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Original Research

Influence of Emotions on Executive Functions in Suicide Attempters

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***Abstract*:** Suicide has been associated with diverse risk factors, including alterations in executive functions and emotional processing. The aim of the present work was to evaluate the performance on executive functioning tasks with emotional content of suicide attempters. 75 subjects participated in the study, divided into 3 groups of 25 individuals each: a) suicide attempters with depressive symptoms; b) participants with depressive symptoms but no attempted suicide; and, c) non-depressed participants. Scales that evaluate depression, anxiety, impulsivity and the risk of suicide were applied, as were the original and emotional Stroop Tests, the Wisconsin Card-sorting task in its original and emotional versions, an Iowa-type gambling task, and the Behavioral Rating Inventory of Executive Functions (BRIEF-A). The suicide attempters scored higher than the other two groups on the depression and motor impulsivity scales and on the category of change in the BRIEF-A. This group also had longer response times under conditions of interference and a higher number of reading errors on the original Stroop Test, compared to the non-depressed participants. Also, on the Iowa-type gambling task, those patients showed no improvement in their performance when the first and last blocks of trials were compared, in contrast to the results from the other two groups. No other differences were observed between the group of suicide attempters and the other two groups in their performance on the executive tasks. These results suggest that patients with suicidal tendencies present problems in inhibitory control in social contexts, together with subtle alterations in their executive functions.

Keywords: suicide attempts, executive function, emotion, neuropsychology, impulsivity, depression

Suicidal behavior is now identified as a public health problem. It is considered to include aspects that run from suicidal thoughts up to completion (DeLeo, Bertolote & Lester, 2002). Estimates indicate that almost one million deaths by suicide occur annually (WHO, 2012). In Mexico, an increase in suicides has been reported: from a rate of 1.13 per 100,000 inhabitants in 1970, to an index of 4.12 in 2007 (Borges, Orozco, Benjet & Medina, 2010).

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Currently, diverse risk factors are associated with suicidal behaviors, including, among others, family antecedents of suicidal tendencies, mental illness, addictive behaviors, impulsivity, economic failure, and the loss of a family member (Joiner, Brown & Wingate, 2005; Kerkhof & Arensman, 2001).

More recently, executive dysfunctions have increasingly come to be considered additional risk factors for suicidal behavior. They may include failures in interference control, cognitive rigidity, and alterations in verbal fluidity and decision-making (Becker, Strohbach & Rinck, 1999; Jollant, Bellivier, Leboyer, Astruc, Torres, Verdier et al., 2005; Keilp, Sackeim, Brodsky, Oquendo, Malone & Mann, 2001). However, not all studies report such dysfunctions in patients with suicidal behavior (Ellis, Berg & Franzen, 1992; King, Conweel, Cox, Henderson, Denning &

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Caine, 2000), so these results are not conclusive. Alterations in the executive functions have been associated with a dysfunction of the prefrontal cortex, and some reports offer evidence of a possible predisposition towards suicidal behavior related to alterations in that cortical region (Mann, 2003; Van Heeringen, 2012).

Other risk factors for suicidal behaviors are emotional alterations such as lability (Jollant et al., 2005), emotional dysfunction (Conwell, Lyness, Duberstein, Cox, Seidlitz, DiGiorgio & Caine, 2000) and, especially, depression. Also, higher vulnerability in circumstances of negative emotions has been observed in subjects with a past history of self-injurious behaviors (Groschwitz & Plener, 2012). Depression is the mental illness most often related to suicidal behaviors (Nock, Hwang, Sampson, Kessler, Angermeyer, et al., 2009), as reports indicate that from 60-to-75% of suicidal patients manifest symptoms of this condition (Dumais, Lesage, Alda, Rouleau, Dumont & Chawky, 2005).

In light of the emotional alterations mentioned above, some studies have added emotional components to traditional tests of executive functioning; a case in point is the Stroop Test. Emotional Stroop Tests have been used to evaluate selective attention and inhibitory control in suicide attempters (Becker, Strohbach & Rinck, 1999) and patients suffering from post-traumatic stress disorder (Bremmer, Vermetten, Vythilingam, Afzal, Schmahl, Elzinga & Charney, 2004). Observations show that performance on such tests is affected by the emotional valence of the words utilized (Nock, Park, Finn, Deliberto, Dour & Banaji, 2010), and it has been suggested that emotionally-charged words attract the attention of subjects and so alter the neural processing involved in inhibitory control tasks (Elliot, Rubinsztein, Sahkian & Dolan, 2002; Hu, Liu, Weng & Northoff, 2012).Patients who have attempted suicide have shown greater interference on emotional Stroop task performance, a finding that could be associated with hypersensitivity to emotional stimuli related to their experience (Williams, Mathews & MacLeod, 1996), or to a particular cognitive scheme (Becker, Strohbach & Rinck, 1999). More specifically, higher interference has been observed on tasks that have utilized words related to suicide compared to emotionally-neutral words (Cha, Najmi, Park, Finn & Nock, 2010). The problems of emotional regulation and motivation that arise in patients who manifest suicidal conduct might also affect their decision-making (Jollant et al., 2005). Emotional components may produce a dysfunction in the regulation of the affective processing associated with the ventral area of the prefrontal cortex, and thus trigger interference in the executive processing that is more closely related to the dorsal area of the prefrontal cortex, causing impairments in inhibitory processes (Morey, Petty, Cooper, LaBar & McCarthy, 2008). It has also been pointed out that the systems of selective attention and emotional regulation share certain cerebral structures: namely, the amygdala, the anterior cingulated cortex and the prefrontal cortex (Keilp, Gorlyn, Oquendo, Murke & Mann, 2008). Therefore, these functions might also be altered by depression and difficulties in impulse control, and thus affect the performance of those subjects on tasks that involve executive functioning and emotional regulation simultaneously. For these reasons, it is important to improve our understanding of executive dysfunctions that involve emotional components.

