Visual reproduction test in normal elderly

Influence of schooling and visual task complexity

Paulo Roberto de Brito-Marques¹, José Eulálio Cabral-Filho², Rafael Moura Miranda²

ABSTRACT. Tests of visual reproduction are used to assess visual memory. However, when the test is based on geometrical elements results could be influenced by schooling. Objective: To evaluate the influence of different schooling levels on performance of a visual reproduction task. Methods: A sample of 253 individuals (66 male and 187 female), aged 60 to 92 years were evaluated on a visual reproduction task comprising three geometric pictures of increasing complexity. Each individual was shown a picture for 8 to 10 seconds and a drawing of it was then immediately elicited. Four groups were defined according to the following schooling levels: illiterate, 1 to 4 years, 5 to 8 years and over 8 years. Individual performance was measured by summing the items correctly reproduced for the three pictures. Results: A significant difference for age was found between the illiterate and other three schooling groups. The reproduction of picture one was better reproduced than pictures 2 and 3 for all schooling levels (p<0,001). Pictures 2 and 3 did not differ among the schooling levels. Picture reproduction among the schooling levels showed that the group with over 8 years of schooling performed better on pictures 1 and 2 (p<0,001) but not on picture 3. Conclusion: Individuals aged 60 years or older, with 8 years’ schooling or less, showed a reduced capacity to reproduce geometric pictures of a high degree of complexity. Clinical evaluations that use geometrical tests could be misinterpreted when not controlled for schooling level.

Key words: visual reproduction, visual memory, schooling.

INTRODUCTION

According to the definition of Lezak,¹ visual memory is the capacity to retain information and utilize it for adaptive purposes. Efficient visual memory requires the intact functioning of many specific brain regions.

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Executive functions consist of those capacities that enable a person to engage successfully in behaviors.

The topography underlying executive functions is located in the frontal lobes, particularly the prefrontal lobes. Dysexecutive syndrome encompasses five types of disorder: [1] Deficits in initiation, cessation, and control of action; [2] Impairments in abstract and conceptual thinking; [3] Deficits in cognitive estimation; [4] Lack of cognitive flexibility and deficits in response to new information; and [5] Deficits in goal-directed behaviors. Executive functions consist of those capacities that enable a person to engage successfully in dependent or independent, constructively self-serving, and productive. When executive functions are impaired, the individual may no longer be capable of carrying out satisfactory self-care, performing remunerative or useful work independently, or able to maintain normal social relationships regardless of how well-preserved their cognitive capacities are — or how high the person scores on tests of skills, knowledge, and abilities.

Visual memory tests can be impaired among aged groups as a result of other factors besides visual memory. According to Lezak, such tests often call for a visuo-motor response, typically drawing. This can complicate the interpretation of performance deficits since failure may arise from constructional disability, impairment of visual or spatial memory, or from an interaction among these and other factors.

Many types of problems drawing printed geometric pictures have been described under the name of constructive apraxia. Indeed, the term has been used to designate both drawing disability and defective execution of many other kinds of constructional tasks. Tests based on geometric pictures require not only preserved attention and STM, but also perception and visuo-constructive skills. Therefore, three abilities are required to allow adequate responses to questions posed in this kind of test: memory, praxia and perception.

Although visual memory tests have been used for individuals of different schooling levels, it is important to investigate visual memory by using tests of reproduction of geometrical pictures according to level of schooling. Some of these tests require the ability to draw geometric figures. On the other hand, the reconstruction of a geometric figure should be easier for individuals with greater schooling since this ability is part of education curricula. The relationship between visual reproduction tests and schooling level could be important because of the risk of misinterpretation of results, having serious repercussions on diagnostic decisions. False negative or false positive results could arise if the relationship between educational level and test performance is not taken into account. However, to our knowledge, few studies investigating this issue in normal elderly are available in the literature. Therefore, an investigation on this topic is opportune. The aim of the present study was to test the hypothesis that individuals with greater schooling perform better than individuals with lower schooling on visual memory tests.

