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The Effect of Culture on Two Information-Processing Speed Tests

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The Symbol Digit Modalities Test (SDMT) has been proposed to replace the Paced Auditory Serial Addition Test-3 (PASAT-3) in the Multiple Sclerosis Functional Composite because it has the same validity but easy and shorter administration. However, among the two tests, the one that is most affected by culture is still unknown. The purpose of this study was to compare the performance of Argentinian and North American populations on the SDMT and PASAT-3. The SDMT and PASAT-3 were administered to 137 healthy volunteers from Buffalo, NY, and 137 healthy participants from Buenos Aires, Argentina. Participants were matched by gender, age (±2), and education (±1). Significant differences were found on the SDMT but not on the PASAT-3. Significant and low correlations were found between the tests and years of education. The SDMT is more affected by culture than is the PASAT-3. Possible interpretations of this result are presented.

Key words: *cross-cultural, information processing, neuropsychology*

The Paced Auditory Serial Addition Test (PASAT) is a frequently implemented neuropsychological tool in multiple sclerosis (MS) clinical practice. It was constructed to evaluate the deterioration of the information-processing speed of patients with craniocerebral trauma (Gronwall, 1977); however, it has been implemented in diverse pathologies (Tombaugh, 2006). The test involves examining multiple cognitive abilities, principally processing speed and working memory in the auditory/verbal sphere (Spreen & Strauss, 1998). According to the instructions, patients are asked to listen to successive numbers presented at a fixed rate and orally provide the sums of consecutive numbers as rapidly as possible. Originally, the time interval between the stimuli was 2.4 s, 2.0 s, 1.6 s, 1.2 s, and 0.8 s (Gronwall, 1977). However, in MS research and

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clinical practice, the 3-s (PASAT-3) and 2-s (PASAT-2) versions of the interstimulus interval have been implemented. These versions are part of two cognitive batteries, the Brief Repeatable Battery of Neuropsychological Tests for Multiple Sclerosis (BRBN-MS; Rao, 1990) and the Minimal Assessment of Cognitive Function in Multiple Sclerosis (MACFIMS; Benedict et al., 2002). It is known that the test is one of the most sensitive techniques for the detection of cognitive deficits (Amato et al., 2006; Boringa et al., 2001; Strober et al., 2009).

In addition, the cognitive area was included in the evaluation of disability in a neurological outcome measure called the Multiple Sclerosis Functional Composite (MSFC; Rudick et al., 1997). However, this test has been criticized because it produces stress in the examinee (Drake et al., 2010; Tombaugh, 2006). The Symbol Digit Modalities Test (SDMT; Smith, 1982) has been proposed to replace the PASAT in the MSFC (Brochet et al., 2008; Drake, et al., 2010).

The SDMT was originally published in 1973 and revised in 1982 (Smith, 1982). The oral version of this test is part of the BRBN-MS (Rao, 1990) and MACFIMS (Benedict et al., 2002). It has been proven that the SDMT is a very sensitive test to detect cognitive impairment in MS (Parmenter, Weinstock-Guttman, Garg, Munschauer, & Benedict, 2007; Sepulcre et al., 2006). In the SDMT, an array of symbols corresponding to numbers is presented to the patients. Later, the symbols are paired with empty spaces and the patients must say the corresponding number as rapidly as possible. The test is a simple, easy to administer, and practical measure of information-processing speed presented in the visual modality (Spreen & Strauss, 1998). It is reliable, sensitive (Benedict et al., 2008; Drake et al., 2010), and strongly associated with measures of brain imagery by magnetic resonance imaging (Benedict et al., 2004; Houtchens et al., 2007; Parmenter et al., 2007). The oral version is recommended for patients with upper-limb mobility difficulties (Spreen & Strauss, 1998). Factor-analytic studies reveal that the PASAT, Digit Symbol, Arithmetic, and Digit Span all loaded on the attention factor referred to as "speed of information processing" (Tombaugh, 2006). Additional construct validity showing that PASAT scores reflect some type of attentional process is provided by studies that have correlated the PASAT with those scores obtained on other tests generally assumed to measure attention. Moderate to high correlations were obtained for Digit Symbol (Tombaugh, 2006). Also, poor performance on the PASAT was related to slow information-processing speed in patients with MS (Forn, Belenguer, Parcet-Ibars, & Ávila, 2008).

