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Demographically Adjusted Normative Data for the Halstead Category Test in a Spanish-Speaking Adult Population: Results from the Neuropsychological Norms for the US-Mexico Border Region in Spanish (NP-NUMBRS)

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Abstract

Objective: The present study aimed to develop norms applicable to Spanish-speakers living in the US- Mexico border region for the Halstead Category Test (HCT), a test of executive function.

Methods: Healthy native Spanish-speakers (*N*=252; Age: range 19-60 years, *M*=37.28, *SD*=10.24; Education: range 0-20 years; *M*=10.65, *SD*=4.33; 58.33% female) living in the US-Mexico border region of California and Arizona completed the HCT as part of a comprehensive neuropsychological test battery. The univariable and interactive effects of demographic variables on HCT raw scores were examined. Total scores were normed using fractional polynomial equations, which adjusted for linear and nonlinear effects of age, education, and gender. T-scores were also computed for HCT scores of the current Spanish-speaking normative sample using published, demographically-adjusted norms for English-speaking non-Hispanic Whites and Blacks. Impairment rates (T-Scores<40) were calculated using published and current norms.

Results: Age was significantly associated with increased number of errors, and education and male gender were associated with decreased number of HCT errors (total raw scores). Applying norms developed for English-speaking non-Hispanic Whites and Blacks resulted in overestimation of impairment rates in the current sample (impairment: 48% with White norms and 27% with Black norms). This pattern was evident across levels of education except in participants with 13+ years of education, where rates of impairment using non-Hispanic Black norms were comparable to those based on newly developed norms.

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Conclusion: The present study presents norms for the HCT in a sample of US Spanish-speakers, providing an important tool for identifying executive dysfunction in this population.

Keywords

Spanish norms; cross-cultural; neuropsychology; Normative data

Introduction

The Halstead Category Test (HCT) is part of the Halstead-Reitan Neuropsychological Battery (Halstead, 1947). It assesses abstraction and concept formation ability, flexibility in the face of complex and novel problem solving, and capacity to learn from experience (Strauss, Sherman, & Spreen, 2006). The HCT is sensitive to a variety of brain disorders (see Choca, Laatsch, Wetzel, and Agresti (1997), and it often appears to be as sensitive as the full Halstead Reitan Battery in determining the presence or absence of neurological impairment (Adams & Trenton, 1981). While the HCT was designed to detect frontal lobe dysfunction (Halstead, 1947), some research has shown no consistent relation to specific location or laterality of brain damage (Anderson, Bigler, & Blatter, 1995; Hom & Reitan, 1990; Reitan & Wolfson, 1995).

The adult version of the HCT is comprised of 208 items and seven subtests organized on the basis of a different principle (e.g. number of objects, ordinal position of an odd stimulus, etc.). These include: A Counting factor (subtests I and II), a Spatial Positional Reasoning factor (subtests III, IV, and VII), a Propositional Reasoning factor (subtests V, VI, and VII), and an Incidental Memory factor (subtest VII; Boyle (1988). There are also two children's versions: 1) one for children ages 5-8 years, which consists of five subtests with eight items each; and 2) another for children ages 9-15, 6 months, which includes 168 items, divided into six subtests (Reed, Reitan, & Kłove, 1965). The version for younger children (ages 5-8) has also been used in adult populations with known impairments, who tend to take longer periods of time to complete the adult version of the test (e.g., (Boyle, 1986; Calsyn, O'leary, & Chaney, 1980; Charter, Swift, & Blusewicz, 1997; Gregory, Paul, & Morrison, 1979; Labreche, 1983; Russell & Levy, 1987).

Demographic factors including age and education significantly impact performance on the HCT, while gender appears to have little to no impact (Heaton, Miller, Taylor, & Grant, 2004; Rosselli, Ardila, Bateman, & Guzman, 2001; Sherrill-Pattison, Donders, & Thomson, 2000). Age effects on the HCT have been found in individuals with and without neurological deficits, such that error scores increase with age (Heaton, Grant, & Matthews, 1991; Heaton et al., 2004; Vega Jr & Parsons, 1967). Education effects also have been found in healthy volunteers and individuals who have neurological impairments, such that those with more years of education make fewer errors in this test (Allen, Caron, Duke, & Goldstein, 2007; Heaton et al., 1991; Vega Jr & Parsons, 1967), though prior findings suggest that these education effects are somewhat smaller among non-Hispanic Blacks than non-Hispanic Whites (Heaton et al., 2004).

