

*COPING, EXECUTIVE FUNCTIONING, INHIBITORY CONTROL AND
DECISION-MAKING IN A SAMPLE OF DEPRESSED SUICIDAL PATIENTS*

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ABSTRACT

Introduction: Suicidal behavior has been associated with several risk factors, including depression, maladaptive coping, and neuropsychological dysfunction. This study aimed to evaluate coping orientations, executive functioning, attentional capabilities and decision-making in depressed suicidal patients.

Methods: Two groups were selected: 32 depressed patients with history of suicide attempt and 30 depressed patients without history of suicide attempt. The Beck Depression Inventory and the COPE Inventory scales were applied, as well as the following neuropsychological tests: Wisconsin Card Sorting Test, Stroop Test, and a modified Iowa Gambling Task.

Results: The results indicate a higher level of dysfunction in the executive functioning, mental control, and decision-making domains, and lower levels of orientation to active and reflective coping strategies, humor, and positive signification in the suicidal group.

Conclusions: These results indicate that there are neuropsychological differences between depressed patients with and without history of suicide attempt, which may contribute significantly to the occurrence of suicidal behavior. However, the processes involved and the way they contribute to the phenomenon are aspects that still need further clarification.

Keywords: *Suicide; depression; executive functioning; decision-making; inhibitory control; coping*

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One million people are estimated to die every year from suicide¹, which is currently one of the three main causes of death among individuals between ages 15 and 35². Considering these numbers, suicide prevention and the reduction of morbidity and mortality due to suicide spectrum behaviors are critical to global health³. An important aspect of the phenomenon refers to the psychopathological diagnostic compatibility for 90% of the attempts, in which mood disorders are the type of psychopathology most associated with suicidal behavior^{4,5}, corresponding to a depressive episode in 56% to 87% of all suicide attempts⁶.

Although environmental factors have an assumed impact on suicide risk, they are not enough to explain why not all individuals commit suicide, even when subjected to the same adversities^{7,8}. Knowledge on the cognitive processes of suicidal behavior is yet limited, but their dysfunctionality is well documented. Hopelessness, perceived depression, suicidal ideation and intent combined with impulsivity are the main factors associated with self-directed aggression^{9,10}. Also related to suicide risk are the set of coping strategies adopted before stressful situations¹¹⁻¹⁶. A higher predisposition for maladaptive coping was identified among suicidal individuals, specifically a higher tendency for passive coping^{13,15,16}, behavioral disengagement¹⁴, avoidance, and self-punishment¹¹.

Williams and Pollock¹⁷ suggest three psychosocial mechanisms that are

essential to the occurrence of suicidal behavior: a) a particular sensitivity to life events reflecting signs of defeat, formulated on an attentional bias and leading to an involuntary hypersensitivity to specific negative stimuli; b) the feeling of being trapped due to a problem-solving inability, usually of interpersonal or social nature; c) the absence of perceived means of rescue, mediated by the lack of cognitive flexibility, leading to feelings of hopelessness^{8,10,17}.

This model, which emphasizes diathesis, is supported by some neuropsychological studies which point out the existence of neurocognitive risk factors in the etiology of suicidal behaviors^{8,10,18-30}. Although this subject is still controversial, there seems to be a trend in specialized literature to find more prominent neuropsychological impairments in suicidal patients when compared to patients with no past attempts, which suggests the existence of a neuropsychological profile⁸.

Several authors emphasize that the executive deficits found in depressed patients with a history of suicidal behavior are greater than those typically found in depressed patients without suicidal history. In addition, these findings are best explained by a pattern of impairments inconsistent with a general functioning disability, which matches a neurocognitive profile^{8,22,24,28,29}. In accordance with these results, several functional neuroimaging studies indicate the existence of metabolic changes, consistent with prefrontal hypofunctioning proportional to the lethality of the last suicide attempt, and covering the ventromedial and dorsomedial prefrontal cortices^{22,31}. Additionally, structural changes with reduced cortical volume in the frontal lobe were observed³².

