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Neuropsychological test performance of Spanish speakers: Is performance different across different Spanish-speaking subgroups?

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Even though theories and research have pointed out the importance of variables such as age, gender, or education on neuropsychological assessment, much less emphasis has been placed on language and culture. With the increasing population of Spanish speakers in North America and the limited amount of clinical and scholarly information currently available, neuropsychological assessment of this group has similarly become of increasing importance. Though several studies have been published over the last two decades, an assumption exists that all Spanish speakers, holding education and age constant, would perform similarly regardless of their origin. To address this assumption, a sample of 126 participants was tested from four different countries (Chile, Dominican Republic, Puerto Rico, and Spain). Participants were compared on the following commonly used neuropsychological tests: Verbal Serial Learning Curve, Rey– Osterrieth Complex Figure Test, Verbal Phonemic Fluency Test, the Stroop Color and Word Test, and the Trail Making Test. Analyses revealed significant differences across the groups in two of the five tests administered. Significant differences were observed in the delayed recall of the Serial Learning Test and in the Verbal Fluency Test. The findings highlight the importance of within-group differences between Spanish speakers.

Keywords: Hispanics; Spanish speakers; Culture; Neuropsychology; Assessment.

Neuropsychological assessment of ethnic minorities continues to be one of the major challenges in current neuropsychology (Razani, Murcia, Tabares, & Wong, 2006). The influence of variables such as age, gender, years of education, or language on neuropsychological tests is well known. However, very few studies have focused on the topic of how—and how much—cultural and linguistic variables influence neuropsychological performance (Ardila, Rosselli, & Puente, 1994; Boone, Victor, Wen, Razani, & Pontón, 2007; Manly & Echemendia, 2007; Puente & Pérez-García, 2000a).

Cross-cultural neuropsychology has typically studied ethnic minorities compared to white North-American population, who usually achieve better performances (Ardila, 1995; Byrd, Sánchez, & Manly, 2005), and, to a lesser degree, has compared international samples. Differences found between cultural groups refer to both verbal and non-verbal tasks (Rosselli & Ardila, 2003) and cover areas such as attention (Byrd, Touradji, Tang, & Manly, 2004), memory (Manly, Jacobs, Touradji, Small, & Stern, 2002; Ostrosky-Solís & Ramírez, 2004; Razani, Burciaga, Madore, & Wong, 2007),

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visual–perceptive ability (Manly et al., 2002; Ostrosky-Solís & Ramírez, 2004), cognitive flexibility (Agranovich & Puente, 2007; Razani et al., 2007), abstract reasoning (Manly et al., 2002; Touradji, Manly, Jacobs, & Stern, 2001), inhibition (Razani et al., 2007), intelligence (Razani et al., 2006), and category fluency (Kempler, Teng, Dick, Taussig, & Davis, 1998; Manly et al., 2002; Touradji et al., 2001).

One of the groups in cross-cultural neuropsychology that are becoming increasingly important are Hispanics, largely due to the increasing demographic shifts in the United States over the last two decades (Humes, Jones, & Ramírez, 2011). In fact, the term "Hispanic" is a term coined by the U.S. government but it does not provide information about linguistic background (e.g., not all Hispanics speak Spanish). As a consequence, the term "Spanish speakers" is used throughout the paper. Studies that include Spanish speakers are very limited (Ardila et al., 1994; Barr et al., 2009; Cherner et al., 2007; Echemendia & Harris, 2004; Puente & Pérez-García, 2000a), and only a limited portion of Spanish speakers is included in the research that does exist. Samples are composed of older adults, generally Mexicans, with limited education, and living in the US (Dansilio & Charamelo, 2005; Gasquoine, 2001; Rosselli & Ardila, 2002). Furthermore, studies consider Spanish speakers as a unique group, composed of people with homogeneous cultural and linguistic features (Puente & Pérez-García, 2000b). Spanish-speaking countries include Spain and Latin American countries. Whereas all of them share certain values such as solidarity, the importance of family links, temporal flexibility, acceptance of death, and the need for living life intensively, but also a peculiar lack of planning, organization, or interest for money (Staton, 2002), nevertheless, Spanish-speaker groups are heterogeneous, and despite their commonalities their economic and educational resources are very different, and their cultural origin is also variable (Europeans, Indigenous, Africans, etc.; see Ardila, 2009). Thus, Spanish speakers comprise a group with a variety of differences and similarities (Puente & Ardila, 2000), and, therefore within-group differences should be considered (Puente & Perez-Garcia, 2000a). To date, within-Spanish-speaking-group differences have not been empirically explored, and thus questions remain as to whether intragroup differences exist and, if so, what are those differences.