The use of normative data that account for the impact of demographic factors on test performance is important for the accurate identification of acquired brain dysfunction. The majority of demographically-adjusted normative data for the HCT have been developed in English-speaking samples from Canada and the United States (U.S.) (Fromm-Auch & Yeudall, 1983; Gong, 1986; Heaton et al., 1991; Russell, 2005). In the U.S., norms have been developed for English speaking non-Hispanic White and Black adults (Heaton et al., 2004). Yet, to our knowledge, none have been published for Hispanics/Latinos/as/x (hereafter referred to as Hispanics/Latinos), who represent the largest ethnic/racial minority group in the U.S. (Census Bureau, 2017). The term Hispanic/Latino refers to persons who trace their origin or descent to Spanish-speaking cultures around the world. As such, they are a very heterogenous group, comprising individuals from different countries of origin, immigration histories and languages, with many speaking primarily Spanish. In fact, over 40 million people (13.3%) speak Spanish at home in the U.S. (Census Bureau, 2017), making the U.S. the country with the second largest number of Spanish-speakers in the world.

Culture may bias cognitive test performance and interpretation through customs, values, or cognitive styles which vary from those individuals on which a test was developed and standardized (Olmedo, 1981). It is safe to assume, therefore, that cultural experiences may differentially impact test performance on tests such as the HCT, yet, only a number of studies have examined performance of the HCT among Hispanics/Latinos. In one study of English-speaking young males with poor academic and low socioeconomic status backgrounds, Hispanics/Latinos (n=12) performed significantly worse on the HCT than both non-Hispanic Blacks (n=13) and Whites (n=20) (Bernard, 1989). Participants in this study, however, did not undergo neurological screening prior to inclusion, making it difficult to isolate and interpret ethnic/racial differences in HCT performance. Another study investigated the effect of acculturation on the HCT by comparing three groups: 1) Mexican (those who had resided in Mexico at least 8 years, claimed a Mexican identity and Spanish was their dominant language), 2) Mexican-American (bicultural; English dominant) and 3) non-Hispanic Whites. Results from this study indicated that the Mexican-American and Mexican groups had significantly worse performance (more errors on the HCT) than the non-Hispanic White group (Arnold, Montgomery, Castañeda, & Longoria, 1994). The limited studies available on HCT performance among Hispanic/Latinos indicate that it might be important to develop norms on this test for this group.

As part of a larger normative effort, the purpose of the present study was to develop demographically-adjusted norms applicable to Spanish-speaking adults living the U.S. - Mexico border region for the HCT (Subtest I through VII and total scores). We were also interested in investigating whether the application of existing published norms (i.e., those created for non-Hispanic English-speaking Whites and Blacks) might result in inadequate specificity in this population.

Method

Participants

Our HCT normative sample consisted of 252 (147 women, 105 men) native Spanish speakers who participated in the Neuropsychological Norms for the US-Mexico Border Region in Spanish (NP-NUMBRS) study. Participants were recruited from the US–Mexico border regions of Arizona (n=102) and California (n=150) using flyers or direct contact with recruiters in different community settings. Data were collected in two study waves (Cohort 1 [n=183]: 1998 – 2000 and Cohort 2 [n=69]: 2006 – 2009). Participants were screened to ensure that they had no significant history of significant neurologic, psychiatric, developmental, or substance use disorders that might affect cognitive performance (for further information plasee see Methods paper in this issue, (Cherner et al., 2019). Our current sample was similar to the overall NP-NUMBRS cohort: age ranged from 19 to 60 years ($M = 37.28$, $SD = 10.24$), education ranged from 0 to 20 years ($M = 10.65$, $SD = 4.33$), and a little over half of the sample was female (58.33%).

