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# BATERÍA NEUROPSICOLÓGICA DE LURIA NEBRASKA PARÁMETROS PORTUGUESES DE 984 SUJETOS PORTUGUESES NORMALES

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## RESUMEN

Se evaluaron un total de 984 sujetos adultos normales con la Batería Neuropsicológica de Luria Nebraska (Versión Portuguesa Experimental – Maia, 2006). Se seleccionaron al azar sujetos de la población portuguesa que voluntariamente aceptaron participar en este proyecto. Todos los sujetos seleccionados tenían especialización manual derecha y eran caucásicos. El rango de edad fue seleccionado siguiendo los procedimientos habituales en Portugal (18 años de edad hasta 65 años de edad, con promedio = 36, 87 y desviación patrón = 12,972). El valor promedio de años en la escuela fue 15, 13 and desviación patrón = 4,005. Los principales resultados de las pruebas fueron evaluados teniendo como factores de agrupación el nivel de edad, sexo e escolaridad. El análisis de datos con la prueba Chi cuadrado, Test t e Anova mostró gran consistencia con resultados alrededor del

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mundo acerca de la coherencia interna del LNNB, como un instrumento fuertemente discriminante, desde el punto de vista neuropsicológico, entre pacientes afectados y sujetos normales. Por último, se presentaron los primeros datos portugueses normativos sobre la LNNB en una fase experimental, con casi un millar de participantes. Creemos que este artículo podría ser de gran valor para quien participa en evaluación neuropsicológica y está principalmente preocupado con la viabilidad de la sobreabundancia de pruebas cognitivas, utilizándolos principalmente para evaluar adecuadamente el desempeño neuropsicológico normal y anormal.

**Palabras clave:** Batería Neuropsicológica de Luria Nebraska, Datos Normativos Portugueses, datos neuropsicológicos normales e anormales.

# LURIA NEBRASKA NEUROPSYCHOLOGICAL BATTERY PORTUGUESE PARAMETERS FROM 984 PORTUGUESE NORMAL SUBJECTS

## **Abstract**

A total of normal 984 adult subjects were evaluated with Luria Nebraska Neuropsychological Battery – LNNB (Portuguese Experimental Version – Maia, 2006). They were randomly selected from the Portuguese population that voluntarily accepted to take part in this project. All subjects selected had right hand specialization and were Caucasian. The age range was selected following the usual procedures in Portugal (18 old – 65 old, with average = 36, 87 and S.D. 12,972). The average value for years in school was 15, 13 and s.d = 4,005. The major results of tests were evaluated having as grouping factors the age, sex and scholar level. The analysis of data with Chi Square test, T tests, and Anova showed great consistency with results around the world about the internal consistency of LNNB in strongly discriminating normal subject from neuropsychological affected patients. Finally, the first Portuguese normative data about LNNB -in an experimental phase, with almost a thousand participants were presented. We believe that this article could be of great value to those who are involved in neuropsychological assessment and are mainly concerned with the viability of the overabundance of cognitive tests mostly used to adequately evaluate normal and abnormal neuropsychological performance.

**Key words:** Luria Nebraska Neuropsychological Battery, Portuguese Normative Data, Normal and Abnormal neuropsychological data.

## INTRODUCTION

In previous studies, we stressed the relevance of obtaining comparative data from LNNB with normative population (Maia, Loureiro, Silva, Vaz-Patto, Loureiro, Correia, *et al.*, 2003; Maia, Loureiro, Silva & Perea-Bartolomé, 2005; Maia, Perea-Bartolomé, Ladera, Silva, Loureiro, Vaz-Patto *et al.* 2005; Maia, Loureiro, Silva, Vaz-Patto, Loureiro & Bartalomé, 2005; Maia, Silva, Correia & Perea-Bartolomé, 2006; Maia, Silva, Perea-Bartolomé, Correia & Parrilla, 2007).

A variety of authors, in diverse countries, have developed this route of investigation not only with normal adult subjects (Moses, Schefft, Wong & Berg, 1992; Agranovic & Puente, 2007; Hsieh & Tori, 2007) but also with normative neuropsychological numbers from children (Gustavson, Golden, Wilkening, Hermann, Plaisted, Macdnes, *et al.*, 1984; Blair, Zelazo & Greenber, 2005).