Culture has an impact not only on neuropsychological performance, cognition, and thoughts (Nisbett, Peng, Choi, & Norenzayan, 2001) in verbal tasks, but also in nonverbal tests (Rosselli & Ardila, 2003). It has been recognized that the subjective values that are influenced by culture, such as speed, underlie performance during the assessment of cognitive functioning (Ardila, 2005). Many cultural factors contribute to optimal performance on attention tests (Razani, Burciaga, Madore, & Wong, 2007). For example, cultural familiarity with the testing format may lead to better test performance. In the same way, other cultural variables, such as test-taking approach or the attitude of the participant toward test taking, may also influence performance (Razani et al., 2007). A personality factor that may influence test performance is competitiveness: Some cultures consider it negatively while others think highly of it (Ardila & Ostrosky, 2012).

Thus, different cultures have different attitudes to instructions such as "do it as fast as possible" (Agranovich, Panter, Puente, & Touradji, 2011; Ardila, 2005). In American culture, besides accuracy, speed is an important value, and even in schools, children are asked to solve exams quickly (Rosselli & Ardila, 2003). On the contrary, in Argentina, children are often given the time that they need to solve a problem, thereby emphasizing more on accuracy than speed.

Also, it should be considered that educational level may be insufficient to explain test performance. Educational experience, whether measured in terms of skill level (Manly et al., 1998) or where (e.g., in what country) the skills are obtained, seems to strongly influence neuropsychological test performance (Razani et al., 2007).

The requirements in the PASAT and SDMT are different in terms of the examinee's time management. The SDMT requires participants to perform "as quickly as possible" and leaves time management in the hands of the examinee. On the contrary, in the PASAT, time is predetermined by the task. Therefore, cultural differences may influence one test—namely, the oral version of the SDMT—more than the other test (i.e., PASAT-3).

A previous study examined SDMT performance of a large MS sample from North America, Europe, Australia, New Zealand, and Israel (Morrow et al., 2010); however, the country groups were not directly assessed. In particular, Argentinian and American participants' performance on the SDMT and PASAT-3 had never been compared earlier.

Thus, the aim of the present study is to compare the performance of two populations from countries with different cultures and socioeconomic conditions—namely, Argentina and the United States—using the PASAT-3 and the SDMT.

METHOD

Participants

A sample of 137 healthy volunteers residing in Buenos Aires, Argentina, and 137 residents of Buffalo, NY,

were recruited. Participants were chosen across selective sampling, considering corresponding gender, age (±2 years), and years of education (±1 years). In both the groups, there were 113 women (82.5%) and 24 men (17.5%). In the Argentinian group, all participants were Caucasian, and in the U.S. group, 7 participants (5.1%) were African American and the rest were Caucasian.

Inclusion criteria were as follows: aged 18 years or older, no precedents of psychiatric disease or substance abuse, no physical disability that could affect performance in cognitive testing, and no systemic disease or any disease that could cause cognitive impairment.

All participants gave written informed consent. The study and informed consent were approved by the institutional ethical committee from each institution.

Measures

The PASAT-3 and SDMT tests were administered to the participants. In the SDMT, a sheet of paper was presented to the participants, in which a symbol matrix that matches with numbers was given. In the middle part, the symbols were in a white square and the participants had to say the number that corresponds to every symbol in 90 s. In the PASAT-3, the examinees must listen to numbers from 1 to 9 and add every number to the immediate previous number. The numbers were heard every 3 s. Both tests employed Version "A" of the BRNB-MS (Rao, 1990).

Research Design

Retrospective analysis was performed on data from the two groups in a between-subjects design. An intentional nonrandom sampling was used.

Procedures

The participants were evaluated individually in one session in the context of an evaluation that included other tests. These tests' data were analyzed and reported in previous publications.

Statistical Analysis

The data were analyzed with the Statistical Package for the Social Sciences Version 16.0. The normality of the distribution models was tested with the Kolmogorov-Smirnov's Z. Inferential calculations were performed with the student's t test when the variable distribution was normal and with the Mann Whitney U test when it was not normal. The associations between variables were calculated by Pearson's r correlations, and the level of significance was established at .01. Fisher's r-to-Z transformation was used to compare correlations.

