

Standard form of the Boston Naming Test: Normative data for the Latin American Spanish speaking adult population

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Abstract.

Objective: To generate normative data on the Boston Naming Test (BNT) across 10 countries in Latin America, with country-specific adjustments for gender, age, and education, where appropriate.

Method: The sample consisted of 3,779 healthy adults who were recruited from Argentina, Bolivia, Chile, Cuba, El Salvador, Guatemala, Mexico, Paraguay, Peru, and, Puerto Rico. Each subject was administered the BNT as part of a larger neuropsychological battery. A standardized five-step statistical procedure was used to generate the norms.

Results: The final multiple linear regression models explained between 3–32% of the variance in BNT scores. Although *t*-tests showed significant differences between men and women for Mexico, Argentina, Chile, Cuba, Guatemala, and Bolivia on the BNT, none of the six countries had an effect size larger than 0.3. As a result, gender-adjusted norms were not generated.

Conclusions: This is the first normative multicenter study conducted in Latin America to generate norms for the BNT; this study will have substantial repercussions for the practice of neuropsychology throughout the global region.

Keywords: Normative data, Boston Naming Test, Latin America, denomination

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1. Introduction

The Boston Naming Test (BNT) is one of the most widely used neuropsychological instruments to evaluate language abilities including naming or word retrieval. It is used to identify individuals with different clinical pathologies, including communication disorders, aphasia or other language disturbances caused by stroke, Alzheimer's disease, or acquired brain lesions (Goodglass & Kaplan, 1983). The BNT was developed in 1983 (Kaplan, Goodglass, & Weintraub, 1983). In its experimental version, the BNT included 85 line drawings in black and white (Kaplan, Goodglass, & Weintraub, 1978), and it was later modified to 60 line drawings (Kaplan et al., 1983). In 2000, a second version of the test was developed which included a 15-item short form (Kaplan, Goodglass, & Weintraub, 2000). Subsequently, the test was included in the Boston Diagnostic Aphasia Examination (BDAE) published by the Psychological Assessment Resources (Goodglass, Kaplan, & Barresi, 2001).

Areas involved in the functioning of the BNT are Broca's (in the frontal lobe) and Wernicke's areas (in the temporal lobe). Other areas activated for language processes are those outside the areas in the left hemisphere, especially anterior to Broca's area, as well as in the right hemisphere regions (Mitchell & Crow, 2005). Overall, research has found that several specific brain regions that showed greater gray and white matter volume and integrity were associated with better task performance on the BNT (Obler et al., 2010). Naming or word retrieval implies the involvement of several processes that are usually activated sequentially as the perceptual recognition of the stimulus, and the participation of the semantic system and the phonological program containing the driving information to articulate the names have been previously activated.

Naming or word retrieval tasks are used for typical neuropsychological evaluations, particularly with older adults (LaBarge, Edwards, & Knesevich, 1986), individuals with brain injuries (Brooks, Fos Greve, & Hammond, 1999), and dementia (Katsumata et al., 2015). BNT performance in populations with brain injuries can be significantly affected (Fernández-Blázquez et al., 2012). Therefore, the BNT is used to detect problems in word retrieval and assess language disorders. Among these are patients with aphasic disorders, with a decrease in words used to talk and an increase in time needed to retrieve them. This deficit in verbal output, also called anomia, nominal aphasia, or amnesic aphasia, is one of the most

common disorders associated with normal aging and Alzheimer's disease (Fernandez-Blazquez et al. 2012), so the BNT may also be applicable in this disease.

The modified version of the BNT published in 1983 is the most widely used version of the test. In the BNT, the examiner presents a number of black and white line drawings of different pictures in order from easiest to most difficult (example: a house, a harp, a compass, and an abacus), allowing the participant to take twenty seconds to name each of the items. The examiner writes down the participant's responses, but if the participant fails to give the correct response, stimulus cues are given which provide the first phonemic cue of the word to facilitate word retrieval. The total score on the BNT is the number of correct spontaneous responses (SR) and with the aid of stimulus cues (SC). The basal rule is eight consecutive pictures named correctly without any assistance, and the discontinuation rule is six consecutive failures.

The BNT has been standardized in many countries such as Spain (Rami et al., 2008; Peña-Casanova et al., 2009), Canada (Graves, Bezeau, Fogarty, & Blair, 2004), Brazil (Miotto, Sato, Lucia, Camargo, & Scaff, 2010), Colombia (Beltran & Solis, 2012), Argentina (Allegrì et al., 1997), Australia (Elkadi et al., 2006), Sweden (Tallberg, 2005), Holland (Mariën, Mampaey, Vervaeke, Saerens & De Deyn, 1998), and the United States (Zec, Burkett, Markwell, & Larsen, 2007). However, the adaptations that have been made to obtain normative data for the BNT, in general, do not come from the first edition but from second or short versions.

Throughout the years, the BNT has been translated to different languages in order to be used in different countries where English is not the primary language. For example, the BNT has been translated to Spanish and Cantonese. Past research using the Modified Boston Naming Test-Spanish (MBNT-S; Ponton et al., 1996) has shown the test to be less sensitive to dementia-related naming impairment than a naming test developed for Spanish-speakers (e.g. Texas Naming Test [TNT]; de la Plata et al., 2008). However, a study looking at MBNT-S found the internal consistency of the 30-item MBNT-S to be generally adequate (e.g., USA = 0.854; Colombia = 0.898; Spain = 0.898; de la Plata et al., 2009). By contrast, past research has found that the 15-item short form of the BNT demonstrated an alpha of 0.37 to 0.84 in healthy Caucasians (Fastenau, Denburg, & Mauer, 1998; Graves, Bezeau, Fogarty, & Blair, 2004). Likewise, other research has reported an internal consistency of 0.83 in a Cantonese version of the BNT (Cheung, Cheung, & Chan, 2004).

