Published in final edited form as:

J Psychiatr Res. 2012 February ; 46(2): 226–232. doi:10.1016/j.jpsychires.2011.10.001.

Deterministic learning and attempted suicide among older depressed individuals: Cognitive assessment using the Wisconsin Card Sorting Task

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Abstract

Background—Late-life suicide is an under-investigated public health problem. Among the putative vulnerabilities for this complex multifactorial behaviour are deficits in cognitive control, an ability to integrate and prioritize multiple cognitive processes in order to flexibly adapt behaviour and meet situational demands. We investigated cognitive control during rule learning in a complex and changing environment in older individuals with suicide attempts of varying lethality.

Method—Ninety-three participants over the age of 60 (30 healthy controls, 29 depressed never suicidal, 20 low-lethality suicide attempters, 14 high-lethality suicide attempters) underwent structured clinical and cognitive assessments. Participants then completed the Wisconsin Card Sorting Test (WCST), a well-studied task of cognitive control during rule learning.

Results—High-lethality attempters demonstrated a pattern of deficits involving poor conceptual reasoning, perseverative errors and total errors. Compared to low-lethality attempters and healthy controls, high-lethality attempters demonstrated poor conceptual reasoning, as well as increased rates of perseverative errors and total errors. Compared to non-suicidal depressed participants, high-lethality attempters also made more conceptual errors.

Conclusion—High-lethality suicide attempts among older people are associated with impaired cognitive control during rule learning as detected by the WCST. Our data suggest that impairment in cognitive control during rule learning may represent a vulnerability distinct from the impulsive diathesis, typically manifesting in young, low-lethality attempters. This vulnerability may contribute to the high incidence of serious or, often, fatal suicidal acts in old age.

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Contributors

AD & KS were involved in obtaining funding. AD, MA, LK and KS designed the study. AM performed the statistical analyses with statistical review by AD & LC. AM drafted the manuscript, which was edited and finalized by AD, MA, LK, & KS.

Conflicts of interest

All authors declare that they have no conflicts of interest.

Keywords

Suicide; Cognitive control; Cognitive function; Learning; Geriatrics; Depression

1. Introduction

Suicide rates among older individuals are higher than among any other age group (WHO, 1999), and suicide in this age group is under-investigated.

It is becoming increasingly clear that individuals who die by suicide have a predisposition for this behaviour (McGirr et al., 2009). Such predispositions, however, are multifactorial and may vary across age groups (Conner et al., 2004; McGirr et al., 2008). Cognitive impairments are one factor that appears to play a particularly important role in older adults (Clark et al., 2011; Dombrovski et al., 2008, 2010; King et al., 2000).

Cognitive impairments are presumed to result in increased risk for suicide through an incorrect appraisal of one's life situation and, consequently, poor decision making. Cognitive control is a low-level cognitive process that underlies rule learning, by integrating feedback with prior knowledge of contingency and environment structure. Thus, cognitive control allows flexible adaptation of behaviour to meet current demands in the face of ambiguous, complex and or changing environments. Decline in cognitive control ability in older age (Amieva et al., 2004; Drag and Bieliauskas, 2010) may, therefore, be one of the explanations for the increase of suicide rates in this population.

Deficits in several aspects of cognitive control, including attentional control (Keilp et al., 2008) and conflict monitoring (Keilp et al., 2001; Raust et al., 2007) have been implicated in suicidal behaviour. Overall, impaired cognitive control is perhaps the strongest and most consistent cognitive deficit found among suicide attempters (Dombrovski et al., 2008; Marzuk et al., 2005; Raust et al., 2007), particularly among high-lethality attempters (Keilp et al., 2001). Similarly, deficits have been observed in learning in the context of uncertain environments, where experiential learning guides subsequent behavioural choices (Dombrovski et al., 2010; Jollant et al., 2005).

In this study, using a design that allowed us to control for the effect of depression, we aimed to characterize the relationship between suicidal behaviour and cognitive control during learning in a complex environment among older individuals. While previous studies using probabilistic learning, where learning occurs in *uncertain and ambiguous* environments, have revealed impairments among suicide attempters (Dombrovski et al., 2010; Jollant et al., 2005), we instead sought to study deterministic learning, or learning in the context of complex yet *unambiguous* environments. We therefore used the Wisconsin Card Sorting Test (WCST), a well known and validated task of cognitive control during rule learning.