Procedures

Participants completed the HCT (Halstead, 1947) as part of a larger neuropsychological test battery. Neuropsychological testing was performed in Spanish by trained bilingual psychometrists using standardized procedures. The adult version of the HCT was administered individually following procedures outlined in (Reitan & Wolfson, 1995) (see Appendix for instructions in Spanish). The HCT can be administered using a slide projector (original version), a booklet or via a computer. In the present study, the former/original method of administration was used. A series of 208 slides were projected onto a 10” x 10” screen. The slides had different geometric or numeric figures, and the examinee was told that something about each slide would remind him/her of a number between one and four. The test is divided into the seven HCT subtests, and in all but the last subtest (a memory group) a single principle could be used to select the correct number (one through four) that follows the correct principle. Participants were instructed to discover the underlying concept or principle of each subtest by choosing how each slide fits their hypothesized principle. Feedback was provided via a bell or buzzer indicating whether item responses were correct or incorrect respectively. The approximate time for administration was about 30 minutes. Scoring was done according to the published guidelines (Reitan & Wolfson, 1995).

We report raw scores for each of the subtests of the HCT (Subtest I through VII), which represent the number of errors in each of the subtests, and the Total Score (i.e., sum of all raw error scores across subtests). T-scores (TS) are reported for the HCT Total Score. Given the skewed distribution of scores some of the subtests, percentile scores are reported for subtests I through VII. See Cherner and Colleagues (this issue) for more details on participants and methodology.

Statistical Analyses

Descriptive characteristics were computed for the raw scores of the HCT subtests and for the Total Score. Shapiro-Wilk tests were used to examine their distribution. We examined the association of demographics with the HCT subtests and total raw scores via a series of univariable linear regression analyses and Spearman ρ (for age and education), and Wilcoxon rank-sum tests (for gender). We also ran a series of linear regression analyses with two-way interaction terms of demographics as predictors (i.e., age X education, age X gender, education X gender) on HCT total raw scores.

Raw scores were transformed to normalized Scaled Scores, having a mean of 10 and SD of 3. TS for HCT Total scores were obtained by fractional polynomial equations controlling for age, education, and gender (see Cherner and colleagues, this issue, for details). We then examined the descriptive characteristics of the resulting TS and their distribution via Shapiro-Wilk tests, the association of age and education with the newly developed TS via Pearson product moment correlation coefficients, and the association of gender with TS via an independent samples t-test. We also compared TS derived from the newly developed norms by study site (Arizona and California) and cohort (Cohorts 1 and 2) via separate independent sample t-tests.

We then calculated TS for the raw total HCT scores based on published norms for English-speaking non-Hispanic Whites and non-Hispanic Blacks in the United States (Heaton et al., 2004). Rates of impairment, defined as TS <40, were obtained in the sample using the existing norms (Heaton et al., 2004) and compared to the rates of impairment based on the new norms in the overall sample and across different levels of education. McNemar's tests were used to compare "impairment" rates between current Spanish-speaking Hispanic norms and published norms for English-speaking non-Hispanic Whites and non-Hispanic Blacks. The expected "impairment" rate using a 1-SD cutoff (T<40), which typically balances sensitivity with specificity in detecting neurocognitive disorders (Heaton et al., 2004), is approximately 16%.

Results

Demographic characteristics of the norming sample

Demographic characteristics of the current norming sample for the HCT by level of education are presented in Table 1. There were no significant age (p=.10) or gender (p=.39) differences across education groups.

Raw scores analyses

Table 2 shows descriptive characteristics of raw scores on the HCT Total Scores and each of the subtests. Results from Shapiro-Wilk tests indicated none of the variables were normally distributed. For associations of HCT Total Score and subtests with demographic variables, we found small to medium effects of age, medium to large effects of education, and small to medium effects of gender on raw scores in subtests III through VII, and in the Total Score; and small effect sizes of education only for subtests I and II (Table 3). There were no significant nonlinear associations of age and education with HCT total raw scores. Separate linear regression models on HCT total raw scores, entering terms for two-way interactions among demographics (age by education; age by gender; education by gender) showed no significant interactions (ps>.12).