## STUDY

In this paper we present the first Portuguese significant data about normative adult subjects when evaluated with the original LNNB (Form I), with almost 1000 subjects profile validated. We intended to study and analyze neuropsychological performance of normal participants, both genders, adults (aged 18-65) with different academic levels. The principal variables correlated with results, were age, sex and academic history. We also analyzed some aspects that should be adapted from the original English to the Portuguese adaptation, particularly in terms of cultural bias, task difficulty, time given to realize each task, etc. Data was collected from May 2005 to July 2011.

## SAMPLE

A total of normal 984 adult subjects were evaluated, randomly selected from the Portuguese population that voluntarily accepted to take part in this project. All subjects selected were Caucasian and right handed.

Inclusion criteria comprised: a) a normal score into the MMSE, using Portuguese standardization (normal in Portuguese MMSE >15 to none academic experience, >22 to 1 to 11 years of scholary and, >27 to academic formation superior to 11 years (Folstein, Folstein & McHugh, 1975; Guerreiro, 1993); b) absence of any known neurological condition, according to prior studies (Maia & de Mendonça, 2002); absence of any known psychiatric condition, according to prior studies (Maia & de Mendonça, 2002); be older than eighteen years of age.

From the final sample of selected subjects we evaluated 576 women (58.8%) and 408 men (41.5%). The age range (18-65; Average = 36,87 s.d. = 12,972) were selected following the normal trials in Portugal, due to the fact that, in Portugal, 18 years is the minimum to consider a person as an adult and; in the superior limit, 65 are the age accepted to the final on normal adult age and the entrance in the elderly (Maia & de Mendonça, 2002). The average value for years in school was 15,13 and s.d = 4,005. Considering the distribution of age differentiated by gender we can perceive an average age of 36.05 and s.d. =12.911 to men and an average age of 36.32 and s.d. = 14,103. This differences are not statistically significant ( $\chi^2= 0,442$ ,  $p=, 899$ ) with a robust symmetry on the distribution concentration of age, considering the variable sex. When variable sex is considered, based on the categories of Age and Academic levels, none statistically significant difference ( $\chi^2= 2.001$ ,  $p=, 432$ ) is verified.

## PROCEDURES

We first informed the subject the purposes of the study asking for its written informed consent, to participate in the study. Next we made an anamnesis to obtain data on the socio-demographic area of the subject (age, schooling, profession, familiar history, etc.). The sessions were individual and realized in a room especially dedicated to clinical consultations, in General Hospitals and other Health Facilities, in Portugal. The duration of each session was approximately 90 to 120 minutes, with a rest of approximately 20 minutes (see Maia & Leite, 2009). Each subject attended two sessions of evaluation, preferably with a time interval of 3 to 7 days, to try to reduce a possible slant related to fluctuations of humor,

demotivation, etc., as well as guaranteeing the possible next evaluation in an acceptable interval of time. After the collection of data the appropriate statistical analysis was made, considering the raised objectives.

