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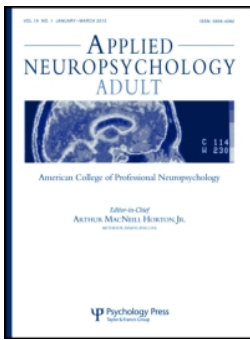
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Diagnostic mistakes of culturally diverse individuals when using North American neuropsychological tests

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ABSTRACT

Although the role of culture has increasingly gained acceptance in clinical neuropsychology, relatively minimal research exists regarding the actual impact on clinical activities. In this study, we assess how using North American neuropsychological tests affects diagnostic accuracy in cognitive disorders of culturally diverse individuals. To address this question, participants from Colombia, Morocco, and Spain were administered five commonly used neuropsychological tests and the test results were used to determine whether they would be classified as having the DSM-5 diagnostic criteria for Mild Cognitive and Major Cognitive Disorder. Results reveal that diagnostic error occurred up to 20% of the time, and that the frequency of misdiagnosis differed by nationality. These results provide evidence that using tests from one culture to assess individuals from other cultures produces significant false positives. Findings are discussed in terms of the foundations of neuropsychological assessment and its relationship to cultural variables.

KEYWORDS

Colombian; culture; Moroccan; neuropsychological assessment; Spanish

Despite the role of culture in neuropsychology having a long history with the work of Luria (1966/1980), it is relatively new to North American neuropsychology (Ardila, 1995). Several books (e.g., Nell, 1999, 2000), chapters (e.g., Puente & Perez-Garcia, 2000), and articles (Ardila, Ostrosky-Solís, & Bernal, 2007; Oberg & Ramírez, 2007; Ostrosky-Solís & Lozano, 2007) have provided important impetus and support for this approach. However, the question arises as to whether theory and idea in neuropsychology is sufficient to buttress the world's explosion in the total number of people and cultures as well as the mixing of them.

Using migration as an example, the number of people living outside of their country of origin increased from 191 million in 2005 to 214 million in 2013 (Chan, Pillay, & Swing, 2013; International Organization for Migration, 2011). After migrating, immigrants are subject to many challenges (e.g., discrimination, exploitation and language barriers), all of which affect their physical and mental wellbeing (Chan et al., 2013; Finch & Vega, 2003; Korenblum et al., 2005; Magana & Hovey, 2003). In turn, these discrepancies creep into neuropsychological assessment.

The Diagnostic and Statistical Manual of Mental Disorders (5th ed.; *DSM-5*; American Psychiatric

Association, 2013) has recognized the importance of culture in the diagnostic criteria. Of interest to neuropsychologists is that a new diagnostic category called Neuro-Cognitive Disorders (NCD) has been added to replace the Dementia category. Two NCDs diagnoses have been established depending on whether performance differs one standard deviation (Mild NCD) or two standard deviations (Major NCD) “compared with norms appropriate to the patient’s age, educational attainment, and cultural background” (American Psychiatric Association, 2013, p. 607).

The question emerges as to whether commonly used neuropsychological instruments address cultural factors and, in turn, affect diagnostic accuracy (Helms, 1992; Manly & Echemendia, 2007; Puente, Pérez-García, Vilar-Lopez, Hidalgo-Ruzzante, & Fasfous, 2013). This is critical not only from the standpoint of the DSM but also from the standpoint of the recently revised Standards for Educational and Psychological Tests (AERA, 2014), which outlines the importance of “fairness” including diagnostic inaccuracy. The chapter on “Fairness” describes the importance of construct irrelevance that could easily occur when instruments measure cultural and/or linguistic knowledge instead of the

construct in question. In this case, one ends up with measurement errors and, by de facto, misdiagnoses.