Several studies show more accentuated attentional and inhibitory control difficulties in depressed patients with history of suicide attempt^{23,24,28}, possibly due to dysfunctions in the anterior cingulate, lateral prefrontal³³, and orbitofrontal cortices^{34,35}, facilitating the occurrence of suicidal acts in an intense emotional context³⁶. However, there is no consensus in the literature²⁶, as a deeper understanding of the topic is still required. In addition, several neuropsychological studies suggest the existence of an attentional bias among suicidal patients, specifically directed to suicide-related stimuli^{18,28}, a finding that may help the prediction of suicide attempts and provide support for future intervention frameworks.

Several studies indicate more accentuated decision-making deficits in suicidal patients when compared to depressed but non-suicidal

patients^{20,21}. This probably results from an emotional dysfunction involving the ventromedial prefrontal cortex, as this process is evaluated using tasks similar to the 1994 Iowa Gambling Task, assessing the decision-making process by the somatic marker hypothesis³⁷. However, the literature is yet to reach a consensus, as there are divergent findings on the matter²⁸.

The limitations resulting from the small number of studies, restricted sample sizes, and lack of consensus reinforce the need for a deeper understanding of the neuropsychology of suicidal behavior^{8,22,32}. This study aimed to evaluate the coping orientations, executive functioning, attentional capacities and decision-making capabilities of a group of depressed suicidal patients and compare the results with a depressed non-suicidal group. Considering the results obtained by most studies in the area, differences between the groups were expected in all or most of the evaluated dimensions associated with frontal lobe activity.

METHODS

Data were collected at the Centro Hospitalar do Alto Ave (Portugal) after evaluation and approval of the research project by the institution's Research Ethics Committee.

The sample was composed of 62 patients diagnosed with depression. Thirty-two of them had attempted suicide in the past 12 months (8 males, 24 females), and 30 had never attempted suicide (4 males, 26 females). Patients were selected in the Department of Psychiatry and Mental Health after analysis of their clinical records. We selected patients diagnosed with major depression, excluding those diagnosed with psychotic psychopathology or substance abuse. Before the test assessment, a short interview was conducted to confirm and clarify the information on the clinical record and the circumstances of the attempt. This confirmed that the episode was an intentional suicide attempt instead of an accident or pseudo-attempt.

The evaluation of the suicidal group included inpatients and outpatients, 1 week to 1 year after the attempt, with all the participants symptomatically stabilized. The participants' age ranged between 18 and 65 years, without clinical history of acquired or congenital brain injury or other medical conditions that could interfere with the test results, such as blindness. Minimum education attainment was set at 4 years to ensure the ability to read.

We applied the Beck Depression Inventory (BDI) and the COPE-Inventory (COPE) scales, as well as the following neuropsychological tests: Stroop Test, Wisconsin Card Sorting Test (WCST), and a modified Iowa Gambling Task: the Bechara Gambling Task (BGT).

The BDI is a tool for the assessment of depressive symptoms, reducing subjectivity in the clinical assessment and distinguishing the degrees of symptomatology severity³⁸. Since it is a quantitative instrument, the BDI allows researchers not only to confirm the diagnosis of the participants, but also to monitor the severity of the groups' depressive symptomatology, as it could interfere with the results. To participate in the study, the patients had to be clinically diagnosed with major depression and score at least 12 points in this scale, confirming the existence of significant depressive symptomatology.

Adapted from the original 1989 version, developed by Carver, Sheier & Weintraub, the COPE-Inventory has been useful in the assessment of coping strategies adopted in stressful situations, identifying the preferred coping orientations. The responses used a six-value Likert scale, according to how often the participant reacts in a certain way to cope with stressful situations. Originally including 60 items, grouped in 15 scales, the Portuguese version removed the scales for restraint and religious coping, increasing the internal consistency and reducing the extension of the instrument. The coping orientations are assessed through the dimensions avoidance, humor, support-seeking, active and reflective strategies, use of substances, and positive signification³⁹.

