

ORIGINAL ARTICLE

Impact of the socio-economic environment on working memory and visuo-constructive skills among students in the Tiznit region of southern Morocco

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Abstract

Cognition is the set of mental and cerebral processes that are specialized in the tasks of information processing. Cognitive functions are of major importance in most learning activities, including the visual perception that allows the identification of the visual information and the working memory that allows the processing and manipulation of this information in real time. The evaluation of these cognitive functions in students is essential to prevent cognitive disorders and deficits, in order to ensure a normal school and sanitary development of the student.

In this work, perceptual and mnemonic processes were followed in relation to the place of residence, gender and age. The study is based on a sample of 121 high school students, healthy and with perception and memory disorders, from rural area of Tiznit, through the Rey Complex Figure (FCR) computerized version test (ELIAN). The results obtained from the statistical analysis showed a relative risk of the appearance of cognitive disorders in these students.

This study shows the value of screening students for cognitive deficits in order to allow the implementation of therapeutic and rehabilitative treatment aimed at improving the competences and prevent problems with their health and education.

INTRODUCTION

Cognitive functions are of major importance in most learning activities, including visual perception and working memory:

- Visual perception is a cognitive skill that allows the individualization and arrangement of elements to form a structure according to their spatial relationships (Branger 2011). The processing of visual-spatial information would be mainly

located in the posterior parietal regions of the right cerebral cortex (Aleman *et al.* 2002).

- Working memory is a system of limited capacity, intended for the temporary maintenance and manipulation of information during the performance of various cognitive tasks (reasoning, comprehension, problem solving) (Baddeley 1986).

Disorders of visual perception and working memory are widespread among schoolchildren (Ahami *et al.* 2010). Knowing that a visuo-constructive deficit or working memory would lead to academic difficulties in geometry, writing and mathematics (very slow, important application to obtain a correct writing), these disorders constitute a real problem that can lead to school failure (Ahami *et al.* 2010), hence the importance of assessing these cognitive functions in students in order to prevent cognitive disorders and deficits and to ensure normal school and health development of the student.

In an effort to identify visual perception and working memory disorders, 121 high school students who were healthy and had perceptual and memory problems were examined through the complex figure test. Rey-A (FCR-A) computerized version (ELIAN software). These students come from the rural region of Tiznit in southern Morocco, among them students who live with their families, others at the boarding high school. Distribution into reference percentiles (Wallon et Messmin 2009) were used to identify potential perceptual and memory deficits in the students examined.

MATERIAL AND METHODS

The study was conducted in the rural region of Tiznit province. This region has experienced long periods of drought due to its remote location and in the mountains. However, it was provided with water in its entirety in the 1990s and electricity in 2000. This region is economically poor; the population is approximately 900 inhabitants, based on farming and livestock to ensure their life.

The size of the sample studied is 121 adolescents at school, including 66 boys (54%) and 57 girls (46%), aged between 14 and 22 years, and the average age is (17.04 ± 1.5 years). They are all high school students.

In order to identify visuoconstructive disorders and working memory, the REY-A (FCRA) test was used. This neuropsychological test aims to measure the perceptive and mnemonic organization of the individual, and also makes it possible to distinguish subjects suffering from a perceptual disorder from those suffering from a memory disorder. This test includes:

- a. The copy of a complex geometrical figure, characterized by a lack of meaning as well as a rather complicated structure to solicit the perceptive analysis and the organizational capacities of the subject (Rey 1941, 1959) ;
- b. The delayed reproduction of memory. Thus the working memory is solicited to reproduce by a reminder of the various elements drawn before a few minutes.

A new method of collecting FCR plots has been developed and implemented by Wallon and Messmin (Wallon et Messmin 2002). With the aid of the Logitech digital pen, the subject is drawn on a paper covered with a weft, so fine that it appears to the naked eye as a uniformly light gray color; CREDAGE A4 paper. The pen thus continuously records the dynamics of the lines as a sequence of x, y coordinates, as well as instantaneous pressures. In addition, the copy and reproduction proofs take place on the same A4 paper page of CREDAGE paper, folded in two equal parts. Thus, to prevent the copy from being printed on the part reserved for reproduction, it is necessary to place a small cardboard between the two half-sheets. The time of handover is free. The data is stored in the pen's memory (approximately 50 to 100 plots depending on the model) to be returned to the computer as soon as it is connected to it via a USB base. Specific "ELIAN" software "Expert Line Information ANalyser" exploits this data, to render on-screen the dynamics of the plot according to various modes, and to provide the encrypted parameters.