**METHODS**

A randomized cross-sectional study was conducted enrolling 253 individuals of both genders (66 male and 187 female), 60 to 92 years old, belonging to low and middle socio-economic classes, from the city of Olinda, Pernambuco, Brazil. Visual memory was assessed using a visual reproduction test according to Wechsler Memory Scale-Revised. The procedure was performed as an immediate recall test. The short test consisted of observing and drawing three printed geometric pictures of increasing complexity. Complexity was defined by a higher number of graphical components. This sub-test assesses the skills of memorization and reproduction of visual stimuli (Figure 1).
The test contains 3 pictures presented on separate cards. The first picture is scored from zero to 3 points: 1 point given for two lines crossing with four flags; 1 point if flags have the correct position facing each other at the top and bottom; 1 point if correct proportions are observed in relation to the central angle (which must be between 60° and 120°) and to dimensions of the 4 sides of each flag (flags should be in the form of a square).

The second picture is scored from zero to 5 points: 1 point for the presence of the bigger outer square, properly divided by perpendicular lines crossing through the middle; 1 point for the presence of 4 medium-sized squares within the large square; 1 point for division of the medium squares by perpendicular lines crossing through the middle; 1 point for the presence of a central dot in each of the 16 small squares; and 1 point for observing the correct proportions of size among the squares.

The third picture task is divided into two distinct parts (a and b) and scored from zero to 7 points: Part a – 1 point if the central rectangle is open in the correct places with good lines extending to the side loops; 1 point for the existence of two more or less correct loops, forming a right angle with the lines derived from the rectangle; 1 point if the two symmetrical loops are placed within the inner part of the drawing; 1 point if the proportions are respected where the height of the inner rectangle should be close to that of the arms supporting the loops. Part b – 1 point for reproduction of the large rectangle with small inner rectangle according to their geometrical forms; 1 point is given if the top of the inner rectangle is joined to the top of the outer rectangle by straight lines; 1 point for reproduction of the correct parallelism between the two rectangles. The maximum score for the 3 picture test is 15 points.

Before being shown each picture, the subject was informed about the test procedure. The picture was then presented for eight to ten seconds and immediately removed from view. Soon after this visual presentation, the individual was required to reproduce the picture manually on a white sheet of paper. Following each picture exposure, the individual drew what they remembered of the picture. For the test, each picture was showed separately starting with the image of lowest complexity. Each picture was scored by summing the items correctly reproduced, adding subtotals to give a final score for the individual, considering the maximal value of 100% in each picture.

A clinical interview was performed with each subject by one of the authors (PRBM) in order to investigate neurological and psychiatric diseases. To verify praxia ability, all individuals reproduced a copy of a circle and a square before testing. Since mentally disabled people have difficulty performing some tasks of daily living, participants were queried about their normal daily routine. Individuals unable to get around, tell the time on a clock, handle cash money, or use a tin opener (intermanual conflict) were excluded. People with low visual or auditory acuity, motor or rheumatic disturbance, chronic alcoholism, cardiovascular disease, recent head trauma (last 12 months) or a lack of motivation, were also excluded.

To verify the influence of schooling on visual reproduction, four groups were formed according to schooling level: Illiterate Group (n=28), with mean age of 73.7 (SD=6.0) years, comprising individuals with no formal schooling; schooling Group 1-4 (n=119), with mean age of 70.2 (SD=7.2) years – individuals with 1 to 4 years of formal instruction; Group 5-8 (n=85), with mean age of 67.6 (SD=5.7) years – individuals with 5 to 8 years of formal education; and a Group over 8 years (n=21), with a mean age of 66.4 (SD=6.5) years – individuals with over 8 years of formal education. This study was approved by the Research Ethics Committee of the University Oswaldo Cruz Hospital in the city of Recife – Brazil.

**Statistical analysis.** Prior to statistical analysis, the variance homogeneity and normality of the data were verified by Levine and Kolmogorov-Smirnov tests, respectively. When these conditions were not met and groups...
were dependent, Friedman’s analysis followed by Dunn’s test for multiple comparisons of median between each pair of two groups, was applied. When the data satisfied the criteria of normality Student’s “t” test was used.

The alpha error for rejection of the null hypothesis was 0.05.

RESULTS
Comparison of the difference in age among the schooling groups (Table 1), revealed that illiterate individuals had a higher mean age than those from the 1 to 4 years (p<0.05), 5 to 8 years (p<0.001), and over 8 years (p<0.001) schooling groups. However, there was not statistical difference among the literate groups.

