

Evaluation of visuo-perceptual functions and their correlation with academic and motor performance in secondary school students: A case study in the Sidi Slimane delegation, Morocco

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Submitted: 2025-01-18 *Accepted:* 2025-03-20 *Published online:* 2025-03-31

Key words: **Visual Perception; Academic Performance; Motor Performance; Elian Test**

Act Nerv Super Rediviva 2025; **67**(1): 28–35

67012504

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Abstract

Neurocognitive functions play a key role in the learning process, so the aim of this study was to investigate the evaluation of visuo-perceptual skills and their relationship with academic and motor performance in secondary school pupils. (Delegation: Sidi Slimane, Morocco). In a sample of 384 students aged between 12 and 19, visual perception was assessed using the FCR-A test (ELIAN-ANOTO digital). School performance in this study is represented by the overall average obtained during the 2021-2022 school year. Motor performance is represented in this study by the final grade in physical education and sports obtained in the second semester of the same school year. The results showed a mean overall test score of 64.93 ± 4.481 , and that FCR-A (visual perception) scores varied increasingly according to school level and age. The study also showed that the difference in visual perception between the environments studied was significant. The study also revealed a significant positive correlation between visual perception and school performance ($r = 0.108$; $p < 0.05$), as well as a significant positive correlation between visual perception and motor performance ($r = 0.125$; $p < 0.01$). It is clear that visual perception plays a decisive role in student performance. Thus, this study invites all those involved in education and other fields to intervene to remedy the problems of neurocognitive functions in order to increase academic success.

INTRODUCTION

Students' academic success depends primarily on their ability to learn. Reading is essential for learning academic subjects and developing new cognitive skills (Bellocchi *et al.* 2017). Classrooms are filled with students whose skills and competition with each other are controlled by several parameters (Brown, 1992). The teacher must monitor, manage, assess and educate all students in a personalized way and at the same time (Borko and Livingston, 1989; Reigeluth *et al.* 2015), and also the students themselves must extract relevant information from the teacher and teaching materials to learn, neglect irrelevant distracting behaviors from their peers (Jarodzka *et al.* 2021). Then, the academic performance of these students is influenced by several Neurocognitive parameters, of which attention, visual perception, and working memory are the main factors (Aguirre-Pérez *et al.* 2007; Puerta Morales, 2015; Gkintoni *et al.* 2021). Handwriting acquisition requires a combination of visual-motor integration with motor skills, cognitive planning and perception (including tactile-kinesthetic abilities, as well as spatial and temporal organization) (Adams *et al.* 2018; Godde *et al.* 2018). Deficiencies in these skills could contribute to difficulties in academic performance, participation in school activities and self-perception (Rajab *et al.* 1996; Cipolletta *et al.* 2018).

As such, performance in learning tasks is directly influenced by the quality of visual input, resulting in visual perception and cognitive performance (Capó-Aponte *et al.* 2009). Fine motor skills require rigorous hand and finger movements and depend on hand-eye coordination to complete a task successfully (Beery and Buktenica, 1997; Carlson *et al.* 2013).

Motor development includes changes in motor behavior throughout life, as well as the processes responsible for these changes (Tepeli, 2013). Indeed, the processing of visual information involves a range of cognitive functions such as attention, executive functions, intellectual, visuo-spatial, gnostic, linguistic abilities, memory, working memory, praxias and speed of information processing. These are the brain capacities that enable us to communicate, perceive our environment, concentrate, remember an event or accumulate knowledge. So, visuo-motor integration involves not only eye-hand coordination, but also visual perception skills (Du Plessis, 2014).

Research focusing on the neuropsychological dimension of students is rare in Morocco. In this sense, our aim is to study the evaluation of Visuo-perceptive skills, and their relationship with academic and motor performance in secondary school pupils.

MATERIAL AND METHODS

Location and duration of study

The study was carried out from March to May 2022 at the high schools of Sidi Yahia Gharb (semi-urban) and

Kceibya (rural), province of Sidi Slimane, Rabat, Salé, Kenitra region in northwest Morocco.

Extracurricular and leisure activities are rare, and the socioeconomic background of the participants is low. In order to provide a representative sample, we established inclusion and exclusion criteria.

Inclusion criteria: aged between 12 and 19, attending a public educational establishment, in secondary school and studying all subjects scheduled for secondary school.

Exclusion criteria: uncorrected visual impairment, neurological history (stroke or head injury...), pharmacological treatment causing attention deficit and/or drowsiness, severe depression or unsterilized psychiatric disorders.

Ethical considerations: All necessary measures were taken to guarantee the protection of the privacy and confidentiality of the information of the students participating in the study, in accordance with the principles of the Declaration of Helsinki 2008. Authorization to conduct the survey was obtained from the provincial delegation of the Ministry of National Education in the province of Sidi Slimane, and school principals were informed of this authorization. In addition, informed consent was obtained from tutors, who were fully informed that their responses would remain anonymous and confidential.