Research illustrates that false-positives and misdiagnoses to administering neuropsychological tests on individuals of diverse cultural backgrounds tends to occur in these circumstances (Norman, Evan, Miller, & Heaton, 2000; Norman et al., 2011). Norman et al. (2011) demonstrated that when applying previously established normative, clinical neuropsychological impairment on tests of executive function, and verbal and visual learning and memory was higher for healthy African American participants than for healthy Caucasian participants. When a normative correction was applied for race/ethnicity, the diagnostic accuracy for African Americans improved significantly. In another study conducted by Norman et al. (2000), 46% of healthy African Americans were erroneously classified as neuropsychologically impaired (i.e., T-score <40) by the California Verbal Learning Test (CVLT) when using the original standardized scores, which were likewise predominately based on Caucasian individuals. Some studies encourage the lowering or altering the normative reference points for people of different ethnic backgrounds (Norman et al., 2000), due to the fact that false positives are likely to occur when neuropsychological tests from one culture are applied to individuals from another (Bakos, Denburg, Fonseca, & de Mattos Pimenta Parente, 2010; Fasfous, Hidalgo-Russante, Vilar-López, & Pérez-García, 2014; Puente et al., 2013). However, such race-specific methods allow ethnicity to serve as a proxy for other underlying cultural variables that are grossly overlooked. This dilemma supports the need to create “culturally fair” neuropsychological tests that are less influenced by cultural variables or that at least understand the potential for diagnostic inaccuracy.

To our knowledge, no study has been conducted on the diagnostic inaccuracies of applying North American neuropsychological tests on individuals of different cultural backgrounds using the new DSM-5 NCD criteria. Moreover, much of the research that has been conducted on the diagnostic effects of applying neuropsychological tests on individuals of different cultures are limited to the United States (Boone, Victor, Wen, Razani, & Pontón, 2007; Norman et al., 2000; Norman et al., 2011; Proctor & Zhang, 2008). Many of these studies in the United States are restricted by bilateral evaluations comparing only a few minority groups to the majority Anglo-Saxon standard, and most often the comparison group is composed of African-Americans who live in the United States (Boone et al., 2007; Norman et al., 2000; Norman et al., 2011; Proctor & Zhang, 2008). In essence, therefore, these studies are

not truly addressing cultural issues but instead are considering ethnic-minority differences.

The current study focuses on the percentage of participants that are erroneously diagnosed with Mild NCD or Major NCD when using original North American normative data. The sample includes individuals that not only differ in cultural backgrounds, but also in their countries of origin. Of the three groups in this study, two share the same language but a different culture (Spanish and Colombian), and the a third represents a different culture and language (Morocco). In doing so, the goal is to try and tease out linguistic from cultural issues. There is evidence in the literature that although Columbians and Spaniards share a common language that there cultures are substantially different (Haensch, 2001).

Considering the evidence that neuropsychological examinations present cultural biases (Fasfous et al., 2014; Puente et al., 2013) and that false-positives are a consequence of such biases (Norman et al., 2000; Norman et al., 2011), we hypothesize that a significant percentage of these three groups will appear as being diagnostically impaired.

Method

Participants

The sample size was established based on the study by Agranovich, Panter, Puente, and Touradji (2011), which shares in common measures and sample characteristics with the present study. Using their effect size (Cohen's *d*) range between 0.34 and 0.79, we calculated the power, setting our effect size at 1.00, our directional alpha at .05, and power at 80%. These calculations proposed a sample size of at least $n=21$ for each group. Taking this information into account, we selected 27 individuals for each group, producing a total of 81 participants (38 men and 43 women).

The nationalities of the three groups (Moroccan, Spanish, and Colombian) were selected because they are most representative of the population residing in Spain (National Institute of Statistics, 2013). Spain is the third largest recipient of immigrants in the European Union with 4,870,487 foreigners, constituting 10.44% of the total population (European Commission Eurostat, 2013; National Institute of Statistics, 2013), and was therefore of special interest to this study. Moreover, these three nationalities offer a wealth of cultural variables since they differ in language (Arab vs. Spanish), religion (Islam vs. Christianity), tradition, and geography (Africa vs. Spain vs. South America). Colombian, while making

a sizeable percentage of Spain's immigrant population provide a considerably different set of cultural norms (Colombianos na Espanha, 2007).