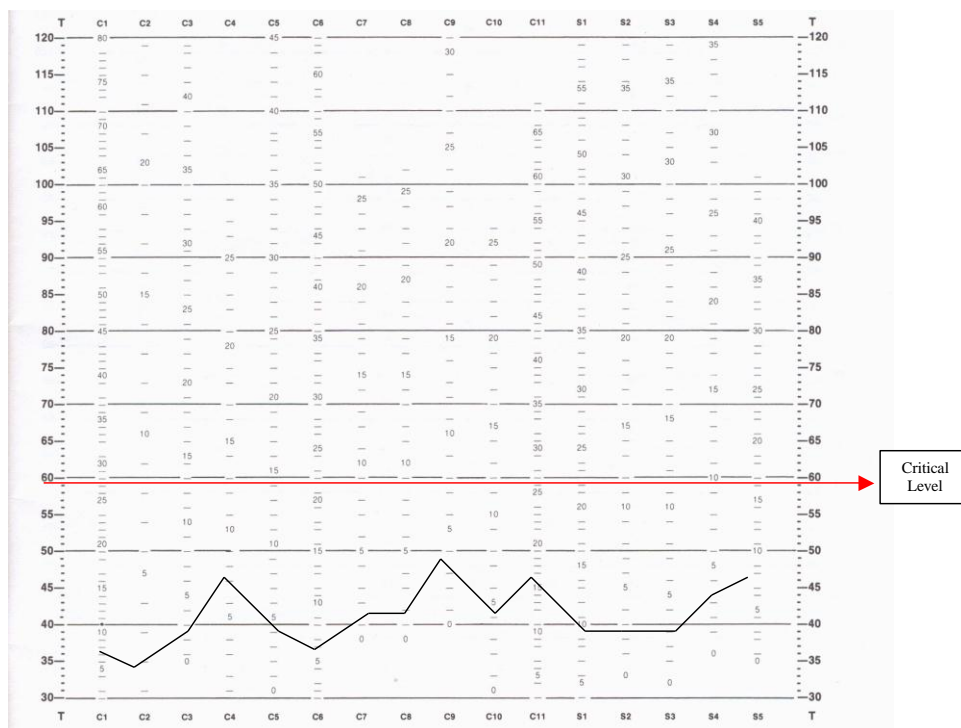
## MAJOR RESULTS

As in previous studies, we represent in descriptive values (Table 1) and graphical representation (Figure 1) a profile, drawn up from the data of almost 1000 subjects. That means, calculating the age and average schooling of the subjects it is possible to obtain a Critical average Level, that allows, as well, to draw an average profile based on the results of the subjects in each one of the Clinical and Summary Scales. We only traced a profile only for the Clinical and Summary Scales following the idea that these scales are those that the clinical practitioners are more concerned in a more pragmatic and immediate analysis of subject protocol, as referred by Moses & Pritchard (1999) and McKinzey, Roecker, Puente, & Rogers, (1998). Thus, locating the regular values for the variables in question, we drew up the corresponding average profile, presented in Figure 1.

As we can see in Figure 1, the average profile produced by the summation of the outcomes of displays a profile of a perfectly normal (theoretical) subject. None of the scales rise above the critical level; the difference between the scale with smaller score (C2 = 1) and with greater score (C11 = 16) when respective notes T are adopted, produce a difference of scores T of 17 points. The greater score also corresponds to a T score of 47. As referred by Moses and Pritchard (1999) the scores of the subjects in the scales of the LNNB is converted into a standard score, (called T score), to simplify the comparisons between subjects and scales, so that into the original version of the LNNB-I all the total scores in each scale of the reference group are converted so that each one has an average of 50 (T score) and a Standard Deviation of 10 points. These transformations anchor the total level of each scale to a collective level and standardize the changes in the global scores in relation to that anchored level.

	N	Minimum	Maximum	Average	Std. Dev.
Age	984	18	65	36,87	12,972
Years in School	984	4	19	15,13	4,005
s1 Pathognomonic	984	0	20	9,59	4,317
s2 Left Hemisphere	984	0	16	2,18	2,860
s3 Right Hemisphere	984	0	16	2,67	2,876
s4 Profile Elevation	984	0	17	3,33	3,291
s5 Impairment	984	0	22	7,67	5,286
C1 Motor Clinical Scale	984	0	32	7,57	5,880
C2 Rhythm Clinical Scale	984	0	7	1,66	1,536
C3 Tactile Clinical Scale	984	0	18	2,86	2,958
C4 Visual Clinical Scale	984	0	17	7,25	3,767
C5 Receptive Speech Clinical Scale	984	0	17	4,66	3,638
C6 Expressive Speech Clinical Scale	984	0	21	5,43	4,275
C7 Writing Speech Clinical Scale	984	0	10	1,49	2,038
C8 Reading Speech Clinical Scale	984	0	8	1,81	2,026
C9 Arithmetic Speech Clinical Scale	984	0	21	3,20	3,272
C10 Memory Speech Clinical Scale	984	0	16	4,40	3,352
C11 Intellectual Speech Clinical Scale	984	2	46	16,15	8,228
Valid N (list wise)	984				

Table 1. Descriptive values of Age, Scholarty in years and Clinical and Summary Scales of LNNB



**Figure 1.** Average discriminative Profile in Clinical and Summary Scales

## ANOVA

We have made an analysis of variance of three factors (sex, age and scholar level) not only for each one of the described dependent variables in the previous section, but also for the remaining scales of the LNNB.

