finding may lend support to Nangle and colleagues'[25] assertion that better executive functioning (e.g., better problem-solving) is associated with better planning and initiation of behavior, which may lead to increased risk of attempting suicide.

Although we did not hypothesize any demographic differences between attempters and ideators, our results indicated that women and those who were married were more likely to have attempted suicide. This gender difference is not unexpected; women attempt suicide three times more often than do men.[34] Marriage, however, is often reported as a protective factor against suicide.[35,36] Given these conflicting findings, further investigation is merited to clarify the role of marital status in suicide risk.

Limitations of the study include small sample size, which may have limited power to detect significant differences between the suicide Attempter and suicide Ideator groups. Replication of these findings with a larger sample is needed. Also, no structured diagnostic interview was used to supplement chart diagnoses, and acute-care settings such as inpatient psychiatric units and crisis-houses necessarily gather cross-sectional information rather than longitudinal data to inform clinical diagnosis and treatment. Therefore, it is possible that some participants were misdiagnosed and were consequently included in the wrong diagnostic group, which could have affected our finding that the groups were neuropsychologically comparable. Also, suicidal ideation and depressive symptoms like hopelessness at the time of the assessment were not evaluated, which precluded analyses controlling for these variables. As previous research has demonstrated, these clinical features may be important to consider.[22,26] Finally, because this was a cross-sectional study, we could not examine long-term outcomes (e.g., completed suicide). Longitudinal data

would be helpful to examine neuropsychological profiles not only of suicide ideators and attempters, but completers as well.

Despite these limitations, our results suggest that neuropsychological functioning may differentially influence the suicidal behavior of psychiatric patients. Specifically, lowered inhibition but better problem-solving appears to be associated with making a suicide attempt, rather than just thinking about suicide. It therefore seems pertinent to develop interventions to target impulsivity and inhibition in an effort to reduce suicidal behavior in people with mental illness. Another important consideration is whether and how the preservation of certain cognitive skills may increase the chances that an individual will attempt suicide. If it is the case that those with better planning ability are more likely to carry out a plan for suicide, then interventions may be able to target individuals who demonstrate good problem-solving ability but are impulsive. Given our results, it may be that disinhibition and intact problem-solving represent a specific neuropsychological profile for those at risk for suicide. Additional investigation is needed to support these conclusions and emphasize the need for targeted interventions to decrease the number of deaths by suicide in psychiatric populations.

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TABLE 1

Demographic, Clinical, and Neuropsychological Characteristics of the Sample (N=77)

	Mean	SD	Frequency	%
Demographic variables				
Age, years	37.5	10.6		
Education, years	12.3	2.3		
Women			39	51%
Minority ethnicity			18	23%
Married			14	18%
Employed			14	18%
Clinical variables				
Diagnosis				
Major depressive disorder			30	39%
Bipolar affective disorder			18	23%
Schizophrenia/schizoaffective disorder			18	23%
Borderline personality disorder			11	15%
Psychosis present			21	27%
Substance abuse or dependence			41	53%
Number of previous suicide attempts	3.6	8.6		
Family history of completed suicide			15	20%
Neuropsychological variables				
ANART-estimated premorbid IQ	105.2	8.6		
Delay=Go total early starts	1.5	5.1		
Trails A, T-score	44.0	10.3		
Trails B, T-score	41.6	11.7		
FAS, T-score	42.9	9.3		
Animals, T-score	43.3	11.0		
Stroop, T-score	38.7	10.0		
WCST total errors, T-score	41.7	8.9		

SD: standard deviation; ANART: American National Adult Reading Test; FAS: from the Controlled Oral Word-Association Test; WCST: Wisconsin Card-Sorting Test.