Accordingly, the aim of the present study is to address potential differences on neuropsychological test performance across Spanish-speaking subgroups based on country of origin and residency (Chile, Dominican Republic, Puerto Rico, and Spain).

METHOD

Participants

Participants were 126 adults from urban areas in Chile, Dominican Republic, Puerto Rico, and Spain. These four countries were selected because of their differences on criteria related to culture, such as ethnic composition, economic resources, literacy, life expectancy, or Human Development Index (see Table 1, adapted from Ardila, 2009).

The inclusion criteria were: 18–30 years of age; native of *and* resident in one of the four countries where data were collected; Spanish the first language and mother tongue; have completed a minimum of 12 years of formal education; and willingness to participate in the study. The exclusion criteria included substance abuse history, significant physical illnesses, taking psychoactive medications at the time of assessment, and any history of neurological or mental illness. All those criteria were obtained by an interview prior to testing. The mean age of the participants was 22.63

TABLE 1
Cultural characteristics of the four groups of the study

Characteristic	*Chile*	*Dominican Republic*	*Puerto Rico*	*Spain*
Gross domestic product per capita ($)	12,983	8,050	22,058	29,148
Literacy (%)	95.7	87.7	98.0	97.7
Average life expectancy (years)	78.6	72.2	75.6	76.2
Human Development Index	.859	.751	.942	.938
Ethnic composition (%)				
European descent	2	16	80.5	88
Indigenous descent	3		0.5	
African descent		11	8	2
Variable[a]	95	73	11	10

[a]Variable indicates that there is a mix of the three groups (Europeans, Indigenous, Africans) or between one and more of the three groups and other groups (i.e., Arabs).

TABLE 2
Descriptive statistics of the sample

Characteristic	*Puerto Rico (n = 30)*	*Chile (n = 30)*	*Dominican Republic (n = 36)*	*Spain (n = 30)*	F/χ^2	*p*
Gender (M/F)	15/15	17/13	20/16	18/12	0.63	.890
Age, years; mean (*SD*)	22.63 (2.58)	23.50 (2.15)	22.86 (3.29)	21.50 (3.50)	2.41	.070
Years of education; mean (*SD*)	15.60 (1.50)	15.03 (1.19)	15.43 (1.54)	14.43 (3.23)	2.02	.115

Note. M = male. F = female.

(*SD* = 2.98) years. Participants had a mean of 15.13 (*SD* = 2.03) years of education. Fifty-six of the participants were females, and 70 were males. From among all of them, 90.5% were right-handed, 7.9% were left-handed, and 1% were ambidextrous. Post hoc comparisons did not reveal any statistically significant differences across sites on gender, age, and years of formal education. Descriptive statistics of demographic variables of the sample are provided in Table 2.