The Stroop Test is widely used in assessing the ability to inhibit a usual response while producing a non-automated and less usual response⁴⁰. Additionally, it is useful as an indicator of processing speed, verbal fluency, and mental flexibility^{33,41}. This version takes into account the number of stimuli that the participant is able to read, identify and inhibit in a 45-second period. The participant is asked to correct his error in case of mistake, and proceed immediately with the task⁴².

We used a computerized version of the 1993 WCST developed by Heaton, Chelune, Talley & Curtiss. This instrument was used as a measure of executive capacity. Assessing the problem-solving ability, perseverance, abstract reasoning and sensitivity to feedback given by the environment, it is a sensitive tool for the assessment of dorsolateral prefrontal dysfunction^{33,34}. The test is composed

of four stimuli cards and 64 response cards, which must be paired according to the criteria "color", "shape" or "number". After each pairing, the participant receives the "right" or "wrong" feedback. Despite the subject knowing what the possible criteria are, the correct rule is unknown, and changes every 10 correct answers. The test ends after 6 series of correct answers, or after 126 attempts⁴³.

The BGT is based on the 1994 Iowa Gambling Test (IGT) developed by Bechara, Damásio, Damásio & Anderson, and was adapted in 2011 for the Psychology Experiment Building Language platform (PEBL) by Mueller. This test, aimed at evaluating the decision-making processes, is based on a gambling task that requires choosing between one of four card decks across 100 attempts divided into five trial blocks. Two of the decks give smaller rewards for each attempt, but withdraw less money in fines, thus being considered the most advantageous. The less advantageous options, on the other hand, give higher rewards, but withdraw more money than they give. Ideally, the participant should be able to predict the positive and negative consequences of his/her choices, preferring the advantageous decks.

Showing sensitivity to the ventromedial prefrontal dysfunction, this test is useful for assessing decision-making based on the somatic marker hypothesis, i.e., not based on individual intelligence or cognitive capabilities, but rather on a process subjected to emotional modulation^{30,37}.

The data collection was performed individually, in a closed cabinet, after explanation of the procedures inherent to the study and obtainment of a signed consent form. The instruments were applied in one session per participant, always in the following order: COPE-Inventory, BDI, Stroop, BGT, and WCST.

For statistical analysis purposes, the participants were divided into two groups: depressed suicidal (DS) and depressed non-suicidal (DNS). Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 22.

The normality of the distribution of the results was assessed with the Shapiro-Wilk test for each of the dimensions analyzed in our study, and either Student's t-test or Mann-Whitney's U test (when at least one of the groups was shown to have a non-normal distribution) were used for comparing independent samples. The Wilcoxon test was also used for comparing matched samples in the first and last block of attempts on BGT.

RESULTS

Table 1 shows the relevant sociodemographic data concerning the sample. Also included are

the BDI results, used to assess the depressive symptomatology and to match the groups according to severity of depression.

Table 1: Participants' Sociodemographic Data and Beck Depression Inventory Results.

	Group		p
	DS (N=32) Mean (SD)	DNS (N=30) Mean (SD)	
Age	38.16 (9.47)	41.27 (11.28)	.243 ^{a)}
Years of Schooling	7.16 (2.78)	7.73 (3.54)	.645 ^{b)}
BDI	28.19 (9.93)	26.83 (9.29)	.582 ^{a)}

DS: Depressed Suicidal Group; DNS: Depressed Non-Suicidal Group; SD = Standard deviation; BDI: Beck Depression Inventory a) Student's t-test; b) Mann-Whitney's U test.

Since there are no significant differences between groups in terms of age, years of schooling and severity of depression, the groups can be considered relatively homogeneous for these dimensions, which, if not controlled, could interfere with the results obtained.

Table 2 shows the results for the characterization of the depressed suicidal group.

