



ORIGINAL ARTICLE

Spanish normative studies in young adults (*NEURONORMA* young adults project): Norms for the Visual Object and Space Perception Battery and Judgment of Line Orientation tests[☆]

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KEYWORDS

Normative data;
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Abstract

Introduction: The Visual Object and Space Perception Battery (VOSP) and Judgment of Line Orientation tests (JLO) are used in clinical practice to assess visuoperceptual and visuospatial abilities.

Objective: In this study, as part of the Spanish normative studies project in young adults (*NEURONORMA* young adults), we present normative data for a short version of the VOSP test and for the JLO test.

Material and methods: The sample consisted of 179 participants who are cognitively normal and range in age from 18 to 49 years. Tables are provided to convert raw scores to scaled scores. Education- and sex-adjusted scores were obtained by applying linear regression techniques.

Results: Our results show that education and sex only affect scores on the JLO test, and that age has no effect.

Conclusions: The normative data obtained will be extremely useful in the clinical evaluation of young Spanish adults.

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PALABRAS CLAVE

Datos normativos;
Edad;
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Reconocimiento
visual

Estudios normativos españoles en población adulta joven (proyecto NEURONORMA jóvenes): Normas para las pruebas Visual Object and Space Perception Battery y Judgment of Line Orientation

Resumen

Introducción: La Visual Object and Space Perception Battery (VOSP) y el Judgment of Line Orientation (JLO) son pruebas utilizadas para explorar habilidades visuoperceptivas y visuoespaciales.

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Objetivo: En el presente estudio, como parte de los estudios normativos españoles del proyecto NEURONORMA jóvenes, se presentan datos normativos para una versión abreviada de la VOSP y el JLO.

Material y métodos: La muestra está formada por 179 participantes, cognitivamente normales, de entre 18 y 49 años de edad. Se aportan tablas para convertir las puntuaciones brutas en escalares y tablas con los ajustes pertinentes por escolaridad y género a partir de regresiones lineales.

Resultados: Los resultados obtenidos muestran la influencia de la escolaridad y el género únicamente en el JLO, y nulo efecto de la edad.

Conclusiones: Las normas obtenidas aportan datos de gran utilidad clínica para la evaluación de población adulta joven española.

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Introduction

Spatial and visual perception tasks provide data about visuoperceptual and visuospatial abilities, visual processing and recognition, object and space perception, and spatial orientation.^{1,2} In addition, the characteristics of these tests help minimise the impact of motor and verbal mediation abilities¹ and other cognitive capacities,^{2,3} regardless of whether tasks are examined one by one or collectively within a semiological group.^{4,5}

In 1991, Warrington and James² developed the Visual Object and Space Perception Battery (VOSP) in order to analyse the perception of objects and space according to Warrington's model.⁶ He recognised 3 subtypes of deficits in object perception: sensory and visual processing disorder, apperceptive agnosia, and associative agnosia. Since that time, the test has not been modified. As explained in certain compilations of neuropsychological tests, the test may be administered as a whole or as a selection of subtests.^{1,4} Researchers generally use the entire battery. However, in light of the data from a recent study,⁷ we opted to administer the VOSP shape detection screening test followed by a selection of 4 subtests from the battery: object decision, progressive silhouettes, position discrimination, and number location.

Several normative studies highlight the importance of the sociodemographic variables and their impact on the VOSP performance. Some of the subtests show a decrease in performance beginning at the age of 50 years^{2,7-9} and an additional decline in subjects aged 70 and older.^{7,9} Most studies suggest that education is correlated to performance on many of the subtests in the battery.⁷⁻⁹ Results regarding a sex effect on the VOSP are inconclusive, although some studies found no significant differences.^{8,9} Nevertheless, one study⁷ identified a sex effect on 5 of the 8 subtests. Researchers do not know how cultural factors affect results from these subtests, since one of the studies identified a culture effect⁹ and another did not.⁷ The influence of cultural factors on the performance of the full VOSP test also remains unclear, based on differences in results from the studies cited above.^{7,9} There are only 2 normalisation studies of the VOSP battery in Spain.^{7,8} Age, educational level,⁷ and sex distribution in both studies are similar to those in the American sample.⁸