Given that cognitive control impairments may differentiate individuals engaging in more serious and lethal attempts (Keilp et al., 2001), and our own recent findings of behavioural differences between high- and low-lethality older suicide attempters (Dombrovski et al., 2011), we examined these two groups separately. Thus, four groups of older participants were studied: 1) healthy control subjects without histories of depression, suicidal behaviour or suicidal ideation, 2) depressed participants without histories of suicidal behaviour or ideation, 3) depressed participants having engaged in low-lethality suicidal behaviour, and 4) depressed participants having engaged in high-lethality suicidal behaviour.

2. Methods

2.1. Participants

Ninety-three participants aged 60 and older were recruited between December 2004 and June 2010 from the Western Psychiatric Institute and Clinic. Suicide attempters and non-suicidal depressed elderly were diagnosed with major depression without psychotic features by Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition Axis I Disorders (SCID/DSM-IV (First et al., 1995)). To exclude individuals with clinically significant dementia and to ensure that participants could provide reliable clinical information, all were required to have a score of ≥ 24 on the Mini-Mental State Exam (Folstein et al., 1975). We excluded individuals with sensory disorders that precluded cognitive assessment, developmental delay, delirium, neurologic disorders, bipolar disorder, schizophrenia, schizoaffective disorder, and exposure to electroconvulsive therapy in the previous 6 months.

All participants provided written informed consent. The University of Pittsburgh Institutional Review Board approved the study.

2.2. Depressed participants with past suicidal behaviour

We recruited 34 patients over the age of 60 (mean age 67.65 years, 50% female) who had made a suicide attempt. To capture a state close to the suicidal crisis, all of these participants were required to have suicidal ideation with a specific plan at the time of study enrolment. These participants displayed a high level of suicidal intent during their attempts and expressed severe suicidal ideation. Suicide attempters made a mean of $1.53 \pm .87$ attempts, with 13/34 making repeat attempts; 23/34 made an attempt within a year of the assessment, of those 17/34 made an attempt within a month of the assessment. Methods of suicide attempt included overdose (27/34), hanging (2/34), jumping (1/34), shooting (1/34) and laceration (3/34). Suicide attempt history was verified by a psychiatrist, using the interview, medical records, information from the treatment team, and information from family or friends. We excluded participants with significant discrepancies between these sources.

Medical seriousness of attempts was assessed using the Beck Lethality Scale (BLS) (Beck et al., 1975). For participants with multiple attempts, data for the most serious attempt are presented. High-lethality attempts required a medical intervention, resulting in coma, need for resuscitation, unstable vital signs, penetrating wounds of abdomen or chest, third-degree burns, major bleeding, as defined by a score of ≥ 4 on the BLS. None of the suicide attempters had experienced head injuries directly related to attempt, however we assessed potential anoxic-ischemic or toxic brain injury, based on the Beck Lethality Scale, medical records and the clinical interview. We excluded suicide attempters who had suffered severe anoxic brain injuries resulting in clinical cognitive decline. In the case of 4/34 suicide attempters (3 high-lethality, 1 low-lethality), the possibility of anoxic brain injury could not be excluded, and in 2/34 cases (high-lethality) there was a definitive possibility of anoxic damage (but no cognitive decline by clinical history).

Past suicidal behaviour was also characterized using the Suicide Intent Scale (Beck et al., 1974). This instrument characterizes several dimensions related to the suicide attempt with 18 items coded on a three-point scale. For the purposes of this study, given the potential importance of cognitive control in developing and maintaining a suicide plan, we also conducted subanalyses on the relationship between performance on the WCST and suicide intent. For these subanalyses, we used the planning subscale of the Suicide Intent Scale (isolation, timing, precautions against discovery, not seeking help, final arrangements, preparation, and suicide note); suicide attempters were dichotomized at the median (SIS-planning score of 6) irrespective of lethality.

2.3. Non-suicidal depressed participants

Thirty non-suicidal depressed older adults (mean age 70.25 ± 8.86 years, 63.3% female) were included in the study to enable detection of an association between learning and suicidal behaviour above and beyond cognitive effects of depression. These participants had no current or lifetime history of suicide attempts or suicidal ideation as established by clinical interview, review of medical records, SCID/DSMIV, and Scale for Suicidal Ideation (Beck and Kovacs, 1979). Participants were excluded from this group if they had indirect self-destructive behaviours.