Between January 2009 and July 2011, participants were recruited in Granada, Spain from various non-profit organizations for immigrants and between the undergraduate and graduate student body at the Universidad de Granada. Two inclusion criteria were considered for participants: an age range between 18 and 55 years, and a Spanish proficiency high enough to comprehend the instructions and tests. The subtest 13 entitled Passage Comprehension of the *Batería Woodcock-Muñoz Psicoeducativa en Español* was used to assess Spanish proficiency (*Woodcock-Muñoz Psycho-Educational Survey in Spanish*; Woodcock, 1982). In addition, Moroccan participants demonstrated having adequate Spanish comprehension by their academic background: 77.8% were university students that took classes in Spanish. The initial interview revealed that 46.7% of the Moroccan individuals had spoken Spanish since they were children, 55.6% spoke Spanish at home, and 48.1% reported thinking in Spanish. Participants that posed confounding variables such as a history of mental illness, neurological disorders and substance abuse were excluded from the study. This information was gathered in the initial interview, using the following questions: "Have you consumed illegal drugs in the past year," "Have you been diagnosed for any mental illness," and "Are you currently taking any medication?"

Materials and procedure

Each individual participated in a structured interview in which socio-demographic information and cultural variables were obtained (i.e., socio-economic status and acculturation).

Neuropsychological tests

The battery includes both tests that are commonly considered as free of cultural biases (nonverbal) and others that are not (tests that require verbal communication). We specifically chose tests that are not adapted and do not have standardized scores for Spaniards, Moroccans, and Columbians. These tests evaluate four of the most commonly assessed cognitive domains in clinical neuropsychology:

1. **Perception:** The Hooper Visual Organization Test (HVOT; Hooper, 1983).
2. **Executive Function:** The Color Trail Making Test B (CTT-B; D'Elia et al., 1996) and Ruff Figural Fluency Test (RFFT; Ruff, 1996).

3. **Verbal Memory:** The Hopkins Verbal Learning Test (HVLT; Benedict, Schretlen, Groninger, & Brandt, 1998).

4. **Visual Memory:** The Rey Complex Figure Test (RCFT; Meyers & Meyers, 1995). A Spanish version of the RCFT is available in TEA Ediciones publisher. However, this version only has an immediate recall and copy trial, and norms do not include adults. Moreover, this version does not include normative scores for the essay of delayed recall nor recognition (Alexander, 1987).

AFF and NHR, doctoral level psychologists, administered the tests at the University of Granada to university students and volunteers from various nonprofit organizations that work with immigrants. Both administrators are licensed in clinical psychology, have ample training and experience in neuropsychological testing, and underwent similar training for this study. Moreover, they alternated assessing participants from each of the three groups so as to avoid testing biases.

Procedure

All participants received both written and verbal information about the study's objectives and procedure, and signed an informed consent record. The Ethics Committee of the University of Granada approved the study, and the participants' confidentiality was maintained in accordance with standard scientific protocol in Spain for personal data protection (Organic Law 15/1999, December 13). Participants were given an incentive of € 20 for their participation.

The entire assessment was completed in Spanish and had a total duration of approximately 150 minutes per individual. From the complete assessment, certain tests were drawn for the analysis of the present study. The duration of these specific tests was 45 minutes, which included the initial interview, test administration, and 15-minute break at the middle of the assessment.

Statistical analysis

First, an analysis of variance (ANOVA) was conducted to examine quantitative variables such as age and number of months living in Spain. To analyze differences among groups in the qualitative variables of gender, income level, and education level, a chi-square test was performed (see Table 1).

Second, an analysis of variance (ANOVA) was conducted to examine differences among groups in the neuropsychological variables (see Table 2). Finally, a chi-square test was conducted to measure how many participants in each group fell into the diagnostic range

Table 1. Descriptive statistics and significance of socio-demographic variables for the Colombian, Moroccan, and Spanish groups.