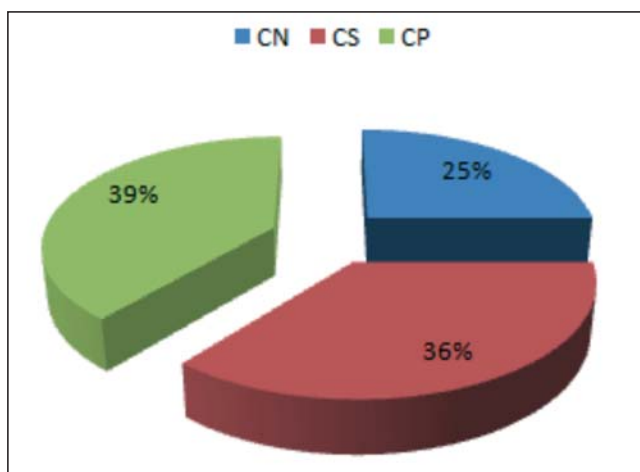


Fig. 1. Distribution of students by score in copy phase
CN: Normal cases CS: Cases to monitor CP: Pathological cases

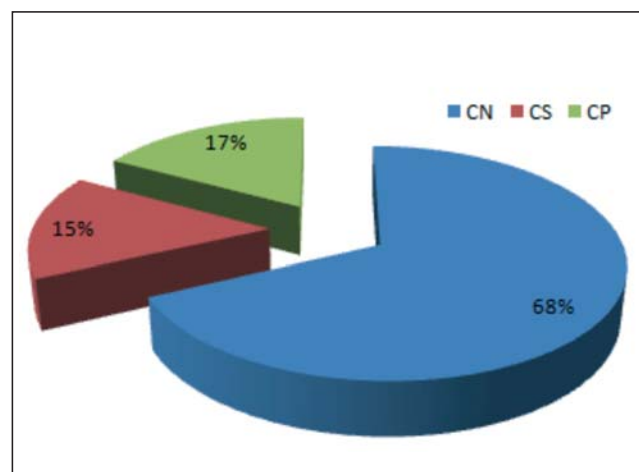


Fig. 2. Breakdown of students according to the recall phase score in memory.
CN: Normal cases CS: Cases to monitor CP: Pathological cases

Tab. 1. Comparison of scores by gender and habitat in copy phase

	Mean± SD	Test	Sig
Boys	61,24±5,81		
Girls	60,07±7,49		
Gender		t=0.96	P=0.33
Boarding school	61,07±6,90		
Family	60,24±6,29		
Habitat		t=0.68	p=0.49

Tab. 2. Comparison of scores by gender and habitat in reminder phase

	Mean± SD	Test	Sig
Boys	42.81±10.32		
Girls	42.74±13.26		
Gender		t=0.03	P=0.97
Boarding school	42.26±11.59		
Family	43.45±11.90		
Habitat		t=-0.55	P=0.58

The presentation of the results will be done from the distribution of the scores in percentiles: the scores are organized in three classes of percentiles to give the diagnosis of orientation. Subjects whose central values between the 25th and 75th are considered to have a "normal" cognitive and neuropsychological profile, those between the 10th and 25th or 75th and 90th percentiles are considered "tangents" or "to be monitored", finally subjects with extreme values of < 10th or >90th are considered "abnormal or pathological" cases. A subject will be considered normal if it is between the percentiles 25 and 75. It will be considered as tangent or to be noticed between the percentiles 10 and 25, and 75 and 90. But it is especially the extreme percentiles which will hold the attention that is, subjects in percentiles less than 10 and greater than 90.

The statistical analysis was performed with the Statistics software for Social Sciences (SPSS, version 20.0) and the Excel spreadsheet (2007 version).

RESULTS

In this study, we evaluated visual perception and working memory, by means of the FCR computerized version test, in a group of adolescents attending secondary school, living in rural areas of the city of Tiznit.

The results are grouped into two categories: results according to the score obtained during the copy or the reproduction, and results according to the dynamic parameters of the plot, namely the duration of execution and the dimensions of the drawing (width and height).

According to the Score:

1. Copy phase:

For the total sample (N = 121), 25% of healthy students were found, while 36% were to be monitored and 39% found with visuoconstruction disorders.

It should be noted that, in this case, students considered pathological are those with percentiles less than 10.

Correlation showed that copy-phase scores were negatively correlated with age ($r = -0.41, p < 0.001$). However, the correlation between visual perception and habitat ($r = -0.06, p = 0.47$) and gender ($r = 0.04, p = 0.61$) is not significant.