Differences between the groups were found for some but not all dimensions from the COPE-Inventory (table 3).

Table 2: Depressed Suicidal Group Characterization.

Number of Previous Attempts		Frequency
Number of Attempts		
1		12
2		7
3		6
4		2
5 or more		5
Method of the Last Attempt		
Hanging		2
Cut with Sharp Object		1
Intoxication		29

Table 3: Results of the COPE-Inventory.

	Group		p
	DS (N=32) Mean (SD)	DNS (N=30) Mean (SD)	
Avoidance	3.38 (0.80)	3.31 (0.71)	.713 ^{a)}
Humor	1.68 (0.70)	2.31 (1.03)	.007^{b)}
Support-Seeking	3.52 (1.31)	3.77 (1.11)	.362 ^{b)}
Active/ Reflective	3.51 (0.84)	4.26 (0.91)	.001^{a)}
Substance Use	1.83 (1.31)	1.62 (0.79)	.779 ^{b)}
Positive Signification	3.42 (0.99)	4.03 (0.91)	.011^{b)}

DS: Depressed Suicidal Group; DNS: Depressed Non-Suicidal Group; SD = Standard deviation;
a) Student's t-test; b) Mann-Whitney's U test;

Significant differences were found in the Humor ($U(62) = 289$; $p = .007$), Active and Reflective Strategies ($t(60) = -3.349$; $p = .001$), and Positive Signification ($U(62) = 299$; $p = .011$) dimensions. The depressed suicidal group obtained significantly lower scores

when compared to the depressed control group. No significant differences were found in the other dimensions.

Differences between the groups were observed for some but not all of the Stroop test measures (table 4).

Table 4: Stroop Test Results.

	Groups		p
	DS (N=32) Mean (SD)	DNS (N=30) Mean (SD)	
Words Read	58.53 (16.39)	61.27 (17.66)	.529 ^{a)}
Identified Colors	47.06 (10.73)	54.87 (12.07)	.009^{a)}
Inhibition Task	25.56 (10.60)	32.23 (9.68)	.012^{a)}
Interference Resistance Index	-0.28 (6.86)	3.97 (7.69)	.025^{a)}

DS: Depressed Suicidal Group; DNS: Depressed Non-Suicidal Group; SD = Standard deviation;
Student's t-test; b) Mann-Whitney's U test.

The differences are significant for the performance on the color identification task ($t(60) = -2.694$; $p = .009$) and the interference task ($t(60) = -2.583$; $p = .012$), in which the depressed suicidal group performed worse when compared to the depressed non-suicidal group. Differences were also found in the interference resistance index ($t(60) = -2.298$; $p = .025$), with the

depressed suicidal group scoring significantly lower. No statistical differences were observed in the word reading task.

The depressed suicidal group also showed more accentuated difficulties in the WCST (table 5), with significantly lower results in some of the performance indexes adopted.

Table 5: Wisconsin Card Sorting Task Results.

