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ORIGINAL ARTICLE

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Executive performance of depressed suicide attempters: the role of suicidal ideation

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Abstract *Objective* Suicidal ideation has been related to cognitive rigidity whereas suicidal behaviour itself was associated with specific executive deficits. Yet it remains unclear if a distinct cognitive suicidal phenotype does exist. The aim of the present study was to further investigate the role of suicidal thinking for the neuropsychological performance in depressive suicide attempters. *Method* Depressive inpatients after a recent suicide attempt, who either had present suicidal ideation (n = 14) or not (n = 15) and healthy controls (n = 29) were recruited. The groups were assessed by means of executive tasks designed to capture impulsive decision-making, and with verbal memory and attention tests. Self-rating measures of impulsivity and aggression were further applied. *Results* Only patients with current suicidal ideation showed executive dysfunctions with impaired decision-making being the most salient. Verbal memory and attention were reasonably intact in all patients. All patients reported increased aggression. *Conclusion* Suicidal ideation is clearly associated with impaired cognitive performance. Our results suggest that executive deficits seen in depressive suicide attempters have a state-dependent component.

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Introduction

Major depression (MDD) is associated with a high risk for committing suicide [28, 41, 55]. It has been suggested that suicidal behaviour is linked to enhanced impulsive behaviour that increases the likelihood of acting out on suicidal ideation [42]. Furthermore, aggression might contribute to suicide risk too [2, 31, 35]. Increased impulsivity and aggression have both been related to disturbed orbitofrontal function in respect to suicidal behaviour in general [7, 8, 11, 19, 20]. However, though many depressive patients exhibit suicidal tendencies, neuropsychological correlates of suicidal behaviour were hardly studied in affective disorder (for review see [39]). By contrast, many studies have demonstrated neuropsychological deficits in patients with MDD with mnestic and executive deficits being the most prominent [4, 15]. Executive dysfunctions were related to structural and functional changes in the prefrontal cortex [54]. Within the prefrontal areas a diminished volume of the orbitofrontal cortex (OFC) [6, 38] as well as an increased metabolism [12] have been observed in patients with MDD.

Orbitofrontal functioning can be assessed by different neuropsychological paradigms, e.g. decision-making [8], response inhibition [17, 32] and delayed alternation [24]. Accordingly, functional imaging studies have shown an association between orbitofrontal activation and the Iowa gambling task (IGT), Go/No-Go and delayed alternation tasks (DAT) in healthy subjects [13, 32, 59]. In addition, Antonucci et al. [1] found an association between increased impulsivity as measured with the Barratt impulsive-

ness scale (BIS-11 [49]) and OFC volume in psychiatric patients.

In line with the concept of disturbed orbitofrontal functioning in major depression Must et al. [46] demonstrated a worse decision-making in the IGT in depressive patients. Kaiser et al. [34] reported an impaired response inhibition in a (non-affective) Go/No-Go task, whereas Freedman et al. [23] demonstrated an enhanced perseveration in a DAT in patients with MDD. Likewise, in respect to suicidal behaviour, Jollant et al. [33] reported a decision-making deficit in suicide attempters with remitted affective disorder compared with healthy volunteers using the IGT. The same study group further demonstrated an impaired response inhibition by means of a Go/No-Go task in the euthymic suicide attempters (unipolar, bipolar, schizophrenic) compared with healthy controls [52]. However, other authors did not find any differences in neuropsychological performance between suicidal and non-suicidal patients (see e.g. [22, 37]). Recently, Nangle et al. [47] even demonstrated superior executive functioning in schizophrenic patients with a history of a suicide attempt compared with schizophrenic non-attempters. In sum, it still remains unclear if suicide attempters can be characterized by a specific cognitive profile [39].