Materials

Participants were administered five neuropsychological tests that measured visual–spatial and visual–motor abilities, memory abilities, and executive function abilities. Tests were selected to tap the main neuropsychological areas, attending to their wide utilization (Camara, Nathan, & Puente, 2000) and their use with Spanish-speaking populations (Ojeda, 2010). The following tests were used: the Verbal Serial Learning Curve (SLC), the Verbal Phonemic Fluency Test (FAS), and the Rey–Osterrieth Complex Figure Test (ROCFT) as described, adapted, and standardized for its use with Spanish speakers by Ardila et al. (1994). Also, the Stroop test and the Trail Making Test (TMT) were selected because they are two of the most commonly used tests in neuropsychological assessment, and they were also frequently used in neuropsychological research with Spanish speakers (i.e., for the Stroop: Boone et al., 2007; Gasquoine, Croyle, Cavazos-González, & Sandoval, 2007; Razani et al., 2007; Rosselli et al., 2002; for the TMT: Arnold, Montgomery, Castañeda, & Longoria, 1994; Boone et al., 2007; Razani et al., 2007). The following is a brief synopsis of each of the tests used.

Verbal Serial Learning Curve—SLC

This test consists in a list of 10 two-syllabic nouns frequently used in Spanish. The list is read to the participants over several trials until they learn all of the 10 words. The recall trial is administered after a 10-min delay. The standardization of this test was conducted with two different samples of Spanish speakers: 180 participants with 1–13 or more years of education, with an age range 16–65 years, and 326 participants between 56 and 80 years (Ardila et al., 1994).

Verbal Phonemic Fluency Test—FAS

This test is an adapted Spanish version of the FAS test (Benton & Hamsher, 1976; published in Ardila et al., 1994). Similar frequency ranges have been reported by the authors for several languages (English, French, German, and Spanish). The Verbal Fluency Test is a measure of executive functions that tap cognitive switching, rule monitoring, and inhibition (Ostrosky-Solís, Gómez, Matute, & Roselli, 2003). Different normative studies were initially administered to 200 normal subjects (illiterate and professional) from 16 to 65 years. The effect of aging on verbal fluency was analyzed using a sample of 346 normal elderly subjects (Ardila et al., 1994). Correlational analyses analyzed the test–retest reliability within acceptable limits, with a Cronbach alpha of .74 (Tombaugh, Kozak, & Rees, 1999).

Rey–Osterrieth Complex Figure Test—ROCF

In the ROCF, subjects are required to copy a complex figure, and after a delay they are asked to draw what they remember of the figure. The ROCFT is a measure of spatial construction, planning, and visual learning (Akshoomoff & Stiles, 1995). Norms for Spanish speakers were completed using 200 participants belonging to two extreme educational groups (totally illiterate and professional), with an age range 16–65 years, and also the authors analyzed the influence of age with 346 subjects older than 55 years. Previous studies have showed that the reliability of this test is high, with a

Cronbach´s alpha of .828 for the copy, and .783 for the memory (Cortés, Galindo y Villa, & Salvador, 1996).

Stroop Color and Word Test (Golden, 1978)

The Stroop is a measure of perceptual interference and inhibition (Golden, 1978). This test includes three cards: the first with the reading condition, the second with the color-naming condition, and the third with the interference condition (the participants are asked to name the color of the ink and not to read the word). The version used of this test was the Spanish adaptation by TEA Ediciones (Golden, 2005). Reliability results are very consistent for its different versions with a global Cronbach's coefficient of .90 for the word condition, .83 for the color condition, and .91 for the interference condition (Spreen & Strauss, 1991).

Trail Making Test—TMT (Reitan & Wolfson, 1995)

The TMT is one of the most common tests employed in neuropsychological assessment as a measure of visual search, scanning, speed of processing, mental flexibility, and executive functions (Camara et al., 2000). This test includes two parts, Parts A and B. Subjects' task on both parts is to connect with a line the sequence of circles as quickly as possible. As described in the administration manual, Part A consists of circles containing numbers from 1 to 25, and Part B consists of circles containing numbers from 1 to 13, as well as letters from A to L; in this part, subjects have to connect the sequence alternating numbers and letters (Reitan & Wolfson, 1995). This test was administered following standard procedures (Mitrushina, Boone, Razani, & D'Elia, 2005). The interreliability on both parts was high, with a Cronbach's alpha of .94 for Part A, and .90 for Part B (Fals-Stewart, 1992).

