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Influence of Age, Sex, and Education on the Visual Object and Space Perception Battery (VOSP) In a Healthy Normal Elderly Population

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ABSTRACT

The assessment of visual perception and cognition forms an important part of any general cognitive evaluation. We have studied the possible influence of age, sex, and education on a normal elderly Spanish population (90 healthy subjects) in performance in visual perception tasks. To evaluate visual perception and cognition, we have used the subjects performance with The Visual Object and Space Perception Battery (VOSP). The test consists of 8 subtests: 4 measure visual object perception (Incomplete Letters, Silhouettes, Object Decision, and Progressive Silhouettes) while the other 4 measure visual space perception (Dot Counting, Position Discrimination, Number Location, and Cube Analysis). The statistical procedures employed were either simple or multiple linear regression analyses (subtests with normal distribution) and Mann–Whitney tests, followed by ANOVA with Scheffe correction (subtests without normal distribution). Age and sex were found to be significant modifying factors in the Silhouettes, Object Decision, Progressive Silhouettes, Position Discrimination, and Cube Analysis subtests. Educational level was found to be a significant predictor of function for the Silhouettes and Object Decision subtests. The results of the sample were adjusted in line with the differences observed. Our study also offers preliminary normative data for the administration of the VOSP to an elderly Spanish population. The results are discussed and compared with similar studies performed in different cultural backgrounds.

INTRODUCTION

The main objective of neuropsychological assessment is to identify the degree of preservation or impairment of an individual's capacities and to determine the real cognitive state of a particular function (Ellis & Young 1988; Peña-Casanova & Bertran-Serra, 1997). The modal/functional approach may prove highly specific when studying particular aspects of a function (Peña-Casanova, 1995). The assessment of visual object and space perception forms part of any comprehensive neuropsychological assessment since vision has two main goals, the identification of stimuli and their localization (Farah, 2003). However, whereas memory or language have received considerable attention within cognitive

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neuropsychology, there exist surprisingly few cognitive studies on visual perception.

The Visual Object and Space Perception Battery (VOSP) is considered very useful when detecting specific deficits in visual object and space perception due to the fact that its tasks are focused on specific cognitive functions (Warrington & James, 1991). The VOSP is based upon Warrington's model (McCarthy & Warrington, 1990), which distinguishes 3 subtypes of impaired object recognition: 1) disorders of visual sensory discrimination, which reflect selective deficits affecting sensory processing, including acuity, shape discrimination, and color discrimination; 2) apperceptive agnosia, which refers to disorders of object perception; and 3) associative agnosia, which refers to disorders when deriving the meaning of visually presented objects, even in the presence of normal sensory and perceptual abilities. In this model, object perception is a prerequisite of object recognition, which implies the adequate integration of the sensory, perceptual, and representational information (Rapport, Millis, & Bonello, 1998) in a complex analytical-synthetical task that integrates perceived details into an organized structure (McCarthy & Warrington, 1990).

The VOSP can be used to better characterize the cognitive state of visual perception in both, normal and pathological populations. An application of the VOSP in patients with early stage of Alzheimer's disease revealed impairment only in the Silhouette subtest suggesting that "early" perceptual processess are not defective in early Alzheimer's disease (Binetti et al., 1996). Another recent application of the VOSP has been reported in patients with multiple sclerosis (Langdon & Thompson, 1999) by studying how cognitive and neurological patient's admission status related to their benefit from neurorehabilitation, although visual perception resulted in no significant influence. The impairment in pre-attentive visual processing in patients with Parkinson disease and the effect of age has also been recently demonstrated (Lieb et al., 1999). It therefore seems appropriate to extend such studies to other populations.