Marzuk et al. [43] offer an alternative view on neuropsychological correlates of suicidality in MDD. The authors stress that suicidal ideation in depressive patients is a major determinant of executive dysfunctions. They found that patients with current suicidal ideation performed significantly worse compared with patients without suicidal ideation on several executive tasks like the Wisconsin Card Sorting Test (WCST). Thus, the presence of suicidal ideation could play an important role with regard to suicidality associated executive dysfunctions in patients with affective disorder. Unfortunately, it has not been examined yet whether suicidal ideation is linked to specific structural or functional changes. However, it has been shown that the WCST like the IGT is associated with the OFC, too [24].

Following Marzuk et al. [43] we decided to examine depressive suicide attempters with or without current suicidal ideation. In contrast to their study all patients had a history of a suicide attempts to rule out the influence of suicidal behaviour when comparing the two patient groups. Furthermore, as suggested by Marzuk et al. [43] for future studies, we assessed personality traits, which might correlate with neuropsychological measures sensitive for orbitofrontal function. Finally, only non-psychotic patients with MDD were included in the study due to the contradictory results in respect to neuropsychological performance of suicidal patients with different psychiatric disorders. On the whole, to our best knowledge this is the first study to examine a homogeneous group of suicide attempters with MDD without psychotic features.

We hypothesized that patients with current suicidal ideation would have more severe executive deficits compared with patients without suicidal thoughts. To control for a possible impact of mnestic or attentional deficits on the expected executive impairment we further assessed these cognitive skills.

Method

Subjects

Twenty-nine inpatients (17 males, 12 females) aged 19–58 years hospitalized due to a suicide attempt within the last 3 months were included in the study. The patients participated in a project within "The German Research Network on Depression" in Bonn. All patients suffered from a unipolar major depression without psychotic features. Exclusion criteria were any neurological disease, substance abuse or addiction and a comorbid borderline-personality disorder with self-harming behaviour.

Fourteen patients tried to commit suicide two times while only six patients had more than three attempts. Twenty patients used medications, etc., to attempt suicide. Furthermore, three patients cut themselves with a sharp-edged device. In accordance the criteria described by Heila et al. [29] six suicide attempters committed a violent suicide attempt (hanging, shooting, car crash, etc.). Two patients had to be treated in an intensive care unit. Two-third of the suicidal patients had committed the present suicide attempt within the last 30 days. Fourteen patients reported of having current suicidal ideation as measured by the scale for suicidal ideation (SSI, see below) [10] ($M = 12.3$; $SD = 5.9$) whereas 15 patients did not show any suicidal ideation at all (SSI $= 0$).

Fourteen patients were drug-free, whereas seven patients were treated with SSRI, six patients with mirtazapine, one patient with an SSRI plus mirtazapine and one patient with doxepin. Seven patients were allowed to take lorazepam in case of anxiety though none of these patients used this benzodiazepine 48 h before neuropsychological testing.

Twenty-nine matched healthy controls were recruited by means of advertisement. Exclusion criteria were a past or present psychiatric or neurological disorder as well as a SSI score > 0.

The structured clinical interview for DSM-IV (SCID) (for axis 1 and 2) was applied to patients only. Controls were interviewed by a psychiatrist and a trained psychologist regarding exclusion criteria.

The study was approved by the Local Ethics Committee. Following a detailed explanation of the study procedure written informed consent was obtained by all participating subjects.

The psychologist administering the neuropsychological tests was blind to the patient's suicidal status.

Clinical assessment

Suicidal ideation was measured with the SSI [10]. This clinician-administered scale consists of 19 items with a maximum score of 38. Patients with a score of 0 were considered to be currently non-suicidal. The suicide attempt characteristics were assessed by means of the Suicide Intent Scale (SIS) [9]. In accordance with Mieczkowski et al. [45] two subscales of the SIS were calculated. The "planning" scale describes the amount of preparation of the suicide attempt as the "lethal intent" scale characterizes the attempter's expectation of potential lethality of the attempt. Furthermore, the method of the last suicide attempt was recorded in order to differentiate between violent and non-violent suicide attempts. Lethality of the last suicide attempt was rated by the attending physician ranging from 1 (innocuous) to 5 (highly lethal).

Severity of the depressive illness was measured by the 21-item version Hamilton depression rating scale [26].