Other research has shown that most of the coefficients of reliability (test-retest) in the BNT are above 0.77 in various samples (del Toro et al., 2011; Flanagan & Jackson, 1997). The internal consistencies for all these versions are generally adequate, however the validity of these tests is questionable, given the cultural and language differences of the items, and the test may not measure the same constructs.

Several studies have shown a relationship between the total score of the BNT and variables such as age, gender, and education (Au et al., 1995; Pineda et al., 1998). In general, in a study administered to individuals over 65 years of age it has been observed that naming performance decreases as age increases and years of education descends (Fernandez-Blazquez et al. 2012). Past research has found that both verbal fluency and naming were significantly associated with level of education in a group of Australian women. They found that women with higher educational levels had better verbal performance when compared to women with lower educational levels (Elkadi et al., 2006). Other research, administered in normal elderly subjects between the ages of 65 and 97 has found that education had a greater impact than age on the BNT test, however this impact diminished at older ages (Neils et al., 1995). Nonetheless this relationship between age, education, and the BNT is not fully established, as some authors have not found an influence of age and education on the performance of the BNT (Aranciva et al. 2012). Finally, past research has not found significant differences between men and women, although some research looking at a group of young adults has found a slight advantage in men, in which many of the items are more directly related to traditional male roles (Aranciva et al., 2012).

Most of the normative data are from participants with high educational levels, and therefore previous samples may not be truly representative of the general population and have above-average vocabularies. A group of researchers published BNT data for normal older adults based on a sample with a mean IQ of 122 (Van Gorp, Satz, Kiersch, & Henry, 1986). The authors recognized the IQ bias in the study, however the data suggest that educational categories may still be deceptive. One subgroup, aged 59–64 obtained a mean Verbal IQ of 122, which is higher than would be expected on the basis of their mean education of 13.58 years.

Because the BNT was originally created in a specific population, and English was the primary language, it is important to collect normative data to adapt this

test to other populations and facilitate clinical practice. Unfortunately, there are very few neuropsychological instruments developed in Spanish, as the majority of the tests are direct translations of the English tests. The validity of these tests, as mentioned before, is questionable, given the linguistic and cultural differences of the items. (de la Plata, 2008; Loewenstein, Rubert, Argüelles, & Duara, 1995). These differences and the lack of normative data could generate erroneous interpretation in the performance of each individual (de la Plata et al. 2009), thus, the aim of this study is to provide cross-cultural normative data for the BNT (Kaplan et al., 1983) to help its clinical interpretation when used in Latin America. We have chosen the standard version of the BNT with 60 items (Kaplan et al., 1983) since this is considered the most complete and most used in clinical work. In addition, these normative data are the first part of a series of psychometric analysis to be developed for the BNT, and for that reason we need the standard version.

2. Method

2.1. Participants

The sample consisted of 3,779 healthy individuals who were recruited from Argentina, Bolivia, Chile, Cuba, El Salvador, Guatemala, Mexico, Paraguay, Peru, and Puerto Rico. The participants were selected according to the following criteria: a) were between 18 to 95 years of age, b) were born and currently lived in the country where the protocol was conducted, c) spoke Spanish as their native language, d) had completed at least one year of formal education, e) were able to read and write at the time of evaluation, f) scored ≥ 23 on the Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975), g) scored ≤ 4 on the Patient Health Questionnaire–9 (PHQ-9, Kroenke, Spitzer, & Williams, 2001), and h) scored ≥ 90 on the Barthel Index (Mahoney & Barthel, 1965).

Participants with self-reported neurologic or psychiatric disorders were excluded due to a potential effect on cognitive performance. Participants were volunteers from the community and signed an informed consent. Socio-demographic and participant characteristics for each of the countries' samples have been reported in Guàrdia-Olmos, Peró-Cebollero, Rivera & Arango-Lasprilla (2015). The multi-center study was approved by the Ethics Committee of the coordinating site, the University of Deusto, Spain.

2.2. Instrument administration

The BNT requires examinees to denominate 60 pictures, which are presented in order of increasing difficulty. If the participant does not give a correct answer

spontaneously, the examiner provides a semantic clue (in case of misrecognition error) or phonological clue (when the semantic clue is still not enough to generate a response, or during the spontaneous response there has been an error that is not a misrecognition

Table 1
Effect of gender in the BNT

Country	Gender	Mean (SD)	<i>t</i>	df	Sig. (2-tailed)	<i>r</i>
Argentina	Male	53.2 (5.0)	3.18	318	0.002**	0.176
	Female	51.0 (5.9)				
Bolivia	Male	47.2 (8.5)	2.01	270	0.045*	0.121
	Female	44.9 (9.0)				
Chile	Male	50.8 (7.1)	4.64	318	<0.001***	0.252
	Female	47.0 (7.4)				
Cuba	Male	50.5 (7.7)	4.03	304	<0.001***	0.225
	Female	46.8 (8.0)				
El Salvador	Male	45.3 (9.5)	0.45	255	0.655	0.028
	Female	44.8 (9.2)				
Guatemala	Male	45.3 (9.9)	-1.62	212	0.107	0.110
	Female	44.8 (8.7)				
Mexico	Male	41.8 (7.2)	5.33	1,298	<0.001***	0.146
	Female	43.9 (7.3)				
Paraguay	Male	55.3 (4.0)	-1.03	261	0.306	0.063
	Female	55.8 (3.4)				
Peru ^a	Male	50.9 (6.0)	1.29	209.3	0.197	0.089
	Female	49.7 (7.4)				
Puerto Rico	Male	48.4 (7.8)	1.28	280	0.203	0.076
	Female	47.1 (9.1)				

