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Executive Dysfunction in Non-Psychotic Unipolar Depressed Patients: Assessement by the Wisconsin (Berg) Card Sorting Test

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Abstract

Introduction: Alterations in executive functioning are frequent in depressed subjects, being the Wisconsin Card Sorting Test (WCST) one of the most utilized instruments to assess it, even though, when individually compared, this test's items did not show consistency.

Method: This study aimed to compare the performance of a group comprising 36 non-psychotic unipolar depressed patients (23 women and 13 men, with a mean age of 44.28 years old [*SD* = 14.78]) with 36 healthy controls (22 women and 14 men, with a mean age of 42.22 years old [*SD* = 15.19]) in a computerized version of WCST.

Results: We found significant differences between depressed patients and healthy controls regarding number of categories, perseverative responses, perseverative errors, non-perseverative errors, percentage of conceptual level responses and failure to maintain set, clearly influenced by the variable age, which showed a shared variance between 17% and 33% in depressive patients' performance and between 16% and 26% in healthy controls' performance.

Conclusions: Results allowed us to identify differences in performance between the two groups, therefore this version of the WCST revealed itself a reliable alternative to assess Executive Functions (EFs), accessible to all clinicians.

Keywords: unipolar depression, Executive Functions (EFs), set-shifting, Wisconsin Card Sorting Test (WCST), normative data

1. Introduction

The Wisconsin Card Sorting Test (WCST) is one of the most currently used instruments in clinical practice to assess executive functioning. It is common its utilization to assess set-maintenance and set-shifting abilities, involved in the execution of prefrontal areas (Carrillo-de-la-Peña & García-Larrea, 2007), more precisely dorsal regions of Prefrontal Cortex (PFC) (Zald & Andreotti, 2010). Despite this fact, the main manuals of neuropsychology caution against using WCST results isolatedly as a marker of damage in the frontal lobe, hence recommending convergent measures of assessment (Lezak, Howieson, & Loring, 2004; Strauss, Sherman, & Spreen, 2006).

According to the Journal Citation Reports (JCR), over the last few years, the number of scientific publications has increased widely and journals that published ten or more papers on the WCST have a high impact factor (Silva-Filho, Pasian, & Humberto, 2011). Clinical studies with Portuguese-speaking population have also increased, especially in Brazil, in particular focusing on clinical disorders such as obesity (Duchesne et al., 2010; Sousa & Ribeiro, 2012), alcohol dependence (Salgado et al., 2009), substance dependence (Almeida, Flores, & Scheffer, 2013; Matumoto & Rossini, 2013), Alzheimer's disease (Hamdan & Bueno, 2005), as well as on

specific population, such as elderly (Beckert, Irigaray, & Trentini, 2012; Wagner & Trentini, 2009) and murderers (Del Pino & Werlang, 2008).

Given that the WCST is an instrument that provides a large amount of statistical information, there are frequently questions about what measures are more important in order to assess the subject's performance, being the most utilized the result of perseverative errors, attempts to achieve the first category, and failure to maintain set (Strauss et al., 2006), as well as non-perseverative errors and number of achieved categories (Greve, Ingram, & Bianchini, 1998; Greve, Bianchini, Hartley, & Adams, 1999; Greve, Stickle, Love, Bianchini, & Stanford, 2005).

Concerning its formats, over the last few years, various computerized versions of the WCST have emerged, either for application or scoring, partly due to the fact that recording and scoring errors are common in the paper version of the test. Clinically, results have been similar in manual and computerized versions (Fortuny & Heaton, 1996).

Regarding depressed patients' performance in WCST, although healthy subjects do often achieve more categories than Major Depressive Disorder (MDD) patients (Wagner, Doering, Helmreich, Lieb, & Tadić, 2012), results have not shown consistency over the past few years. Differences have appeared regarding only number of errors, non-perseverative errors and percentage of conceptual responses (Degl'Innocenti, Agren, & Bäckman, 1998), number of categories and perseverative errors (Moritz et al., 2002), perseverative errors (Harvey et al., 2004), and, failure to maintain set and perseverative errors (Stordal et al., 2004).

Therefore, this study aimed to compare the performances of a sample of non-psychotic unipolar depressed patients with healthy controls, concerning the main psychometric markers in a computerized version of the WCST. One other objective of the current study was to present initial normative data of this version in order to enable its utilization in clinical contexts and in further investigation. This study is important because, on the one hand, it allowed to understand the cognitive functioning of unipolar depressed patients (without any influence of depressive disorders with manic and psychotic symptoms [e.g., bipolar and schizoaffective]), and, on the other hand, provided initial normative data so that clinicians across the world can use this instrument.

2. Method

2.1 Participants

Both studied samples, experimental and control groups, were comprised of 36 subjects each. The experimental (patients') group was composed of 23 women and 13 men, with a mean age of 44.28 years old (SD = 14.78) and a mean of 8.94 (SD = 3.54) years of education. The participants from this group were recruited in the city of Faro (Portugal), more precisely from the Department of Psychiatry and Mental Health of Hospital Center of Algarve (a state owned entity). With analogous characteristics, healthy controls comprised 22 women and 14 men, with a mean age of 42.22 years old (SD = 15.19) and a mean of 9.53 (SD = 3.68) years of education. Patients and controls did not differ significantly regarding gender (χ^2 = .059, df = 1, p = .808), age (t = .583, df = 70, p = .562, d = .137), and education (t = -.978, df = 70, p = .331, d = -.163). All participants were Caucasians and Portuguese speakers.