Variables	Colombians (<i>n</i> = 27)	Moroccans (<i>n</i> = 27)	Spaniards (<i>n</i> = 27)	<i>F</i> / χ^2	<i>P</i>
Sex				.694	0.702 ^a
Men	40.7% (11)	48.1% (13)	48.1% (13)		
Women	59.3% (16)	51.9% (14)	51.9% (14)		
Age	29 (7.17)	27.77 (5.1)	25.63 (3.33)	2.120	0.127 ^b
Education level ^c				17.796	0.122 ^a
Primary	7.4% (2)	14.8% (4)	0% (0)		
Secondary 1st level	3.7% (1)	3.7% (1)	0% (0)		
Professionals	7.4% (2)	0% (0)	3.7% (1)		
Secondary 2nd level	11.1% (3)	3.7% (1)	7.4% (1)		
Professionals	14.8% (4)	0% (0)	22.2% (1)		
Superiors					
University 1st level	14.8% (4)	44.4% (12)	33.3% (12)		
University 2/3 level	40.7% (11)	33.3% (9)	33.3% (9)		
Income level				1.306	0.520 ^a
Less than 360€	57.7% (15)	41.7% (10)	48.1% (13)		
Between 361€–900€	42.3% (11)	58.3% (14)	51.9% (14)		
Months of Migration	41.22 (40.67)	67.78 (29.32)	–		

^aStatistics utilized for the comparison of distributions: Chi-squared. ^bStatistics utilized for the comparison of distributions: ANOVA. ^cEducation Level: Classified by the INE (Instituto Nacional de Estadística, National Institute for Statistics).

Table 2. Standard deviation and significance of neuropsychological variables for Colombian, Moroccan, and Spanish groups.

Test	Colombian <i>M</i> (<i>SD</i>)	Moroccan <i>M</i> (<i>SD</i>)	Spanish <i>M</i> (<i>SD</i>)	<i>F</i>	<i>p</i>	Colombian % (<i>n</i>)		Moroccan % (<i>n</i>)		Spanish % (<i>n</i>)		<i>X</i>	<i>p</i>
						Mild	Major	Mild	Major	Mild	Major		
RCFT_DR	23.17 (6.95)	20.28 (6.67)	27.46 (4.43)	9.42	.004	22.2% (6)	14.8% (4)	11.1% (3)	25.9% (7)	7.4% (2)	0% (0)	11.26	0.24
CIT-A	45.52 (14.77)	57.26 (30.31)	33.04 (10.28)	9.56	.000	37% (10)	14.8% (4)	22.2% (6)	33.3% (9)	14.8% (4)	0 (0)	16.81	0.002
CIT-B	89.33 (28.23)	96.41 (38.06)	64.11 (12.32)	9.74	.000	22.2% (6)	3.7% (1)	18.5% (5)	14.8% (4)	0% (0)	0% (0)	12.898	0.012
RFFT	83.85 (26.72)	95.41 (30.39)	100.22 (17.60)	2.94	.059	14.8% (4)	7.4% (2)	7.4% (2)	11.1% (3)	14.8% (4)	0% (0)	3.691	0.449
HVLT_DR	9.67 (1.52)	8.00 (2.16)	10.26 (1.74)	11.06	.000	14.8% (4)	7.4% (2)	40.7% (11)	18.5% (5)	18.5% (5)	7.4% (2)	9.8	0.044
HVLT Tot	26.74 (4.19)	23.41 (3.89)	28.63 (3.96)	11.69	.000	29.6% (8)	7.4% (2)	29.6% (8)	22.2% (6)	14.8% (4)	7.4 (2)	6.682	0.154
HVOT	23.63 (4.33)	18.29 (5.23)	26.72 (2.04)	29.28	.000	18.5% (5)	11.1% (3)	29.6% (8)	51.9% (14)	7.4% (2)	0% (0)	35.67	.000