Benton^{3,10} designed the Judgment of Line Orientation test (JLO) in order to assess spatial perception and orientation. The test assesses the subject's ability to estimate angular relationships between line segments. Subjects are asked to match an angled line on a stimulus card to one of the angled lines shown on a reference card. The test includes 2 complete versions and a few abbreviated versions that have been described in multiple neuropsychological test compendia.^{1,4} The complete version contains 30 items, with 2 alternative forms (H and V). Since it was published, several abbreviated versions have been proposed, and most of these versions include 15 items. Another adapted version includes 20 items. Lezak et al. collected a wide selection of the different versions.¹ Additionally, the Repeatable Battery for the Assessment of Neuropsychological Status presents a JLO-type subtest with 10 items involving comparing line segments.¹¹

Multiple normative studies highlight the impact of sociodemographic factors on JLO performance. According to several studies, there is curvilinear age effect on test performance.³ A decline is recorded beginning at the age of 50 for both the long version^{3,12,13} and the abbreviated versions.¹⁴ Researchers have also found an education effect on JLO scores, since subjects with a low educational level present poorer performances,³ which also reveal differences between men and women. In addition, an education effect has also been observed in JLO results collected from a sample of older adults,^{8,12,13} and in studies using the abbreviated 15-item version. Concerning sex, published data on JLO show that men score higher than women on both the long version^{3,8,16-20} and the abbreviated versions.^{14,21} This effect has also been confirmed in studies of patients with stroke or Parkinson's disease matched to control group subjects.^{13,22} A sexual orientation effect has also been observed among males, with the heterosexual group scoring higher than the homosexual group.^{23,24} According to the literature, ethnic factors do not have a significant effect on JLO results,^{3,25} with the exception of one study reporting poorer performance in an African-American adult population.¹⁵

A recent study published normative data for the JLO taken from a sample of Spanish adults aged between 50 and 90.⁸

Until now, research intended to obtain normative data for the VOSP and JLO tests has focused on older adults. Some of

these studies have not taken educational level into account, and most studies were carried out in English-speaking populations, as stated by Mitrushina et al.⁵ Normative studies are needed, given that sociodemographic factors clearly influence cognitive performance, and normative data from Spanish young adults are lacking.²⁶

The main objective of the NEURONORMA project (NN) is to gather normative data from widely used neuropsychological tests. During the first phase of the study, Peña-Casanova et al.²⁷ collected normative data from these tests in adults aged 50 and older. The present study is an extension of the NEURONORMA young adults project (NNy) and provides normative data from these tests for adults younger than 50. These data are presented in multiple articles.^{28–31} The general characteristics of this study are described in another article.³²

Within the framework of the project mentioned above, the current article presents normative data from younger adult subjects (aged between 18 and 49) on 4 VOSP subtests – 2 subtests for object perception (object decision and progressive silhouettes) and 2 subtests for spatial perception (position discrimination and number location) – plus 1 test of spatial perception and orientation (JLO).

Material and methods

Subjects

Recruitment methods and sample characteristics have already been described in another article. To summarise, we recruited 179 white subjects who had been educated in Spain and were either native Spanish speakers or bilinguals. The sample was stratified by age and educational level. None of the subjects presented cognitive impairment; scores on the Mini-Mental State Examination (MMSE)^{33,34} were ≥ 24 and scores on the Memory Impairment Screen (MIS)^{35,36} were ≥ 4 .

Neuropsychological measurements

We followed the neuropsychological protocol established for the NN project.⁸ All tests were administered according to the procedures described in their manuals.

Visual Object and Space Perception Battery

We administered the initial screening test, followed by the 4 subtests selected for the NN test protocol:

Shape detection screening test: the patient is shown 20 stimulus cards, half of which display an embedded and degraded 'X' symbol. The subject is asked to determine whether or not the X is present.

Object decision: the subject is shown a series of 20 cards, each of which displays 4 black shapes; one is the silhouette of a real object and the other 3 are distractor shapes. The subject has to identify the real object without hearing its name. The total correct responses are counted, and the maximum score is 20.

Progressive silhouettes: this section uses 2 card series, one representing a pistol and the other, a trumpet. Cards

display a silhouette, beginning at a maximum rotation; each silhouette progressively approaches the more familiar lateral view. Participants are asked to identify the object as early in the series as possible. We calculated the total number of cards the subject needed to identify each object (maximum of 20).

Position discrimination: 20 cards are presented, each of which contains two adjacent squares. A dot marks the exact centre of one square; in the other, it is off-centre. The subject identifies the square containing the centred dot. Correct responses were recorded; the maximum score is 20.

Number location: 10 cards are presented, each containing 2 squares, one above the other. The top square has the numbers 1 to 9 randomly spaced within it, and the other square has only a black dot. The patient is asked to identify the number that corresponds to the precise position of the black dot. The total number of correct responses was recorded; the maximum score is 10.