^aValue of the *t*-test for independent groups from the different variances with the corresponding correction of Yuen-Welch of degrees of freedom.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 2
Final multiple linear regression models for BNT

Country		B	Std. Error	<i>t</i>	Sig.	R ²	SD _e (residual)
Argentina	(Constant)	49.122	0.427	115.093	<0.001	0.175	5.184
	Education	4.780	0.582	8.210	<0.001		
Bolivia	(Constant)	45.102	0.582	77.503	<0.001	0.025	8.732
	Education	3.746	1.415	2.647	0.009		
Chile	(Constant)	51.671	1.241	41.631	<0.001	0.203	6.662
	Age	-0.082	0.020	-4.094	<0.001		
Cuba	(Constant)	54.515	1.297	42.027	<0.001	0.110	7.637
	Age	-0.123	0.022	-5.523	<0.001		
El Salvador	(Constant)	47.675	1.509	31.588	<0.001	0.241	8.108
	Age	-0.086	0.025	-3.477	0.001		
Guatemala	(Constant)	38.929	0.765	51.469	<0.001	0.243	8.017
	Age	0.090	0.032	2.837	0.005		
Mexico	(Constant)	51.054	0.552	92.527	<0.001	0.139	6.820
	Age	-0.081	0.009	-8.639	<0.001		
Paraguay	(Constant)	55.231	0.240	229.679	<0.001	0.055	3.527
	Education	2.215	0.569	3.894	0.003		
Peru	(Constant)	44.828	0.613	73.152	<0.001	0.324	5.704
	Education	8.229	0.763	10.784	<0.001		
Puerto Rico	(Constant)	52.641	1.638	32.144	<0.001	0.106	8.105
	Age	-0.120	0.027	-4.403	<0.001		
	Education	2.506	1.005	2.494	0.013		

error). The total score is the sum of correct spontaneous answers plus correct answers followed by a semantic clue (Goodglass, Kaplan, & Barresi, 2001). The administration of the BNT was rigorous. Thus, synonyms were not taken as correct responses.

2.3. Statistical analyses

The detailed statistical analyses used to generate the normative data for this test are described in Guàrdia-Olmos et al. (2015). In summary, the data manipulation process for each country-specific dataset involved five-steps: a) *t* – tests for independent samples and effect sizes (*r*) were conducted to determine gender effects. If the effect size was larger than 0.3, gender was included in the model with gender dummy coded and female as the reference group (male = 1 and female = 0). b) A multivariable regression model was used to specify the predictive model including gender (if effect size was larger than 0.3), age as a continuous variable, and education as a dummy coded variable with 1 if the participant had >12 years of education and 0 if the participants had 1–12 years of education. If gender, age and/or education was not statistically significant in this multivariate model with an alpha of 0.05, the non-significant variables were removed and the model was re-run. Then a final regression model was conducted that included age (if statistically significant in the multivariate model), dichotomized education (if statistically significant in the multivariate model), and/or gender (if effect size was greater than 0.3) [$\hat{y}_i = \beta_0 + (\beta_{Age} \cdot Age_i) + (\beta_{Educ} \cdot Educ_i) + (\beta_{Gender} \cdot Gender_i)$] c) residual scores were calculated based on this final model ($e_i = y_i - \hat{y}_i$) d) using the SD (residual) value provided by the regression model, residuals were standardized: $z = e_i / SD_e$, with SD_e (residual) = the standard deviation of the residuals in the normative sample; and e) standardized residuals were converted to percentile values (Strauss et al., 2006). Using each country's dataset, these steps were applied to BNT score.

3. Results

Regarding the effect of gender on BNT scores, the *t*-tests showed significant differences between men and women for Argentina, Bolivia, Chile, Cuba, and Mexico, however, none of these five countries had an effect size larger than 0.3. Table 1 shows the results of the gender analyses by country on BNT scores. As shown in Table 1, the effect sizes for all countries were less than

0.3, and therefore gender was not taken into account to generate BNT normative data for any of the countries in the study.

The final ten BNT multivariate linear regression models for each country are shown in Table 2. In all countries, BNT score increased for those with more than 12 years of education (see Table 2) and, except for Argentina, Bolivia, Paraguay, and Peru, BNT scores decreased in a linear fashion as a function of age. The amount of variance explained in BNT scores ranged from 3% (in Bolivia) to 32% (in Peru).

3.1. Normative procedure

Norms (e.g., a percentile score) for the BNT score test were established using the five-step procedure described above. To facilitate the understanding of the procedure to obtain the percentile associated with a score on this test, an example will be given. Suppose you need to find the percentile score for a Mexican man, who is 59 years old and has 15 years of education. He has a score of 52 on the BNT. The steps to obtain the percentile for this score are: a) Check Table 1 to determine if the effect size of gender in the country of interest (Mexico) on this test and task (BNT) is greater than 0.3 by country. The column labelled *r* in Table 1 indicates the effect size. In this example, the effect size is 0.146, which is not greater than 0.3. For Mexicans on this test, gender does not influence scores to a sufficient degree to take it into account when determining the percentile. b) Find Mexico in Table 2, which provides the final regression models by country for the BNT. Use the B weights to create an equation that will allow you to obtain the predicted BNT score. The corresponding B weights are multiplied by the actual age and dichotomized education scores and added to a constant in order to calculate the predicted value. In this case, the predicted BNT score would be calculated using the equation [$\hat{y}_i = 51.054 + (-0.081 \cdot Age_i) + (4.593 \cdot Dichotomized\ Educational\ Level_i)$] (the values have been rounded for presentation in the formula). The subscript notation *i* indicates the person of interest. The person's age is 59, but the education variable is not continuous in the model. Years of education is split into either 1 to 12 years (and assigned a 0) or more than 12 years (and assigned a 1) in the model. Since our hypothetical person in the example has 15 years of education, his educational level value is 1. Thus the predicted value is $\hat{y}_i = 51.054 + (-0.081 \cdot 59) + (4.593 \cdot 1) = 51.054 - 4.763 + 4.593 = 50.88$) c) In order to calculate