The aim of this work has been to study the possible influence of age, gender, and education on visual object and space perception by studying the performance on the VOSP in a normal elderly Spanish population. It will contribute to a better understanding of the role of these sociodemographic variables on the performance of the test and, therefore, on specific aspects of visual perception. Although object and space perception may initially appear free of cultural aspects, this possibility cannot be discarded (Bentley & Deregowski, 1987; Deregowski, 1989). Normative studies contribute to clarify the importance of these sociodemographic variables. Our study will also provide preliminary normative data for an elderly Spanish population to be compared with similar studies in English (Warrington & James, 1991) and American (Bonello, Rapport, & Millis, 1997) populations.

METHODS

Subjects

Ninety healthy adult volunteers residing in Spain (45 men and 45 women) were studied. All lived in an urban area and were recruited on a case-by-case basis among family members of patients attending our memory clinic and from different senior citizen activity centers. Their first language was either Spanish (58%) or Catalan (42%). Mean (*SD*) age was 65.97($\pm$9.23; range, 50–80 years). Mean (*SD*) years of education were 8.62 ($\pm$4.53; range, 1–18 years). There were no significant differences between males and females concerning age or years of education ($p = 0.907$ for age and $p = 0.951$ for education: Kruskall–Wallis test.

The following criteria were applied to recruit subjects of both sexes and to assess subjects' status of general cognitive health. Inclusion criteria: 1) age 50 years or older; 2) absence of impairment in activities of daily living, as measured by the Spanish version of the Interview of Deterioration of Daily Living Activities in Dementia (IDDD < 36; Böhm et al., 1998); 3) absence of cognitive impairment, measured by Mini Mental Status Examination (MMSE > 24; Folstein, Folstein, & McHugh, 1975; Blesa et al., 2001). We have not measured estimations of verbal IQ as this was done by both Warrington and James (1991) and Bonello et al. (1997) using the National Adult Reading Test (Nelson, 1982) and the Shipley-Hartford Vocabulary Test (Zachary, 1986), although this exclusion was not seen as a significant weakness due to the minimal impact of IQ on VOSP performance (Bonello et al., 1997).

Exclusion criteria: 1) personal history of central nervous system disease possibly causing neuropsychological deficits (e.g., stroke, epilepsy, head injury); 2) a score of 6 or more on the Hachinski Ischemia Scale or more than 3 on the Rosen Ischemia Scale; 3) personal history of alcohol or other psychotropic substance abuse; 4) presence of active uncontrolled systemic diseases associated with cognitive impairment (e.g., diabetes mellitus, hypothyroidism); 5) history of psychiatric diseases; 6) presence of severe sensorial deficits (loss of vision and/or hearing) that might have impeded the administration of the test. No specific tests of visual and auditory acuity were performed. Results on the Screening subtest (Shape Detection Screening) of the VOSP were taken as a surrogate for sufficient visual acuity in order to be able to pass the test.

Instrument

The VOSP (Warrington & James, 1991) consists of 4 subtests that measure visual object perception (Incomplete Letters, Silhouettes, Object Decision, and Progressive Silhouettes) and 4 visual space perception tasks (Dot Counting, Position Discrimination, Number Location, and Cube Analysis). In a sample of healthy, normal older adults, this two-factor model of visuospatial perception as proposed by the authors of the test (Warrington & James, 1991) has recently been proven to be accurate using a confirmatory factor analysis approach (Rapport et al., 1998).

The Spanish or Catalan instructions of the VOSP were translated from English according to the following steps: the original version was translated into Spanish or Catalan by three different natives, independently. This then translated back into English by a native English speaker with a very good knowledge of Spanish and Catalan and compared to the original English version.

The VOSP also contains a screening test that checks whether the subject's visual sensory capacities are sufficiently intact to permit further examination (Shape Detection Screening). It consists of 20 stimuli, 10 of which contain an incomplete form of the letter "X," while the other 10 do not. The subject is required to determine whether an X is present. According to the test's manual, subjects with a score of 15 or lower should not be further tested.