2.4. Comparison participants without depression or suicidal behaviour

Non-depressed never-suicidal control subjects served as the benchmark group. We recruited 30 adults over the age of 60 (mean age 69.77 ± 6.76 years, 46.7% female). In order to be considered for inclusion, these participants could not have had any lifetime history of psychiatric disorder as determined by SCID/DSMIV and Antidepressant Treatment History Form (Sackeim, 2001). Further, the absence of current or lifetime suicidal ideation or attempts as established by clinical interview, review of medical records, SCID/DSMIV, and Scale for Suicidal Ideation was also required.

3. Procedures

Our study was conducted at a university psychogeriatric inpatient unit and a specialty outpatient research clinic for late-life depression. Since we aimed to capture cognitive control during learning in a state similar to a suicidal crisis, we assessed participants with major depression during an acute depressive episode. Participants were tested within two weeks of inpatient admission or at the beginning of outpatient treatment. Depressed participants continued to receive psychotropic medications as clinically indicated. We ensured that none were intoxicated or had withdrawal symptoms at the time of assessment. Neuropsychological assessment took place in one to two sessions over 1–3 days. Assessors were blind to clinical history and ratings.

4. Measures

4.1. Cognitive assessment

Current global cognitive function was assessed with the Dementia Rating Scale (DRS (Mattis, 1976)). The DRS provides a global assessment of cognitive function with subscales assessing Initiation/Perseveration (37 points), Attention (37 points), Construction (6 points), Conceptualization (39 points), and Memory (25 points) for a maximum total of 144 points. Depression severity was measured with the 17-item Hamilton Depression Rating Scale (HAM-D (Hamilton, 1960)). Intra-class correlations were 0.95 for HAM-D and 0.99 for the Dementia Rating Scale.

4.2. Wisconsin Card Sorting Test

Participants completed the 64-card Wisconsin Card Sorting Test (Kongs et al., 2000). In this test, four cards displaying objects varying in shape, color or number, are placed in front of the participant. The participant is then handed a deck of 64 cards with similar characteristics and is asked to group each card with one of the 4 display cards. Participants are provided feedback (i.e., reinforcement) following the assignment of each card. When a participant has correctly assigned 10 consecutive cards according to the rule, the rule is covertly changed and correct/incorrect feedback is given accordingly, requiring participants to adapt to the changing feedback and shift mental set. No time constraints are imposed for assigning cards.

The WCST provides several scores for correct responses and errors, perseverative errors, non-perseverative errors, conceptual-level responses and number of completed categories. Perseverative errors correspond to errors involving delayed ability or inability to shift mental set, specifically errors maintaining the obsolete rule.

5. Analyses

We performed analyses using the SPSS statistical package version 19 (SPSS Inc., Chicago, IL). Data distributions were checked for normality. Chi square tests were used for categorical measures. For continuous variables, we employed one-way ANOVA with Tukey post-hoc tests for normally distributed variables, and the Kruskal–Wallis test, with Mann–Whitney planned comparisons and Hodges–Lehman confidence interval estimation, for non-normally distributed data. Significance was set at $\alpha < .05$. Assuming a moderate effect size ($w = .35$), our sample had 0.818 power to detect significant differences at $\alpha < .05$. Independence of effect between attempt lethality and planning in predicting significant WCST scores was assessed using linear regression among suicide attempters. Despite decreased power for multivariate analyses (.711 power for $w = .35$), we performed sensitivity analyses using multinomial logistic regression to control for trends in demographic characteristics.

6. Results

The demographic and clinical characteristics of this sample are presented in Table 1. Average lethality of suicide attempts on the 8-point Likert scale was 1.55 ± 1.23 for low-lethality attempters and 5.35 ± 1.15 for high-lethality attempters. As expected, the depressed controls, as well as both high- and low-lethality attempters had significantly higher HAM-D17 scores than comparison participants ($F(3, 92) = 157.09, p \leq .001$). Suicide ideation scores were significantly higher in the high- and low-lethality groups compared to control and depressed groups ($F(3, 82) = 95.91, p \leq .001$). With respect to scores on the DRS, controls had significantly higher scores than depressed and low-lethality, but not high-lethality, groups ($F(3, 92) = 4.00, p \leq .01$). Group differences on the subscales of the DRS did not reach statistical significance. No difference was noted between depressed controls or high- or low-lethality attempters on the ATHF cumulative strength of antidepressant treatment item ($F(2, 38) = .50, ns$).