Raw scores to scale scores and percentiles conversions

Table 4 shows the raw-to-scale score conversions for the HCT Total Score. Table 5 shows percentile ranges for the HCT subtest scores, given the limited range of scores for some subtests.

T-Scores Equations

Table 6 shows the TS equations used to compute individual TS on HCT total scores. As expected, the resulting TS on the HCT Total Score had a mean of 50 and a SD of 10. TS ranged from 25 to 79. Pearson product moment correlation coefficients showed no significant effect of age (p=.98) or education (p=.98) on the HCT TS, and there were no significant differences in mean TS between sexes (p=0.96).

Group Comparisons

There were no significant cohort effects on HCT TS based on the newly developed norms (Cohort 1: M=49.83, SD=10.51; Cohort 2: M=50.29, SD=8.56, p=.72). There was a statistically significant difference on HCT TS by site, such that participants tested in Arizona obtained slightly lower TS (M=48.39, SD=11.13) than participants in California (M=51.01, SD=9.03, p=.0496), but with a small effect size (Cohen's d=.26). In order to shed some light onto factors that might be driving these small differences, in follow-up analyses we investigated whether there were differences in demographic factors by site for participants with data on the HCT, via independent sample t-tests (for age and education) and a chi-square test (for gender). We found no significant site differences on age (p=.27), education (p=.31), or gender (p=.36). We also examined whether the effect of demographics on TS might differ by site, via a series of linear regression models on HCT TS with terms for each demographic variable (age, education and gender), site (Arizona and California) and their interaction. We found no significant interactions of site X education (p=.10), site X age (p=.49) or site X gender (p=.59).

Applications of the existing norms

Figure 1 shows rates of impairment (TS < 40) based on current Spanish-speaking norms as well as applying published norms for English-speaking non-Hispanic Whites and Blacks (Heaton et al., 2004). Differences in rates of impairment between norms for Spanish-speakers and for English-speaking Non-hispanic Whites and Blacks were compared for the entire sample and by level of education.

As expected, rates of impairment utilizing current norms for Spanish-speakers ranged from 13 to 17% across different levels of education. Applying both non-Hispanic White and Black norms for English-speaking individuals resulted in significantly higher rates of impairment for the entire sample ($p < .0001$). When published norms for non-Hispanic Whites were utilized within education subgroups, 42-57% of the sample was classified as impaired, significantly higher than using the current norms (all $p < 0.001$), with the highest misclassifications rates occurring at the lowest level of education (≤ 6 years). When norms for non-Hispanic Blacks were utilized in the current sample, 12% of participants 13 years and over were classified as impaired, which was relatively comparable to estimates utilizing current norms (p=0.7). However, rates of misclassification increased with lower levels of education, with impairment rates ranging from 30% to 41%, significantly higher than using the current normative adjustments (all ps <.005).

Discussion

The purpose of the present study was to provide norms applicable to Spanish-speakers for the HCT as part of a larger neuropsychological norms project for the US-Mexico Border Region in Spanish (NP-NUMBRS). We were also interested in investigating the impact of utilizing existing published norms in English-speaking non-Hispanic Whites and Blacks on the current sample of Spanish-speakers.

Results for the current sample of Spanish-speakers showed age, education and gender were significantly associated with performance on the HCT. Specifically, error scores on the test decreased with more years of formal education and increased with advanced age, and females made significantly more errors than men. These effects were found on HCT total raw scores and across most subtests. Similar effects of age have been found in other ethnic/racial groups (Heaton et al., 1991; Heaton et al., 2004; Vega Jr & Parsons, 1967). The effect of education on the HCT is also well documented, though in a prior study of English-speakers (Heaton et al., 2004), education accounted for a significantly smaller amount of variance in HCT performance among non-Hispanic Blacks than non-Hispanic Whites. In contrast, we found an effect of education on HCT performance in the current sample of Spanish-speakers that was quite robust, and even greater than that seen in the Heaton et al. (2004) study for non-Hispanic Whites. The large range of education in the present sample, and the sizeable proportion with quite limited education (see Table 1) might explain these strong effects at least in part. Also, at odds with prior literature (Heaton et al., 2004), we found medium effects of gender on the HCT. Overall, present findings indicate that demographic variables (age, education and gender) are all important to consider when interpreting performance on the HCT among Spanish-speakers living in the US, and effect sizes of these variables are significantly different than those seen in other racial/ethnic (English-speaking) groups. Thus, population-specific demographic adjustments are needed to account for these differences.

