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Planning Dysfunction in Non-Psychotic Unipolar Depressed Patients: Assessement by a Computerized Version of the Tower of London Task

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Abstract

Introduction: Alterations in executive functioning are frequent in depressed patients, being common the appearance of planning difficulties.

Method: This study aimed to compare the performance of a sample of 40 non-psychotic unipolar depressed patients (26 women and 14 men, with a mean age of 44.15 years old [*SD* = 13.82]) with 40 healthy controls (24 women and 16 men, with a mean age of 42.05 years old [*SD* = 15.19]) using a computerized version of the Tower of London (TOL) task.

Results: Significant differences regarding extra moves and execution time between groups were found, with healthy controls outperforming depressed patients, who took significantly longer to complete the task. The variable age influenced clearly the results, showing a shared variance of 55% for both groups.

Conclusions: The results allowed us to identify differences in performance between both groups, therefore this version of the TOL revealed itself as a reliable alternative to assess planning, accessible to all clinicians.

Keywords: unipolar depression, planning, Tower of London, normative data

1. Introduction

Cognitive assessment in mental health contexts is a field of interest for clinical practice since it provides clinicians with a better understanding of patients and their competences for treatment (e.g., psychotherapy), as well as data for differential diagnosis.

In this regard, cases in which patients exhibit alterations in executive functioning (e.g., planning, set-shifting), recurrently associated with clinical features of non-psychotic unipolar depression, are common (Rogers et al., 2004; Wagner, Doering, Helmreich, Lieb, & Tadić, 2012).

Thus, it is important to understand the cognitive functioning of non-psychotic unipolar depressed patients, particularly concerning functions associated with executive functioning, being common in depression (moderate and severe) the occurrence of alterations in planning, often assessed using tests, such as the Tower of London (TOL) (Beats, Sahakian, & Levy, 1996; Elliott et al., 1996).

Planning consists in a process that involves many capacities employed, for instance, in the acts of identifying and assembling factors, such as skills, materials or other people, and organizing each step towards the pursue of a certain objective or intention (Lezak, Howieson, & Loring, 2004). It requires the subject the ability to conceive, in the present, changes in order to adequate him/herself objectively in relation to the future circumstances of a given environment. Planning also involves the ability to conceptualize and evaluate alternatives to make decisions, which takes the subject to order and prioritize the essential ideas to the development of a conceptual scheme with the purpose of carrying out a determined plan (Lezak et al., 2004). Given its relative complexity,

planning often consists in a difficult task for those suffering from depression.

The TOL is a visuospatial planning task that recruits the dorsal prefrontal-parietal-striatal network (Van Den Heuvel et al., 2003; Wagner, Koch, Reichenbach, Sauer, & Schlösser, 2006). In Major Depressive Disorder (MDD), performances in tasks requiring high planning demands, such as TOL, are characterized by a prefrontal hyperactivation.

Regarding the task itself, it seems that there are no differences between the manual and the computerized versions (McKinlay & McLellan, 2011), being however necessary for the second to keep up with the same level of difficulty as the first, so that planning can be assessed (Kaller, Unterrainer, Rahm, & Halsband, 2004; Newman, Greco, & Lee, 2009). With the task employed in the current study, it was possible to obtain a mean of seven moves per problem, as recommended by Kaller and colleagues (2011). As in the study of Piper and colleagues (2012) the version that we have used has no restrictions on the height of the pegs or on the number of moves allowed to solve the problem.

The objective of this study was to compare the performance of a clinical sample of non-psychotic unipolar depressed patients with adult healthy controls in a computerized version of the TOL. We also intended to present initial normative data for depressed patients. It is our goal that clinitians can use this task to assess planning in clinical practice, and that its utilization is possible in future research.

This study is important since it increases our knowledge on cognitive functioning of unipolar depressed patients (without any influence of depressive disorders with manic and psychotic symptoms [e.g., bipolar and schizoaffective]), as well as provides initial normative data for its clinical use. Given the absence, in recent years, of studies with patients with unipolar depression using the Tower of London as the main measure (Beats et al., 1996; Elliott et al., 1996), this study aims to suppress that limitation in clinical research.

2. Method

2.1 Participants

Both studied samples, experimental and control groups, were comprised of 40 subjects each, selected using a quasi-experimental desigh. The experimental (patients') group was composed of 26 women and 14 men, with a mean age of 44.15 years old (SD = 13.82) and a mean of 8.80 (SD = 3.70) 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, the control group comprised 24 women and 16 men, with a mean age of 42.05 years old (SD = 15.19) and a mean of 9.37 (SD = 3.40) years of education. Patients and controls did not differ significantly regarding gender (χ^2 = .213, df = 1, p = .644), age (t = .65, df = 78, p = .52, d = .14), and education (t = -.72, df = 78, p = .47, d = -.16).