In addition, executive dysfunctions might also make it more difficult for subjects with suicidal conduct to adapt their behavior to social contexts. Observations reveal that people with a past history of self-injurious behaviors show a poor ability to resolve problems in social contexts (Groschwitz, Plener, 2012). Also, studies have been designed to determine the impact of the executive dysfunctions observed in neuropsychological tests on functioning in daily life in different population groups: such as patients with traumatic lesions (Schiehser, Delis, Filoteo, Delano-Wood, Han & Jak, 2011), and adults with attention deficit disorder (Barkley, Murphy, 2010). However, studies of this kind have not yet been carried out on patients with suicidal tendencies, despite evidence of executive alterations in this population. In particular, inventories of executive functioning have achieved higher levels of validity than objective evaluations of the executive functions in terms of predicting problems in the daily life of certain patients (Barkley & Murphy, 2010).

Given this, the aim of the present study was to evaluate the performance on different tasks that involve executive functioning with diverse emotional components, and to conduct an assessment using an inventory of executive functions in a social context with suicide attempters, and then to compare the results to those of patients with depressive symptoms but no antecedents of suicidal behavior, and a group of non-depressed participants.

The first hypothesis was that suicide attempters would perform worse in the executive function tasks mainly with emotional components in comparison with depressed non attempters and non-depressed participants. The second hypothesis was that suicide attempters would report major executive dysfunction in daily activities inventory in comparison with depressed non-attempters and non-depressed participants.

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Methods

Participants

The study group consisted of 75 volunteer participants (Mdn=21 years, age range: 18-41 years), who were separated into 3 groups: a) 25 participants (9 men, 16 women) with depression and anxiety symptoms and recent suicide attempt (SA); b) 25 participants with depression and anxiety symptoms but no suicide attempts (DNA); and, c) 25 non-depressed participants (NDS). It was possible to match both the group with depression and anxiety symptoms but no suicide attempts (DNA) and the group of non-depressed participants (ND) to the group of patients who had attempted suicide by sex, age and educational level. Exclusion criteria included: past history of neurological damage, addictions, or psychotic symptoms requiring pharmacological treatment.

Suicide attempts were defined as any conscious, self-destructive act carried out by an individual with the express intent of ending her/his life (Brown, 2006). The attempt to commit suicide had to have taken place within the 3 months prior to assessment.

The groups of patients labeled SA and DNA presented symptoms of depression and anxiety, but the latter had no attempted suicide. The minimum score on the Beck Depression Scale for this group was 11 points (Mdn=20; Score range of 11-42), which corresponds to a level of mild mood disturbance (Jurado, Villegas, Mendez, Rodríguez, Loperena & Varela, 1998), while the minimum score on the Hamilton Anxiety Scale was 10 points (Mdn=19; Score range of 10-41), indicative of mild anxiety (Bobes, Caballero, Vilardaga & Rejas, 2011).

Non-depressed participants were those volunteers who were found to present no suicide attempt or depression or anxiety symptoms, and who scored below the minimums established as the inclusion criteria for the previous group (DNA).

The participants in groups SA and DNA were identified at the municipal medical emergency service of the city of Guadalajara, Mexico. Patients who were not undergoing pharmacological treatment were selected, since they had not adhered to any treatment regimen prescribed by a psychiatrist, or had never been referred to a psychiatric service. Upon completing the evaluation, they were referred to a mental health service with the recommendation that they accept treatment.

This research project was approved by the Ethics Committee of the Instituto de Neurociencias at the University of Guadalajara. Before beginning the procedure, all participants were asked to give their informed, written consent.

Clinical instruments

The clinical history of each participant was recorded, and spanish versions of the Beck's Depression Inventory (BDI) (Bobes-García, G.-Portilla, Bascarán Fernández, Saíz Martínez & Bousoño García, 2002; Beck, Ward, Mendelson, Mock & Erbaugh, 1961), the Hamilton Anxiety Scale (HARS) (Bobes-García et al., 2002; Hamilton, 1958), the Plutchik Risk of Suicide Scale (RS) (Saiz, García-Portilla & Bobes, 2011; Plutchik, van Praag, Conte & Picard, 1989) and the Barratt's Impulsivity Scale were applied to each participant (BS-11) (Barratt, 1994; Bobes-García et al., 2002).

Neuropsychological instruments

Stroop's Test. The three conditions of the original version of Stroop's Test were applied: i.e., reading the names of colors written in black ink; naming the color of the ink in 4Xs sequences; and naming the color of the ink on a list of color words where the color shown did not coincide with the color of the ink. For each condition, a template with 100 stimuli was used (Stroop, 1935). Response times and the number of errors were recorded for each condition. This test assesses attention, inhibition and interference control (Bausela & Santos, 2006).

An emotional version of the Stroop Test was also applied. This task included 4 conditions, each with a template of 4 words distributed in 5 columns adjusted for 100 stimuli and printed in one of 4 possible colors of ink (blue, yellow, green, red). The interference conditions were: words related to suicide and emotionally neutral, positive, and negative words. Participants were asked to name the color in which the word was written. Response times and the number of errors were registered for each condition. The presentation of the 4 conditions was counterbalanced, as in the case of the template of condition three of the original Stroop Test.

During the experimental sessions, the conditions 1 and 2 of the original Stroop Test were presented first, followed by the third condition of the original Stroop Test and then the 4 conditions of the emotional version of the test, all counterbalanced.

The words used in the emotional version of the Stroop Test were selected from long lists of emotional words provided by: 10 non depressed participants, 10 suicide attempters, 10 mental health professionals, and 6 participants with depression symptoms. None of the individuals that participated in the preliminary study to select the stimuli for the emotional version of the Stroop Test were included in the experiment.