The Barratt impulsiveness scale (BIS-11 [49]) was used to measure self-reported impulsivity. The scale consists of three subscales: attentional impulsiveness, motor impulsiveness and non-planning impulsiveness.

Aggression was measured with the Inventory for the assessment of factors of aggressiveness (FAF [27]), which is similar to the American Buss-Durkee Hostility Inventory [16]. The FAF is comprised of five subscales with the first three (spontaneous aggression, reactive aggression, irritability) being added to a summed aggression score. Furthermore, self-directed aggression and inhibition of aggression are measured (the subscale "openness" was left out as it does not measure aggressiveness).

Neuropsychological assessment

The "Mehrfachwahl-Wortschatz-Intelligenztest" (MWT-B [40]) was used to measure the premorbid verbal IQ.

Decision-making performance was assessed by using the IGT [7]. The subject's goal is to win as much (virtual) money as possible by drawing cards from four decks (A, B, C and D). Each deck consists of 40 cards. Two decks (A and B) offer immediate gain but also huge losses while the other two decks (C and D) yield a margin in the long run. A total of 100 trials were conducted. Dependent variables were the IGT net score representing the relationship between drawing cards from advantages and disadvantages decks during the game (for further details see [51]).

Subjects also completed a Go/No-Go Task [48] with total gain, summed omission and commission errors serving as performance parameters. Commission errors are related to disinhibition and increased impulsivity respectively (for a detailed description see [51]). The task's object is to learn by trial and error to press a button for "active" stimuli and resist from pressing for "passive" stimuli. Stimuli consist of eight two-digit numbers ranging from 03 to 99 with four being active and four being passive. Correct responses are reinforced (with virtual 5 Cent) while wrong reactions are punished (5 Cent). The task consists of two conditions, a reward–punishment and a punishment–reward condition. Each condition has a different set of numbers running 80 trials.

Furthermore, a computer-based modification of the DAT was originally introduced by Freedman and Oscar-Berman [25]. An explanation of the task is displayed on the screen instructing the subject to find a star depicted on two cards looking alike on the reverse side. By pressing the right or left shift button the participant has to decide which card he wants to turn over. Both cards are baited with a star in the first trial round. After finding the star the cards are shuffled and the next trial begins. The star is located at the opposite side with regard to the subject's first choice and changed in the same manner the following trials. A total of 25 consecutive trials succeed the first trial. The dependent variable was the total number of errors being made with a maximum of 25 errors being able to occur.

The d2-letter cancellation test (Aufmerksamkeits-Belastungstest [14]) was used to assess selective attention. The d2 is a paper-and-pencil cancellation test requiring speed and accuracy of performance. The participant is instructed to discriminate visual similar targets (d's with two dashes) from non-targets (d's with one, three or four dashes and p's with dashes). Time to cancel out targets is 4 min and 40 s. The dependent variable is the concentration index (KL) (for further details see [44]).

At last the German version of the Auditory Verbal Learning Test (AVLT) [53], the "Verbaler Lern- und Merkfähigkeitstest" (VLMT) [30] was used to examine verbal declarative memory function. The dependent variables were learning capacity, i.e., the sum of words of trials (1–5), delayed recall and recognition. The first trial is used as a measure of verbal working memory.

Data analysis

The suicide attempters were divided into two groups according to high and low suicidal ideation. All data were analyzed using SPSS 14.0 for Windows. In case of a high amount of outliers variables were transformed using square root transformation.

The ratio of men and women and violent and non-violent suicide attempters between groups was analyzed using χ^2 tests.

Single comparisons were calculated by means of univariate analysis of variance (ANOVA). Multiple comparisons of the clinical variables were performed by means of multivariate analysis of variance (MANOVA). Post hoc tests were calculated with the Tukey–HSD test. Within suicide attempters the ordinally scaled variable "lethality of the last suicide attempt" was compared with the Mann–Whitney test.

Relations between demographic/clinical parameters and cognitive deficits were explored by correlation analysis. Pearson's r was used for normally distributed data, Spearman's ρ for data with ordinal-scale level, respectively. Due to the high number of comparisons level of significance was set to $P < 0.01$ to avoid alpha-error accumulation.