Judgment of Line Orientation

The test consists of 30 stimulus cards, each showing a different pair of angled lines at the top of the page. The subject matches those lines to those shown on a multiple choice reference card at the bottom of the page. The first 5 items are practice items. The total number of correct responses for both line segments is recorded; the maximum score is 30. Spontaneous corrections by the participant were accepted, since no guidelines about how to score answers were provided.

Statistical analysis

We completed the general statistical analysis procedure established in the NNy protocol since this project serves as a co-normalisation study. The procedure was as follows: (a) we converted raw scores into percentile ranks according to the distribution of cumulative frequencies. Percentile ranks were then converted to NSS (NEURONORMA Scaled Scores) ranging from 2 to 18. This conversion of raw scores produces an approximation of a normal distribution (mean $\pm$ standard deviation: 10 ± 3) that permits use of linear regression models. (b) Age, education, and sex effects were defined by calculating NSS correlation coefficients (r) and coefficients of determination (R^2) with respect to the variables listed above. Variables were adjusted only in cases in which the explained variance exceeded 5% and where the regression coefficient was statistically significant. (c) The NSS was adjusted for age, education, and sex according to the following formula: $SS_{\text{Adjusted}} = SS - (\beta_1^* \times [\text{Age} - 35]) + \beta_2^* \times [\text{Education} - 13] + \beta_3^* \times (\text{Sex})$. The regression coefficient (β) from this analysis was used as the basis for adjusting for sociodemographic factors. The resulting value was truncated to the next lower integer.

Results

Table 1 displays the array of frequencies of raw scores for the entire group aged 18 to 49, with the corresponding scaled

Table 1 Scalar scores and percentiles corresponding to the VOSP and JLO tests.

SS	Percentile ranks	VOSP				JLO
		Object decision	Progressive silhouettes	Position discrimination	Number location	
2	<1	≤10	≥14	≤17	≤5	≤13
3	1	11	13–12	—	6	14–16
4	2	12	—	18	7	17–18
5	3–5	13–14	11	—	8	19
6	6–10	15	10	19	—	20
7	11–18	16	9	—	9	21–23
8	19–28	—	8	—	—	24
9	29–40	17	7	—	—	25
10	41–59	18	—	—	—	26
11	60–71	—	6	—	—	27
12	72–81	—	5	—	—	28
13	82–89	19	—	—	—	29
14	90–94	—	4	—	—	—
15	95–97	—	—	—	—	—
16	98	—	—	—	—	—
17	99	—	—	—	—	—
18	>99	20	≤3	20	10	30
Number of subjects		179	179	179	179	179

SS: scaled scores; VOSP: Visual Object and Space Perception Battery; JLO: Judgment of Line Orientation.

scores and percentile ranks. To use the table, we select the patient's raw score for each test and identify the corresponding NSS and the percentile rank.

The correlation coefficient (r) and coefficient of determination (R^2) are shown in Table 2. No age differences were observed for the JLO or any of the VOSP subtests. The variable 'years of education' explained 6.8% of the variance on the JLO. This variable did not affect any of the VOSP sub. The variable 'sex' explained 8.9% of the variance on the JLO; sex effect on VOSP subtests was minimal.

Multiple regression β -values were used to adjust for sex and education according to the $NSS_{A\&E}$ formula. Based on these data, we created sex and education adjustment tables for the JLO test (Table 3). To use the table, select the variable 'years of education' on the top row to view the correction to be applied to scores generated by both men and women (Table 1).

Discussion

Visual Object and Space Perception Battery

Results from the current study reveal a slight education effect in all subtests of the VOSP. The low impact of this factor differed from findings in prior normative studies,^{7–9} which delivered evidence of a significant, although less pronounced, correlation between education and performance on these subtests. This discrepancy with regard to past findings could be explained by the fact that our sample contains no subjects with fewer than 8 years of education.

No significant age effects on performance were detected in any of the subtests in the test battery. These results do not coincide with those from prior normative studies,^{2,7–9} which suggest that age has a negative influence on performance.

Table 2 Correlation coefficients (r) and coefficients of determination (R^2) of the scaled scores adjusted by age, education, and sex.