Sample and type of study

The study is simple exploratory descriptive research carried out on a sample of secondary school students. They were selected at random and were physically fit enough to participate in sports.

In this study, the total number of participants was 384, including 193 boys (mean age = 15.34 ± 2.03 years) and 191 girls (mean age = 15.10 ± 1.98 years). All participants agreed to carry out this research.

Tools used

Elian test

L'évaluation des processus neurocognitifs à savoir la **perception visuelle** a été menée par la version informatisée du **Test de la Figure Complexe de Rey (FCR-A)**.

Assessment of neurocognitive processes, namely visual perception, was carried out using the computerized version of the Rey Complex Figure Test (RCF-A).

This is a two-dimensional complex figure containing 18 elements: crosses, squares, triangles and a circle; arranged inside and outside a central rectangle. It assesses various cognitive processes such as visual perception, visuo-spatial organization, working memory, inhibition and attention (Vannetzel, 2010). We used the digital version of the test, which involves the use of:

- An Anoto DP-201 digital pen with ballpoint pen lead and infrared camera.
- Rastered paper with a familiar look that doesn't interfere with the writer's work. The raster consists

of a juxtaposition of a myriad of dots, generated by a mathematical algorithm.

- ELIAN (Expert Line Information Analyser) software has been developed by Seldage (<http://www.eliansoftware.com>) to visualize and analyze pen data. Several versions are available; we used the “Expert” version, which provides an Excel-type data table and analysis to aid diagnosis. ELIAN provides access to very fine objective data (1/10 mm, 1/100 sec) and automated analysis. After tracing, the pen is placed on the foot, connected to the computer via its USB port, the “ELIAN” software is launched and the tracings are immediately loaded.

Experimental approach :

- The FCR-A is administered in two phases: a copying phase and a reproduction phase. In the copying phase, the subject is presented with a clearly visible horizontal model, and asked to copy the drawing. In the reproduction phase, the subject is asked to produce the drawing without a model. The duration of the test is unrestricted for both copying and reproduction. Wallon and Mesmin, 2009; Alice, (2012), in their test manual, specify that the two phases must be separated by a wait of less than three minutes.

Rey (1959) proposes two types of scoring: numerical scoring and type scoring. Numerical scoring is used to establish a score. However, we are interested in numerical scoring.

School performance

We studied school performance in this study through the overall average obtained during the 2021-2022 school year. This average was calculated from the results obtained for the various subjects programmed in the secondary school.

Motor performance

Measurement of motor performance was represented in this study by the final grade of physical education and sports obtained in the second semester of the 2021-2022 school year. According to the Orientations Pédagogiques des programmes d'Enseignement d'EPS dans le cycle secondaire (OP 2007- OP 2009).

Statistical analysis

All data collected were processed using specific statistical software. The statistical analysis of the data is based on two axes.

- **Descriptive statistics:** The sample is described. Results are presented as percentages and averages plus or minus standard deviation.
- **Analytical statistics:** The composition of data between different groups is determined using statistical tests (Student's t test and ANOVA/non-parametric tests). Data are analyzed according to gender, age and grade.

The significance of the results is checked using the (*p*) value. Results are considered significant if the (*p*) value is less than 0.05.

RESULTS

Studied sample

The distribution of our sample by gender, age, level of education and living environment. According to gender, 193 boys make up 50.3% of the population, aged between 12 and 19, six levels of secondary school (1st, 2nd, 3rd year of secondary school, Common Core, 1st year of A-levels and 2nd year of A-levels) represented by 64 pupils for each level of schooling, and in each living environment represented by 192 pupils. The sample is distributed as follows (Table 1).

Perceptual profile study

a) Overall results of visual perception test scores

The study of visual perception in the sample showed an overall test score of mean 64.93 ± 4.481 . The distribution of the sample according to visual perception scores is shown in Figure 1.

b) Distribution of visual perception test results by gender

The distribution of mean visual perception scores by gender (Figure 2) shows that boys' scores are higher (65.01 ± 4.327) than girls' (64.85 ± 4.642). For girls, the highest visual perception score was 72 and the lowest was 40. For boys, the best visual perception score was 72 and the lowest was 45.

Tab. 1. Sample distribution by gender, age, educational level and living space

		Frequency	Pourcentage
Sex	Female	191	49.7
	Male	193	50.3
Age	12 years	31	8.1
	13 years	73	19.0
	14 years	54	14.1
	15 years	47	12.2
	16 years	50	13.0
	17 years	74	19.3
	18 years	42	10.9
	19 years	13	3.4
School level	1 AC	64	16.7
	2 AC	64	16.7
	3 AC	64	16.7
	Common core	64	16.7
	1 ^{ère} Bac	64	16.7
	2 ^{ème} Bac	64	16.7
Area	Urbain	192	50
	Rural	192	50