Concerning the picture reproduction by the four schooling levels (Figure 2), results verified that subjects with a schooling level of over 8 years performed better for pictures 1 and 2 (p<0.001) but not for picture 3, compared with the other schooling levels. There were no statistical differences among the three other schooling levels for any of the pictures.

Upon examining the three pictures at each schooling level (Figure 3), it was observed that only Picture 1 differed compared to the others.

DISCUSSION
Several studies have shown an association of the execution or reproduction of mental and memory tasks with schooling level.11-16 The process of visual reproduction

<table>
<thead>
<tr>
<th>Table 1. Age comparisons by schooling level.</th>
<th>Illiterate 1-4 years 5-8 years &gt;8 years</th>
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<tbody>
<tr>
<td>(n=28) (n=119) (n=85) (n=21)</td>
<td></td>
</tr>
<tr>
<td>X±SD</td>
<td>73.7±6.0 70.2±7.2 67.6±5.7 66.4±6.5</td>
</tr>
</tbody>
</table>

Comparisons among levels: ANOVA. Multiple comparisons of each pair of levels. Tukey’s test. Illiterate X (1-4 y), p<0.05; Illiterate X (5-8 y), p<0.001; Illiterate X (>8 y), p=0.001.

Figure 2. Visual reproduction by individuals, aged 60-92 years, with different schooling levels according to picture complexity.

Figure 3. Visual reproduction of geometrical pictures of increasing complexity by individuals aged 60-92 years, according to schooling level.
of a picture after a time interval, such as that used in
the present study, is dependent on memory, especially
short-term memory. Moreover, the relationship be-
tween schooling and visual acquisition may influence
the reliability of reproduction. Our results show that
individuals with over 8 years of schooling had superior
performance to the other groups on visual reproduction
of Pictures one and two (Figure 2). This is an important
finding because it could indicate that schooling level in-
fuences performance on the test. On the other hand,
the illiterate group had an overall lower performance
but was significantly older than the over 8 years school-
ing group. In this case, the influence of age on the result
observed cannot be ruled out, thus precluding confirma-
tion of an effect of schooling on the performance of
these individuals. Nevertheless, the fact that pictures
one and two yielded a difference in scores between the
highest schooling group (>8 years) and the other school-
ing levels (Figure 2) allows the deduction that, for the
reproduction of the pictures one and two, individuals
perceive the basic principle of their construction more
easily than that of picture three. Indeed, the first two
pictures each present only one focus of attention, while
picture three presents two foci. It is probable that to
draw more reliably a geometric picture from the obser-
vation of another similar picture, some acquired hand
skill or innate intellectual ability could be relevant, a
skill which could be acquired during school training. In
addition, it has been demonstrated that the memory of
a scene can be influenced by the meaning of that scene.2
Considering the variations in complexity of the
pictures, it was verified that the best performance was
observed for Picture one for all schooling levels, while
the visual reproduction of Pictures two and three was
equivalent for all schooling levels, despite being lower
than that of Picture one (Figure 3). The superior repro-
duction of Picture one for all schooling levels could sug-
gest that other factors other than schooling influence
visual reproduction. The most important factors for the
reproduction of pictures displayed in this test are draw-
ing skill, attention, holistic perception of the picture,
and visual memory.1
The lower familiarity of the less schooled individuals
regarding handling of school implements (pencil, pen,
paper, etc.) could have induced an apparent construc-
tive apraxia or incapacity to draw, especially in relation
to complex pictures.
In healthy individuals, visual memory is a dynamic
cognitive component dependent on a number of cogni-
tive and functional cortical components that contribute
to the establishment of information for the formation
of immediate memory and short-term memory. Visual
memory may involve several components such as lan-
guage, praxia, supported by attention, perception, and
motivation. In individuals with neurodegenerative dis-
eases, as well as Pick’s disease, Lewy body disease or
corticobasal degeneration that lead to loss of visual mem-
ory, changes are evident on the tests in various ways.
It is believed the functional structure of the cerebral
cortex can change the extent to which the degenerative
disease progresses. Thus, it is possible to change the vi-
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