With regard to the comparison of the scores obtained by gender and habitat, no significant difference was found between the two groups ($p > 0.05$).

2. Reproduction phase:

For the total sample (N = 121), 68% of healthy students were found, while 15% were to be monitored and 17% showed visuoconstruction disorders.

Correlation showed that reproductive phase scores were negatively correlated with age ($r = -0.32, p < 0.001$). However, the correlation between visual perception and habitat ($r = 0.09, p = 0.31$) and gender ($r = -0.01, p = 0.86$) is not significant.

With regard to the comparison of the scores obtained by gender and habitat, there is no significant difference between the two groups of students ($p > 0.05$).

Dynamic parameters:

These parameters are concerned with the dynamics of the plot: the size of the drawing and its duration

Tab. 3. Comparison of Dynamic Parameters by Gender

Variable	Mean ± SD boys	Mean ± SD girls	t-value	Sig
Duration copy (sec)	180,39±63,93	194,80±74,24	-1,14	0,25
Duration memory (sec)	151,04±67,34	143,10±48,81	0,72	0,46
Drawing height copy (mm)	105,68±13,27	106,63±11,68	-0,41	0,67
Drawing height memory (mm)	103,53±19,81	100,90±20,17	0,71	0,47
Drawing width copy (mm)	173,75±18,41	174,43±19,18	-0,19	0,84
Drawing width memory (mm)	166,80±21,72	158,07±26,07	2,009	0,04
max speed copy (mm/s)	71,43±33,57	59,56±21,18	2,27	0,02

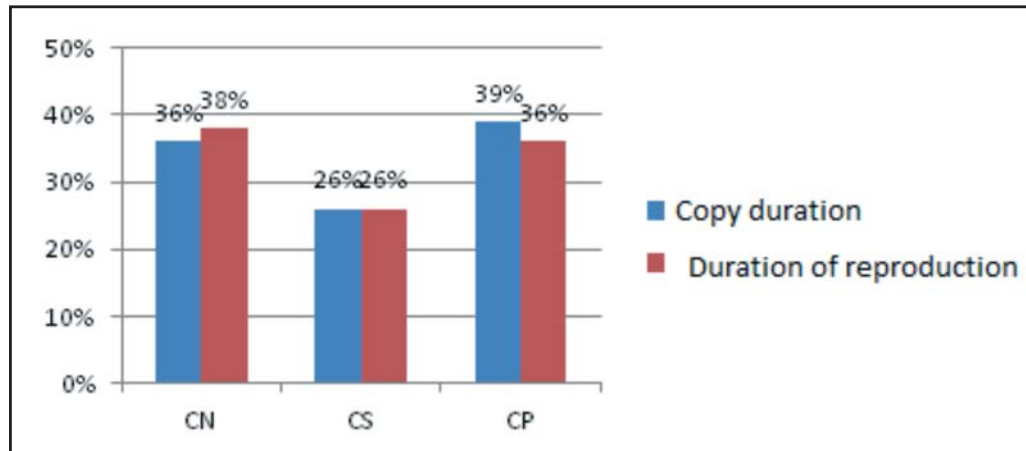


Fig. 3. Representation of the sample according to the duration of execution
 CN: Normal cases CS: Cases to monitor CP: Pathological cases

of execution. The model imposes on the drawing of the subject a certain size; as for the duration of execution, it identifies the slowness or the speed of the subject. Copy and reproduction are processed independently.

1. Duration of execution:

For the copy, it is on average 187 seconds on the totality of the sample, and for the reproduction of 147.2 seconds. For the entire sample, we found:

- Copy phase: 36% of healthy subjects, 26% to be monitored and 39% are pathological;
- Reproduction phase: 38% healthy, 26% to be monitored and 36% are pathological.

The correlation between the duration of execution on the one hand and age, gender and habitat on the other hand is not significant.

2. The dimensions of the layout: height and width of the drawing:

The height and width of the drawing designates the dimensions of a rectangle (horizontal base and vertical height) in which the entire realization (copy on the one hand, reproduction on the other hand). For the entire sample, we found:

For the height:

- Phase of copy: 20% of healthy subjects, 31% to be watched and 49% are pathological;

- Phase reproduction: 31% healthy, 33% to be monitored and 36% are pathological.

For the width:

- Phase of copy: 3% of healthy subjects, 8% to be monitored and 89% are pathological;
- Phase of reproduction: 11% healthy, 22% to be monitored and 67% are pathological.

A significant correlation was found between breeding height and habitat ($r = -0.2, p < 0.05$) on the one hand, and breeding width and gender ($r = -0.18, p < 0.05$) on the other hand. The other dynamic parameters are not significantly correlated with age, gender and habitat.