Card-Sorting Tests. The computerized version of the Wisconsin Card Sorting Test (Berg, 1948) was applied. This test consists in sorting a

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series of cards into 3 possible categories (color, number or form). During the trials, 4 cards were always visible in the upper section of the computer screen, each one with 3 different possible categories (color, number or form). Participants had to classify a card shown in the lower section of the monitor as belonging to one of the 4 options shown in the upper section. After making the selection, the participant received feedback on her/his performance and then a new card was presented for sorting. The test ended when the participant had classified 6 series of 10 cards each based on alternating categories (i.e., color, form and number on 2 occasions each), or after a total of 128 cards were presented. The participant's performance was evaluated by the number of cards shown, number of correct-incorrect responses, number of sequences, perseverative errors, perseverative responses, conceptual responses, failures to maintain sets, and the number of attempts required to complete the first, second and third categories (Heaton, Chelune, Talley, Kay & Curtiss, 1993). This test assesses cognitive flexibility and the ability to form abstract concepts. The WSCT is considered primarily a test of cognitive aspects, since it probes dominion over the exterior world through actions that take place in time and space (Zelazo & Müller, 2002).

In the second computerized Wisconsin-type card-sorting test the cards used were marked with words reflecting emotional content (Deveney & Deldin, 2006). This test was similar to the original version except that instead of showing geometrical figures, the cards contained the word "word" and were presented as follows: one word in red in the Bauhaus 93 font, two words in green in the Curlz MT font, three words in blue in the Edwardian Strip ITL font, and four words in brown in the Romana font. The cards to be sorted bore words related to suicide. During the sorting trials, participants were instructed to ignore the meaning of the words; otherwise, the rules, the number of cards shown, and the system for evaluating their performance were the same as those used in the original WCST test.

The Iowa-type Gambling Task. An Iowa-type gambling task (Bechara, Damasio, Damasio & Lee, 1999) was also applied in a computerized version. This test presents a task based on gambling that simulates decision-making by including uncertainty factors, rewards and sanctions. Four decks of cards were shown in the upper section of the monitor and participants were "given" an initial amount of $2000 Mexican pesos. The game consisted in choosing a series of cards from the 4 decks. Participants could win or lose money with each choice. Two of the decks resulted in frequent losses, but of only small amounts of money (positive decks), while the other two produced losses much less frequently but in much larger amounts (negative decks). After choosing a card, the participant received feedback on her/his choice to indicate the amount of money won or lost. Then she/he was offered the opportunity to select a new card. The test consisted in 100 choices. Participants were told that the goal was to win as much money as possible by rapidly identifying the positive and negative decks and choosing cards from the positive decks more frequently. At the end of the task, they were awarded the amount of money they would have won during their simulated performance. The Iowa-type gambling task evaluates decision-making with an emotional load represented by winning or losing money, though in its original version participants do not receive an economic reward (Bechara et al., 1999).

Executive Functions Behavior Inventory. The Behavioral Rating Inventory of Executive Functions Adult version (BRIEF-A) translated to Spanish was applied. This inventory was used to assess executive functioning associated with everyday social conduct (Isquith, Roth & Gioia, 2005). It consists of 75 questions divided into 9 scales that assess inhibition, self-monitoring, planning and organization, shift, initiative, task monitoring, emotional control, working memory, and organization of materials.

To evaluate the selective attention, inhibitory control and cognitive flexibility the Stroop-test and the WCST were applied; the emotional versions of these tasks were used in order to study the influence of the emotional content in these executive processes. The Iowa gambling task has been related to the decision making process with emotional implications. Finally, the BRIEF-A was applied in order to evaluate executive dysfunction in daily life activities in social context and to contrast it with executive function tasks performance in lab conditions.

Experimental Procedure

All procedures were conducted individually in a cubicle. At the beginning of the session each participant's clinical history was recorded, followed by the application of the BDI, HARS, RS and BS-11 clinical scales, all in a counterbalanced fashion. After applying the scales, the next step was to apply the neuropsychological instruments: the original and emotional Stroop Tests, the original and emotional WCST, and the Iowa-type gambling task, all counterbalanced. The original Stroop Test and the WCST were applied with their respective emotional versions together. To conclude the session, the BRIEF-A inventory was applied.

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Table 1. Sociodemographic characteristics.

Groups	ND (N=25)		DNA (N=25)		SA (N=25)	
	Mean	SD	Mean	SD	Mean	SD
Age	23.56	1.30	24.04	1.24	24.24	1.28
Formal education (years)	12.00	0.36	11.8	0.36	11.72	0.32

Mean and Standard Deviation of age and years of formal education by group. SD = Standard Deviation. ND: Non-depressed Participants, DNA: Depressed Non-Attempters, SA: Suicide Attempters.

Statistical Analysis

For the analysis of the BDI, HARS, RS and BS-11 scales and the BRIEF-A inventory, the score on each scale was obtained and between-group comparisons conducted using a Kruskal Wallis test. Performance on the original and emotional Stroop Tests and the original and emotional WCST was similarly compared among the 3 groups (SA, DNA, ND), also by means of a Kruskal Wallis test. A Mann Whitney U test was used for inter-group pair analysis. To assess the differences among groups on the gambling task, a Wilcoxon test was applied to quantify and then compare the number of disadvantageous choices made during the first 20 trials and the last 20 trials.

Finally, a Spearman correlation analysis was applied to the scores from the clinical instruments and the results of all tests, tasks, and the executive functions inventory. This analysis revealed significant differences among the groups, both when all participants were taken together, and individually for each one of the 3 groups. The objective of this procedure was to identify possible relations between the clinical characteristics and the executive functions.