the residual value (indicated with an *e* in the equation), we subtract the actual value from the predicted value we just calculated ($e_i = y_i - \hat{y}_i$). In this case, it would be $e_i = 52 - 50.8 = 1.117$. d) Next, consult the SD_e column in Table 2 to obtain the country-specific SD_e (residual) value. For Mexico it is 6.820. Using this value, we can transform the residual value to a standardized *z* score using the equation (e_i / SD_e). In this case, we have $(1.117) / 6.820 = 0.163$. This is the standardized *z* score for a Mexican man aged 59 years with 15 years of education and a score of 52 on the BNT. e) The last step is to look-up the tables in the statistical reference books (e.g. Strauss et al., 2006) or use a trusted online calculator like the one available at <http://www.measuringu.com/pcalcz.php>. In the online calculator, you would enter the *z* score and choose a one-sided test and note the percent of area after hitting the submit button. In this case, the probability of 0.163 corresponds to the 56th percentile.

3.2. User-friendly normative data tables

The five-step normative procedures explained above can provide more individualized norms. However, this method can be prone to human error due to the number of required computations. To enhance user-friendliness, the authors have completed these steps for a range of raw scores based on small age range groupings (see Guàrdia-Olmos et al., 2015) and created tables that clinicians can more easily use to obtain a percentile range associated with a given raw score on this test. These tables are available by country in the Appendix. In order to obtain an approximate percentile for the above example (converting a raw score of 52 for a Mexican man who is 59 years old and has 15 years of education) using the simplified normative tables provided, the following steps are recommended. (1) First, identify the appropriate table ensuring the specific country and test. In this case, the table for BNT scores for Mexico can be found in Table A7. (2) Note if the title of the table indicates that it is only to be used for one specific gender. In this case, gender is not specified. Thus Table A8 is used for both males and females. (3) Next, the table is divided based on educational level (1 to 12 vs. more than 12 years of education). Since this man has 15 years of education, he falls into the more than 12 years of education category. These data can be found in the top section of the table. (4) Determine the age range most appropriate for the individual. In this case, 59 falls into the column 58–62 years of age. (5) Read down the age range column to find the approximate location of

the raw score the person obtained on the test. Reading down the 58–62 column, the score of 52 obtained by this Mexican man corresponds to an approximate percentile of 60.

The percentile obtained via this user-friendly table method (60th) is slightly different than the more exact one (56th) obtained following the individual conversion steps above because the table method is based on an age range (e.g., individuals aged 58–62) instead of the exact age (individuals aged 59). If the exact score is not listed in the column, you must estimate the percentile value from the listed raw scores.

4. Discussion

The purpose of the current study was to generate normative data on the BNT across 10 countries in Latin America, with country-specific adjustments for gender, age, and education, where appropriate. The final multiple linear regression models explained between 3–32% of the variance in BNT scores. Although men had higher scores on the BNT in Mexico, Argentina, Chile, Cuba, Guatemala, and Bolivia, these effect sizes were all small. As a result, gender-adjusted norms were not generated. These findings are generally in line with the previous literature which has not found significant gender differences, although one study found a slight advantage in men which was interpreted as a reflection of the items being more in line with traditional male roles (Aranciva et al., 2012). Considering the previous literature, the current results suggest that gender should not be taken into account in calculating participants' percentiles for the BNT in Latin America when using these norms.

BNT scores increased linearly as a function of education in all countries. These findings were quite consistent with the previous research which has robustly found BNT scores to increase with higher educational levels (Elkadi et al, 2006; Fernandez-Blazquez et al., 2012; Neils et al., 1995). Therefore neuropsychologists in Latin America should use the education-adjusted norms generated for each country when administering the BNT in that country. There are potentially major differences in the quality of education across countries in Latin America, and the current data provide a good starting point for standardizing across education on the BNT.

BNT scores decreased with advancing age in all countries except Argentina, Peru, Paraguay, Guatemala, and Bolivia, and as a result, age-adjusted norms are presented for only the countries showing an effect of

age. These age findings are similar to previous studies that have shown lower BNT scores in older adults (Fernandez-Blazquez et al., 2012), although as with the current study, age effects were generally smaller than education effects (Neils et al., 1995). On the other hand, one study did not find an effect of age on BNT performance (Aranciva et al., 2012). The current findings, in light of the previous research, suggest that BNT corrections for age in Latin America should only be made in the countries where age effects were present.

4.1. Limitations and future directions

This study has several limitations that should be taken into account and that can also be seen as directions for future research. First, neuropsychologists should exercise caution when using the BNT norms from this study for people in countries other than the 10 countries from which data were collected. It is important that future studies create BNT norms in other Latin American countries such as Ecuador, Uruguay, Venezuela, and Panama. Nonetheless, the current BNT norms could be more accurate in those Latin American countries than other norms currently in use, such as those from Spain. Examining this generalizability is a crucial area for future research.