Comparison of dynamic parameter values by gender and habitat:

A significant gender difference was found for copy execution speed ($t = 2.27, p = 0.02$), and memory drawing width ($t = 2.00, p = 0.04$).

Regarding to the boarding school, no significant difference was found between the two groups (boarding and non-boarding).

DISCUSSION

The present study is a comparative study of visual perception and working memory among adolescents examined by age, gender and place of residence.

Tab. 4. Comparison of Dynamic Parameters by Habitat

Variable	Mean ± SD Boarding school	Mean ± SD family	t-value	Sig
Duration copy (sec)	176,16±61,87	200,77±75,31	-1,97	0,05
Duration memory (sec)	145,79±64,38	149,54±53,20	-0,34	0,73
Drawing height copy (mm)	106,55±11,37	106,63±11,68	0,43	0,66
Drawing height memory (mm)	101,57±17,22	105,54±13,98	-0,47	0,63
Drawing width copy (mm)	174,25±16,21	173,83±21,62	0,12	0,9
Drawing width memory (mm)	163,61±20,83	161,83±27,91	0,4	0,68

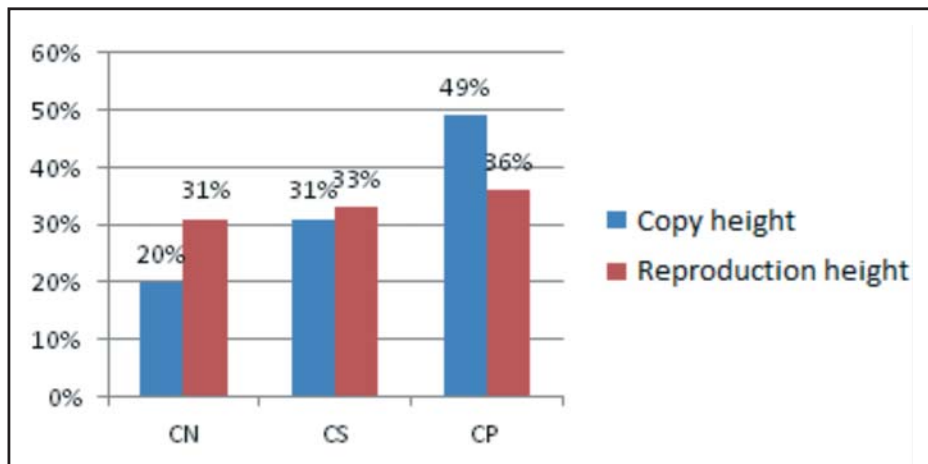


Fig. 4. Representation of the sample according to the height of the drawing
 CN: Normal cases CS: Cases to monitor CP: Pathological cases

Girls' education is low compared to boys in these regions due to traditions and habits of the inhabitants, which means that girls do not have to go to school and continue their education. However, boys continue their studies without problems. We want to check if this can affect the cognitive skills of students according to their gender.

The comparison seems interesting since students have similar genetic origins, share a certain number of values of eating habits, socio-cultural and are subject to the same educational system. Indeed, students in the study population come from the same community, except that students reside at the boarding school due to the distance between their homes and the school. This evaluation was done by analyzing digital data from the ELIAN software.

With regard to the numerical score of the FCR-A test, the analysis of the performances obtained in the Rey test showed that 40% of pupils showed signs of perception deficit and 17% of the signs of memory deficiency short term. These results are comparable to those of the

works of Ahami and al, (2010) and A. Eloirdi and al, (2018) in Moroccan children of school age.

The results highlight a lack of relationship between the gender of the students and the score obtained in the copying phase and memory reproduction, which means that there is no effect of the gender on the number of points obtained at the FCR. Our results are similar to those obtained by Alice T-C (Alice 2012) who shows that the gender variable does not significantly influence FCR-A test results.