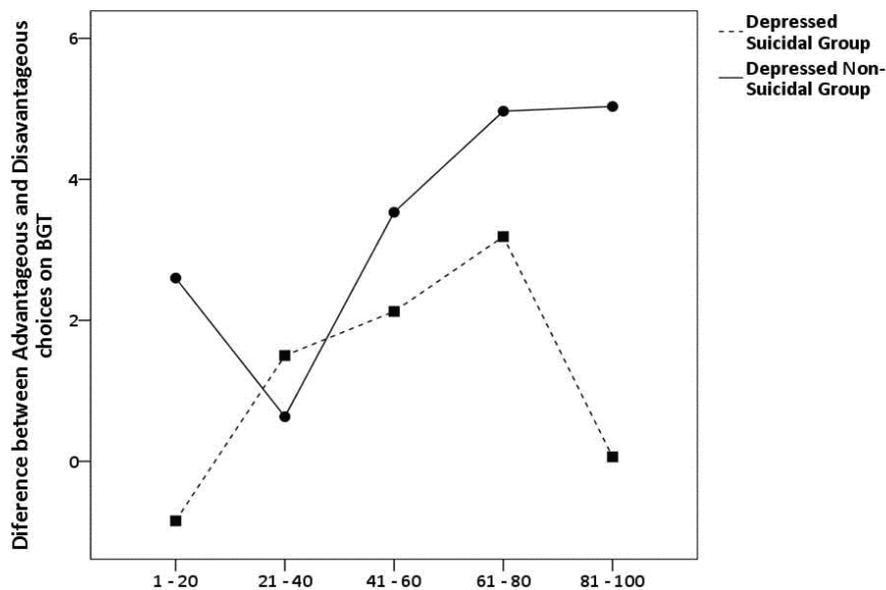
	Groups		p
	DS (N=32) Mean (SD)	DNS (N=30) Mean (SD)	
Completed Categories	2.06 (1.61)	3.80 (2.04)	.001^{b)}
Errors	70.44 (17.34)	48.43 (23.04)	.000^{a)}
Perseverant Errors	40.87 (18.80)	32.30 (15.49)	.101 ^{b)}

DS: Depressed Suicidal Group; DNS: Depressed Non-Suicidal Group; SD = Standard deviation; a) Student's t-test; b) Mann-Whitney's U test.

There are significant differences in the number of categories completed in the WCST ($U(62) = 248$; $p < .001$). The depressed control group completed on average more categories than the depressed suicidal group, which made more mistakes ($t(60) = 4,266$; $p < .001$). No significant differences were observed in the perseverant errors.

No significant differences were observed for the total money won in the Iowa Gambling Task

(graph 1), or for the ratio between advantageous and disadvantageous choices. However, the depressed suicidal group shows a significantly lower ratio than the depressed control group for the last block of attempts ($t(60) = -2.151$; $p = .036$). In addition, no significant differences were found between the first and last blocks of trials for the depressed suicidal group.



DISCUSSION

This study has an advantage regarding the sample, which is the balance between groups for the severity of depressive symptomatology, age and educational level variables, allowing to control factors that could otherwise interfere with some of the results.

Although the findings of this study are of particular interest and importance to the clinical practice, it would be relevant to include a third group of healthy controls as a comparative measure, since depression can cause and exacerbate some of the cognitive deficits observed.

Even though the central limit theorem was taken into account (postulating the existence of a normal distribution in samples composed of 30 or more participants⁴⁴), allowing for the use of parametric statistics, this was not possible for all of the dimensions assessed as some of the scores were not in conformity with a normal distribution.

Regarding the results, which were in accordance with the expectations, we found differences between the groups for coping orientations, inhibitory capacity, executive functioning and decision-making. These results support the proposition that despite mental illness being a factor of significant risk for suicidal behavior, it is not sufficient to explain the neuropsychological differences between depressed patients with and without past history of suicidal attempt¹⁰, nor the fact that not all depressed individuals commit suicide.

In this study, depressed suicidal patients scored lower for the coping dimensions humor, active and reflective strategies, and positive signification when compared to depressed non-suicidal patients. These results indicate a lower tendency for the use of humor and positive interpretation in stressful situations among depressed suicidal patients. In addition, we found lower orientations to the use of active and reflective coping strategies in depressed suicidal patients, which might relate to the results found by other authors, describing a higher tendency for passive coping^{13,15,16}, behavioral disengagement¹⁴, and avoidance¹¹ in this type of population. Still, there is doubt as to why no differences were found between groups for the avoidance dimension. This might be due to different psychometric properties of the scales used, or even due to other characteristics inherent to the populations studied, such as cultural and psychiatric differences between the American war veterans studied by Pietrzak et al.¹¹ and our sample of depressed Portuguese patients.