As expected, the TS derived from application of the newly developed norms were normally distributed, free of demographic effects and resulted in expected rates of impairment (defined as TS<40). There were no cohort effects on TS, indicating that time when the data were collected did not significantly impact performance. This is important given that the data were collected in two waves approximately seven to 11 years apart. We did, however, find differences in TS between participants tested in Arizona and California, albeit quite small. There were no significant age, education or gender differences across site, and the effect of demographics on HCT TS were comparable across site. This suggests that these specific demographic factors cannot account for the modest site differences. Systematic differences in administration across sites also are unlikely to explain these disparities, given that great efforts were undertaken to assure the quality and consistency of the data collected. Instead, it might be the case that certain unmeasured and unaccounted for differences across sites may be playing a role. Unfortunately, we do not have data on other culturally-relevant factors, such as country/ies where education was completed and degree of bilingualism, among others, which might have varied across site and would be important to consider in future studies.

Findings from the current study are consistent with those of prior research and findings form other tests in the present issue showing that applying norms developed for English-speaking, non-Hispanic Whites to Spanish-speaking Hispanic/Latino individuals results in significant misclassification of cognitive impairment for this population (Ardila, 1995; Arnold et al., 1994; Casaletto et al., 2016; Cherner et al., 2007; Heaton et al., 2004). As expected, based upon use of a 1-SD TS cutoff, rates of impairment utilizing current norms ranged from 13 to 17% across different levels of education. In contrast, 42-57% of Spanish-speakers in our sample were classified as impaired when applying norms for non-Hispanic Whites, with the highest misclassification rate occurring among those with the lowest level of education (≤ 6 years); such low education levels in the prior, English-speaking cohorts were virtually non-existent. A similar pattern was observed when applying norms for non-Hispanic Blacks to our current sample, but rates of impairment, although still excessive, were less pronounced (30% to 41%). Additionally, there were comparable rates of impairment in participants with more than a high school education when applying non-Hispanic Black norms as those observed utilizing the newly developed norms. These findings suggest that caution should be taken when applying published norms from other ethnic/racial and language groups to Spanish-speakers, as this might result in over classification of impairment and substantial misdiagnosis of having a brain disorder in normal healthy Spanish-speakers.

It is important to consider that findings from the present study cannot directly address the factors underlying ethnic/racial differences in neuropsychological test performance. The increased rate of misclassification of impairment across lower levels of education indicates that lower educational attainment is likely an important factor in explaining these disparities. Yet racial/ethnic differences existed across most levels of education, underscoring the need to consider other factors. Consistently, prior research suggests that quality of education can have an important effect beyond years of education (Manly et al., 1999). Furhtermore, culture may uniquely play an integral role in the understanding and processing of different neuropsychological tasks (Rosselli & Ardila, 2003), and the cultural relevance of test stimuli and task requirements might be important to consider (Ardila, 1995). Further research needs to be undertaken before strong assertions can be done in this regard.