With regard to the place of residence, it was found that it did not influence the perceptual and memory skills of the pupils between the two groups of students (residents at the boarding school or with their families), which means that living in the boarding school has no effect on students' perception and working memory. However, the average obtained by students residing at the boarding school is 61.09 ± 6.99 compared to 60.25 ± 6.19 for pupils living with their families during the copy phase, whereas the average obtained during the in-memory reproduction is 61.09 ± 6.99

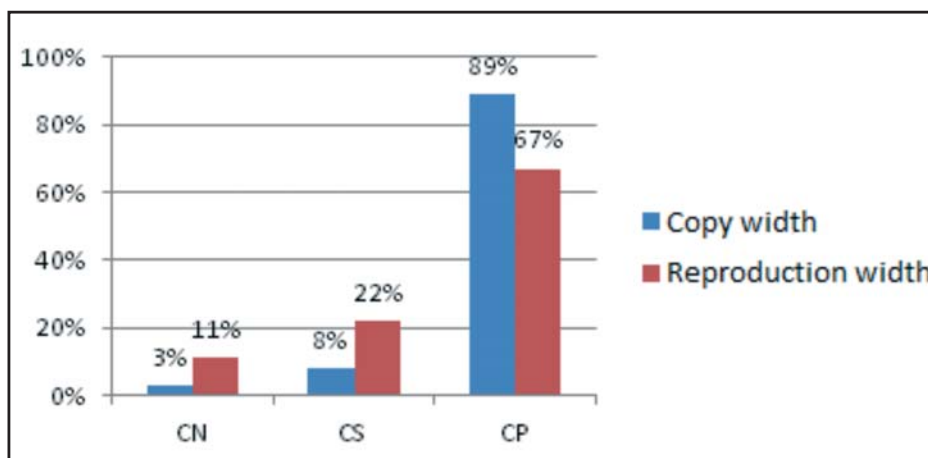


Fig. 5. Representation of the sample according to the width of the drawing
 CN: Normal cases CS: Cases to monitor CP: Pathological cases

for resident boarding students versus 61.09 ± 6.99 for non-boarding students, showing a slight improvement in perception and working memory among adolescents living at the boarding school.

This can be explained by the fact that the school work at the boarding school is constantly and strongly present; the boarding school is not only a place of accommodation, but also an educational aim, with a direct supervision of teachers. In fact, the boarding school favors school work, provides a less exhausting rhythm of life, protects and controls students. It can thus become a place of self-construction (Glassman 2012).

Jennings and Colhberg (1983) have shown that in delinquent adolescents moral judgment is evolved into a boarding school, and the created atmosphere of equality and equity favors their cognitive development.

With regard to age, it turned out that the youngest pupils are more successful in terms of visual perception and working memory than the older ones. Several previous studies have shown a close relationship between age and performance in the copy-and-copy phases of FCR-A (Bennett Levy 1984; King 1981; Ardila et Rosselli 1989; Boone and al. 1993; Janowsky and al. 1993; Lisa and al. 1997).

According to Janowsky and al. (1993), the difference according to age is not related to the strategy used. However, the work of Wallon and Messmin (2009) and Alice (2012) revealed no influence of age on the performance of the FCR test. These results suggest that the age difference in the performance of the FCR test would probably be due to the fact that the oldest students are the least inhibited, especially as their average copy speed is higher.

With regard to the dynamic parameters of the plot, namely the execution time and the dimensions of the drawing, it is found that the execution time is, on average for the copy of 186,9 seconds on the entire sample, and for the reproduction of 147,4 seconds. This difference is explained by the fact that the student spends more time analyzing the figure to copy it than to restore memory.

No statistically significant effect of age on exercise duration was found, however, there is a tendency for a decrease in duration with age. This is confirmed by the work of Rbiaa (2017) and Ouali (2013) who confirmed that the time of completion of the Rey complex figure decreases as a function of the evolution of age.

With regard to the dimensions of the drawing, we found a significant correlation between the height of the drawing during the reproduction in memory and the habitat on the one hand, and the width of the drawing during the reproduction in memory and the gender on the other hand. Other dynamic parameters are not significantly correlated with age, gender and habitat.

It is found that the correlation is important at the stage of reproduction in memory. Indeed, during the

reproduction, the student is no longer constrained by the model, and the size of the drawing has more meaning than the copy. An excessive size refers to a lack of control of the gesture, an insufficient size to an inhibition.

Indeed, the results obtained by Ouali (2013) also highlight the absence of a significant effect of the gender on the realization times of the Rey Complex Figure and its dimensions. Which are consistent with our results except at the level of the width of the drawing reproduction and gender.

CONCLUSION

This study of a population of 121 school-aged adolescents in rural Tiznit revealed a deficit in visual perception and working memory among students in the study population (40% have perception deficits) and 17% have a potential working memory deficit, reflecting the seriousness of the situation).

Also, the results of the RCF-A test reveal that visual perception and working memory depend only on age, whereas there is no effect of gender and place of habitat on perception and working memory.

The establishment of a nationwide benchmark is to be hoped, as well as a collaboration between the Ministry of Health and the Ministry of National Education with the aim of putting a strategy of early detection and remediation of psychomotor and attention disorders so as to ensure a health and education of quality.

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