Within the Objects Perception part of the battery the *incomplete Letters subtest* consists of 20 letters that are 70% degraded; the subject has to identify the letters. The *Silhouettes subtest* consists of 15 silhouettes of animals and 15 of inanimate objects, drawn from an unusual perspective. Subjects are required to identify the drawings. For *Object Decision*, 4 figures are shown simultaneously to the subject only one of which corresponds to a real object; the other three are nonsense form distracters. The subject is required to identify the real object, shown at a rotation of 75%. The *Progressive Silhouettes subtest* consists of 2 series of stimulus cards (depicting a gun and a trumpet), each consisting of 10 silhouette drawings, with each successive drawing revealing progressively more details of the object. The subject is required to identify the object as early as possible (in this subtest, higher scores imply worse performance).

Within the Spatial Perception part of the VOSP the first subtest is *Dot Counting*. This task consists of 10 cards with 5 to 9 dots on each. The subject has to identify the number of dots presented on each stimulus card. The *Position Discrimination subtest* consists of 20 cards. Each shows two squares containing dots. The subject has to decide which square has the dot in the center. The *Number Location subtest* consists of 10 cards. Each shows 2 squares. The top square contains randomly placed numbers while the lower square shows a black dot, placed in the same position as one of the numbers above, and which the subject has to identify. The last subtest, *Cube analysis*, presents 10 stimuli where the subject is asked to determine the number of cubes shown on each stimulus card.

Procedures

Informed consent was obtained from all participants. They were tested with the MMSE, IDDD, and VOSP in one session. All of them fulfilled the referred inclusion/exclusion criteria.

The statistiscal analysis (SPSS 8.0 for Windows) extended to both sociodemographic variables and the performance of the subjects on the 8 subtests of the VOSP. Descriptive statistics were obtained. Analysis of the distribution for each sample was also performed (Kolmogorov-Smirnov coefficient, skewness, and kurtosis). The statistical analysis was different depending on the distribution of the sample (normal or not normal distribution).

Simple or multiple lineal regression was used to study the score of subtests that followed normal distribution. A model of lineal function was proposed

(R-squared values [r^2], standard error of estimate [SEE], standardized (β), and unstandardized (B) beta coefficients are reported) considering the influence of age, gender (woman = 1, man = 0), and education. Where appropriate ($p < .05$), preliminary factors of correction were determined.

When normal distribution was not present, age and years of education were categorized into groups. Age was classified by decades into 3 groups: 1) 50–60 years old; 2) 61–70 years old; and 3) 71–80 years old. Years of education were also classified into 3 groups: 1) basic education (1–5years); 2)medium education (6–11 years); and 3) higher education (12–18 years). Non-parametric methods (Mann–Whitney tests) were first applied to determine significant differences between groups. Secondly, ANOVA with post hoc application (Scheffé's correction), based on the robustness of the test, was used to compare the difference of means between the groups that resulted significant with the non-parametric methods. This was done in order to obtain a possible preliminary factor of correction.

In a second step a comparative study was made using a Confidence Interval Analysis Program (CIA. Version 0.1 alpha, copyright Trevor Bryant) that compares size and the mean and standard deviation of the samples (95% confidence interval). The performance of our sample on the VOSP has been compared to similar studies done in different cultural backgrounds.

RESULTS

Study of the Type of Distribution on the Performance of the Sample for the Subtests of the VOSP

Descriptive statistics are shown in Table 1 (n, mean, standard deviation, and minimum-maximum values). The Silhouettes, Object Decision, and Progressive Silhouettes subtests all showed normal distribution; the Incomplete Letters, Dot Counting, Position Discrimination, Number Location, and Cube Analysis subtests did not.

Influence of Age, Gender and Education on Subtests with Normal Distribution

Silhouettes

The lineal multiple regression *analysis* resulted significant ($r^2 = .182$, $p < .01$) for age ($p < .01$; B = −0.13); $\beta = -0.29$), and gender ($p < .005$; B = −2.60; $\beta = -0.31$). Education resulted marginally significant ($p = .078$). The following prediction equation was obtained: $Y' = 30.06 + (-0.13 \times \text{age}) + (-2.60 \times \text{gender})$ (SEE = 3.90). From these partial regression coefficients, preliminary factors of correction were determined: every 8 years of age, starting at age 50, 1 extra point, if female, 2 extra points.