2.2 Measures

A computerized version of the WCST (Mueller, 2013), from the Psychology Experiment Building Language (PEBL), a free access battery (Mueller & Piper, 2014), described in greater detail elsewhere (Lyvers & Tobias-Webb, 2010; Piper et al., 2012), was employed.

The same computer running Microsoft Windows 8.1 was used with all subjects, with a touch screen in order to minimize the difficulties of older subjects in using a mouse or a keyboard, and to attempt reproduce the manual version regarding the way of choosing the card.

We utilized a total number of 128 cards (i.e., two packs of 64 cards) and the principles were color, form or number, which changed every ten trials. After each trial, a feedback ("correct" or "incorrect") was displayed for 500 milliseconds (ms). Results obtained in each trial were provided by the software.

2.3 Procedures

All participants were assessed individually by a psychologist specifically certified for the purpose. Each participant completed a health and demographic questionnaire and depression diagnoses were confirmed through the MINI (Mini International Neuropsychiatric Interview) (Sheehan et al., 1997), the BSI (Brief Symptom Inventory) (Canavarro, 2007) and the Hamilton Depression Rating Scale for Depression (HAM-D—17-item) (Sousa, Lopes, & Vieira, 1979). Exclusion criteria were current or prior history of bipolar disorders, schizophrenia, major psychosis, substance abuse, dementia and neurologic disease, including head injury

involving a loss of consciousness. To discard malingering, Rey 15-Item Memory Test (15-IMT) was used (Simões et al., 2010).

This study was approved by the Hospital Center of Algarve Ethics Committee, in conformity with the Helsinki declaration. After being provided with all the information about the study, all participants signed an informed consent.

All analyzes were conducted using the Statistical Package for the Social Sciences (SPSS), version 20.0. The level of significance was set at $p < .05$.

3. Results

Results showed statistically significant differences between unipolar depressed patients and controls regarding number of achieved categories (t = -2.911, df = 64.6, p = .005, d = -.692), perseverative responses (t = 2.408, df = 70, p = .019, d = .568), perseverative errors (t = 3.303, df = 70, p = .002, d = .778), non-perseverative errors (t = 2.555, df = 70, p = .013, d = .602), percentage of conceptual level responses (t = -3.518, df = 70, p = .001, d = -.829), and failure to maintain set (t = 2.108, df = 57.9, p = .039, d = .505).

Depressed patients showed a higher mean in trials to achieve the first category (M = 26.25, SD = 24.70) compared to healthy controls (M = 18.08, SD = 12.94), however, that difference was not statistically significant (p = .085) (Table 1).

Table 1. Descriptive statistics (N = 72)

	Depression [a]	Healthy [b]				
	M (*SD*)	*M* (*SD*)	*t*	*df*	*p*	*d*
Number of categories achieved	4.41 (1.74)	5.47 (1.29)	-2.911	64.6	.005	-.692
Perseverative responses	49.36 (15.59)	41.66 (11.14)	2.408	70	.019	.568
Perseverative errors	20.13 (12.39)	11.55 (9.45)	3.303	70	.002	.778
Non-perseverative errors	16.03 (11.02)	10.01 (8.84)	2.555	70	.013	.602
% Conceptual level responses	55.69 (19.37)	71.49 (18.73)	-3.518	70	.001	-.829
Trials to achieve 1st category	26.25 (24.70)	18.08 (12.94)	1.757	52.8	.085	.414
Failure to maintain set	1.36 (1.41)	.77 (.86)	2.108	57.9	.039	.505

Note. [a] n = 36, [b] n = 36

Healthy controls exhibited a strong negative correlation between the demographic variable age and number of achieved categories (r(36) = -.519, p = .001) and percentage of conceptual level responses (r(36) = -.487, p = .003), as well as a strong positive correlation regarding perseverative errors (r(36) = .469, p = .004), trials to achieve the first category (r(36) = .482, p = .003), and failure to maintain set (r(36) = .401, p = .015) (Table 2).

Table 2. Correlations and shared variances between WCST scores and age

	Depression [a]		Healthy [b]	
	r	r^2	*r*	r^2
Number of categories achieved	-.418*	.175*	-.519**	.269**
Perseverative errors	.582**	.338**	.469**	.220**
% Conceptual level responses	-.531**	.282**	-.487**	.238**
Trials to achieve 1st category	.052	.003	.482**	.233**
Failure to maintain set	.101	.010	.401*	.161*

Note. [a] n= 36, [b] n= 36, * $p \leq .05$, ** $p \leq .01$

Similar results were observed in the unipolar depressed patients' group, showing a strong negative correlation between age and number of achieved categories ($r(36) = -.418$, $p = .011$) and percentage of conceptual level responses ($r(36) = -.531$, $p = .001$), and a strong positive correlation regarding perseverative errors ($r(36) = .582$, $p = .001$).