Table 2. Characteristics of Suicide Behaviors

	SA (N=25)	
	Mean	SD
Number of suicide attempts	1.56	0.76
Days since last suicide attempt	39.24	28.08
Family history of suicide behavior (N)	12	
Mean used of the last suicide attempt (N):		
Hanging	2	
Drugs overdose	20	
Selfpoisoning by pesticide	1	
Selfpoisoning by domestic poison	2	
Past attendance to mental health services (N)	14	

Results

Table 1 shows the socio-demographic characteristics of the individuals in the 3 groups (SA, DNA, ND), which were similar in terms of the number of participants by sex (9 men, 16 women), age and educational level.
Insert Table 1

Table 2 presents details of the suicidal behaviors from the group of suicide attempters, 15 of whom had made his/her first attempt. The average time elapsed between the most recent suicide attempt and the date of this evaluation was 39 days. The method most often used in those attempts was a drug overdose (20 participants). Twelve participants had past family histories of suicidal behavior, and 14 indicated that they had been attended by mental health services (psychiatric or psychological, mainly the latter). Only 3 had been attended by a psychiatrist, but all reported poor adherence to treatment.

Clinical symptoms

As Table 3 shows, SA had higher scores on the scales of the risk of suicide ($\chi 2$ (2, N=75) = 56.04, p < .0001) than DNA (U (n=50) = 76, p < .001) and ND (U (n=50) = 0.50, p < .001). Moreover, SA showed higher scores on the depression inventory ($\chi 2$ (2, N=75) = 48.45, p < .0001) than DNA (U (n=50) = 153.50, p < .001) and ND (U (n=50) = 6.00, p < .001). Also, SA had higher scores on the motor impulsivity sub-scale ($\chi 2$ (2, N=75) = 15.26, p < .001) compared to DNA (U (n=50) = 186.00, p < .01) and ND (U (n=50) = 121.00, p < .001).

The participants in SA and DNA also scored higher on the scales of anxiety ($\chi 2$ (2, N=75) =43.53, p < .0001; SA vs ND: U (n=50) = 26.00, p < .001; DNA vs ND: U (n=50) = 22.50, p < .001), general impulsivity ($\chi 2$ (2, N=75) = 16.94, p < .001; SA vs ND: U (n=50) =121.50, p < .001; DNA vs ND: U (n=50) = 145.00, p = .01), cognitive impulsivity ($\chi 2$ (2, N=75) = 17.8, p < .0001; SA vs ND: U (n=50) =114.5, p < .0001; DNA vs ND: U (n=50) =151.5, p < .01); and unplanned impulsivity ($\chi 2$ (2, N=75) = 11.06, p < .01; SA vs ND:

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Table 3. Clinical Scales Scores by Group

	ND		DNA		SA	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Suicide risk(SR)***	1.08	1.07	5.04	2.13	8.07	2.38
Depression(BDI)***	3.80	3.00	16.08	6.74	23.76	8.89
Anxiety (HARS)***	4.84	3.56	18.04	8.52	24.16	11.52
Impulsivity (BS 11)**	41.28	12.52	56.00	13.70	59.8	16.67
Cognitive impulsivity***	12.4	4.03	16.72	4.87	18.36	5.26
Non planning impulsivity*	15.96	6.17	22.52	7.66	21.44	7.15
Motor impulsivity**	14.12	10.98	16.60	7.45	21.88	6.93

Mean and Standard Deviation of each clinical scale scores by group. SD = Standard Deviation, ND: Non-depressed Participants, DNA: Depressed Non-Attempters, SA: Suicide Attempters. Kruskal Wallis: * p<.01; ** p<.001; ***p<.0001

Table 4. Original and Emotional Stroop Tasks

Original Stroop	ND		DNA		SA	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Words lecture*	42.08	5.024	44.12	8.671	45.20	7.544
Color naming	63.32	9.607	66.88	10.018	69.80	12.376
Interference*	109.2	25.449	120.32	22.490	124.92	23.685
Emotional Stroop						
Neutral words	85.88	20.00	89.72	16.849	91.20	15.982
Positive words	81.64	17.24	91.40	17.529	90.36	15.607
Negative words	81.52	14.69	88.44	18.111	89.96	17.650
Suicide words	84.96	19.33	90.56	15.570	93.20	15.990

Mean and Standard Deviation of lecture times in seconds by each condition, by group in Original and Emotional Stroop Tests. SD = Standard Deviation, ND: Non-depressed Participants, DNA: Depressed Non-Attempters, SA: Suicide Attempters. * ND < SA, p<.05

U (n=50) = 171, p < .01; DNA vs ND: U (n=50) = 159.5, p < .01) than those in ND. However, no differences were detected between the two groups of patients (SA, DNA).

Original Stroop Test

The SA group had higher response times in the interference condition (U (n=50) = 211.5, $p \leq .05$) and more reading errors (U (n=50) = 224.5, $p \leq .05$) compared to ND. Participants in DNA had more interference errors (U (n=50) = 208, $p \leq .05$) than ND (Table 4). No differences were found between the two groups of patients on any of the performance indicators in the original Stroop Test.

Emotional Stroop Test

No differences were observed among the 3 groups in their response times in the interference conditions with neutral, positive, negative, and suicidal words (Table 4); however, compared to the other two groups, SA did show a tendency towards longer response times in the interference condition when suicidal words were presented.

Also detected was a lower amount of words read in 45 seconds by DNA in the version with positive stimuli, compared to ND (U (n=50) = 202.5, $p \leq .05$), though no between-group differences were found on the other emotional stimuli (Table 4). No intra-group differences were observed in execution times on the interference templates of the neutral, positive and suicidal stimuli.