There are several limitations to the current study that should be considered and that could be pursued in future research efforts. First, the current study did not systematically collect information on other culturally-relevant variables that might be important to take into consideration (e.g., degree of bilingualism, quality of education, and acculturation, among others). Research has suggested that cognitive performance in differing ethnicities is effected by factors of acculturation (i.e., years in the US, language spoken, generational status; (Arnold et al., 1994; Boone, Victor, Wen, Razani, & Pontón, 2007; Pontón & Ardila, 1999), which are important factors that should be applied in the development of future norms. Second, it should be noted that these norms are specific to Spanish-speakers living in Arizona and California, who are almost exclusively of Mexican origin. Thus, caution is needed when applying current norms to other Spanish-speaking subgroups living in the US (e.g., native Puerto Ricans, Cubans, and those from the Dominican Republic). The Hispanic/Latino US population is comprised of a wide variety of subgroups that can have marked differences in ethnicity, culture, origin, and dialects. Therefore, the use of these norms with other groups of Hispanics/Latinos could affect interpretation and representation of test results, compromising the validity of the assessment. Third, future studies should validate the HCT for sensitivity to brain dysfunction in Spanish speaking patient groups. This special issue will present a validity paper and use of our current norms in Spanish-speaking adults living with HIV (Kamalyan et al., 2019; issue in this journal). Fourth, data presented in the current study were collected a number of years ago, and thus might be subjected to cohort effects. However, present findings showing no cohort effects provide evidence that cohort effects, if present, might not be notable. A final limitation worth noting is that our sample was comprised of individuals aged 19-60 years, indicating that the utilization of the present norms in populations older than 60 should be done carefully, if at all .

With these limitations in mind, the present study has significant clinical and research implications for the growing field of cultural neuropsychology and serves as a significant step towards addressing the limited number of norms for the HTC in this population, as well as meeting some needs of currently practicing neuropsychologists. To date, very few normative efforts for co-normed, comprehensive neuropsychological batteries for Spanish-speakers in the U.S. have been established, compared to those for other ethnic/racial minorities (see review paper on this issue for a list of Spanish-speaking norms in the U.S.). The present findings, as part of a larger number presented in this special issue, will allow for the comparison of neurocognitive performance across tests. The normative data presented in this study can be utilized as a tool for detecting cognitive impairment among Spanish-speakers living in the U.S., especially those of aged 19-60 and those living close to the US-Mexican border. While much work remains to be done in order to understand demographic and cultural factors that impact cognitive test performance, this study adds to the limited literature on the development of neuropsychological test norms in this growing minority population.

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Appendix

Halstead Category Test Instructions in Spanish

Instructions to the participant:

> “En la pantalla verá diferentes figuras y diseños geométricos. Algo del diseño en la pantalla le indicará algún número entre el uno y el cuatro. En el teclado frente a usted (point to keys 1, 2, 3 and 4 on keyboard), las teclas se encuentran numeradas 1, 2, 3 y 4. Primero observe la pantalla y decida que número debe escoger para cada figura. Después oprima la tecla correspondiente al número que haya escogido. Por ejemplo, ¿qué número debe escoger para esta figura?” (Project the first picture.)

If the subject presses the correct key (1), say:

> “El timbre que acaba de escuchar le indicará que escogió la respuesta correcta. Cada vez que usted acierte a una respuesta, escuchará este timbre.”

Instruct the subject to try one of the other keys in order to find out what happens when an incorrect key is pressed.

> "Cuando se equivoque, escuchará el segundo timbre. De esta manera, usted sabrá cada vez que acierte o se equivoque. Sin embargo, sólo tendrá una oportunidad de acertar por cada figura que aparece en la pantalla. Si se equivoca, simplemente continúe con las demás figuras. (Proceed with Subtest 1) Ahora, ¿cuál tecla escogería para esta figura?"

After subset 1, say:

> "Esa fue la primera serie de la prueba. Esta prueba está dividida en siete series. En cada serie hay una idea que existe a lo largo de ella. Una vez que haya descifrado la idea que existe en la serie, deberá usarla para responder correctamente cada vez. Ahora comenzaremos con la segunda serie y la idea en ella puede ser igual a la serie anterior o puede ser diferente. Quisiera que usted la descifre."