Statistically, participants were divided into three age groups: (a) 17-34; (b) 35-49; and (c) more than 50 years. Regarding education, participants were also divided into three groups: (a) up to 6 years of education; (b) 9 years of education; and (c) 12 or more years of education. We only considered the completed cycles of education (i.e., 4th grade, 6th grade, 9th grade, 12th grade, and university), but then, only three groups were considered, since there were very few elements with 4 years of education, as well as with higher education. All participants were Caucasians and Portuguese speakers.

2.2 Measures

A computerized version of the TOL (described in detail in a recent study by Piper et al., 2012), from the Psychology Experiment Building Language (PEBL) (Mueller, 2013), a free access battery, was selected (Mueller & Piper, 2014). Stimuli were organized according to trial "A", proposed by Phillips, Wynn, Gilhooly, Della Sala, and Logie (1999).

> The instructions were the following:
>
> You are about to perform a task called the "Tower of London". Your goal is to move a pile of disks from their original configuration to the configuration shown on the top of the screen. You can only move one disk at a time. To move a disk, touch with the finger on the pile you want to move a disk off of, and it will move up above the piles. Then, touch on another pile, and the disk will move down to that pile.

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 keyboard. The total amount of the extra movements was calculated by subtracting 48 (the amount of moves necessary to solve all the seven problems) to the total result provided by the software, having also been recorded the total time.

2.3 Procedures

All participants were assessed individually by a psychologist specifically certified for the purpose. Each participant completed a health and demographic questionnaire. Depression diagnoses were confirmed using the MINI (Mini International Neuropsychiatric Interview) (Sheehan et al., 1997), and the symptomatology controlled using the Portuguese adaption of 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 substance abuse, current or prior history of bipolar disorders, schizophrenia, major psychosis, dementia and neurologic disease, including head injury involving 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 statement.

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

We found statistically significant differences between unipolar depressed patients and controls regarding extra moves ($t = 7.12$, $df = 78$, $p = .000$, $d = 1.59$; M depressed = 23.57, $SD = 7.03$; M healthy = 13.67, $SD = 5.25$) and execution time ($t = 2.81$, $df = 78$, $p = .006$, $d = .62$; M depressed = 381.4, $SD = 150.8$; M healthy = 296.4, $SD = 117.6$). On the other hand, T-tests demonstrated no significant group differences concerning gender, regarding extra moves in depressed patients ($t = -.75$, $df = 38$, $p = .46$, $d = -.25$; M female = 22.96, $SD = 7.33$; M male = 24.71, $SD = 6.55$), regarding extra moves in healthy subjects ($t = .05$, $df = 38$, $p = .96$, $d = .02$; M female = 13.70, $SD = 5.64$; M male = 13.62, $SD = 4.78$), and, execution time in depressed patients ($t = -1.06$, $df = 38$, $p = .30$, $d = -.34$; M female = 363.0, $SD = 136.4$; M male = 415.8, $SD = 174.7$), and execution time in healthy subjects ($t = 1.36$, $df = 38$, $p = .18$, $d = .44$; M female = 316.7, $SD = 117.1$; M male = 265.9, $SD = 115.2$).

One of this study's main variables was age (Figure 1). A one-way analysis of variance (*ANOVA*) showed age differences concerning execution time in both, experimental ($F(2,37) = 14.32$, $p = .001$, $\eta_p^2 = .44$) and control groups ($F(2,37) = 16.15$, $p = .001$, $\eta_p^2 = .47$).