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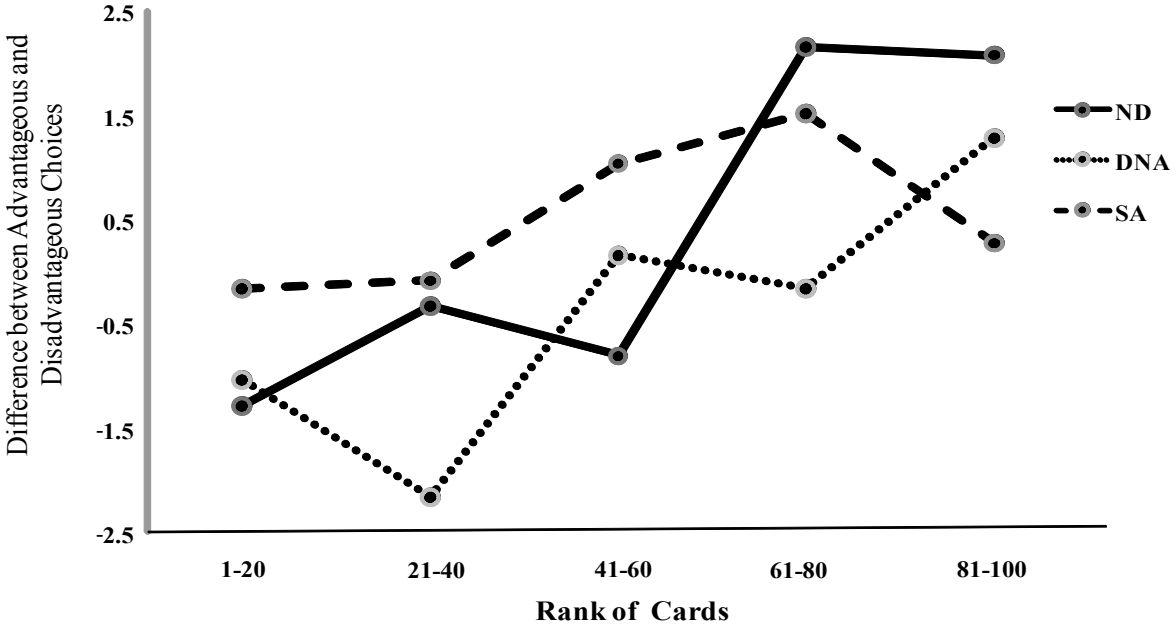
Figure 1. Changes in performance in the Iowa-type gambling task for groups.



Mean of the difference between disadvantageous and advantageous choices per group. ND: non-depressed Participants, DNA: Depressed Non-Attempters, SA: Suicide Attempters.

Card-sorting tasks

No significant differences were observed among the 3 groups on the indicators evaluated in the classic WCST, or on the emotional version of the WSCT.

Iowa-type gambling task

No significant differences were observed among the groups in their performance on the gambling task; however, intra-group comparisons of the frequency of disadvantageous choices made between the first and last 20 blocks of trials revealed that SA participants made the same number of disadvantageous choices in both blocks (Z (n= 25) = -1.219; p = .22). This contrasted to the results of the DNA participants (Z (n= 25) = -2.266; p = .02) and ND participants (Z (n=25) = -1.975; p = .05), who made fewer disadvantageous choices in the last set of 20 trials compared to the first set; respectively (see Figure 1).

Behavioral Rating Inventory of Executive Function

The SA group had higher scores than DNA (U (n=50) =72.00, p < .001) and ND (U (n= 50) = 90.00, p < .001) in the category of shift ($\chi 2$ (2, N=75) = 26.51, p < .001), a finding associated with the ability to use alternate strategies to resolve problems and think flexibly, and with the capacity to shift one's focus of attention. Also, SA and DNA obtained higher scores than ND in the following categories: a) inhibition ($\chi 2$ (2, N=75) = 20.27, p < .001; SA vs. ND U (n=50) = 93.00, p < .001; DNA vs. ND U (n=50) = 5.7, p = .05), which is related to impulse delay; b) emotional control ($\chi 2$ (2, N=75) = 29.15, p < .001; SA vs. ND U (n=50) = 85.00, p < .001; DNA vs. ND U (n=50) = 30.80, p < .001) associated with the modulation of emotional response; c) self-monitoring ($\chi 2$ (2, N=75) = 19.45, p < .001; SA vs. ND U (n=50) = 121.00, p < .001; DNA vs. ND U (n=50) = 19.036, p < .001), which relates to reviewing one's own actions; d) initiative ($\chi 2$ (2, N=75) = 19.00, p < .001; SA vs. ND U (n=50) = 88.00, p < .001; DNA vs. ND U (n=50) = 22.91, p < .001), associated with the ability to initiate a task, or to generate ideas or strategies to solve problems; e) working memory ($\chi 2$ (2, N=75) = 16.27, p < .001; SA vs. ND U (n=50) = 108.50, p < .001; DNA vs. ND U (n=50) = 21.38, p < .001), related to the capacity to retain information in mind; f) planning and organization ($\chi 2$ (2, N=75) = 20.49, p < .001; SA vs. ND U (n=50) = 76.50, p < .001; DNA vs. ND U (n=50) = 24.51, p < .001), that have to do with anticipation of future events, objectives, and programming in a systematic order; and finally, g) task monitoring ($\chi 2$ (2, N=75) = 10.75, p < .001; SA vs. ND U (n=50) = 139.00, p = .001; DNA vs. ND U (n=50) = 13.18, p = .001).