Procedure

Recruiting procedures were approved by the Institutional Review Board of the University of North Carolina Wilmington (UNCW) and were authorized by the different collaborating institutions. Participants were contacted through the psychology departments of the different universities or hospitals in which one of the collaborators had an appointment in Santiago de Chile (Chile), San Juan (Puerto Rico), Santo Domingo (Dominican Republic), and Granada (Spain).

Research collaborators in the different countries asked the potential participants (students at the universities and relatives of the patients and staff from the hospitals) if they were interested in participating in the study. Advertisements were also placed at the different locations to recruit more of a community sample. After agreeing to participate as volunteers, individuals were taken to a quiet area without disruption and completed the tests individually. Individuals gathering the data were psychology graduate students with training and supervised experience in neuropsychological test administration. Researchers followed the same administration protocol and determined the eligibility of participants based on the inclusion and exclusion criteria previously described. Participants completed a demographic form prior to the administration of each of the tests. All participants were tested in one session of approximately 45 min. One of the authors (A.B.), blind to the country of origin of the participants, scored the tests following the published criteria for scoring.

RESULTS

Differences among countries in sociodemographic variables

To determine whether there was a difference in age and educational levels across the four groups, analyses of variance (ANOVAs) were conducted. The results did not reveal significant differences for age or years of education. Additionally, to determine the relationship between gender and country of origin, a chi square of independence was conducted. The result revealed no significant relationship between gender and country of origin (see Table 2).

Differences among countries on neuropsychological tests

To determine the existence of differences on the neuropsychological test scores, a multivariate analysis of variance (MANOVA) was conducted. Results showed statistical differences according to Wilks's lambda ($\Lambda = .717$, $df = 21, 316$, $p = .014$). The observed covariance matrices of the dependent variables were equal across groups [Box's $M = 106.139$, $F(84, 27842) = 1.124$, $p < .206$].

To further determine differences across the four groups (Chile, Dominican Republic, Puerto Rico, and Spain) in their performance on the different neuropsychological measures, ANOVAs were

TABLE 3
Descriptive statistics, ANOVAs, and a posteriori analysis for the different groups on the variables of the different neuropsychological tests

Variables	*PR M (SD)*	*Ch M (SD)*	*DR M (SD)*	*Spain M (SD)*	*F*	*p*	*Post hoc Bonferroni*[a]	*Effect sizes*
SLC	8.52 (1.48)	8.60 (1.16)	8.75 (1.32)	9.43 (.73)	3.56	.02	(PR = Ch = DR) < S	PR vs. S $d = 0.823$ Ch vs. S $d = 0.878$ DR vs. S $d = 0.622$
ROCF	34.50 (2.10)	34.30 (2.52)	33.50 (2.80)	33.91 (2.98)	0.93	.43	NA	
ROCF (1)	22.82 (6.10)	21.55 (6.65)	22.60 (6.57)	22.64 (7.52)	0.22	.88	NA	
FAS	35.53 (6.12)	34.23 (5.89)	39.86 (6.77)	38.67 (7.24)	5.20	.00	Ch < DR	Ch vs. DR $d = 0.881$
STROOP	46.00 (8.95)	45.03 (10.61)	46.94 (12.98)	49.50 (10.04)	1.45	.23	NA	
TMT(A)	29.25 (13.01)	31.90 (12.33)	30.05 (12.17)	32.43 (8.54)	0.58	.67	NA	
LgTMT(B)	1.80 (.21)	1.79 (.13)	1.78 (.14)	1.74 (.14)	0.67	.56	NA	