Analyses with respect to the WCST are presented in Table 2 and Fig. 1. High-lethality suicide attempters exhibited poorer performance on the WCST than comparison subjects, depressed subjects, and the low-lethality suicidal group. The high-lethality group made significantly more errors than the healthy comparison and low-lethality groups ($\chi^2 = 9.85, p \leq .05$). Similarly, high-lethality attempters made more perseverative errors than the comparison and low-lethality attempters, while the depressed group made more perseverative errors than the comparison group ($\chi^2 = 9.47, p \leq .05$). Fewer participants in the high-lethality group demonstrated a conceptual understanding of the rule compared to all other groups ($\chi^2 = 9.85, p \leq .05$).

Mean scores on the planning subscale of the suicide intent scale were 5.94 ± 3.43 (range 0–14; median = 6). No differences in WCST performance were noted as a function of suicide intent when defined dichotomously. Though no differences were noted, planning as a continuous variable was further explored using Pearson's correlation. Planning was associated with non-perseverative errors ($r = .40, p = .018$) and marginally associated with conceptual responses ($r = -.32, p = .060$). No other associations were noted ($p \geq .099$). Linear regression modelling was performed to test independence of lethality and planning. This model ($F(2, 32) = 5.23, p = .011$) revealed a significant contribution from the constant

($t = 4.10$, $p \leq .001$, $B = 138.58$, $SE = 33.77$), and lethality ($t = -2.46$, $p = .020$, $B = -20.37$, $SE = 8.27$), but not planning ($t = -.62$, $p = .540$).

6.1. Sensitivity analyses: effects of potential anoxic brain injury and education

Analyses were performed to exclude the potential confounding effect of anoxic injury relating to the suicide attempt, which was more prevalent among the high-lethality attempters ($\chi^2 = 5.34$, $df = 1$, $p = .021$). Comparison of suicide attempters with and without potential anoxic injury indicated no significant differences in perseverative errors (25.26 ± 11.39 vs. 27.43 ± 16.09 , $t(32) = .31$, $p = .757$), total errors (28.33 ± 12.14 vs. 27.60 ± 10.80 , $t(32) = .14$, $p = .885$) or conceptual responses (44.80 ± 22.19 vs. 41.83 ± 29.69 , $t(32) = .28$, $p = .781$).

Finally, we examined the effects of education in multinomial logistic regression models. In these models, high-lethality subjects were the reference group and WCST indices in addition to education were included in the model. Results were replicated for total errors, and conceptual responses, but not for perseverative errors.

Specifically, the model including total errors ($\chi^2 = 18.64$, $df = 6$, $p = .005$) revealed significant contributions from total errors ($p = .032$) and education ($p = .002$), with total errors distinguishing high-lethality attempters from all other groups (low-lethality $B = -.06$, $p = .027$; depressed $B = -.05$, $p = .037$; control $B = -.07$, $p = .007$). With respect to conceptual responses, the final model ($\chi^2 = 20.08$, $df = 6$, $p = .003$) received significant contributions from conceptual responses ($\chi^2 = 10.21$, $df = 3$, $p = .017$), but not education ($p = .080$), with conceptual responses distinguishing high-lethality attempters from low-lethality attempters ($B = .05$, $p = .005$) and controls ($B = .03$, $p = .016$), but not from depressed participants ($B = .02$, $p = .112$). Last, the model including percent perseverative errors ($\chi^2 = 16.15$, $df = 6$, $p = .013$), no longer received a significant contribution from perseverative errors ($p = .099$) after controlling for education.

7. Discussion

Suicide among older individuals is a poorly recognized and investigated public health problem. Cognitive function is an important consideration for clinicians who manage older patients, and growing evidence suggests that cognitive changes or pre-existing deficits may be involved in suicide.

Using a four-group design controlling for the cognitive effects of depression, we examined participants' performance on the WCST in order to examine deficits in cognitive control during rule learning in depressed older adults. We observed poorer performance in the high-lethality attempters across multiple measures on the WCST, including errors, perseverative errors and conceptual-level responses. The WCST is a task requiring cognitive control and thus relates to impaired ability to adapt to changing situations. Though the effect with respect to perseverative errors did not withstand correction for education in this sample, the pattern observed among high-lethality attempters suggests an overarching deficit in cognitive control, rule acquisition, and learning from reinforcement.