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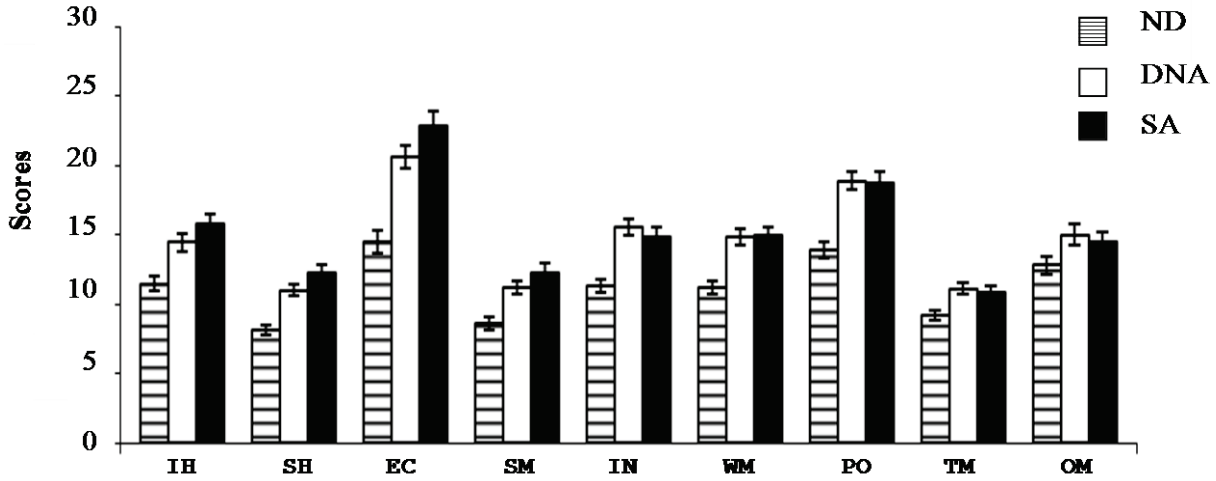
Figure 2. Mean and standard error of the scores by scale in the Behavioral Rating Inventory of Executive Functions-Adults by group.



IH: Inhibit; SH: Shift; EC: Emotional Control; SM: Self Monitor; IN: Iniciative; WM: Working Memory; PO: Plan/Organize; TM: Task Monitor; OM: Organization of Materials. ND: Nondepressed Participants, DNA: Depressed Non-Attempters, SA: Suicide Attempters.

Table 5. Correlation between Behavioral Rating Inventory of Executive Function and clinical scales

BRIEF	BDI	HARS	BIS	BIS COG	BIS MOT	BIS NP	PSRS
Inhibit	0.593***	0.555***	0.609***	0.423***	0.709***	0.385**	0.605***
Shift	0.680***	0.622***	0.442***	0.454***	0.416***	0.305**	0.647***
Emotional Control	0.571***	0.692***	0.440***	0.391**	0.493***	0.300**	0.629***
Self monitor	0.564***	0.545***	0.627***	0.486***	0.624***	0.439***	0.555***
Iniciative	0.508***	0.517***	0.501***	0.529***	0.348*	0.396***	0.509***
Working memory	0.617***	0.663***	0.518***	0.475***	0.462***	0.404***	0.576***
Plan/Organize	0.580***	0.491***	0.495***	0.394***	0.388**	0.436***	0.535***
Tasks monitor	0.468***	0.427***	0.423***	0.366**	0.386**	0.325*	0.399***
Organization of materials	0.285*	0.228	0.285*	0.178	0.244	0.313*	0.230
General	0.652***	0.659***	0.610***	0.516***	0.573***	0.457***	0.636***

Values of Spearman´s correlation between executive functions inventory categories and clinical scale scores. BRIEF: Behavioral Rating Inventory Executive Function Adults; BDI: Beck's Depression Inventory; HARS: Hamilton Anxiety Rating Scale; BIS: Barratt Impulsivity Scale; BIS COG: Barratt Cognitive Impulsivity Subscale; BIS MOT: Barratt Motor Impulsivity Subscale; BIS NP: Barratt Non Planning Impulsivity Subscale; PSRS: Plutchik's Suicide Risk Scale. N=75 * $p < .01$; ** $p < .001$.; *** $p < .0001$

Correlations

In most cases, correlation analyses of the scores on the clinical instruments and the results of the tasks revealed no significant differences. Only the gambling task produced a positive correlation between the number of disadvantageous choices in the final 20 trials and impulsivity, both general (r (73) = .22; p = .05) and motor (r (73) = .23; p = .05), when all participants were considered together.

The scores obtained in the category of shift on the BRIEF-A inventory did not correlate with any of the clinical scales in the group of patients with suicide attempt, or controls. In contrast, for the group of patients with depression but no suicide attempts,

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scores on shift correlated with both the depression scale (r (23)= .63; p = .001) and the cognitive impulsivity sub-scale scores (r (23) = .50; p = .01). All categories of the BRIEF correlated positively with the scores on the depression and anxiety scales, the impulsivity sub-scales, and the suicide risk scale (Table 5).

Discussion

The results of the present study show that the suicide attempters reported problems of inhibitory control in their daily lives, as evidenced by their higher scores on the motor impulsivity subscale and the category of change in the executive functions inventory, as well as their greater symptomatology of depression and anxiety. Performance on executive functions was affected only on the original Stroop Test in the interference condition when suicide attempters were compared to nondepressed participants.

The group of suicide attempters manifested moderate depression, while the depressed patients with no suicide attempts presented mild depression. Non-depressed participants showed no depression. Likewise, suicide attempters had moderate anxiety, as did those participants with depressive and anxiety symptoms but no suicidal behaviors. The presence of moderate levels of depression in the group of suicide attempters has been considered a factor associated with suicidal behaviors (Jímenez-Genchi, Sentíes Castella & Ortega Soto, 1997). In studies conducted in Latin American populations especially, the presence of depression is sufficient to increase the risk of suicide significantly, when compared to other disorders, such as anxiety disorders (Mojica, Sáenz & Rey-Anacona, 2009). In addition to depression symptoms, moderate-to-severe anxiety has been associated with suicidal behaviors in latin americans (Gómez Restrepo, Rodríguez Malagón, Bohórquez, Diazgranados, Ospina García & Fernández, 2002). Studies of latin american subjects have found that stressful events are associated significantly with suicidal behaviors (Fortuna, Perez, Canino, Sribney & Alegria, 2007); results that might explain the high scores for anxiety seen in suicide attempters in our study. In developed countries, in contrast, the most important risk factor for the manifestation of suicidal behaviors is the occurrence of mood alterations (Nock, Borges, Bromet, Alonso, Angermeyer, Beautrais, et al., 2008).