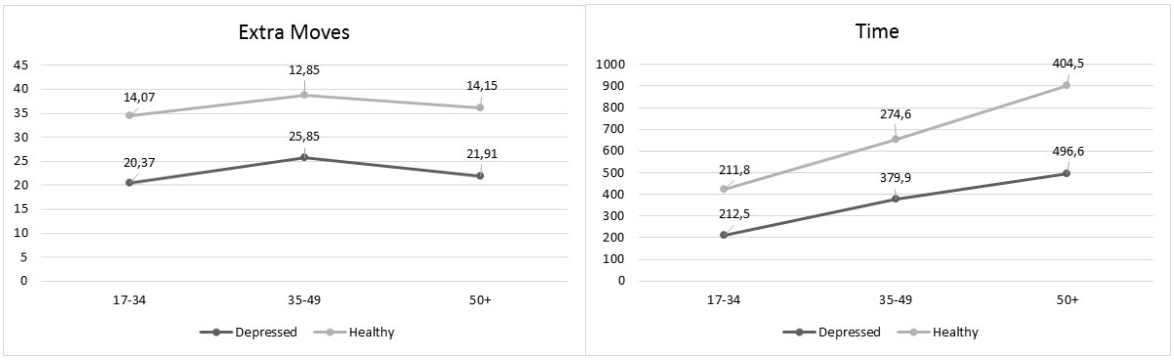

Figure 1. Mean results by age groups

Controls showed a strong positive correlation between age and execution time ($r(40) = .74$, $p = .001$), and a high shared variance was also verified ($R^2 = .55$, $F(1, 38) = 46.81$, $p = .001$). Similar results were found in the patients' group regarding the magnitude and direction of the correlation ($r(40) = .74$, $p = .001$), as well as the shared variance ($R^2 = .55$, $F(1, 38) = 46.80$, $p = .001$).

There was, however, a negative correlation between age and education in both, patients' group ($r(40) = .34$, $p = .03$) and controls ($r(40) = .315$, $p = .05$), for that reason results concerning education were not taken into account.

4. Discussion

Differences between patients' group and controls were found concerning the total result, in conformity with previous research (e.g., Beats et al., 1996; Elliott et al., 1996) but contradicting Stordal and colleagues (2004) study results.

As in previous studies, the influence of the variable age was evident in performance (De Luca et al., 2003; Korkman, Kemp, & Kirk, 2001; Malloy-Diniz et al., 2008; Paula, Neves, Levy, Nassif, & Malloy-Diniz, 2012; Piper et al., 2012), given that, with regard to the execution time, we were able to identify a statistically significant difference concerning age, with older subjects (over 50 years old) taking more time to complete the task, which was expected and may be related to cognitive loss associated with aging, affecting both executive and motor functioning.

As far as the influence of gender is concerned, performance results in tasks such as TOL have shown little consistency. In spite of Boghi and colleagues (2006) suggestion that there are distinct functioning strategies in the way the task is performed, with males having more trust in visuospatial abilities and females in executive processing, these researchers did not find significant differences, as in Paula and colleagues (2012) study and in the current one.

There are studies that, on the contrary, have clearly identified differences regarding gender (De Luca et al., 2003; Dias & Seabra, 2012). Thus, further research, especially with wider samples, is needed in order to clarify this matter.

Nevertheless, the results obtained in this study are of added relevance because we tried to isolate individuals with non-psychotic unipolar depression, excluding psychotic and bipolar pathologies liable to influence overall results, since such patients have a distinct cognitive functioning compared to non-psychotic unipolar depressed subjects. Although this effort of circumscribing the study to non-psychotic unipolar depressed subjects ended up by limiting somehow the sample extension, it allowed a more precise analysis of the assessed depressive symptoms.

The main contribution of this study was to present initial normative data for this test (Table 1), hoping to help clinicians with future applications of the TOL task. This task constitutes a crucial tool to assess planning abilities of depressive patients, enhancing clinicians' knowledge on individuals. Based on the data collected through this research, it will be possible for theraphists to better select and adjust therapeutic techniques (e.g., psychotherapy or cognitive remediation therapy), in order to improve the recovery and life quality of their patients, with specific characteristics assessed by TOL.

Table 1. Percentile of healthy and depressed subjects

	Extra Moves		Time	
Percentile	Depression [a]	Healthy [b]	Depression [a]	Healthy [b]
5	38.70	20.95	644.29	561.91
10	32.80	19.00	599.99	475.25
25	28.00	18.00	498.54	376.87
50	23.00	14.00	370.53	276.34
75	19.00	10.00	273.51	206.21
90	15.00	8.00	161.28	157.71
95	10.20	4.10	154.37	116.49

Note. [a] n= 40, [b] n = 40

In addition to the version used in this study, the PEBL test battery has already available various free-access versions of TOL, namely those by Shallice (1982), Fimbel, Lauzon, and Rainville (2009), the TOL-R version by Schnirman, Welsh, and Retzlaff (1999), the TOL-DX version by Culbertson and Zillmer (1998) and trials A, B, and C by Phillips et al. (1999).

The main limitation of this study was the sample size, regarding both patients and health controls, which prevented us from validating more clearly normative data for TOL. Hence, we recommend that future research

attempts to compare a wider number of subjects, integrating more homogeneous samples concerning age groups.

The correlation between age and education highlighted the difficulty of using the education variable, because nowadays, in Portugal, the elderly population has lower education levels.

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