At last effect sizes in accordance to Cohen [18] were calculated for those neuropsychological variables that significantly differentiated between the groups.

Results

Demographic variables

The groups did not significantly differ with respect to age [$F(2,55) = 1.28$; $P = 0.287$], years of education [$F(2,55) = 1.26$; $P = 0.291$] or verbal IQ [$F(2,55) = 2.14$; $P = 0.127$] (Table 1). Furthermore, gender was equally distributed between the groups of suicide attempters and healthy controls [$\chi^2(2) = 0.83$; $P = 0.661$] as well as the violence and lethality of the last suicide attempt within the patient groups [$\chi^2(1) = 0.68$; $P = 0.411$; $\chi^2(4) = 2.79$; $P = 0.593$]. Six patients without suicidal thinking were treated with antidepressants as nine suicide attempters were treated with current suicidal ideation, respectively [$\chi^2(1) = 0.191$].

Clinical parameters

Depression severity ranged from 5 to 36 as measured by the HAM-D with nine patients being only mildly depressed (HAM-D < 10). The groups differed significantly with regard to severity of depressive symptoms [$F(2,55) = 50.69$; $P < 0.001$] with patients having suicidal ideation being significantly more depressed than the other patients ($P < 0.001$) and healthy controls ($P < 0.001$). Furthermore, patients without current suicidal thoughts were more depressed than healthy participants, too ($P < 0.001$). With respect to impulsivity only attentional impulsivity yielded significant results [$F(2,55) = 15.4$; $P < 0.001$]. Post hoc tests demonstrated that patients with suicidal ideation showed increased attentional impulsivity compared with the other patient group ($P = 0.006$) and healthy controls ($P < 0.001$). At last, the groups differed with regard to FAF summed aggression [$F(2,54) = 6.91$; $P = 0.002$] and FAF self-directed aggression [$F(2,54) = 43.90$; $P < 0.001$]. Patients with suicidal ideation reported more (summed) aggression and self-directed aggression than healthy

Table 1 Demographic and clinical characteristics of suicide attempters and controls

	A: Patients with suicidal idea		B: Patients without suicidal idea		C: Controls		Results ($P < 0.05$)
	Mean	SD	Mean	SD	Mean	SD	
Age	34.3	11.1	40.4	11.0	39.0	10.9	[a]
IQ	100.7	9.6	104.3	16.9	108.4	9.4	[a]
Years of education	13.4	1.7	14.5	2.0	14.4	2.3	[a]
Psychometric measures							
HAM-D	18.6	8.4	11.4	5.6	2.0	2.3	A > B > C[a]
BIS-11 total	67.3	13.2	63.5	10.9	59.4	9.4	[b]
BIS-11 attentional	19.1	3.3	15.8	2.8	14.1	2.5	A > B, C[b]
BIS-11 motor	23.1	6.4	22.1	5.3	21.0	4.2	[c,b]
BIS-11 non-planning	25.1	6.2	25.7	4.5	24.4	4.2	[b]
FAF summed A	13.9	6.6	14.7	7.6	7.9	5.9	A, B > C[b]
FAF self-directed A	8.2	1.7	6.4	2.3	2.0	2.2	A, B > C[b]
FAF inhibition of A	5.5	1.6	5.7	1.6	5.1	2.0	[b]

[a]Subgroups of suicide attempters were compared with healthy controls by means of univariate analysis of variance with Tukey test as post hoc test
[b]Subgroups of suicide attempters were compared with healthy controls by means of multivariate analysis of variance with Tukey test as post hoc test
[c]Data were transformed by means of square-root transformation due to a high number of outliers

controls ($P < 0.022$; $P < 0.001$) as did patients without current suicidal thoughts ($P < 0.005$; $P < 0.001$) (Table 1).