Second, the BNT is a very common neuropsychological measure in Latin America, but many other assessments need to be normed in the same manner to improve their use in this region. Future studies should investigate the psychometric properties and ecological validity of the BNT and other typical instruments in Latin America. If shown to be low, researchers need to create instruments within Latin American cultures that have strong ecological validity. For example, the Modified Boston Naming Test-Spanish (MBNT-S; Ponton et al., 1996) is less sensitive to dementia-related naming impairment than a naming test developed for Spanish-speakers (Texas Naming Test [TNT]; de la Plata et al., 2008). Much more of this line of research needs to be conducted, as the BNT was created in a Western culture that may differ from the diverse cultures in Latin America. Future studies would benefit from creating assessments within local cultures, not simply translate and norm tests from other cultures and countries.

Third, the current data should be interpreted and used in light of several sampling limitations. Participants in the current study spoke Spanish as their primary language. This study did not collect data on whether participants spoke additional local languages or English, and BNT performance could differ among people who

speak secondary languages. Future research should examine the influence of bilingualism on BNT performance. It should also be noted that data collection occurred in specific cities or regions of the countries in this study as opposed to nationally. Although the current study is the largest neuropsychological normative study in the history of Latin America for the BNT, or in any global region, it should be seen as a first step toward larger, nationally representative normative studies. For example, many participants had fewer than 12 years of education, but illiterate individuals were excluded. Therefore the current norms cannot generalize well to illiterate adults. Similarly, participants were excluded who had a history of neurological conditions; future studies should be conducted with illiterate adults, with neurological populations, as well as children.

Although these limitations are present, only limited studies have produced BNT norms in Spanish-speaking populations (Allegrí et al., 1997; Peña-Casanova et al., 2009; Rami et al., 2008). This study was the first to generate BNT norms across ten countries in Latin America with nearly 4,000 participants. Therefore this was the largest, most comprehensive BNT normative study to date in any global region, and its norms will likely affect the standard of neuropsychological assessment with the BNT in Latin America unlike any study before it.

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Appendix

Table A1
Normative data for the BNT stratified by education levels for ARGENTINA

Percentile	1 to 12 years of education	>12 years of education
95	57.6	–
90	55.8	60.0
85	54.5	59.3
80	53.5	58.3
70	51.8	56.6
60	50.4	55.2
50	49.1	53.9
40	47.8	52.6
30	46.4	51.2
20	44.8	49.5
15	43.7	48.5
10	42.5	47.3
5	40.6	45.4

Table A2
Normative data for the BNT stratified by education levels for BOLIVIA

Percentile	1 to 12 years of education	>12 years of education
95	59.4	–
90	56.3	60.0
85	54.2	57.9
80	52.4	56.2
70	49.6	53.4
60	47.3	51.0
50	45.1	48.8
40	42.9	46.7
30	40.6	44.3
20	37.8	41.5
15	36.0	39.8
10	33.9	37.7
5	30.8	34.5

Table A3
Normative data for the BNT stratified by age and education levels for CHILE

Percentile	Age (Years)													
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77	
>12 years of education	95	–	–	–	–	–	–	–	–	–	–	–	60.0	60.0
	90	–	–	–	–	–	–	–	60.0	60.0	60.0	60.0	59.9	59.5
	85	–	–	–	–	60.0	60.0	60.0	59.9	59.5	59.1	58.7	58.3	57.9
	80	60.0	60.0	60.0	60.0	59.8	59.4	59.0	58.6	58.2	57.8	57.4	57.0	56.6
	70	59.3	58.9	58.5	58.1	57.7	57.3	56.9	56.5	56.1	55.7	55.3	54.9	54.4
	60	57.5	57.1	56.7	56.3	55.9	55.5	55.1	54.7	54.3	53.9	53.5	53.1	52.6
	50	55.9	55.5	55.1	54.7	54.2	53.8	53.4	53.0	52.6	52.2	51.8	51.4	51.0
	40	54.2	53.8	53.4	53.0	52.6	52.2	51.8	51.4	50.9	50.5	50.1	49.7	49.3
	30	52.4	52.0	51.6	51.2	50.8	50.4	50.0	49.6	49.1	48.7	48.3	47.9	47.5
	20	50.3	49.9	49.5	49.1	48.6	48.2	47.8	47.4	47.0	46.6	46.2	45.8	45.4
	15	48.9	48.5	48.1	47.7	47.3	46.9	46.5	46.1	45.7	45.3	44.9	44.5	44.0
	10	47.3	46.9	46.5	46.1	45.7	45.3	44.9	44.5	44.1	43.7	43.3	42.9	42.5
	5	44.9	44.5	44.1	43.7	43.3	42.9	42.5	42.1	41.7	41.3	40.9	40.5	40.1
1 to 12 years of education	95	60.0	60.0	60.0	59.7	59.3	58.9	58.5	58.1	57.7	57.3	56.9	56.5	56.1
	90	58.6	58.2	57.7	57.3	56.9	56.5	56.1	55.7	55.3	54.9	54.5	54.1	53.7
	85	57.0	56.6	56.2	55.7	55.3	54.9	54.5	54.1	53.7	53.3	52.9	52.5	52.1
	80	55.6	55.2	54.8	54.4	54.0	53.6	53.2	52.8	52.4	52.0	51.6	51.1	50.7
	70	53.5	53.1	52.7	52.3	51.9	51.5	51.1	50.6	50.2	49.8	49.4	49.0	48.6
	60	51.7	51.3	50.9	50.5	50.1	49.7	49.3	48.8	48.4	48.0	47.6	47.2	46.8
	50	50.0	49.6	49.2	48.8	48.4	48.0	47.6	47.2	46.8	46.4	46.0	45.5	45.1
	40	48.4	48.0	47.6	47.1	46.7	46.3	45.9	45.5	45.1	44.7	44.3	43.9	43.5
	30	46.6	46.2	45.8	45.3	44.9	44.5	44.1	43.7	43.3	42.9	42.5	42.1	41.7
	20	44.4	44.0	43.6	43.2	42.8	42.4	42.0	41.6	41.2	40.8	40.4	40.0	39.5
	15	43.1	42.7	42.3	41.9	41.5	41.1	40.7	40.3	39.8	39.4	39.0	38.6	38.2
	10	41.5	41.1	40.7	40.3	39.9	39.5	39.1	38.7	38.2	37.8	37.4	37.0	36.6
	5	39.1	38.7	38.3	37.9	37.5	37.1	36.7	36.3	35.8	35.4	35.0	34.6	34.2