RESULTS

The groups did not differ in age, $t(272) = 0.16$, $p = .866$, or average education, $t(272) = 0.39$, $p = .697$.

Significant differences were found between the groups on the SDMT, $t(251) = -9.32$, $p < .001$, $d = 1.1$; however, the difference was not significant for the PASAT-3, $t(272) = 0.14$, $p = .886$, $d = 0.0$. Group performances are shown in Table 1.

As shown in Table 2, low and positive significant correlations were found between the SDMT and education for both the Argentinian and American participants, with a similar strength across groups, $Z = 0.83$, *ns*. The PASAT-3 also correlated significantly and positively to education for the Argentinian and American participants. The strength of the correlations was comparable across the samples, $Z = 0.18$, *ns*; however, no significant correlations were found between the PASAT-3 and age in either group, $Z = 1.12$, *ns*.

DISCUSSION

The main purpose of the present study was to analyze whether culture has an impact on performance on the SDMT and PASAT-3 by comparing two groups of participants from different cultural backgrounds. Although it has been reported that both the SDMT and PASAT-3 have similar validity to assess the presence of cognitive

TABLE 1
Demographic Data and SDMT and PASAT-3 Scores

	Argentina		*United States*	
Variable	*M (SD)*	*99% Confidence Intervals (Lower, Upper)*	*M (SD)*	*99% Confidence Intervals (Lower, Upper)*
Age	41.39 (10.06)	39.14, 43.63	41.18 (9.96)	38.96, 43.41
Education	15.21 (2.23)	14.71, 15.71	15.11 (2.09)	14.64, 15.58
SDMT	52.36 (12.18)	49.64, 55.08	64.48 (9.1)	62.45, 66.51
PASAT-3	49 (9.33)	46.94, 51.1	48.83 (9.92)	46.62, 51.05

SDMT = Symbol Digit Modalities Test; PASAT-3 = Paced Auditory Serial Addition Test-3.

TABLE 2
Correlations Between Demographic Variables and the SDMT and PASAT-3

Country	*Parameter*	*Age*	*Education*	*SDMT*	*PASAT-3*
Argentina	Age	α			
	Education	−.190*	α		
	SDMT	−.219*	.281**	α	
	PASAT-3	−.005	331**	.394**	α
United States	Age	α			
	Education	−.154	α		
	SDMT	−.389**	.185*	α	
	PASAT-3	−.141	.311**	.414**	α

SDMT = Symbol Digit Modalities Test; PASAT-3 = Paced Auditory Serial Addition Test-3.
*$p < .05$. **$p < .01$.

impairment in MS (Drake et al., 2010; Strober et al., 2009), the particular characteristics of administration in each test may determine a varied cultural bias in performance. In this regard, it has been reported that the attitude toward tasks that require speed performance is different for individuals educated in the American culture compared with those educated in the Russian culture, and the latter have been noted to have a similar attitude to Latin American participants (Agranovich et al., 2011).

It was hypothesized that the differences in subjective conception of speed would impact more strongly on performance on the SDMT. In contrast, the PASAT does not have this bias because the required response speed is determined by the task itself. The results obtained in this study on the comparison of SDMT performance in both groups (Americans vs. Argentinians) exhibit statistically significant differences, with the performance of the Argentinian sample being lower than that of the American sample. At the same time, performance on the PASAT was similar in both groups. These results support the hypothesis regarding the presence of varying cultural bias in one task in contrast to the other task. However, if the information-processing speed itself was lower for one group, when compared with the other, then we expect this performance pattern to reflect statistically significant differences on the PASAT, which was not observed. These findings are of great importance because it is considered that the SDMT, being a nonverbal test unaffected by language skills, is relatively free of cultural bias. However, the results suggest that it is necessary to consider other variables, such as cultural values of the participants, to analyze the performances of different populations.

The majority of neuropsychological tests have been developed in the United States and Canada, and many times, these norms were implemented in other countries, while ignoring cultural variables. Our results highlight the need to obtain appropriate reference values for each population. Because of the importance of the PASAT and SDMT within clinical neuropsychological assessment, it is of high relevance to develop normative data.

Furthermore, although participants from both groups were matched by education, the parameter used was years of schooling. However, schooling differs from culture to culture. Future research should consider other parameters to match participants and analyze other variables not considered in this study, such as anxiety and the combined influence that it may have with culture on these tests.

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