The patient groups did not differ significantly with regard to suicidal parameters with exception of days passed since the last suicide attempt (Table 2). Significantly more days had passed between the time of the suicide attempt and the neuropsychological examination in the group of suicide attempters without current suicidal ideation [$F(1,27) = 4.36$; $P = 0.047$]. The number of patients committing a violent suicide attempt was equally distributed between the groups.

Neuropsychological performance

Iowa gambling task

Due to equipment failure three healthy women could not complete the IGT. Table 3 displays the cognitive performance of the participants. The examination of the neuropsychological performance of suicide attempters with and without current suicidal ideation revealed the following result: suicide attempters with suicidal thoughts showed a significantly impaired decision-making on the IGT [$F(2,52) = 5.38$; $P = 0.008$] compared with the attempters without current suicidal ideation ($P < 0.015$; $d = 1.06$) and healthy controls ($P = 0.013$; $d = 0.91$).

Go/No-Go task

With respect to the Go/No-Go task a MANOVA yielded significant effects of all parameters: omission errors [$F(2,55) = 3.44$; $P = 0.039$], commission errors [$F(2,55) = 3.55$; $P = 0.036$] and gain [$F(2,55) = 4.13$; $P = 0.021$] (Table 3). Post hoc comparisons yielded significant differences between suicide attempters with current suicidal ideation and healthy controls with regard to commission errors ($P = 0.027$; $d = 0.86$) and gain ($P = 0.020$; $d = 0.88$). Post hoc tests did not reach significance in respect omission errors.

Table 2 Characteristics of suicidal behavior in the depressive patients

	A: Patients with suicidal ideation		B: Patients without suicidal ideation		Results ($P < 0.05$)
	Mean	SD	Mean	SD	
Suicide attempts (range 1–6)	3.0	1.0	2.2	1.4	[a]
Days passed since last SA	18.6	11.4	34.7	26.8	A < B[a]
Lethality of the last suicide attempt (range 1–5)	2.7	1.2	3.1	1.0	[b]
Suicide intent scale (SIS)	16.7	6.9	14.2	6.2	[c]
SIS lethality	9.1	3.9	7.5	3.2	[c]
SIS planning	7.6	4.0	6.7	4.1	[c]

[a]Subgroups of suicide attempters were compared by means of univariate analysis of variance
[b]Mann–Whitney test
[c]Subgroups of suicide attempters were compared by means of multivariate analysis of variance

Delayed alternation task

The groups did not differ on the DAT [$F(2,55) = 1.16$; $P = 0.321$].

d2 Test

After a significant ANOVA [$F(2,54) = 3.57$; $P = 0.035$] post hoc tests demonstrated a significant difference between patients without suicidal ideation and healthy controls ($P = 0.034$; $d = 0.73$).

VLMT

With regard to mnestic performance only learning capacity (sum of words of trials) yielded a significant effect of group [$F(2,55) = 4.13$; $P = 0.021$]. Post hoc tests were close to significance with both patients groups performing worse than healthy controls ($P = 0.052$; $P = 0.064$).

In order to confirm the difference found in the IGT between the two groups of suicide attempters univariate analysis of covariance (ANCOVA) was calculated.

Since the subgroups of suicide attempters differed with regard to the following three clinical parameters we used HAM-D, BIS-11 attention and days passed since the last suicide attempt as covariates. The difference in the IGT remained significant [$F(1,24) = 4.54$; $P = 0.044$]. Even when adding the number of suicide attempts (which tended to be higher in patients with suicidal ideation), FAF summed aggression, FAF self-directed aggression and verbal IQ to the covariates this difference remained significant [$F(1,19) = 4.25$; $P = 0.049$].

We finally divided suicidal patients into subgroups with respect to high or low impulsivity, violence and lethality of the last suicide attempt and being medicated or not. We could not detect any significant neuropsychological differences either way between the patients groups themselves or compared with healthy controls.