Krpan et al.⁴⁵, using a sample of adults with

acquired brain injury, found that patients who score higher at executive functioning have higher predisposition to adaptive coping and problem-solving. Additionally, Zakarian⁴⁶ found a moderation relationship between executive functioning, active coping and depression. Since coping may include some of the components associated with executive functioning, regarding the ability to properly apply behavioral strategies and implying a proper assessment of the situation, mobilization, and monitoring of personal resources⁴⁷, it is possible that the differences observed may relate to discrepant executive functioning capabilities.

The depressed suicidal group also performed significantly worse in the Stroop test, demonstrating a higher vulnerability to interference, higher disinhibition, and lower mental control when compared to the depressed non-suicidal control group⁴⁰. This is in accordance with other similar studies^{23,24,28}. The lack of mental control may increase vulnerability to negative emotional states and facilitate certain acts in intense emotional contexts, predisposing and contributing to the occurrence of suicidal behaviors²².

Some neuropsychological studies point out the existence of an attentional bias among depressed suicidal patients, directed specifically towards emotional suicide-related stimuli^{18,28}. It would have been interesting to determine whether the same results would occur in our sample.

We also verified performance differences in WCST regarding a higher level of prefrontal impairment among the depressed suicidal patients^{33,48}. These results were also obtained by other studies on the subject^{24,29}, reflecting higher levels of dysfunctionality on mental flexibility and problem-solving in suicidal patients^{33,34}. Mental flexibility impairment is associated with a higher vulnerability to suicidal ideation²⁹ and may exacerbate feelings of hopelessness, increasing suicide risk^{8,10,17}.

The results of the modified Iowa Gambling Task suggest slight differences on the decision-making domain, with the depressed suicidal group performing significantly worse than the control group in the last block of trials. More importantly, there are no differences in the ratio between advantageous and disadvantageous choices when comparing the first and last block of attempts, which indicates difficulties in the "emotional learning" process. These results are similar to those described by other studies in the subject^{20,21}, as well as by Bechara et al.³⁷ in patients with ventromedial prefrontal lesion. Thus, it is likely

that suicidal patients have difficulties predicting the consequences of their decisions due to a deficit in associating the consequences of their decisions with a positive or negative emotional sign, ultimately leading to difficulties in the formation of a somatic marker. Due to this, suicidal patients may tend to make choices based on the latest consequences of their decisions, regardless of the consequences of previous actions.

In the absence of an established neuropsychological model of suicide, Jollant et al.²² provide an explicative model of the influence of the neurocognitive dysfunctions found in suicidal patients on the occurrence of the behavior. The attentional processes, which are debilitated and dysfunctional, can increase vulnerability to automatic negative emotional states. On the other hand, dysfunctions in the mediodorsal prefrontal cortex, anterior cingulate gyrus and respective connections (i.e., amygdala) are associated with deficits in emotional regulation, leading to prolonged negative emotional states, including hopelessness and suicidal ideation, thus increasing the suicide risk²².

The results of this study suggest that depressed suicidal patients feature a higher neuropsychological impairment than the one typically found in depressed patients without history of suicide attempt. These impairments affect executive functioning, mental control, and, to a lower extent, decision-making. Additionally, the results indicate differences in the orientations

for coping, with a lower tendency for the use of active and reflexive strategies, humor, and positive signification by depressed suicidal patients.

One aspect regarding clinical practice is the psychopathological illness, an important risk factor that should not be overlooked. Despite the cognitive performance showing favorable evolution alongside the therapeutic remission⁴⁹, the effectiveness of the intervention in neuropsychological deficits for the prevention of suicidal behavior is still unknown⁸. Nevertheless, understanding the neuropsychological processes underlying the suicide phenomenon can assist in shaping future therapeutic frameworks for the prevention of suicidal behavior.

In conclusion, increasing evidence shows the importance of neuropsychological factors for the etiology of suicidal behavior. However, the processes involved and the way they contribute to the phenomenon are still an issue that needs further clarification and deserves the attention of clinicians and researchers in contact with this type of population.

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Conflicts of Interest

The authors declare no conflicts of interest.

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