TABLE 2

Demographic, Clinical, and Neuropsychological Features of Suicide Attempters Versus Ideators

	Attempters (N=37)		Ideators (N=40)				
	Mean or Frequency	**SD or %**	**Mean or Frequency**	**SD or %**	**t or χ^2**	**df**	**p**
Demographics							
Age, years	35.4	10.8	39.5	10.1	1.718	75	0.090
Education, years	12.4	2.4	12.2	2.1	−0.244	75	NS
Women	24	64.9%	15	37.5%	5.758	1	0.023
Minority ethnicity	6	16.2%	12	30.0%	2.039	1	NS
Married	12	32.4%	2	5.0%	9.723	1	0.002
Employed	11	29.7%	3	7.5%	6.385	1	0.017
Clinical features							
Major depressive disorder	12	32.4%	18	45.0%			
Bipolar disorder	10	27.0%	8	20.0%			
Schizophrenia/schizoaffective disorder	5	13.5%	13	32.5%			
Borderline personality disorder	10	27.0%	1	2.5%			
Psychosis present	5	13.5%	16	40.0%	6.798	1	0.011
Substance/alcohol abuse or dependence	22	59.5%	19	47.5%	1.104	1	NS
Previous suicide attempts (square root)	1.3	1.0	1.5	1.6	0.512	75	NS
Family history of completed suicide	9	24.3%	6	15.4%	0.958	1	NS
Neuropsychological measures							
ANART estimated premorbid IQ	106.2	8.2	104.3	9.0	−0.954	74	NS
Delay=Go total early starts (square root)	0.4	0.6	0.9	1.3	2.312	54.4	0.025
Trails A, T-score	45.1	10.1	43.0	10.5	−0.888	75	NS
Trails B, T-score	44.2	10.2	39.2	12.6	−1.947	75	0.055
FAS, T-score	41.7	8.7	44.0	9.8	1.094	75	NS
Animals, T-score	42.4	8.2	44.2	13.2	0.745	65.8	NS
Stroop, T-score	37.4	8.9	39.9	10.9	1.107	75	NS
WCST total errors, T-score	44.5	8.8	38.8	8.2	−2.881	72	0.005

SD: standard deviation; ANART: American National Adult Reading Test; FAS: from the Controlled Oral Word-Association Test; WCST: Wisconsin Card-Sorting Test.

TABLE 3

Logistic Regression Predicting Ideator Versus Attempter Status (N=72)

Variable	OR	95% CI	p
Block 1			
Age	0.97	0.91–1.03	NS
Education level	1.00	0.77–1.30	NS
Gender	2.79	0.92–8.51	0.071
Ethnic minority	0.71	0.17–3.02	NS
Marital status	9.70	1.79–52.44	0.008
Employment status	2.31	0.48–11.16	NS
Block 2			
Age	0.97	0.91–1.03	NS
Education level	1.00	0.75–1.33	NS
Gender	3.03	0.87–10.58	0.082
Ethnic minority	1.11	0.23–5.53	NS
Marital status	13.67	2.25–83.03	0.005
Employment status	1.27	0.22–7.24	NS
Psychosis present	0.26	0.06–1.19	0.082
Substance/alcohol abuse or dependence	2.14	0.63–7.24	NS
Previous suicide attempts (square root)	0.86	0.51–1.43	NS
Family history of completed suicide	2.08	0.38–11.28	NS
Block 3			
Age	1.02	0.94–1.12	NS
Education level	1.06	0.69–1.61	NS
Gender	7.22	1.12–46.57	0.038
Ethnic minority	1.73	0.15–19.85	NS
Marital status	9.01	1.09–74.69	0.042
Employment status	9.23	0.49–173.10	NS
Psychosis present	0.27	0.04–1.97	NS
Substance/alcohol abuse or dependence	2.53	0.37–17.28	NS
Previous suicide attempts (square root)	0.56	0.25–1.26	NS
Family history of completed suicide	3.36	0.34–32.76	NS
ANART estimated premorbid IQ	1.11	0.96–1.29	NS
Delay=Go total early starts (square root)	0.49	0.13–1.90	NS
Trails A, T-score	1.01	0.90–1.13	NS
Trails B, T-score	1.07	0.96–1.18	NS
FAS, T-score	0.99	0.89–1.10	NS
Animals, T-score	0.98	0.87–1.11	NS
Stroop, T-score	0.79	0.66–0.94	0.010
WCST total errors, T-score	1.22	1.06–1.41	0.007

OR: odds ratio; CI: confidence interval; ANART: American National Adult Reading Test; FAS: from the Controlled Oral Word-Association Test; WCST: Wisconsin Card-Sorting Test.