Object Decision

The lineal multiple regression study resulted significant ($r^2 = .093$, $p < .01$) for age ($p < .05$, B = − 0.06, $\beta = -0.19$), and gender ($p < .05$; B = − 1.02, $\beta = -0.20$). Education resulted marginally significant ($p = .056$). The following prediction equation was obtained: $Y' = 20.99 + (-0.06 \times \text{age}) + (-1.02 \times \text{gender})$ (SEE = 2.44). From these partial regression coefficients, preliminary factors of correction were determined: every 16 years of age, starting at age 50, 1 extra point, if female, 1 extra point.

Table 1. Basic Descriptive Statistics for Each VOSP Test.

VOSP test	*n*	Mean	*SD*	Min–Max
Incomplete Letters	90	19.14	1.04	15–20
Silhouettes	90	19.74	4.26	8–28
Object Decision	90	16.38	2.53	8–20
Progressive Silhouettes	90	10.89	2.55	4–16
Dot Counting	90	9.76	0.50	8–10
Position Discrimination	90	19.10	1.98	7–20
Number Location	90	8.56	1.77	1–10
Cube Analysis	90	8.57	1.89	1–10

Progressive Silhouettes
The lineal multiple regression study resulted significant ($r^2 = .174$, $p < .01$) for age ($p < .01$; B = 0.09, $\beta = 0.32$), and gender ($p < .005$, B = −1.37, $\beta = -0.27$). The following prediction equation was obtained: $Y' = 4.46 + (0.09 \times \text{age}) + (1.37 \times \text{gender})$ (SEE = 2.34). From these partial regression coefficients, preliminary factors of correction were determined: from age 50 onwards, 1 point less for every 10 years of age, and 1 point less if female.

Influence of Age, Gender, and Education on Subtests that Did Not Show Normal Distribution

Incomplete Letters
No significant differences were observed between groups for age, gender, or education. (Descriptive statistics are presented in Tables 2–4.)

Position Discrimination
The Mann–Whitney test revealed significant differences between age group 3 and groups 1 and 2 ($p < .05$, both cases) as well as between both genders ($p < .05$). The ANOVA also resulted significant ($p < .05$, $F = 4.293$) and Scheffé's correction showed significant difference between age group 3 and groups 1 ($p < .05$, difference between means = 1.27) and 2 ($p < .05$, difference between means = 1.23). There were also significant differences between males and females on the ANOVA ($p < 0.05$, $F = 4.989$), differences between means = 0.92). There were no significant differences with respect to education. From these differences of means, the following preliminary factors of correction were determined: if older than 70 years, 1 extra point, if female, 1 extra point.

Dot Counting
The Mann–Whitney test revealed significant differences between age group 3 and groups 1 and 2 ($p < .05$, both cases). The ANOVA also resulted significant ($p < .05$, $F = 4.739$) and Scheffé's correction revealed significant differences between age group 3 and groups 1 and 2 ($p < .05$, difference between means = 0.33, both cases). However, the difference between means was not considered of sufficient magnitude to determine a factor of correction that had to be of at least one point. There were no significant differences found with respect to either education or gender.

Number Location
The Mann–Whitney test revealed significant differences between age groups 3 and 1 ($p < .05$) and between education groups 3 and 1 ($p < .05$). However, such statistically significant differences were not confirmed by the ANOVA with Scheffé's correction, and no factor of correction was determined. There were no significant differences found with respect to gender.

Table 2. Descriptive Statistics by Age Groups for Each VOSP Test.