The variable age also maintained a high shared variance in healthy controls with regard to number of achieved categories ($R^2 = .269$, $F(1, 34) = 12.54$, $p = .001$), perseverative errors ($R^2 = .220$, $F(1, 34) = 9.58$, $p = .004$), percentage of conceptual level responses ($R^2 = .238$, $F(1, 34) = 10.59$, $p = .003$), trials to achieve the first category ($R^2 = .233$, $F(1, 34) = 10.31$, $p = .003$), and failure to maintain set ($R^2 = .161$, $F(1, 34) = 6.51$, $p = .015$).

In the patients' group, however less significant, a shared variance between age and number of achieved categories ($R^2 = .175$, $F(1, 34) = 7.21$, $p = .011$), perseverative errors ($R^2 = .338$, $F(1, 34) = 17.39$, $p = .001$), and percentage of conceptual level responses ($R^2 = .282$, $F(1, 34) = 13.34$, $p = .001$) was evident.

4. Discussion

We performed a student's *t*-test to compare the current study's results to those obtained by a similar one that used a computerized version of WCST as well (Merriam, Thase, Haas, Keshavan, & Sweeney, 1999) (Table 3) and found no significant differences, except for percentage of conceptual level responses in patients' group ($t = 2.260$, $df = 113$, $p = .025$, $d = -.454$) and trials to achieve the first category in healthy controls ($t = 2.341$, $df = 95$, $p = .021$, $d = .446$).

Table 3. Comparison of the current study's results to Merriam et al.'s (1999) ($N = 212$)

	Depression					
	Current Study [a]	Merriam (1999) [b]				
	M (*SD*)	M (*SD*)	*t*	*df*	*p*	*d*
Age (years)	44.28 (14.78)	35.49 (8.12)	4.109	113	.001	.738
HDSD – 17-item	20.44 (7.40)	16.79 (6.11)	2.776	113	.006	.537
Number of categories achieved	4.41 (1.74)	5.00 (1.53)	1.836	113	.069	-.360
Perseverative errors	20.13 (12.39)	17.57 (12.42)	1.025	113	.307	.206
% Conceptual level responses	55.69 (19.37)	64.42 (19.06)	2.260	113	.025	-.454
Trials to achieve 1st category	26.25 (24.70)	18.84 (16.83)	1.879	113	.062	.350
Failure to maintain set	1.36 (1.41)	1.08 (1.27)	1.058	113	.291	.208
	Healthy					
	Current Study [c]	Merriam (1999) [d]				
	M (*SD*)	*M* (*SD*)	*t*	*df*	*p*	*d*
Age (years)	42.22 (15.12)	26.08 (7.67)	6.970	95	.001	1.346
Number of categories achieved	5.47 (1.29)	5.65 (1.02)	.759	95	.449	-.154
Perseverative errors	11.55 (9.45)	10.26 (7.05)	.765	95	.445	.154
% Conceptual level responses	71.49 (18.73)	74.31 (13.90)	.855	95	.394	-.170
Trials to achieve 1st category	18.08 (12.94)	13.61 (5.74)	2.341	95	.021	.446
Failure to maintain set	.77 (.86)	.75 (1.15)	.090	95	.928	.019

Note. [a] $n = 36$, [b] $n = 79$, [c] $n = 36$, [d] $n = 61$

These differences may be due to mean difference in age between studies (p = .001), having this variable a percentage of variance of 28% in unipolar depressed patients regarding percentage of conceptual level responses and of 23% in healthy controls concerning trials to achieve the first category.

As far as depressed subjects' performance is concerned, the current study focused only on non-psychotic unipolar depressed patients and therefore it was possible to find differences in perseverative errors, categories, failure to maintain set and percentage of conceptual level responses—the test's main neuropsychological markers (set-shifting, set-failure and insight)—enabling us to validate individually results obtained by previous studies (Degl'Innocenti et al., 1998; Harvey et al., 2004; Moritz et al., 2002; Stordal et al., 2004).

This study's main limitation was the size of the sample concerning both patients and healthy controls, which prevented us from validating clearly normative data of this test. Future research comparing wider numbers of subjects is therefore recommended.

Since this is an instrument not covered by copyright law, we can hypothesize the sampling being hereafter carried out not by a clinician individually, but more consistently by several psychologists, which might allow the increase of the reference sample size.

In order to share these initial data, we present a percentile table of the present sample (Table 4).

Table 4. Percentile of healthy and depressed subjects

	Depression [a]					Healthy [b]				
	10	25	50	75	90	10	25	50	75	90
Number of categories completed	1	3	5	6	6	2.7	6	6	6	6
Perseverative errors	36	29.5	17	10.2	6.7	25.6	17.7	7	5	4
% Conceptual level responses	23.4	42.1	57.0	65.9	83.1	34.9	59.4	79.1	86.9	88.2
Trials to achieve 1st category	69.5	31	14	11	10	35.5	20.7	13	11	10
Failure to maintain set	3.3	2	1	0	0	2	1	1	0	0

Note. [a] n= 36, [b] n= 36

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