Note. RCFT = Rey Complex Figure Test; CTT = Color Trail Test; RFFT = Ruff Figural Fluency Test; HVLT = Hopkins Verbal Learning Test; HVOT = Hooper Visual Organization Test; DR = Delayed Recall; IR = Immediate Recall; Tot = Total Responses; C = Colombians; M = Moroccan; S = Spaniards.

for Major NCD (-2 standard deviation: *t* score <30 , percentile <2), Mild NCD (-1 standard deviation: *t* score $30-40$, percentile $2-16$), or normal cognition (*t* score >16 , percentile >40) based on original standardized scores (see Table 2).

Results

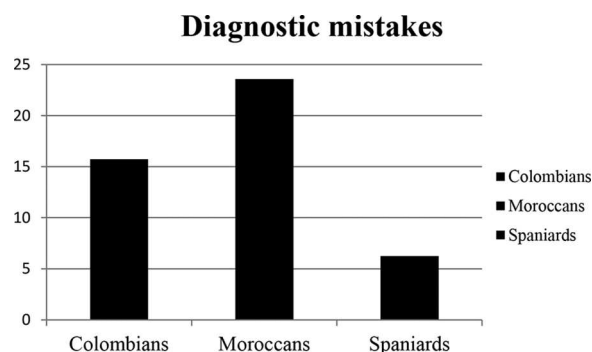
No significant differences were found between the Colombian, Moroccan, and Spanish groups in age, gender, education level, and monthly income.

These results demonstrate that neuropsychological diagnostic mistakes range from 3.7–37% ($M = 15.72$;

$SD = 8.70$), for Colombians 7.4–51.9% ($M = 23.59$; $SD = 11.70$) for Moroccans, and 0–18.5% ($M = 6.24$; $SD = 6.43$) for Spaniards (see Figure 1). The chi-squared analysis revealed that there were significant deviations from average scores on the HVOT (Hooper Visual Organization Test): $X^2 (4, N = 81) = 35.67$, $p < .000$; CTT-A (Color Trail Making Test-A): $X^2 (4, N = 81) = 12.81$, $p < .002$; HVLT-DR (Hopkins Verbal Learning Test- delayed recall): $X^2 (4, N = 81) = 9.88$, $p < .04$; and RCFT-DR (Rey Complex Figure Test- delayed recall): $X^2 (4, N = 81) = 11.26$, $p < .02$.

Discussion

The objective of this study is to examine the percentage of diagnostic errors committed when using the original standardized scores of North American neuropsychological tests with culturally diverse populations. In our sample of 27 Colombians, 27 Moroccans, and 27 Spaniards, we found that false positive diagnoses occur an average of 16% for Colombians, 23% for Moroccans, and 6% of Spaniards, and that up to 51% of those assessed may be misdiagnosed as having Mild/Major Cognitive Disorder, depending on the test and population. Furthermore, percentages of diagnostic error

**Figure 1.** Mean of diagnostic mistakes.

range from 3.7% to 51.9%, which differs from the range of 24–49% that previous studies have found (Norman et al., 2011).

While the present study supports prior findings for ethnic-minorities, our data addresses issues that have seldom been considered in previous research. First, instead of comparing performance differences between individuals of diverse cultural groups, we focus on the amount of diagnostic error that occurs when using tests on individuals of different nationalities. Second, we include participants who have a high degree of education instead of those with low levels of education who are typically used. Third, many previous studies limit their assessment to a few specific neuropsychological domains (Byrd et al., 2004; Ostrosky-Solís & Lozano 2006; Ramírez et al., 2005), and do not study neuropsychological performance extensively by assessing a variety of domains. Finally, comparisons often do not use linguistically and culturally diverse groups. In this case, both were assessed.