VOSP test	Age 50–60				Age 61–70				Age 71–80			
	n	*M*	*SD*	Min–Max	*n*	*M*	*SD*	Min–Max	*n*	*M*	*SD*	Min–Max
Incomplete Letters	30	19.47	0.82	18–20	30	19.13	0.94	17–20	30	18.83	1.26	15–20
Silhouettes	30	20.97	4.83	10–28	30	20.23	3.66	12–28	30	18.03	3.76	8–24
Object Decision	30	16.63	2.50	10–20	30	16.80	2.14	12–20	30	15.70	2.84	8–20
Progressive Silhouettes	30	10.10	2.41	6–14	30	10.60	2.61	4–14	30	11.97	2.31	8–16
Dot Counting	30	9.87	0.35	9–10	30	9.87	0.35	9–10	30	9.53	0.68	8–10
Position Discrimination	30	19.53	1.22	14–20	30	19.50	1.01	16–20	30	18.27	2.90	7–20
Number Location	30	8.93	1.55	4–10	30	8.83	1.29	6–10	30	7.90	2.22	1–10
Cube Analysis	30	9.00	1.20	6–10	30	8.90	1.49	5–10	30	7.80	2.52	1–10

Table 3. Descriptive Statistics by Groups of Education for Each VOSP Test.

VOSP test	Basic				Medium				Higher			
	n	*M*	*SD*	Min–Max	*n*	*M*	*SD*	Min–Max	*n*	*M*	*SD*	Min–Max
Incomplete Letters	30	18.87	1.11	16–20	30	19.10	1.18	15–20	30	19.47	0.73	18–20
Silhouettes	30	18.97	3.69	10–26	30	19.03	4.87	26–28	30	21.23	3.87	13–28
Object Decision	30	15.97	2.46	10–20	30	15.77	3.01	8–20	30	17.40	1.69	13–20
Progressive Silhouettes	30	11.27	2.45	6–16	30	11.37	2.14	6–16	30	10.03	2.86	4–15
Dot Counting	30	9.73	0.45	9–10	30	9.67	0.61	8–10	30	9.87	0.43	8–10
Position Discrimination	30	18.77	1.69	13–20	30	19.07	1.74	14–20	30	19.47	1.22	15–20
Number Location	30	8.13	1.77	4–10	30	8.57	1.98	4–10	30	8.97	1.52	4–10
Cube Analysis	30	8.23	1.61	5–10	30	8.30	1.56	5–10	30	9.17	1.12	6–10

Note. Basic = 0–5 years of formal education; lower = 6–11 years of formal education; higher = 12–20 years of formal education.

Cube Analysis

The Mann–Whitney test revealed significant differences between age group 3 and groups 1 and 2 ($p < .01$, both cases), between males and females ($p < .05$), and between education groups 1 and 3 ($p < .05$). The ANOVA also resulted significant ($p < .05$, $F = 3.969$) and the Scheffé's correction revealed significant differences between age groups 3 and 1 ($p < .05$, difference between means = 1.20) and marginally significant between age groups 3 and 2 ($p = .07$, difference between means = 1.10). There were also significant differences between males and females with the ANOVA ($p < .05$, $F = 4.938$, difference between means = 0.87). The significant differences between years of education groups 1 and 3 ($p < .05$) observed by the Mann–Whitney test were not confirmed by the ANOVA with Scheffé's correction. From these differences of means, preliminary factors of correction were determined: if older than 70 years, 1 extra point; if female, 1 extra point.

Comparative Study Between the Performance of Our Sample on the VOSP and Others (Warrington & James, 1991; Bonello et al., 1997)

The comparative study of means (CIA program) obtained by our sample (90 subjects, age range from 50 to 80 years) and that of Warrington & James (1991; 160 subjects, age

Table 4. Descriptive Statistics by Gender for Each VOSP Test.