Table A4
Normative data for the BNT stratified by age and education levels for CUBA

Percentile	Age (Years)													
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77	
>12 years of education	95	–	–	–	–	–	–	60.0	60.0	60.0	60.0	60.0	59.5	
	90	–	–	–	–	60.0	60.0	60.0	59.9	59.2	58.6	58.0	57.4	56.8
	85	–	–	60.0	60.0	59.9	59.2	58.6	58.0	57.4	56.8	56.2	55.6	54.9
	80	60.0	60.0	59.6	59.0	58.3	57.7	57.1	56.5	55.9	55.3	54.6	54.0	53.4
	70	58.4	57.7	57.1	56.5	55.9	55.3	54.7	54.0	53.4	52.8	52.2	51.6	51.0
	60	56.3	55.7	55.1	54.4	53.8	53.2	52.6	52.0	51.4	50.8	50.1	49.5	48.9
	50	54.4	53.8	53.2	52.5	51.9	51.3	50.7	50.1	49.5	48.8	48.2	47.6	47.0
	40	52.5	51.9	51.2	50.6	50.0	49.4	48.8	48.2	47.6	46.9	46.3	45.7	45.1
	30	50.4	49.8	49.2	48.6	48.0	47.3	46.7	46.1	45.5	44.9	44.3	43.6	43.0
	20	48.0	47.4	46.7	46.1	45.5	44.9	44.3	43.7	43.0	42.4	41.8	41.2	40.6
	15	46.4	45.8	45.2	44.6	44.0	43.4	42.7	42.1	41.5	40.9	40.3	39.7	39.1
	10	44.6	44.0	43.4	42.8	42.1	41.5	40.9	40.3	39.7	39.1	38.5	37.8	37.2
	5	41.9	41.2	40.6	40.0	39.4	38.8	38.2	37.6	36.9	36.3	35.7	35.1	34.5
1 to 12 years of education	95	–	–	–	–	60.0	60.0	60.0	59.7	59.0	58.4	57.8	57.2	
	90	–	60.0	60.0	60.0	59.4	58.8	58.1	57.5	56.9	56.3	55.7	55.1	54.4
	85	60.0	59.4	58.8	58.2	57.5	56.9	56.3	55.7	55.1	54.5	53.8	53.2	52.6
	80	58.5	57.9	57.2	56.6	56.0	55.4	54.8	54.2	53.5	52.9	52.3	51.7	51.1
	70	56.0	55.4	54.8	54.2	53.6	52.9	52.3	51.7	51.1	50.5	49.9	49.3	48.6
	60	54.0	53.3	52.7	52.1	51.5	50.9	50.3	49.7	49.0	48.4	47.8	47.2	46.6
	50	52.1	51.4	50.8	50.2	49.6	49.0	48.4	47.7	47.1	46.5	45.9	45.3	44.7
	40	50.1	49.5	48.9	48.3	47.7	47.1	46.5	45.8	45.2	44.6	44.0	43.4	42.8
	30	48.1	47.5	46.9	46.2	45.6	45.0	44.4	43.8	43.2	42.5	41.9	41.3	40.7
	20	45.6	45.0	44.4	43.8	43.2	42.6	41.9	41.3	40.7	40.1	39.5	38.9	38.3
	15	44.1	43.5	42.9	42.3	41.7	41.0	40.4	39.8	39.2	38.6	38.0	37.3	36.7
	10	42.3	41.7	41.0	40.4	39.8	39.2	38.6	38.0	37.4	36.7	36.1	35.5	34.9
	5	39.5	38.9	38.3	37.7	37.1	36.5	35.8	35.2	34.6	34.0	33.4	32.8	32.1

Table A5
Normative data for the BNT stratified by age and education levels for EL SALVADOR