7.1. Cognitive control, learning and suicidal behaviour

From the reinforcement-learning standpoint, our data clearly suggest that high-lethality suicide attempters exhibit an impaired ability to represent their environment with multiple reciprocally reinforced rules. Specifically, the WCST exemplifies a complex and changing environment, contingent on the ability to flexibly discount punishment for previously reinforced rules while simultaneously assigning reward to alternative rules. We found that individuals with a history of high-lethality suicide attempts did not behave in a manner

responsive to the higher-level structure of the task. This failure of higher-order, strategic learning undermines one's ability to select the right approach to a problem.

Lack of cognitive control has been previously implicated in suicide either indirectly through a decreased ability to problem solve (Grover et al., 2009; Schotte et al., 1990) or directly using tests of cognitive control (Keilp et al., 2001; King et al., 2000; Raust et al., 2007). In a sample of middle-aged adults, Raust et al. (2007) administered a large battery of tasks of cognitive control that demonstrated impaired inhibition (Stroop test) among suicide attempters, but no differences on a simpler, two-stimulus task of deterministic reversal learning. Similarly, deficits on the Stroop and the Trail Making Test were detected among the relatives of suicide completers, where a standardized laboratory stress task unmasked impairment in cognitive control and executive function (McGirr et al., 2010).

While some studies have not identified differences on WCST performance in suicide attempters (Bartfai et al., 1990), incongruence with our results may be related to the older age of our population or the clear demarcation between high- and low-lethality attempters. In older age, the WCST, notably perseverative errors, has been previously shown to distinguish elder depressed suicide ideators from depressed never suicidal controls (Marzuk et al., 2005). Similarly, in accordance with our findings, differences on the WCST specific to high-lethality attempters have been observed among non-geriatric adults (Keilp et al., 2001). More specifically, the 'failure to maintain set' variable discriminated high-lethality attempters from controls and low-lethality attempters. As relates to cognitive control among older adults, among individuals over the age of 50, King et al. (2000) used a cognitive battery including the WCST where suicide attempters made substantially more perseverative errors on the WCST. This, however, did not withstand statistical correction for age and sex and no sub-analyses were performed with respect to attempt lethality.

Considering the present findings, impaired probabilistic reversal learning in suicide attempters (Dombrovski et al., 2010) and the literature discussed above, we posit that lethal suicide attempts among older adults are associated with learning impairment in complex environments. The challenge in probabilistic reversal learning relies on misleading feedback, where a low-complexity contingency involving simple stimuli is obscured by misleading or unreliable feedback. This is in opposition to the environment created by the WCST, where rule learning occurs in the context of entirely unambiguous feedback nevertheless occurring in a complex environment with stimuli varying according to multiple dimensions. This is interesting in light of past research suggesting that task complexity is well suited at unmasking decision-making impairment in older age (Finucane et al., 2005). In the context of the learning and suicide literature, we suggest that suicide in older adults may be related to the degree of demand imposed by the complexity of the environment.

The juxtaposition of these data with findings of impaired value-based decision-making in suicide attempters (Clark et al., 2011; Dombrovski et al., 2011) suggests an intriguing double dissociation. Our previously published data with a partially overlapping sample revealed that low-lethality attempters tend to make disadvantageous, impulsive choices (Dombrovski et al., 2011), while the high-lethality attempters in the current study display impaired rule learning without clear association with the level of planning involved in the attempt. This may suggest two independent dimensions of suicidal diathesis, namely impulsivity and rule learning. The independence and interaction of these cognitive vulnerabilities are an intriguing avenue for future research designed to elucidate age related or specific vulnerability. While impulsivity in value-based decision making seems to be related to the impulsive-aggressive suicidal diathesis important in younger adults (McGirr et al., 2008), further studies can address whether learning deficits may play an increasingly important role in lethal suicidal behaviour commonly seen in older individuals.

With regards to effects of major depression and its influence on cognitive control, studies among non-demented elderly depressed individuals have revealed deficits in cognitive control (Feil et al., 2003; Kindermann et al., 2000). In the geriatric population, cognitive impairments identified in the depressive state persist following remission from depression (Bhalla et al., 2006; Butters et al., 2000). Moreover, studies employing the WCST to study deficits in deterministic learning among previously depressed middle aged participants have identified deficits in non-perseverative errors and number of completed trials (Austin et al., 1999; Merriam et al., 1999). In our study, high-lethality suicide attempts were associated with impairments in multiple indices of deterministic learning above and beyond the effects of major depression, which appeared less robust in this sample. The consistency with which the domains of the WCST discriminated high-lethality attempters indicates that this instrument may have clinical utility, although the interpretation must clearly be cautious given the limited specificity of poor conceptual reasoning and perseverative errors.