Correlations between suicide attempt characteristics, clinical and neuropsychological parameters within the patient group

Multiple correlations between suicide attempts characteristics, clinical parameters and cognitive deficits were calculated with level of significance set to $P < 0.01$. The variables assessing different aspects of suicidality were not significantly associated with each other except of correlations within the SIS-scales. The number of suicide attempts was correlated with several parameters of impulsivity and aggression: The strongest relations appeared between the number of suicide attempts and BIS-11 total score ($r = 0.56$; $P = 0.002$) and FAF summed aggression ($r = 0.58$; $P < 0.001$), respectively. Interestingly, BIS-11 motor impulsiveness was negatively associated with the days passed since the last suicide attempt ($r = -0.49$; $P = 0.007$) suggesting a decline since the actual time of the suicide attempt. The parameters concerning suicidality were not correlated with the neuropsychological performance with exception of suicidal ideation. In keeping with the differences found between the two groups of suicide attempters' suicidal ideation was strongly associated with the IGT net score ($r = -0.50$; $P = 0.006$). HAM-D score was significantly correlated with the Go/No-Go commission errors ($r = 0.53$; $P = 0.003$).

Though not being significant the orbitofrontal sensitive parameters IGT net score and Go/No-Go commission errors showed a moderate negative correlation ($r = -0.36$; $P = 0.056$).

Discussion

The main finding of our study is that the presence of suicidal ideation is an important mediator in regard

Table 3 Neuropsychological performance of suicide attempters and controls

	A: Patients with suicidal idea		B: Patients without suicidal idea		C: Controls		Results ($P < 0.05$)
	Mean	SD	Mean	SD	Mean	SD	
IGT net score	−3.3	12.9	19.1	22.0	17.0	23.3	A < B, C[a]
Go/No-Go commission errors	32.5	13.4	24.5	21.2	18.7	15.6	A < C[b,c]
Go/No-Go omission errors	14.1	7.5	12.8	7.6	8.5	7.0	[b]
Go/No-Go gain	5.6	2.0	6.5	2.4	7.5	2.0	A < C[b]
Delayed alternation (errors)	4.2	4.1	5.8	7.1	3.5	3.4	[a]
d2 (KL)	141.6	31.2	129.5	40.3	162.1	43.0	[a]
VLMT trial 1	6.8	2.6	6.4	2.0	7.5	1.8	[b]
VLMT trial 1–5	52.0	11.6	52.4	9.2	58.8	6.8	[b]
VLMT trial 7 (delayed recall)	11.0	4.2	11.9	3.0	13.0	2.1	[b]
VLMT recognition	13.2	1.7	13.3	2.6	13.8	1.5	[b]

[a]Subgroups of suicide attempters were compared with healthy controls means of univariate analysis of variance with Tukey test as post hoc test
[b]Subgroups of suicide attempters were compared with healthy controls means of multivariate analysis of variance with Tukey test as post hoc test
[c]Data were transformed by means of square-root transformation due to a high number of outliers

to executive performance in depressed suicide attempters. In accordance with Marzuk et al. [43] patients with current suicidal ideation demonstrated more severe executive deficits, i.e., an impaired decision-making compared with the suicide attempters without current suicidal ideation and healthy controls. In extension to the study of Marzuk et al. [43] the influence of suicide attempts was ruled out by examining suicide attempters only. Furthermore, the two patients groups were comparable with regard to personality traits that might have interfered with executive performance and decision-making, respectively. To our best knowledge this is the first study to examine solely unipolar depressive patients without psychotic symptoms after a recent suicide attempt. The patients did not suffer from a comorbid borderline-personality disorder. Keilp et al. [35] recently demonstrated in patients with MDD that aggressiveness but not impulsivity distinguished successfully between suicide attempters and non-attempters. Most importantly, the role of aggression was not visible until the authors controlled for comorbid borderline-personality disorder. Correspondingly, all patients in the present study reported more aggressive feelings and behaviour compared with the healthy participants. On the whole, though we eliminated potential sources of error with regard to psychopathological heterogeneity in advance, the clinical characteristics of our patient sample still match the crucial features of suicidal behaviour. When comparing both groups of suicide attempters they did not differ on demographic and trait-related clinical measures with exception of the attentional impulsivity, which is negligible for suicidal behaviour (see [35]). Only state-dependent severity of depression was different between the groups. Importantly, the decision-making deficit of the patients with suicidal ideation remained significant even after controlling for depressive symptoms. Hence it is unlikely that the severity of the depressive illness is responsible for these deficits. Even when we controlled for all variables that differed between the groups the decision-making deficit still was significant. Altogether, the impaired decision-making in patients with current suicidal ideation in all probability cannot be ascribed to variables other than the suicidal thinking itself. Therefore, our results together with the findings of Marzuk et al. [43] suggest that suicidal ideation measures up to the influence of actual suicidal behaviour on executive performance and decision-making, respectively, in patients with major depression.