		Age (Years)												
Percentile		18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	63-67	68-72	73-77	>77
> 12 years of education	95	-	-	-	-	-	-	-	-	-	-	-	-	-
	90	-	-	-	-	-	-	-	-	-	-	-	60.0	60.0
	85	-	-	-	-	-	-	-	60.0	60.0	60.0	60.0	59.7	59.3
	80	-	60.0	60.0	60.0	60.0	60.0	60.0	59.8	59.4	58.9	58.5	58.1	57.7
	70	60.0	59.8	59.3	58.9	58.5	58.1	57.6	57.2	56.8	56.3	55.9	55.5	55.1
	60	58.0	57.6	57.1	56.7	56.3	55.9	55.4	55.0	54.6	54.2	53.7	53.3	52.9
	50	56.0	55.5	55.1	54.7	54.3	53.8	53.4	53.0	52.6	52.1	51.7	51.3	50.8
	40	53.9	53.5	53.1	52.7	52.2	51.8	51.4	51.0	50.5	50.1	49.7	49.2	48.8
	30	51.8	51.3	50.9	50.5	50.0	49.6	49.2	48.8	48.3	47.9	47.5	47.1	46.6
	20	49.2	48.7	48.3	47.9	47.5	47.0	46.6	46.2	45.7	45.3	44.9	44.5	44.0
	15	47.5	47.1	46.7	46.3	45.8	45.4	45.0	44.5	44.1	43.7	43.3	42.8	42.4
	10	45.6	45.2	44.7	44.3	43.9	43.5	43.0	42.6	42.2	41.7	41.3	40.9	40.5
	5	42.7	42.3	41.8	41.4	41.0	40.5	40.1	39.7	39.3	38.8	38.4	38.0	37.5
1 to 12 years of education	95	59.3	58.8	58.4	58.0	57.5	57.1	56.7	56.3	55.8	55.4	55.0	54.6	54.1
	90	56.3	55.9	55.5	55.1	54.6	54.2	53.8	53.3	52.9	52.5	52.1	51.6	51.2
	85	54.4	54.0	53.5	53.1	52.7	52.3	51.8	51.4	51.0	50.5	50.1	49.7	49.3
	80	52.8	52.3	51.9	51.5	51.1	50.6	50.2	49.8	49.4	48.9	48.5	48.1	47.6
	70	50.2	49.8	49.3	48.9	48.5	48.0	47.6	47.2	46.8	46.3	45.9	45.5	45.0
	60	48.0	47.6	47.1	46.7	46.3	45.9	45.4	45.0	44.6	44.1	43.7	43.3	42.9
	50	46.0	45.5	45.1	44.7	44.3	43.8	43.4	43.0	42.5	42.1	41.7	41.3	40.8
	40	43.9	43.5	43.1	42.7	42.2	41.8	41.4	40.9	40.5	40.1	39.7	39.2	38.8
	30	41.7	41.3	40.9	40.5	40.0	39.6	39.2	38.8	38.3	37.9	37.5	37.0	36.6
	20	39.2	38.7	38.3	37.9	37.4	37.0	36.6	36.2	35.7	35.3	34.9	34.4	34.0
	15	37.5	37.1	36.7	36.2	35.8	35.4	35.0	34.5	34.1	33.7	33.3	32.8	32.4
	10	35.6	35.2	34.7	34.3	33.9	33.4	33.0	32.6	32.2	31.7	31.3	30.9	30.4
	5	32.7	32.2	31.8	31.4	31.0	30.5	30.1	29.7	29.2	28.8	28.4	28.0	27.5

Table A6
Normative data for the BNT stratified by education levels for GUATEMALA

Percentile	1 to 12 years of education	>12 years of education
95	52.1	60.0
90	49.2	58.6
85	47.3	56.6
80	45.7	55.0
70	43.1	52.5
60	40.9	50.3
50	38.9	48.3
40	36.9	46.3
30	34.8	44.1
20	32.2	41.6
15	30.6	40.0
10	28.7	38.0
5	25.8	35.1

Table A8
Normative data for the BNT stratified by age and education levels for MEXICO

Percentile	Age (Years)														
	18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	63-67	68-72	73-77	>77		
>12 years of education	95	-	-	-	-	-	-	60.0	60.0	60.0	60.0	60.0	60.0	60.0	
	90	-	-	-	60.0	60.0	60.0	60.0	59.9	59.5	59.1	58.7	58.3	57.9	
	85	60.0	60.0	60.0	59.9	59.5	59.1	58.7	58.3	57.9	57.5	57.1	56.7	56.3	
	80	59.8	59.4	59.0	58.5	58.1	57.7	57.3	56.9	56.5	56.1	55.7	55.3	54.9	
	70	57.6	57.2	56.8	56.4	56.0	55.6	55.2	54.8	54.3	53.9	53.5	53.1	52.7	
	60	55.7	55.3	54.9	54.5	54.1	53.7	53.3	52.9	52.5	52.1	51.7	51.3	50.9	
	50	54.0	53.6	53.2	52.8	52.4	52.0	51.6	51.2	50.8	50.4	50.0	49.6	49.2	
	40	52.3	51.9	51.5	51.1	50.7	50.3	49.9	49.5	49.1	48.7	48.3	47.9	47.5	
	30	50.5	50.1	49.7	49.3	48.9	48.5	48.1	47.7	47.3	46.9	46.4	46.0	45.6	
	20	48.3	47.9	47.5	47.1	46.7	46.3	45.9	45.5	45.1	44.7	44.3	43.9	43.5	
	15	46.9	46.5	46.1	45.7	45.3	44.9	44.5	44.1	43.7	43.3	42.9	42.5	42.1	
	10	45.3	44.9	44.5	44.1	43.7	43.3	42.9	42.5	42.1	41.7	41.3	40.9	40.5	
	5	42.8	42.4	42.0	41.6	41.2	40.8	40.4	40.0	39.6	39.2	38.8	38.4	38.0	
	1 to 12 years of education	95	60.0	60.0	59.8	59.4	59.0	58.6	58.2	57.8	57.4	57.0	56.6	56.2	55.8
		90	58.2	57.8	57.4	57.0	56.6	56.2	55.7	55.3	54.9	54.5	54.1	53.7	53.3
85		56.5	56.1	55.7	55.3	54.9	54.5	54.1	53.7	53.3	52.9	52.5	52.1	51.7	
80		55.2	54.8	54.4	54.0	53.6	53.1	52.7	52.3	51.9	51.5	51.1	50.7	50.3	
70		53.0	52.6	52.2	51.8	51.4	51.0	50.6	50.2	49.8	49.4	48.9	48.5	48.1	
60		51.1	50.7	50.3	49.9	49.5	49.1	48.7	48.3	47.9	47.5	47.1	46.7	46.3	
50		49.4	49.0	48.6	48.2	47.8	47.4	47.0	46.6	46.2	45.8	45.4	45.0	44.6	
40		47.7	47.3	46.9	46.5	46.1	45.7	45.3	44.9	44.5	44.1	43.7	43.3	42.9	
30		45.9	45.5	45.1	44.7	44.3	43.9	43.5	43.1	42.7	42.3	41.9	41.5	41.0	
20		43.7	43.3	42.9	42.5	42.1	41.7	41.3	40.9	40.5	40.1	39.7	39.3	38.9	
15		42.3	41.9	41.5	41.1	40.7	40.3	39.9	39.5	39.1	38.7	38.3	37.9	37.5	
10		40.7	40.3	39.9	39.5	39.1	38.7	38.3	37.9	37.5	37.1	36.7	36.3	35.9	
5		38.3	37.9	37.4	37.0	36.6	36.2	35.8	35.4	35.0	34.6	34.2	33.8	33.4	