(Proceed with Subtest 2)

When you reach the first slide with circles, say:

> "Observe que primero vimos cuadros, después líneas y ahora círculos. Aunque los diseños cambian, deberá seguir usando la misma idea para obtener la respuesta correcta." (Proceed with Subtest 2)

After Subtest 2, say:

> "Esa fue la segunda serie de la prueba y como probablemente notó, no es necesario ver un número para que se le sugiera uno. Probablemente también notó que solamente hay una idea que existe a lo largo de la serie. Una vez que haya descifrado la idea, continué aplicándola para obtener la respuesta correcta cada vez. Ahora empezaremos con la tercera serie y la idea puede ser igual a la serie anterior o puede ser diferente. Quisiera ver si usted puede descifrar la idea y usarla para conseguir la respuesta correcta. Recuerde que la idea permanece igual a lo largo de la serie. Yo le indicaré cuando haya terminado una serie y vaya a comenzar la siguiente." (Proceed with Subtest 3)

After Subtests 3, 4, 5 and 6, say:

> "Ese fue el final de esta serie. Ahora comenzará con la siguiente. Recuerde que la idea puede ser igual a la serie anterior o puede ser diferente. Quisiera que la descifrara." [Begin test]

In Subtest 4, after slide #6---first slide without numbers---say:

> "Éste sigue siendo el mismo grupo, pero ahora los números no están. La idea permance igual." (Proceed with Subtest 6)

At Subtest 7, say:

> "En esta última serie no hay ninguna idea a lo largo de ella porque está compuesta de figuras que ha visto en series anteriores. Intente recordar cual fue la respuesta correcta la última vez que vio la figura y de esa misma respuesta de nuevo."

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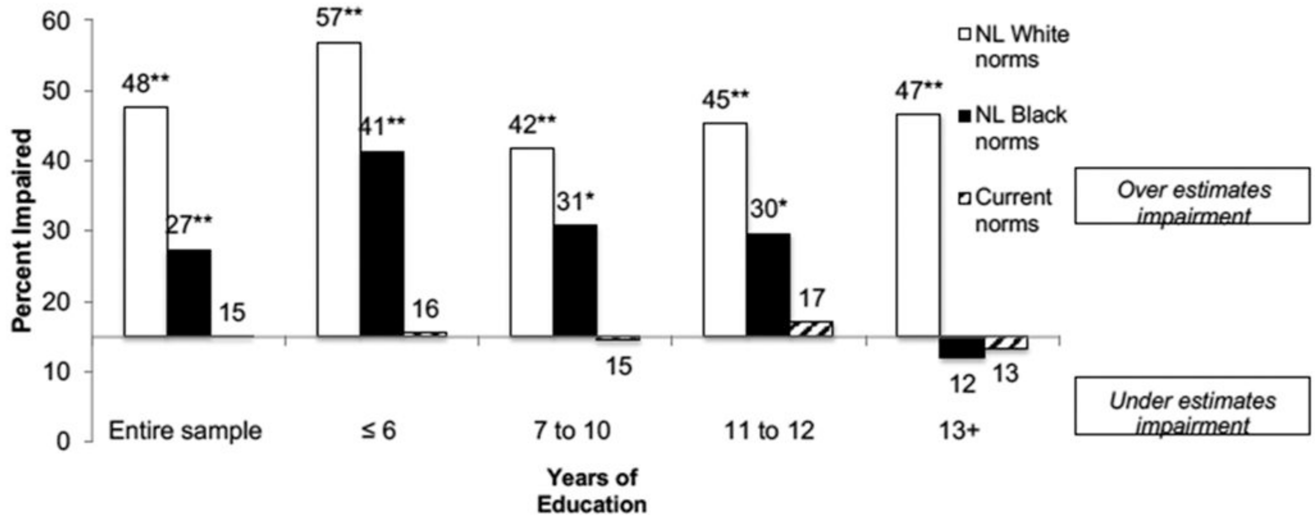

Figure 1.

Percent of the current sample classified as impaired on the Halstead Category Test Total Score based on published norms for non-Hispanic Whites and Blacks (Heaton et al., 2004), and newly developed norms for this test. Impairment was defined as T-Score <40. Asterisks denote significant difference based on McNemar's tests compared to currently developed norms.

*p<.005; **p<.0001

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Table 1.