Note. ANOVA = analysis of variance; SLC = Serial Learning Curve (delayed recall); ROCF = Rey–Osterrieth Complex Figure Test (Copy); ROCF (1) = Complex Figure Test (delayed recall); FAS = Verbal Fluency Test–Semantic and Phonetic; STROOP = Stroop Color and Word Test; TMT(A) = Trail Making Test Part A; LgTMT(B) = logarithm of Trail Making Test Part B; PR = Puerto Rico; Ch = Chile; DR = Dominican Republic; S = Spain; NA = not applicable.
[a]Only significantly different pairwise comparisons are displayed.

conducted with the following dependent variables: one variable from the SLC (number of words recalled in the delayed recall), two variables from the ROCF (score on the copy and score on the delayed recall), one variable from the FAS (sum of the number of words produced with the three letters), one variable from the Stroop (number of words read on the interference condition), and two variables from the TMT (time to complete Part A and time to complete Part B). Results showed significant differences among the groups in the number of words recalled in the delayed recall of the SLC. Post hoc Bonferroni analyses revealed differences in the delayed recall, with participants from Puerto Rico, Chile, and the Dominican Republic obtained lower scores than participants from Spain. Significant differences were also found in the FAS, with post hoc Bonferroni analyses revealing that participants from the Dominican Republic named more words than participants from Chile. No other significant differences were found across the groups. Effect sizes were calculated to evaluate the magnitude of the differences between the groups that showed a large strength (Cohen, 1988; Kraemer et al., 2003; see Table 3).

DISCUSSION

Neuropsychological assessment of individuals from different cultural and linguistic backgrounds has become a major challenge within the specialty of clinical neuropsychology. Nevertheless, existing research is limited and often assumes homogeneity across Spanish-speaking groups of different geographic origin. The present study was conducted to determine whether different subgroups of Spanish speakers from Chile, Dominican Republic, Puerto Rico, and Spain perform differently on a variety of neuropsychological tests (SLC, ROCFT, FAS, Stroop, and TMT). The results showed the existence of differences as well as commonalities in the execution of neuropsychological tests across the different groups. Performance of the groups was similar in the ROCFT, Stroop, and TMT. However, differences were observed in two of the seven measures used (number of words recalled in the delayed recall of the SLC, and number of words in the FAS). The magnitude of these differences was large and appeared despite the fact that groups were assessed in their countries of residency and birth, matched on the basic neuropsychological sociodemographic variables (years, sex, and years of education) and were evaluated in their own language (Spanish) and by native speakers from the country of origin. No clear pattern emerged from the results (no group is systematically better or worse on the different measures), demonstrating heterogeneity across the groups in the measures employed. However, there is a pattern attending to the domain of the neuropsychological tasks, with differences being restricted to the verbal tests.

Regionalisms and dialectical differences in the Spanish language between the countries of this study could account for the results; the specific language in which tests were constructed cannot correspond to the dialect of the participant, and the dialect used by the examiner during the instructions and administration of the tests can also be different of that of the participant (Vilar-López & Puente, 2010). Thus, words from the dialect of the different participants were allowed during the

FAS administration. It is possible that different dialects have different frequency of use of the words starting with the same letter (for example, people from Chile could use words starting with the letters "f," "a" and "s" less frequently than people from the Dominican Republic). Nevertheless, variations in the Spanish language are small (Ardila, 2009), and they are probably not enough to account for our results. Furthermore, the word list used in this research (SLC) was designed to avoid possible bias of regional language differences, including only words with very high frequency of use for the different Spanish-speaking countries (Puente & Ardila, 2000). Also, linguistic and cultural differences can affect test performance due to differences in giving the instructions during the administration session, but examiners pertained to the same geographic and cultural context of the participants, so this explanation seems unlikely. Furthermore, this fact allows ruling out other possible explanations for the differences found between the groups linked to the use of evaluators from other cultures (such as the personal distance used during the testing, the use of a formal or stereotyped language far away from the individual and their costume patterns, the use of questions that the participant perceive as humiliating, and so on; Ardila & Keating, 2007; Vilar López & Puente, 2010).