On the one hand our findings point to a state-dependency of the decision-making deficits found since the intensity of suicidal ideation varies and (usually) declines after psychiatric treatment [50, 56]. Marzuk et al. [43] concluded in same manner that "the cognitive rigidity may be temporary and not a persistent characteristic or cognitive style in some individuals" (p 299). This temporary mental inflexibility could underlie suicidal ideation and impaired decision-making, respectively. However, on the other hand genetic studies have reported an association between a polymorphism of the serotonin 2A receptor gene and suicidal ideation in patients with MDD [3, 21]. Hence the presence, persistence and recurrence of suicidal thinking could reflect a genetic disposition and trait. Thus, our results do not necessarily contrast prior studies with regard to state-independency of a "cognitive suicidal phenotype".

Jollant et al. [33] demonstrated a decision-making deficit in suicide attempters with remitted affective disorder when compared with healthy volunteers. Due to the remitted state of the patients' illness the authors suggest a suicidal trait rather than state-dependency of this executive impairment. In accordance with this result, Westheide et al. [58] did not find a decision-making deficit in partly remitted depressives without a history of a suicide attempt compared with healthy controls. However, in the study of Jollant et al. [33] only violent suicide attempters performed worser than the matched clinical controls without a history of a suicide attempt. In the present study merely six suicide attempters committed a violent suicide attempt at all. This subgroup of patients was very small when examined separately and did not yield any significant differences or even trends when compared to the other patients and healthy controls. Due to this small sample size, it cannot be ruled out that these patients might represent a specific "trait-based" subtype of suicide attempters in general. Yet, the relationship between a specific suicidal behaviour and personality traits remains controversial [5, 57].

Keilp et al. [36] found executive deficits in depressive suicidal patients who committed a highly lethal suicide attempt compared with non-suicidal depressive patients. In our study only six patients committed a highly lethal suicide attempt with five of these attempts being violent as well. In accordance to these overlapping small subgroups of attempters a separate analysis of patients with a highly lethal suicide attempt did not generate any significant differences regarding clinical or neuropsychological parameters, either. Altogether, violent and lethal suicide attempts were only present in minority of patients that might have led to the non-significant results.

Our study has several limitations. The sample size is rather small and limits the statistical power and generalizability of our investigation. Furthermore, we did not examine a clinical control group of depressive suicide non-attempters. Half of the patients were medicated though the subgroups did not differ with regard to the number of medicated patients. A limitation regarding lethality of the suicide attempt is the fact that we did not use a validated scale for assessing the lethality of the last suicide. Finally, we did not examine patients in the remitted phase of major

depression. However, since we tried to determine the role of suicidal ideation which—by definition—is not present in fully remitted patients, this was an inevitable constraint.

In sum, our results suggest that there may be two different pathways to executive dysfunctions and decision-making deficits seen in suicidal patients. On the one hand, the presence of suicidal ideation could reflect a cognitive rigidity responsible for executive impairment. Suicidal ideation and cognitive rigidity could partly be determined genetically [3, 21]. On the other hand some suicide attempters might be characterized by lethal or violent suicidal behaviour representing a trait-like insensitivity for (painful) future consequences underlying the executive deficits [7, 33, 36].

Further studies should examine whether this trait is equally distributed among different psychiatric diseases. Moreover, the role of suicidal ideation for the neuropsychological performance in regard to the underlying psychiatric disease needs to be further clarified.

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