Regarding to C1 Motor Clinical Scale, there are verifiable statistically significant differences in the factor Age ( $F= 8,261$ ;  $p=, 002$ ) and Scholary (  $F= 4,218$ ;  $p=, 014$ ) but not for Sex variable. In respect to C2 Rhythm Clinical Scale and C3 Tactile Clinical Scale statistically significant differences in this variables in the variables/factor studied sex and age are not verified, being nevertheless found significant differences at the level of variable Scholary. In the C4 Visual Clinical Scale statistically significant differences in this variable in the variables/factor studied sex and age are not verified, but found significant differences at the level of variable Scholary ( $F= 16,174$ ;  $p= ,005$ ). In the C5 Receptive Speech Clinical Scale statistically significant differences are verified in the variables/factor studied Age ( $F= 4,025$ ;  $p=, 014$ ) and Scholar Level ( $F= 3,004$ ;  $p=, 019$ ), but not for Sex variable ( $F=1, 333$ ;  $p=, 352$ ). In the C6 Expressive Speech Clinical Scale statistically significant differences are verified in the variables/factor studied Age ( $F= 4,527$ ;  $p=, 022$ ) and Scholar level ( $F= 18,124$ ;  $p=, 002$ ), but not in the Sex variable ( $F=, 602$ ;  $p=, 678$ ). In the C7 Writing Clinical Scale statistically significant differences are only verified in the variables/factor studied Sex ( $F= 3,623$ ;  $p=, 651$ ) and Scholar level ( $F= 8,402$ ;  $p=, 002$ ). In C8 Reading Clinical Scale statistically significant differences are only verified in the variables/factor studied Age ( $F= 3,025$ ;  $p=, 043$ ), Scholar level ( $F= 34,604$ ;  $p=, 000$ ) and in the interaction between Age and Scholar Level ( $F= 9,210$ ;  $p=, 002$ ). In C9 Arithmetic Clinical Scale statistically significant differences are only verified in the variables/factor studied Sex ( $F= 4,430$ ;  $p=, 023$ ), Scholar Level ( $F= 6,548$ ;  $p=, 024$ ) and in the interaction between Sex and Scholar Level ( $F= 3,107$ ;  $p=, 005$ ). In C10 Memory Clinical Scale statistically significant differences are only verified in the variables/factor studied Age ( $F= 11,203$ ;  $p=, 012$ ) and Scholar Level ( $F= 10,040$ ;  $p=, 003$ ). In C11 Intellectual Clinical Scale none statistically significant differences are verified in the variables/factor studied Sex and Age, but a strong relation was found with the variable Scholar Level ( $F= 20,703$ ;  $p=, 002$ ).

In Summary Scale S1 (Pathgnomonic) statistically significant differences are only verified in the variables/factor studied Age ( $F= 7,154$ ;  $p=, 013$ ), Scholar Level ( $F= 5,110$ ;

$p=, 023$ ) and in the interaction between Age and Scholar Level ( $F= 2,326$ ;  $p=, 029$ ). In the Summary Scale S2 (Left Hemisphere) none relevance for the implication of Sex variable was found, Scholar Level and Age. In Summary Scale S3 (Right Hemisphere) statistically significant differences are only verified in the variables/factor studied Age ( $F= 5,654$ ;  $p=, 023$ ) and Scholar Level ( $F= 2,763$ ;  $p=, 012$ ). In Summary Scale S4 (Profile Elevation) significant differences are only verified in the variables/factor studied Age ( $F= 4,115$ ;  $p=, 028$ ), Scholar Level ( $F=19,082$ ;  $p=, 029$ ) and in the interaction between Age and Scholar Level ( $F= 3,006$ ;  $p=, 023$ ), as well as between Age and Scholar Level ( $F= 2,056$ ;  $p=, 021$ ). In Summary Scale S5 (Impairment) no relevance for the implication of Sex variable was found, Scholar Level and Age.