Another variable traditionally used to explain neuropsychological differences is education. Several studies have demonstrated the important role played by education when assessing people from different cultural backgrounds (Oberg & Ramirez, 2006; Ostrosky-Solís & Lozano, 2006; Ostrosky-Solís, Lozano-Gutierrez, Ramirez-Flores, & Ardila, 2007), but the groups of the study were matched on years of education, so this variable cannot account for the results. However, recent research has highlighted the importance of quality of education instead of years of education to explain differences between people from different cultures and/or languages (Kennepohl, Shore, Nabors, & Hanks, 2004; Manly et al., 2002), and thus quality of education could explain the differences our groups had on the verbal tasks. Different educational systems can give different importance to diverse psychological processes that underlie academic abilities, and those systems can be quite different between the countries included in the present study. For example, memory is a cognitive domain sensitive to literacy and reading level, and those abilities are developed more or less depending on the educational system during our scholar years (Manly, Touradji, Tang, & Stern, 2003). Thus, in our study, the group with a poorer execution in memory was Chile, which is clearly the country with a higher analphabetism (Ardila, 2009). It could be possible that delayed recall would be more frequently taught in Spanish schools, fluency would be more important in Dominican Republic school tasks, and attention span would be more practiced in Puerto Rico and Chile. This hypothesis should be proved in future research.

Another confounding variable could be the socioeconomic status (Armengol, 2002; Llorente, 2008). Life expectancy, Human Development Index, and incomes are quite variable between the countries of the study. These socioeconomic differences could be the base of discrepancies on the quality of the educational systems and, thus, be related to the neuropsychological performance. Finally, there are small discrepancies in the recruiting of participants. However, since demographic variables were held as constant as was feasible, this methodological discrepancy does not appear robust enough to explain the results.

The present results address ongoing discussions about the problems and caveats of developing ethnic or race-based norms (Ardila, 2007; Brickman, Cabo, & Manly, 2006; Manly, 2005; Manly, Byrd, Touradji, & Stern, 2004; Manly & Echemendia, 2007; Manly et al., 2002; Pedraza & Mungas, 2008). Some authors pointed out that the existing thousands of languages and cultures make the endeavor of developing race-specific norms for all of them impossible (Ardila, 2007; Brickman et al., 2006). Considering that the present study reflects that within-Spanish-speaking-group differences may exist as well, and that similar differences could be anticipated in other large cultures/languages, creating specific norms seems even more difficult. An alternative and more suitable option, which is supported by the present findings, is to deconstruct culture into factors such as those previously shown to be robust and contributory (e.g., quality of education, socioeconomic status, etc.), which could be responsible for the differences found between ethnic groups on cognitive measures (Razani et al., 2007; Touradji et al., 2001).

This study has several limitations. First, it has a relative small sample size, only four countries were included, and eight neuropsychological measures were used to compare the groups. The use of additional tests as well as the inclusion of other nationalities can provide a more comprehensive understanding of within-group differences with Spanish speakers. Moreover, future studies should research the effect of culture or language into English-speaking localities, English being the language with the third highest number of speakers in the world; bilingualism should also be considered. Also, since

the present study focused on healthy and highly educated individuals, further research is required to compare clinical patients across countries and to study different levels of education. Most notably, this study did not measure quality of education and socioeconomic status, though this would be difficult to do, especially in Spanish-speaking countries.

Despite the long-standing belief that culture is not a critical variable in neuropsychological assessment, there is increasing evidence to the contrary (Ardila, 1995). However, this is one of the few studies indicating that within-cultural-group variability exists to the point of challenging the long-held notion that if culture does play a role in neuropsychological assessment, it may be more multidimensional and less cohesive than previously thought. The present study points to the heterogeneity of different groups of Spanish speakers regarding neuropsychological tests and, thus, challenges a simple and unified concept of culture, at least when it comes to Spanish speakers and neuropsychological assessment.

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