8. Limitations

This study employed cross-sectional design and retrospective assessment of suicidal behaviour. Dichotomizing based on attempt lethality reduced our ability to detect modest differences and small effects. The effects of co-occurring conditions should be further investigated in larger samples. While the design dissociates the role of major depression, it does not identify whether the deficits in cognitive control identified are state dependent or stable. Moreover, the WCST is a commonly used test of higher order cognitive processes which does not fully detail basic cognitive processes, such as attentional control or working memory. While analyses of the Dementia Rating Scale initiation/perseveration, attention, and memory subscales did not reveal a pattern of differences to account for high-lethality attempters' poorer rule learning, more sensitive tasks could possibly reveal differences in underlying low-level abilities.

Future studies should prospectively investigate cognitive dyscontrol as a predictor of new onset suicidal behaviour among older individuals. As executive function in populations at risk for suicide has been related to stress induced executive impairment experimentally (McGirr et al., 2010) and observationally (Grover et al., 2009), we cannot exclude the possibility that individuals who engage in high-lethality suicidal behaviour are faced with greater psychosocial demands. Prospective studies should include assessment of life events to determine the role of cognitive control impairments in the genesis of stress-induced suicidal behaviour. Moreover, a prospective design would disentangle the cognitive repercussions of having engaged in a high-lethality attempt, which is precluded using the current design. Lastly, depressed patients with suicidal ideation should be included as a separate group to distinguish the role of rule learning through the entire spectrum of suicidal behaviour.

9. Conclusion

High-lethality suicide attempts among older people are associated with several impairments in cognitive control during rule learning as detected by the WCST. Our data suggest that impairment in cognitive control during rule learning may represent a vulnerability distinct from the impulsive diathesis, typically manifesting in low-lethality attempts. This vulnerability may contribute to the high incidence of serious or, often, fatal suicidal acts in old age.

Acknowledgments

We would like to thank the participants in this study for their time, their effort, and dedication to improving our knowledge of the aetiology of suicide in the elder population.

Role of funding source

This study was supported by a Mentored Patient-Oriented Research Career Development Award from the National Institute of Mental Health in support of Alexandre Dombrovski (K23 MH086620) and Katalin Szanto (MH 05436 (RO1) and K23 MH070471). The NIMH had no further role in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

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Fig. 1. High-lethality suicide attempters' WCST performance: errors, perseverative errors and conceptual responses. * $p \leq .05$, ** $p \leq .01$.

Table 1

Demographic and clinical characteristics.

	High-lethality attempter (N = 14)		Low-lethality attempter (N = 20)		Non-suicidal depressed (N = 29)		Control (N = 30)		F or χ^2	p
	M	SD or N(%)	M	SD or %	M	SD or %	M	SD or %		
Female	7	(50.0%)	10	(50.0%)	19	(65.5%)	14	(46.7%)	5.22	.515
Male	7	(50.0%)	10	(50.0%)	10	(34.4%)	16	(53.3%)		
Age	68.86	± 7.53	66.80	± 8.15	70.30	± 9.03	69.77	± 6.76	.84	.474
Education (years)	12.93	± 2.94	13.10	± 2.17	14.75	± 2.78	14.43	± 3.18	2.23	.090
DRS-Total ^a	133.36	± 4.74	131.50	± 8.97	132.90	± 4.53	136.70	± 3.92	4.00	.010
Initiation/Perseveration	35.57	± 1.65	34.72	± 3.61	35.44	± 2.40	36.27	± 1.73	1.30	.278
Attention	35.14	± 1.56	34.94	± 2.04	35.56	± 1.15	35.73	± 1.11	1.45	.232
Construction	4.93	± .73	4.72	± 1.40	5.07	± .67	5.27	± .72	1.39	.250
Conceptualization	35.71	± 3.02	35.72	± 3.57	35.00	± 2.40	36.31	± 1.95	1.05	.372
Memory	22.0	± 1.92	21.65	± 3.20	21.56	± 2.63.50	23.12	± 1.53	2.06	.111
HAMD-17 ^b	21.21	± 4.98	23.35	± 5.35	19.85	± 3.63	2.67	± 1.97	156.32	≤.001
Suicide Ideation Scale ^c	22.58	± 8.40	19.31	± 8.51	1.04	± 3.20	.00	± .00	95.91	≤.001
Suicide Intent Scale	7.92	± 3.42	4.55	± 2.74	–		–		t(32) = 3.18	.003
ATHF – Cumulative strength ^d	1.86	± 1.95	2.46	± 2.57	1.68	± 1.97	–		.50	.611
Alcohol misuse	2	(14.3%)	4	(20.0%)	1	(3.2%)	–		3.13	.209
Substance misuse	1	(7.1%)	2	(10.0%)	0	(0.0%)	–		2.63	.268
Panic disorder	3	(21.4%)	3	(15.0%)	3	(10.3%)	–		1.56	.458
Generalized anxiety	3	(21.4%)	4	(20.0%)	7	(24.1%)	–		.44	.802
Specific phobia	1	(7.1%)	3	(15.0%)	3	(10.3%)	–		.21	.900
Post-traumatic stress disorder	1	(7.1%)	1	(5.0%)	0	(0.0%)	–		2.12	.346