Additionally, suicide attempters showed higher motor impulsivity, compared to the other two groups. Other studies have pointed out the participation of general impulsivity (Guibert Reyes & Del Cueto de Inastrilla, 2003) and motor impulsivity (Dougherty, Mathias, Marsh, Papageorgiou, Swann & Moeller, 2004) in suicidal behavior. Jiménez Genchi et al. (1997) and Grunebaum et al. (2005) found higher impulsivity in patients with suicide attempt, compared to patients with psychiatric disorders. Impulsivity is thus considered a predictor for suicide in depressed patients, particularly young people (Dumais et al., 2005). Findings from developing countries show that impulse control disorders have a higher predictive capacity for suicidal behaviors than mood disorders (Nock et al., 2008).

In summary, suicide attempters showed higher levels of depression and motor impulsivity than the other two groups of participants. Among latin american people especially, but also from other developing countries, observations of the interaction of mood disorders, anxiety disorders, and impulse control disorders with manifestations of suicidal behaviors are becoming more frequent (Nock et al., 2009).

With respect to executive functioning, this study found that the group of suicide attempters had higher response time in the interference condition and more reading errors on the original Stroop Test, compared to the group of non-depressed participants. The higher response times observed among the former could be one of the first signs of alterations of the selective attention system, (Keilp et al., 2008) whose functioning could be affected by depressive symptoms and impulse control problems. However, these possible alterations of the selective attention system were not apparent when the emotional stimuli were presented, as has been reported in other studies (Keilp et al., 2001; Keilp et al., 2008). Similarly, no differences were observed in the emotional Stroop Test with any of the templates of neutral, positive, or negative words and terms related to suicide in the 3 groups reported in other studies (Becker, Strohbach & Rinck, 1999; Cha et al., 2010; Williams, Mathews & MacLeod, 1996). The absence of such differences might be explained by the characteristics of the sample groups evaluated in the different studies. The mean age of the participants in the present study was 10-to-20 years less than that of the participants in the studies that report differences on the original and emotional Stroop Tests between suicide attempters and depressed patients without suicide attempt (Becker, Strohbach & Rinck, 1999; Carver, Johnson & Joormann, 2008; Cha et al., 2010; Keilp et al., 2001; Keilp et al., 2008; Williams, Mathews & MacLeod, 1996). This has led to reports that the Stroop Test is sensitive to age increases in patients and to greater chronicity of affective disorders (Kertzman, Reznik, Hornik-Lurie, Weizman, Kotler & Amital, 2010; Levy, Medina, Manove & Weiss, 2011; Williams, Mathews

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& MacLeod, 1996). For example, in a study that found concordance between emotional processing and depressive states, the mean age of participants was 42 years, and their depressive disorders had been evolving, on average, for 15 years (Elliot et al., 2002). Another possible contrast with other studies is that most of the patients in the present study had used low lethality methods in their attempted suicides (eg., drug overdose), while those in other studies in which alterations in the performance on the Stroop Test were observed had resorted to more deadly methods (Keilp et al., 2001; Keilp et al., 2008).

Another substantial difference could be related to the number of previous attempts, since observations revealed a correlation between deficient performance on the interference template in the Stroop Test, the number of previous suicide attempts, and the degree of lethality of those attempts. In that study, the poorest performance was by a group of patients with an average of 4 suicide attempts, whose most recent episode involved a highly lethal means (Keilp et al., 2008). In our study, the average number of attempts was just 1.5, and most involved methods of low lethality. An additional factor that could influence these differences is that other studies had a high percentage of patients with histories of drug abuse, a feature that could interact with depressive symptoms and suicide attempts to produce a deterioration of the executive functions (Carver, Johnson & Joormann, 2008; Cha et al., 2010). In the present study, no patient reported a history of illegal drug use. It is also possible that the attentional demands of the original Stroop Test center more on a domain of automatic processing (Den Hartog, Derix, Van Bemmel, Kremer & Jolles, 2003), in contrast to the emotional Stroop Test, which entails a more conscious form of attentional processing.

In the present study, no differences were observed among the 3 groups evaluated with respect to their performance on the traditional Wisconsin Card-Sorting Test (WCST) or on the emotional stimulus version of that test (ECST). These results coincide with other study that has assessed depressed patients in comparison to non-depressed participants without observing differences on this task performance (King et al., 2000). Taken together, these findings suggest that cognitive flexibility and working memory are not affected by the onset of symptoms of depression, anxiety or impulsivity in either group of patients (SA, DNA), or by previous suicide attempt involving low lethality methods. However, some studies have observed differences between patients with suicidal behaviors and other groups on these tasks (Keilp et al., 2001; Marzuk, Hartwell, Leon & Portera, 2005). Specifically, those studies found differences in comparison to a control group in the factor of failures to maintain sets among participants who had attempted suicide using highly lethal means and averaged 42 years of age, while suicide attempters who used low lethality methods and had an average age of just 31 showed no differences (Keilp et al., 2001). Thus, the possible failures in the cognitive flexibility and working memory of the participants who had attempted to commit suicide using highly lethal methods may be more closely related to their age, cognitive deterioration due to chronic depression, and repetitive suicide attempts.