	Age (years)		Education (years)		Sex	
	r	R^2	r	R^2	r	R^2
VOSP						
Object decision	−0.041	0.002	0.070	0.005	−0.066	0.004
Progressive silhouettes	−0.141	0.020	0.023	0.001	−0.218 ^a	0.047
Position discrimination	−0.066	0.004	0.066	0.004	−0.032	0.001
Number location	−0.002	0.000	0.122	0.015	−0.114	0.013
JLO						
	−0.027	0.001	0.260 ^a	0.068 ^b	−0.298 ^a	0.089 ^b

VOSP: Visual Object and Space Perception Battery; JLO: Judgment of Line Orientation.

^a Correlation significant at a level of 0.01 (bilateral).

^b $R^2 \geq 0.05$.

Table 3 Education-adjusted table for the JLO task in men and women.

	Education ^a												
	8	9	10	11	12	13	14	15	16	17	18	19	20
Men	+1	+1	0	0	0	0	0	0	0	−1	−1	−1	−1
Women ^b	+3	+3	+2	+2	+2	+2	+1	+1	+1	0	0	0	0

JLO: Judgment of Line Orientation.

^a $\beta = 0.264$.^b $\beta = 2.164$.

These discrepancies may be due to the fact that the age range of our sample differs from that included in all prior studies. This may indicate that younger adult subjects are not affected by the age-related decline in performance which begins to appear in middle age.

We did not find a significant sex effect on VOSP subtest scores. The results obtained in our study support those concluding that there is no sex effect on these subtests.^{7,11} However, they do not concur with those from a study that found differences in 5 of the 8 VOSP subtests.⁷

We cannot confirm the age effect on test performance compared to other studies of Spanish population samples.^{7,13} This may be due to the fact that the study samples have different age ranges and there is no age effect on the present study. Concerning education, this study does not corroborate the differences found by Herrera-Guzmán et al.⁷ in the object decision subtest.

The age effect on the progressive silhouettes subtest showed different results with respect to those from the NN study⁸ of subjects aged 50 and older. The sample containing older subjects revealed an age effect on performance which was not present in the sample of younger subjects. This finding might be explained by the characteristics of the test, which evaluates visuospatial abilities but also requires spatial rotation. Some authors state that these abilities are sensitive to the ageing process.³⁷ A recent study revealed correlations of up to 70% between age and scores on a test of non-prototypical images in which the ability to rotate images was crucial for task completion.³⁸ We also found differences regarding the education effect on performances on the same subtest; these differences are probably due to the fact that our younger sample contains no subjects with fewer than 8 years of education.

Judgment of Line Orientation

Results indicate a slight education effect on the JLO scores. This result coincides with those from prior normative studies, which suggest that education has a positive effect on task completion.^{3,14,15} The presence of a more marked education effect on JLO than on the VOSP spatial perception subtests may be related to JLO's more rigorous standards. These data indicate that JLO may be more sensitive for detecting visuospatial deficiencies.¹

No age influence on test performance could be determined. This result does not coincide with data obtained from most earlier normative studies, which provide evidence

of an age effect on scores for this test.^{3,12,13} These differences may also be explained by the hypothesis, confirmed by Benton et al.,³ that performance declines with normal ageing. These authors observed a curved relationship between age and scores on JLO in which scores rose progressively until reaching a maximum in subjects aged 13; they began declining in subjects aged 50.

A sex effect is reflected by the JLO; male subjects scored higher on the test than females. Our data agree with all relevant earlier studies that also found better performance by males on the long version of the test,^{3,8,16–20} the short version,^{14,21} and in studies of patients with stroke or Parkinson's disease matched to control group subjects.^{13,22}

Regarding prior normalisation studies using Spanish population samples,^{7,13} the age effect on test performance has not been confirmed. This is probably due to the effect of the differences in age range in the samples and the lack of age-related impact on this study, as we mentioned before. Our results with regard to sex coincide with those found by Alegret et al.,¹³ but do not concur with the findings of Herrera-Guzmán et al.⁷

Compared to results from the NN study of subjects aged 50 and older,⁸ findings are similar with respect to the effects of education and sex on performance, but different with respect to the effect of age.

Final remarks

It is important to note that this is the first study to present data from both the JLO test and numerous VOSP subtests in the same sample of adults younger than 50. Furthermore, these are the first published normative data for either the JLO or the VOSP tests in a population of younger Spanish adults.

This article provides normative data from the JLO and selected VOSP subtests for the population mentioned above. Data have been processed for easier use in diagnostic tasks. The results we obtained confirm the effect of education and sex on the JLO test, but not on the VOSP subtests. They also indicate that age has a minimal impact on performance on both tests in the age range included in the study.

Conflicts of interest

The authors have no conflicts of interest to declare.

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