Examining these findings by the country of origin reveals that in order from greatest to lowest, most diagnostic error occurs with participants from Morocco (23%), then Colombia (16%), and finally Spain (6%). Approximately 23% of Colombians, 20% of Moroccans, and 11% of Spaniards meet the diagnostic criteria for Mild Cognitive Disorder. As for Major Cognitive Disorder, 11% of Colombians, 24% of Moroccans, and 1.2% of Spaniards fall two standard deviations or more away from the average. These differences in performance on neuropsychological assessment between groups are consistent with an increasing amount of research that demonstrates cultural differences in neuropsychological performance (Agranovich et al., 2011; Bakos et al., 2010; Boone et al., 2007; Rosselli & Ardila, 2003).

One explanation for such differences could be test and/or testing familiarity. In our study, 80% of Moroccan participants and just 20% of Spaniards had never taken a psychological examination (Fasfous, Hidalgo-Ruzzante, Vilar-López, Catena-Martínez, & Pérez-García, 2013). This difference in familiarity may have impacted performance, as individuals who are less acquainted with test protocol may rely on more complex cognitive functions associated with executive function to complete tasks (Diaz-Asper, Schretlen, & Pearlson, 2004; Fasfous et al., 2013). In addition, testing and test familiarity as well as bilingualism (early, late and balanced) have been identified as a facilitating factor in test performance (AERA, 2014). Various studies have found that bilingual individuals experience differences in aphasia, suggesting that the knowledge of more than one language has underpinning cognitive

effects on verbal functioning (Fabbro, 2001a, 2001b). Therefore, testing, test and bilingualism should be considered in future studies to understand their influence on neuropsychological testing, especially on verbal fluency.

In addition, age and education level have been cited as two of the most significant factors for certain neuropsychological tests, such as memory (Ardila et al., 2007). There are conflicting findings as to whether age or education is a stronger predictor variable (Crossley, D'Arcy, & Rawson, 1997; Ostrosky-Solís & Lozano, 2007). Nonetheless, both are widely recognized as strong predictors for neuropsychological performance and must therefore be considered when examining diagnostic criteria (Ostrosky-Solís & Lozano, 2007).

Categorically examining these findings by tests, we find that the Color Trails Test-A was the test with the most diagnostic mistakes. Sixteen percent of participants perform within the range for Mild Cognitive Disorder and 24.7% in the range for Major Cognitive Disorder on this test. These findings are surprising, considering that the Color trails Test-A has previously been described as a culture free test (D'Elia, Satz, Uchiyama, & White, 1999; Elkin-Frankston, Lebowitz, Kapust, Hollis, & O'Connor, 2007).

Another test that exhibits great diagnostic error with our sample is the Hopkins Verbal Learning Test (HVLT). To our knowledge, only one study has examined the amount of diagnostic error in this test (Norman et al., 2011). While Norman et al. (2011) found a 25% diagnostic error using a one standard deviation cut off for the HVLT, we discovered that between 14.8% and 29.8% of participants perform one standard deviation away from the mean (Mild Cognitive Disorder), and between 7.4% and 22.2% fall within the diagnostic criteria for Major Cognitive Disorder (two or more standard deviations from the mean).

It is important to mention certain limitations that restrain the scope of this study. The small sample size of 81 participants limits the data's generalization and power. Moreover, the sample includes both immigrant and nonimmigrant participants and from only three countries. While all groups were matched in socioeconomic status and education, it would be interesting to study the neuropsychological performance of individuals from different countries that still reside in their country of origin. Furthermore, we assessed mental illness, neurological disorders, and substance use in the initial interview but not with a specific measure. Future studies should use standardized measures for determining presence of psychiatric or neurological disorders.

Despite these limitations, this study contributes to the emerging body of knowledge surrounding

diagnostic error in neuropsychological testing of diverse individuals. Our findings strongly support the need for neuropsychological tests with more representative normative standards in the commonly measured domains of perception, executive function, verbal memory, visual memory, and nonverbal fluency. We hope that this preliminary study will encourage more interest and research in cross-cultural neuropsychology, and encourage clinical neuropsychologists to reevaluate their methods of assessing and understanding diverse individuals.

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