The performance of the suicide attempters on the gambling task showed no improvement when their first and last blocks of 20 trials were compared, results that contrast strongly to those of patients with depressive symptoms but no suicide attempts, and nondepressed participants. This might be a nearly sign of difficulty in identifying the advantageous decks, which has been related to dysfunctions in the prefrontal ventromedial cortex (Bechara, Damasio, Tranel & Damasio, 2005). The present study did not obtain significant differences between the groups studied, in contrast to the results from Jollant et al. (2005). In their work, the most deficient performance was by patients with high-lethality suicide attempts. Also, Jollant et al. (2007) noted that the performance on the Iowa gambling task of patients with mental disorders was negatively affected by ingestion of psychiatric drugs and by the higher age of the participants; on the other hand, younger patients and those with psychiatric disorders who were not taking medication had better performance levels on this task. In our study, most of the attempted suicides involved low lethality methods, the participants were younger, and none were taking any psychiatric drugs. Finally, it has been reported that patients with depression achieve more advantageous choices than nondepressed participants on this task, a phenomenon that has been attributed to insensitivity towards negative information (Dalgleish et al., 2004) or a higher aversion to risk (Smoski, Lynch, Rosenthal, Cheavens, Chapman & Krishnan, 2008). However, no correlation was found between performance on the gambling test and depression scores. In contrast, a positive correlation was seen between motor impulsivity and the higher number of disadvantageous choices in the final 20 trials when all groups of participants were considered jointly. This correlation could suggest the interaction of impulsivity and suicidal behaviors in the performance of gambling tasks. It has been observed that subjects with high impulsivity tend to make their choices in relation to immediate rewards and are less sensitive to the negative consequences of their elections (Martin & Potts, 2009). Patients with suicidal

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behaviors tend to be impulsive (Jollant et al., 2005); indeed, studies have found higher impulsivity in these patients compared to patients suffering from a variety of other mental diseases (Grunebaum et al., 2005; Jiménez-Genchi et al., 1997). This suggests a possible interaction between decision-making and motor impulsivity in suicide attempters. Other observations indicate that alterations in the prefrontal, dorsal and ventral cortex are associated with impulse control problems, problem-solving, cognitive rigidity and, especially, decision-making, in patients who have attempted suicide (Van Heeringen, 2012).

With respect to executive functioning abilities in daily life, the suicide attempters reflected more difficulty than the other two groups in the category of shift, a skill that entails the capacity to alter strategies when solving problems, to think flexibly, and to change one's focus attention. Cognitive flexibility, as evaluated by the original and emotional WSCT, showed no differences between groups, nor were significant contrasts seen in attentional control, assessed by the original and emotional Stroop Tests. Therefore, it would seem that self-perceptions of inflexibility and a lack of cognitive control could emerge in the circumstances of interpersonal relations that require emotional processing, or in stressful situations of daily life. It has also been suggested that evaluations of executive functions based on inventories emphasize functions related to a level that is strategic socially, economically and occupationally (Barkley & Murphy, 2010).

This study revealed subtle alterations in the executive functions of the suicide attempters, particularly on attentional-type Stroop tasks and the Iowa-type gambling task. No executive alterations were noted on the other executive tasks in the group of suicide attempters, or on the executive tasks with emotional stimuli, compared to traditional executive tasks. This suggests that the aforementioned interactions between executive functioning and emotional regulation may not be manifested through tests of executive tasks conducted in the experimental conditions of the laboratory. Specifically, alterations occurred in what has been called automatic processing in the cognitive domain, but not on tasks that require greater cognitive effort (Den Hartog et al., 2003). These alterations in automatic processing could be an indicator of the onset of cognitive deterioration in patients who have attempted suicide. It may be that deterioration of the executive functions in these patients increases proportionately with the evolution of their illness, since most of the studies that have observed differences in suicidal patients involve subjects whose depressive disorders have evolved over several years, and who have attempted suicide on various occasions, sometimes using highly lethal methods. This agrees with the theoretical model of the diathesis of suicidal behavior, which posits that vulnerability to suicidal behavior may increase over the course of the suicide process (Van Heeringen, 2012). This theory considers suicidal behavior a temporal process; i.e., diathesis is a continuous, dynamic process, not a dichotomous one. During this ongoing process, the patients' cognitive resources deteriorate progressively as the so-called 'suicide process' becomes more acute, and this is reflected in more frequent attempts to commit suicide using more deadly methods. Considerations of the characteristics of the aspects of vulnerability in patients with suicidal conduct may vary over time with the evolution of the affliction, and may help explain the differences observed in the executive functioning of suicidal patients among the various studies cited.

It is necessary to continue these studies in order to confirm the results obtained in the present work, improve our understanding of the specific circumstances that lead patients to be perceived as inflexible and with poor attentional control, and determine how self-perceptions might interact with the clinical characteristics of patients and suicidal behavior.

Some of the strengths of the present study that merit consideration are the following: in the formation of the groups, participants were matched by sex, age and education, thus assuring that performance on the neuropsychological tasks was not affected by these variables. Also, at the time of the evaluation no participant was consuming any kind of drug that could have altered her/his performance on the neuropsychological tasks. The present study was conducted among a comparatively younger population than those tested in other research on the neuropsychological performance of suicide attempters, so it was possible to avoid confusions in the results that might have arisen due to patients' ages and the possible effects of pharmacological treatment. Finally, the study design allowed a better characterization of patients who had attempted suicide in developing countries, since they have been found to show distinct clinical characteristics to those of populations assessed in developed countries.

In clinical terms, the applications of this study suggest that treatments for patients with a history of suicide attempts similar to that of this study population must focus on reducing depression and anxiety symptoms, improving impulse control, and fostering strategies of cognitive change and flexibility in social contexts.

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One limitation of this study is the relatively small number of participants in each group, which impedes generalizing the results. It is necessary to carry out a study with a larger sample, but without relaxing the inclusion criteria to select potential participants.

The principal findings of this work are that in young patients who have attempted suicide, impulsivity and cognitive rigidity were observed in the behavioral inventories, though not in the objective tests of traditional executive functions involving emotional components. The lack of inhibitory control and difficulty in decision-making that have usually been reported in patients who have attempted suicide were seen only at moderate levels in the present study. Thus, impulsivity and the self-perception of experiencing difficulties in adapting to the changes of daily life may be some of the first signs of cognitive deterioration that leads to suicidal conduct; further research, including longitudinal designs is needed to investigate this issue.

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