Table A9
Normative data for the BNT stratified by education levels for PARAGUAY

Percentile	1 to 12 years of education	>12 years of education
95	60.0	-
90	59.7	-
85	58.9	-
80	58.2	60.0
70	57.1	59.3
60	56.1	58.3
50	55.2	57.4
40	54.3	56.6
30	53.4	55.6
20	52.3	54.5
15	51.6	53.8
10	50.7	52.9
5	49.4	51.7

Table A10
Normative data for the BNT stratified by education levels for PERU

Percentile	1 to 12 years of education	>12 years of education
95	54.2	—
90	52.1	60.0
85	50.8	59.0
80	49.6	57.8
70	47.8	56.0
60	46.3	54.5
50	44.8	53.1
40	43.4	51.6
30	41.9	50.1
20	40.0	48.3
15	38.9	47.1
10	37.5	45.8
5	35.5	43.7

Table A11
Normative data for the BNT stratified by age and education levels for PUERTO RICO

Percentile	Age (Years)													
	18–22	23–27	28–32	33–37	38–42	43–47	48–52	53–57	58–62	63–67	68–72	73–77	>77	
>12 years of education	95	—	—	—	—	—	60.0	60.0	60.0	60.0	60.0	59.5	58.9	
	90	—	—	—	60.0	60.0	60.0	59.5	58.9	58.3	57.8	57.2	56.6	56.0
	85	60.0	60.0	60.0	59.4	58.8	58.2	57.6	57.0	56.4	55.8	55.2	54.6	54.0
	80	59.6	59.0	58.4	57.8	57.2	56.6	56.0	55.4	54.8	54.2	53.6	53.0	52.4
	70	57.0	56.4	55.8	55.2	54.6	54.0	53.4	52.8	52.2	51.6	51.0	50.4	49.8
	60	54.8	54.2	53.6	53.0	52.4	51.8	51.2	50.6	50.0	49.4	48.8	48.2	47.6
	50	52.8	52.2	51.6	51.0	50.4	49.8	49.2	48.6	48.0	47.4	46.8	46.2	45.6
	40	50.7	50.1	49.5	48.9	48.3	47.7	47.1	46.5	45.9	45.4	44.8	44.2	43.6
	30	48.5	47.9	47.3	46.7	46.2	45.6	45.0	44.4	43.8	43.2	42.6	42.0	41.4
	20	45.9	45.4	44.8	44.2	43.6	43.0	42.4	41.8	41.2	40.6	40.0	39.4	38.8
1 to 12 years of education	15	44.3	43.7	43.1	42.5	41.9	41.3	40.7	40.1	39.5	38.9	38.3	37.8	37.2
	10	42.4	41.8	41.2	40.6	40.0	39.4	38.8	38.2	37.6	37.0	36.4	35.8	35.2
	5	39.5	38.9	38.3	37.7	37.1	36.5	35.9	35.3	34.7	34.1	33.5	32.9	32.3
	95	—	—	60.0	60.0	60.0	60.0	60.0	59.4	58.8	58.2	57.6	57.0	56.4
	90	60.0	60.0	59.4	58.8	58.2	57.6	57.0	56.4	55.8	55.2	54.6	54.0	53.5
	85	58.7	58.1	57.5	56.9	56.3	55.7	55.1	54.5	53.9	53.3	52.7	52.1	51.5
	80	57.1	56.5	55.9	55.3	54.7	54.1	53.5	52.9	52.3	51.7	51.1	50.5	49.9
	70	54.5	53.9	53.3	52.7	52.1	51.5	50.9	50.3	49.7	49.1	48.5	47.9	47.3
	60	52.3	51.7	51.1	50.5	49.9	49.3	48.7	48.1	47.5	46.9	46.3	45.7	45.1
	50	50.3	49.7	49.1	48.5	47.9	47.3	46.7	46.1	45.5	44.9	44.3	43.7	43.1
40	48.2	47.6	47.0	46.4	45.8	45.2	44.6	44.0	43.4	42.8	42.2	41.6	41.1	
30	46.0	45.4	44.8	44.2	43.6	43.0	42.4	41.9	41.3	40.7	40.1	39.5	38.9	
20	43.4	42.8	42.2	41.6	41.1	40.5	39.9	39.3	38.7	38.1	37.5	36.9	36.3	
15	41.8	41.2	40.6	40.0	39.4	38.8	38.2	37.6	37.0	36.4	35.8	35.2	34.6	
10	39.9	39.3	38.7	38.1	37.5	36.9	36.3	35.7	35.1	34.5	33.9	33.3	32.7	
5	37.0	36.4	35.8	35.2	34.6	34.0	33.4	32.8	32.2	31.6	31.0	30.4	29.8	