VOSP test	Men				Women			
	n	*M*	*SD*	Min–Max	*n*	*M*	*SD*	Min–Max
Incomplete Letters	45	18.96	1.15	15–20	45	19.33	0.90	17–20
Silhouettes	45	21.04	3.42	11–28	45	18.44	4.65	8–27
Object Decision	45	16.89	2.16	10–20	45	15.87	2.78	8–20
Progressive Silhouettes	45	10.20	2.63	4–14	45	11.58	2.29	8–16
Dot Counting	45	9.80	0.40	9–10	45	9.71	0.59	8–10
Position Discrimination	45	19.56	1.31	14–20	45	18.64	2.40	7–20
Number Location	45	8.51	2.03	1–10	45	8.60	1.50	4–10
Cube Analysis	45	9.00	1.71	1–10	45	8.13	1.98	2–10

Table 5. Descriptive Results of the Performance of English, American, and Spanish Samples in the VOSP.

VOSP test	English sample ($n = 160$)		American sample ($n = 111$)		Spanish sample ($n = 90$)	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Incomplete Letters	18.8	1.4	19.46	0.73	19.14	1.04
Silhouettes	22.2	4.0	20.40	3.77	19.74	4.46
Object Decision	17.7	1.9	17.54	1.89	16.38	2.53
Progressive Silhouettes	10.8	2.5	9.62	2.20	10.89	2.55
Dot counting	9.9	0.2	9.77	0.61	9.76	0.5
Position Discrimination	19.6	0.9	19.48	1.34	19.10	1.98
Number Location	9.4	1.1	9.08	1.31	8.56	1.77
Cube Analysis	9.2	1.2	9.54	0.8	8.57	1.89

range from 50 to 69 years) for each subtest showed no significant differences. The comparative study of means obtained by our sample and that of Bonello et al., (1997; 111 subjects, age range from 50 to 84 years) for each subtest showed no significant differences, with the exception of the Progressive Silhouettes subtest ($p < .01$). Differences between samples in terms of education were not considered in this comparative study. The American sample had a mean (*SD*) education of 13.3 (±2.2) years; the Spanish sample had mean (*SD*) education of 8.62 (±4.53) years. The English sample shows no data on education. See Table 5 for descriptive results.

DISCUSSION

This work addresses the important topic of analyzing the effects of age, gender, and education on specific aspects of visual perception (using the VOSP) in a normal elderly population living in Spain (subjects between ages 50 and 80). It also examined the psychometric properties of the test, obtaining preliminary normative data for each subtest in that population.

The socio-demographic factors that may influence the performance of a cognitive instrument must be known to establish the appropriate correction scores if needed. Herein lies the importance of normative studies. These factors of correction are particularly relevant to better discriminate between normal or pathologic situations, to establish the severity of a neuropsychological deficit, or to assess the efficiency of a given treatment. When appropriate, we have determined factors of correction to be considered for each subtest, covering age, gender, and education.

Statistical analysis varied depending on distribution of the score in each subtest. Simple or multiple lineal regression were used when subtests followed normal distribution and lineal function models have been proposed. Preliminary factors of correction were determined from the partial regression coefficients of the presented equations. A different procedure was applied if subtests did not follow normal distribution. The Mann–Whitney test was first used to establish significant differences, as it is considered a powerful non-parametric test to compare two independent variables. ANOVA with post-hoc application (Scheffé's correction) was used, based on the robustness of the test to confirm the results of the non-parametric method and to compare the difference of means to establish possible preliminary factors of correction. The significant influence of the studied variables is shown, suggesting the convenience of applying these preliminary correction scores even in a healthy normal elderly population.

It is likely that there were some ceiling effects. Maximum scores were obtained in three subtests (Incomplete Letters, dot Counting, and Position Discrimination). These results coincide with those of Warrington & James (1991) showing that the majority of normal controls achieved maximum scores although these subtests reliably distinguished between controls and individuals with right hemisphere damage. Accordingly, Bonello et al. (1997) showed that participants scored more than 96% correct on these three subtests.