DRS: Dementia Rating Scale. HAMD-17: Hamilton Depression Inventory 17-item. ATHF: Antidepressant Treatment History Form.

^aLeast Significant Difference Post-hoc: Controls vs. Depressed $p = .011$; Controls vs. Low-lethality $p = .002$, Controls vs. High-lethality $p = .071$.

^bLSD: Controls vs. Depressed, $p \leq .001$; Controls vs. Low-lethality, $p \leq .001$; Controls vs. High-lethality, $p \leq .003$; Depressed vs. Low-lethality, $p = .003$; Depressed vs. High-lethality, $p = .292$; Low-lethality vs. High-lethality, $p = .120$.

^cLSD: Controls vs. Depressed, $p = .460$; Controls vs. Low-lethality, $p \leq .001$; Controls vs. High-lethality, $p \leq .001$; Depressed vs. Low-lethality, $p \leq .001$; Depressed vs. High-lethality, $p \leq .001$; Low-lethality vs. High-lethality, $p = .102$.

^dLSD: Controls vs. High-Lethality $p = .021$, Controls vs. Low-Lethality $p \leq .001$, Controls vs. Depressed $p = .004$. No other significant post-hoc comparisons.

Table 2

Performance on the Wisconsin Card Sorting Test – Lethality.

	A. High-lethality attempter (N = 14)	B. Low-lethality attempter (N = 20)	C. Non-suicidal depressed (N = 29)	D. Control (N = 30)	χ^2	p	A vs B		A vs C	A vs D	B vs C	B vs D	C vs D
	M $\pm$ SD Mean rank	M $\pm$ SD or % Mean rank	M $\pm$ SD or % Mean rank	Median difference (95%CI); p									
WCST scores													
Total errors	34.00 $\pm$ 11.13 65.68	23.35 $\pm$ 8.42 40.85	26.67 $\pm$ 11.69 49.24	23.50 $\pm$ 10.28 40.22	9.85	.020	11.00 (4.00–19.00); p = .005	7.00 (0.00–15.00); p = .064	12.00 (4.00–19.00); p = .006				
Non-perservative errors	12.64 $\pm$ 5.55 62.25	8.80 $\pm$ 4.26 42.50	8.47 $\pm$ 5.17 40.48	10.10 $\pm$ 5.14 49.18	6.95	.073							
Percent perseverative errors	33.38 $\pm$ 17.02 61.68	22.63 $\pm$ 12.44 44.25	28.43 $\pm$ 18.93 52.10	20.97 $\pm$ 16.46 37.05	9.47	.024	10.00 (2.00–19.20); p = .036		8.00 (3.00–14.00); p = .005				6.50 (0.00–15.20); p = .048
Percent conceptual-level responses	30.8 $\pm$ 23.70 27.71	53.71 $\pm$ 17.96 52.53	48.36 $\pm$ 23.42 45.67	53.23 $\pm$ 22.52 53.60	9.85	.020	25.15 (8.00–41.00); p = .005	18.90 (1.30–34.40); p = .033	25.65 (8.00–41.00); p = .006				
Failure to maintain set	.43 $\pm$.51 48.14	.55 $\pm$.82 48.70	.53 $\pm$.68 50.71	.33 $\pm$.66 41.75	2.70	.259							