Demographic Characteristics of the Halstead Category Test Normative Sample Stratified by Years of Education

	≤ 6 (*n*=58)	**7-10 (*n*=55)**	**11-12 (*n*=64)**	**≥13 (*n*=75)**
Age (years), *M*(*SD*)	39.71 (9.86)	37.00 (9.58)	35.13 (10.36)	37.45 (10.69)
Education (years), *M*(*SD*)	4.72 (1.55)	8.60 (0.91)	11.81 (0.39)	15.76 (1.66)
% Female	62.07	54.55	65.63	52.00

M=mean; SD = standard deviation.

Table 2.

Mean, standard deviation (SD), and range of the Halstead Category Test subtests and Total Score

	Mean (SD)	Range
Subtest I	0.23 (0.72)	0-5
Subtest II	0.69 (1.06)	0-12
Subtest III	21.69 (11.76)	0-36
Subtest IV	14.28 (11.03)	0-37
Subtest V	14.20 (6.75)	2-30
Subtest VI	8.34 (5.82)	0-30
Subtest VII	4.54 (2.52)	0-14
Total Score	64.01 (27.81)	9-132

Table 3.

Association between Raw scores in the Halstead Category Test and Demographic Characteristics

	Age[a]	Education[a]	Gender			
			Male, *M*(*SD*) *n*=105	**Female, *M*(*SD*) *n*=147**	***p*[b]**	***Cohen's d***
Subtest I	0.11	−0.24***	0.13 (0.36)	0.31 (0.89)	.34	0.25
Subtest II	−0.00	−0.22***	0.56 (0.61)	0.79 (1.29)	.48	0.22
Subtest III	0.35***	−0.35***	19.30 (12.43)	23.46 (10.95)	.02	0.37
Subtest IV	0.23***	−0.45***	11.23 (10.18)	16.51 (11.12)	<.001	0.49
Subtest V	0.19**	−0.25***	12.35 (5.75)	15.56 (7.11)	<.001	0.49
Subtest VI	0.18**	−0.35***	6.46 (4.57)	9.73 (6.25)	<.001	0.58
Subtest VII	0.36***	−0.41***	3.87 (2.29)	5.03 (2.57)	<.001	0.47
Total Score	0.32***	−0.52***	53.83 (24.95)	71.29 (27.54)	<.001	0.66

[a] *Note*. Based on results from Spearman ρ

[b] Wilcoxon rank-sum tests.

M=mean, SD=standard deviation.

* p<.05

** p<.01

*** p<.001

Table 4.

Raw-to-scale score conversions for the Halstead Category Test Total score

Scaled	Total Score
19	0 - 3
18	4 - 9
17	10 - 13
16	14 - 16
15	17 - 22
14	23 - 29
13	30 - 37
12	38 - 50
11	51 - 58
10	59 - 66
9	67 - 76
8	77 - 88
7	89 - 98
6	99 - 108
5	109 - 114
4	115 - 126
3	127 - 131
2	132 - 187
1	188 - 208

Table 5.

Raw Scores to Percentile Scores Conversions for the Halstead Category Tests Subtest Scores

Percentile	Subtest 1	Subtest 2	Subtest 3	Subtest 4	Subtest 5	Subtest 6	Subtest 7
1st	4 or more	4 or more	35 or more	35 or more	30 or more	25 or more	11 or more
2nd	3	3	--	33	29	23	10
5th	2	--	--	32	26	20	9
9th	1	2	34	31	25	17	8
16th	--	--	33	29	21	15	7
25th	--	--	31	24	20	12	6
37th	--	--	30	19	17	9	--
50th	--	1	28	11	13	7	5
63d	--	--	19	6	11	5	4
75th	--	--	10	5	9	4	3
84th	--	--	5	3	7	3	2
91st	--	--	3	2	--	2	1
95th	--	--	2	--	5	1	--
98th	--	--	--	--	4	--	--
99th	0	0	1	1	3	0	0

Table 6.

T-Score Equation for the Halstead Category Test Total Score

Measure	Equation
Total Score	$10 \times \left(\frac{\text{SS Total Errors} - (8.45166 - 8.06022 * \frac{age}{100} + 3.34100 * \frac{(\text{edu} + 1)}{10} + 1.60179 * \text{gender})}{2.31403} \right) + 50$

Gender: Male=1; Female=0