Age has been described as a decisive factor in perceptive tasks (Albert, 1998; Bonello et al., 1997; Warrington & James, 1991). In our study, age proved significant in 5 of the 8 subtests. Related to object perception, age resulted significant for 3 subtests. Related to space perception, age resulted significant for 2 subtests. Our data are almost identical with those of other normative studies in American (Bonello et al., 1997) and English (Warrington & James, 1991) populations, showing an age effect on visual object and space perception. However, these results should be cautiously interpreted for two reasons. First, it is known that visual ability decreases with age, affecting visual acuity, accommodation, adaptation to darkness, as well as depth perception and object size (Bennet & Eklund, 1983); we have not controlled these factors with specific tests. Second, some psychometric limitations of the VOSP consistent with poor internal consistency reliabilities have been referred to (Bonello et al., 1997; Rapport et al., 1998), in both space and object perception subtests. However, this effect of aging has also been shown for other visuospatial perception tests such as the Visual Object Learning Test (Glahn et al., 1997) the Benton Visual Retention Test (Coman et al., 1999), the Hooper Visual Organization Test (Richardson & Marottoli, 1996), or the Shum Visual Learning Test (Shum, Gorman, & Eadie, 1999).

Apart from the predictable aging effect observed in our results we have found differences concerning the variable of gender in the VOSP. The magnitude of gender differences in spatial abilities has been approached in a meta–analysis (Voyer, Voyer, & Bryden, 1995); although partial support was found to consider that the magnitude of gender differences has decreased in recent years, results showed that sex differences are significant in several tests. In our study, significant differences between males and females were observed in 5 of the 8 subtests. The variable gender resulted significant in the same subtests where an aging effect has been shown. The influence of the variable gender was not studied in the English population (Warrington & James, 1991) and proved not to be significant in the American population (Bonello et al., 1997) where a subgroup of 43 men and 43 women with similar age, education, and IQ were compared. In our sample we ensured that there were no differences between genders in terms of age and years of education. Our results coincided with other studies, which likewise revealed differences between gender when performing multisensory integration in spatial orientation (Berthoz & Viaud-Delmon, 1999), passive storage and active manipulation in visual-spatial processing (Vecchi & Girelli, 1998), dimensional mental rotation test (Collins & Kimura, 1997), or visual detail ability on scene recognition (Hamel & Ryan-Jones, 1997). However, these mentioned tasks suppose greater difficulties than VOSP subtests or imply the activation of cognitive abilities that are not required when performing the VOSP.

The effect of years of formal education was also studied. Our results showed marginally significant influences for both Object Decision and Silhouettes subtests. These results are similar with those of the American sample (Bonello et al., 1997), in which formal education proved equally significant for the Silhouettes and Object Decision subtests. Semantic knowledge may be adduced in order to explain the observed differences between groups. Bonello et al. (1997) also described significant though weak correlations between the estimated verbal IQ and the performance on Silhouettes, Dot Counting, and Cube Analysis subtests. The influence of education in the English sample was not studied (Warrington & James, 1991).

A comparative study of the mean performance on the VOSP obtained by our sample and that of the English sample (Warrington & James, 1991) revealed no significant differences. A similar comparative study of our data and that of the American population study (Bonello et al., 1997) revealed no significant differences, with the exception of the Progressive Silhouettes subtest. Although all three studies were carried out on normal subjects, some differences can be noted especially related to education. The American sample had higher education and included 45 men and 66 women with women significantly older and less educated (Bonello et al., 1997). Our sample included 45 men and 45 women with no differences between genders in terms of age and education. The English study shows no data on education. These differences suppose limitations to the comparative study. However, it is relevant for us that, when comparing the mean performance of the VOSP subtests, similar results were obtained, suggesting that different geographical and cultural populations perform in a similar way (at least in occidental cultures, in the U.S. and two European countries).

The present results are mainly coincidental compared with other studies that provide evidence of the importance of the socio–demographic variables when performing specific object and spatial visual perception tasks. The influence of age and education appears very similar in our study to that of Bonello (1987), while the influence of gender has shown some differences. Some limitations have to be considered to interpret these results. We have also provided the first preliminary normative data for the VOSP in a Spanish population of normal elderly subjects. The present study should be extended by others, broadening the age range studied, increasing the sample size, and comparing the performance of normal and pathological populations.

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