In Summary Scale S1 (Pathgnomonic) statistically significant differences are only verified in the variables/factor studied Age ( $F= 9,194$ ;  $p=, 012$ ), Scholar Level ( $F= 4,210$ ;  $p=, 013$ ) and in the interaction between Age and Scholar Level ( $F= 2,005$ ;  $p=, 041$ ). In the Summary Scale S2 (Left Hemisphere) none relevance for the implication of Sex variable was found, Scholar Level and Age. In Summary Scale S3 (Right Hemisphere) statistically significant differences are only verified in the variables/factor studied Age ( $F= 5,632$ ;  $p=, 013$ ) and Scholar Level ( $F= 3,733$ ;  $p=, 027$ ). In Summary Scale S4 (Profile Elevation) significant differences are only verified in the variables/factor studied Age ( $F= 4,621$ ;  $p=, 014$ ), Scholar Level ( $F=20,232$ ;  $p=, 020$ ) and in the interaction between Age and Scholar Level ( $F= 3,016$ ;  $p=, 042$ ), as well as between Age and Scholar Level ( $F= 2,054$ ;  $p=, 020$ ). In Summary Scale S5 (Impairment) none relevance for the implication of Sex variable was found, Scholar Level and Age.

## DISCUSSION

With respect to time of application of the LNNB, although the average time of administration presented by Golden, Freshwater and Vayalakkara (2000) for neurological populations is about 3 hours, and for Hebben and Milberg (2002) is 1,5 to 2,5 hours, the average administration of time in our subjects evaluated was around 3.5 hours. To that time we must add 2 1/2 to process of annotation, construction of the graphical profiles, interpretation, etc. Nevertheless, our work is based on a deep and comprehensive investigation, receiving clinical contributions of other specialists (neurologist, psychiatrist, general practitioner, etc.) in the entire evaluation process. With regard to a primary



analysis of the results, an evaluator always verifies if the evaluated subject presents a high profile (indicator of impairment), specifically in the Clinical and Summary Scales.

These data are reinforced (as in previous studies – Maia & Leite, 2009) by the fact that in three factors ANOVA (Sex, Age and School Levels) with clinical scales (C1 to C11) and Summary Scales (S1-s5) none significant statistically effects are verified. So, in this sample of normal subjects, the variables Sex, Age and Scholar Level, do not seem to contribute for the differentiation between the subjects; that is to say, in these normal subjects, the scores do not present a great variance, in each one of the referred scales. This suggests, at the level of an initial analysis, that LNNB like previously sustained by McKinzey, Roecker, Puente and Rogers (1998), is very strong in the classification of normal subjects, not presenting, in our study, identification of any subject like False Positive. These results are in conformity with Golden, Freshwater and Vayalakkara (2000) that sustain the strong battery psychometric characteristics. According with them, the first factor to consider in this field of analysis points its validity and reliability: agreement between evaluators, internal consistency and validate test-retest. Previously Golden, Hammeke and Purisch (1978) compared LNNB profiles by five independent pairs of evaluators, with respect to the application of the battery to five subjects. A high level of agreement between evaluator has been verified, with 95% of agreement between the evaluations. Another study shows an internal consistency (alpha) that varied from 0,82 in the C2 scale to 0,94 in the C1 scale, for the 14 principal Scales of LNNB of 146 patients with cerebral damage and 74 controls (Mikula, 1981; Moses, Johnson & Lewis, 1983). In another study, a sample of patients with cerebral damage and without cerebral damage has been examined (n= 559), jointly with separated groups of clients with cerebral dysfunction (n= 451) and with schizophrenia (n= 414), a mixed set of psychiatric patients (n= 128) and a normal sample of 108 subjects (Maruish, Sawicki, Frabzen & Golden, 1984, In Golden, Freshwater & Vayalakkara, 2000). The correlations for all the groups, except for the sample of the normal subjects, were clearly elevated, varying from 0,81 to 0.93. Still in agreement with Golden, Berg & Graber (1982), the test-retest validity of the clinical scales vary of 0, 78 in the C3 scale to an elevation of 0,96 in the C9 scale. Palisted and Golden (1982 In Golden, Freshwater & Vayalakkara, 2000) analyzed the test-retest confidence degree for the 14 original scales, and the confidence degree varied from 0, 83 to 0.96.

In conformity with our works, MacInnes, Paul and Schima (1987), stressed the necessity to come to an adjustment of the results of the normal data at the age of the subjects. In a longitudinal study with groups of normal subjects, throughout four years (59 voluntary, old normal subjects, throughout 4 years) the clinical scales showed tenuous alterations during the 4 years of the test. The main evidences of the study were: the correlations test-retest of the clinical scales that varied from 0,32 to 0.82; low differences between male and female subjects; the fact to belong to a sub-group younger-older did not affect the pattern of alteration in the performances; in spite of the health state of the subjects to present few alterations throughout the four years, the health state at moment 2 of evaluation appeared like strongly predicting the performances in 16 of the 17 principal scales of LNNB, at moment 2. As final conclusion of this study, the authors refer that LNNB appears like a trustworthy instrument in the identification of old normal subject, once the performance of such subjects has presented little significant variations throughout the four years.

Garmoe, Schefft and Moses (1991) postulated the diagnostic validity of LNNB Form II in the differentiation between normal subjects (55) and brain damaged subjects (55), matched by age and school levels. The authors still refer that these results confirm the traditional idea that age and academic level strongly interferes with performance of normal subjects (note: gender was presented like having any implication in the variability of major performances).

In conclusion we referred that if we considered that the average results of the normal subjects of our sample, those reinforces the idea that this battery presents discrimination of nonclinical subjects from the neuropsychological point of view, confirming prior results (Maia, 2006, Maia & Leite, 2009).

Let us remember what we referred at the beginning of this discussion in which, with regard to a primary analysis of the results, specifically in the Clinical and Summary Scales, in our sample of 984 normal subjects, no one presents a typical profile of a neurological patient. Even considering the exception conditions of evaluation of the profile (re-estimation of the critical level, elevation of two clinical scales, etc.) does not classify any subject with a "Clinical Profile" (suggestion of neuropsychological affectation) (Moses & Pritchard, 1999).

We finalize this paper with a brief reflection about the average results reached by the subjects. As is possible to be verified, the average profile produced by the accumulation of

the results of the subjects presents a profile of a perfectly (hypothetical) normal subject. None of the scale rises above the "Critical Level".

In fact, in our study, when we evaluated the scales that are anchored around T Score 50 (with one Stand. Dev., under or above), we verified that all the Clinical and Summary Scales are under the Critical Calculated Average Level. From the 11 Clinical Scales, the Scales C3 to C11 are within the rank of under a Stand. Dev. (T from 40 to 47). Only the rest three clinical scales present greater S.D., being, nevertheless, two of them (C1 with 37 Note T = and C6 with Note T = 38) little significant. The only scale with more reduced T Score is the C2 (T=31).

These values are perfectly acceptable, like referred in the Manual of the LNNB, in which concerns the accomplishment of normal subjects (Golden *et al.*, 1982). Moses Jr. (1995) refers that the expected presentation of normal subjects with high schooling and low age is a reduced Critical Level, and it generate lower Critical Levels for young and educated participants, and the elevation of Clinical Scale are more prone to happen. Other authors reinforce this aspect stressing that the valuation of protocols of neuropsychological patients usually present strong scores (worse) in comparison with normal subjects, considering variables as intellectual level and socio-demographic characteristics (Benedet, 2003).

## CONCLUSION

With our works we keep having in mind that much is left to do. Many adaptations of items will have to be done in the future. Perhaps, the own approach of neuropsychological assessment is decentralized of an attempt to present standard reference data, or as well, reinforces the initial perspective of Luria, that defended that neuropsychological evaluation would be turned in a theoretically empty Psychometric Entity from the point of view of Neurosciences (Luria & Majovski, 1977). Ardilla (1999, p. 68) refers that "(...) *Luria's procedures will be combined with some others, including more standardized and psychometrically oriented assessment instruments. Further development of Luria's ideas with regard to neuropsychological assessment is foreseen*". Nonetheless, whatever the future holds for our work, we are aware that we are consolidating the first steps (since 2003) in Portugal about the challenge to the revision of which Tupper (1999), named *The Neo-Lurian Perspective*.

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