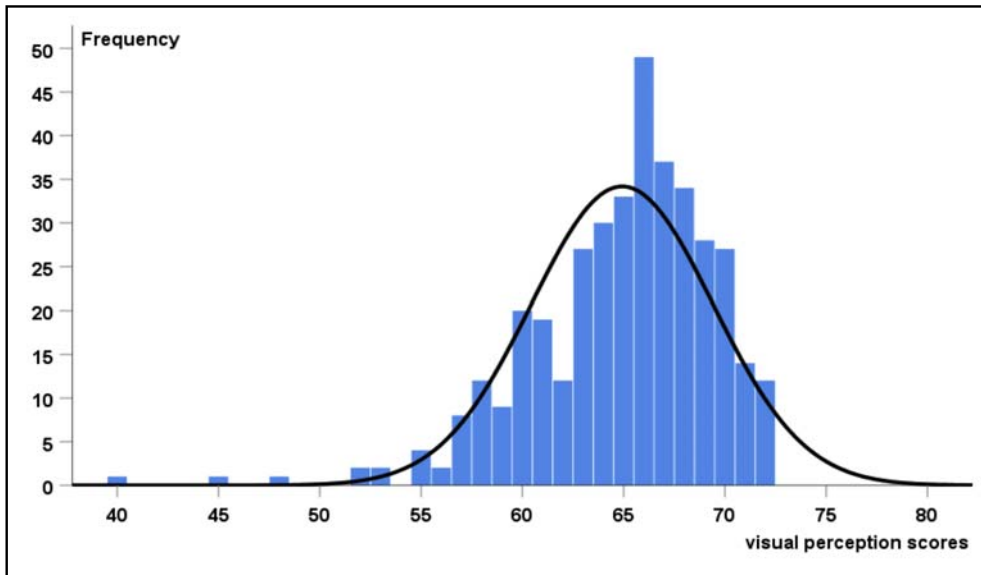


Fig. 1. Distribution of study sample according to visual perception scores

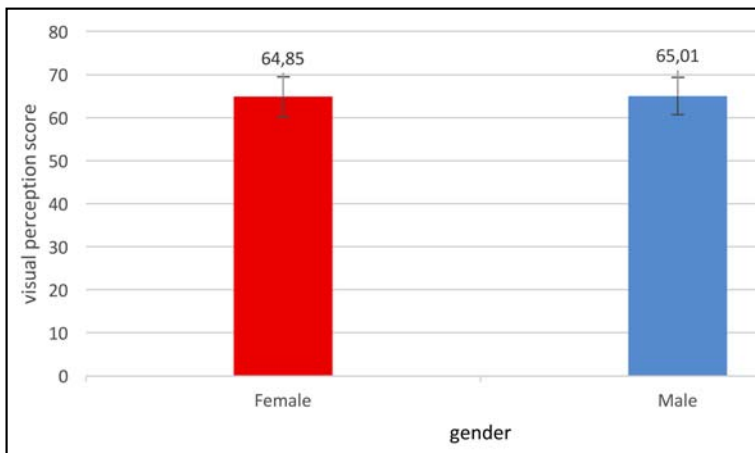


Fig. 2. Distribution of visual perception scores by student gender

Statistical analysis using the Mann-Whitney U test showed no significant difference between the two sexes ($U = 18517.0$; $W = 37238.0$; $p = 0.937$). This means that gender has no effect on visual perception.

c) Age distribution of perception test results

The highest mean visual perception score was 66.70 ± 3.51 at age 17. It is still high, at 65.60 ± 4.72 for the age of 18. The lowest score was 62.32 ± 4.56 for 12-year-olds (Figure 3).

In general, there is a progressive increase in visual perception scores as age increases, but after the age of 17, there is a slight decrease among the pupils surveyed.

Statistical study using the Kruskal-Wallis test shows a highly significant difference between the different ages ($H = 31.038$; $ddl = 7$; $p = 0.000$). It seems that visual perception depends on the age of the pupils.

d) Distribution of perception test results by school level

The highest mean score for visual perception was recorded among 2nd year baccalaureate students (65.58 ± 3.481), and the lowest was for 1st year college students (62.50 ± 5.765) (Figure 4).

There was a progressive increase in visual perception scores as school levels increased.

Statistical analysis using the Kruskal-Wallis test shows a highly significant difference between the means of the different school levels ($H = 25.935$; $ddl = 5$; $p = 0.000$). This means that visual perception depends on school level.

e) Distribution of perception test results by living environment

The distribution of average visual perception scores according to environment (Figure 5) shows that on average, rural highlanders (65.57 ± 4.655) score higher than urban highlanders (64.29 ± 4.216).

Statistical analysis using the Mann-Whitney U test shows a highly significant difference between the scores of urban and rural students ($U = 22014.0$; $W = 40542.0$; $p = 0.001$). This means that living environment has an effect on visual perception.

Relationship between perception and solar and motor performance

a) Overall academic and motor performance results

a-1) Overall school performance results

In the sample studied, school performance averaged 13.04 ± 2.73 (min = 6.00; max = 19.35) out of 20, a fairly good average (Figure 6).

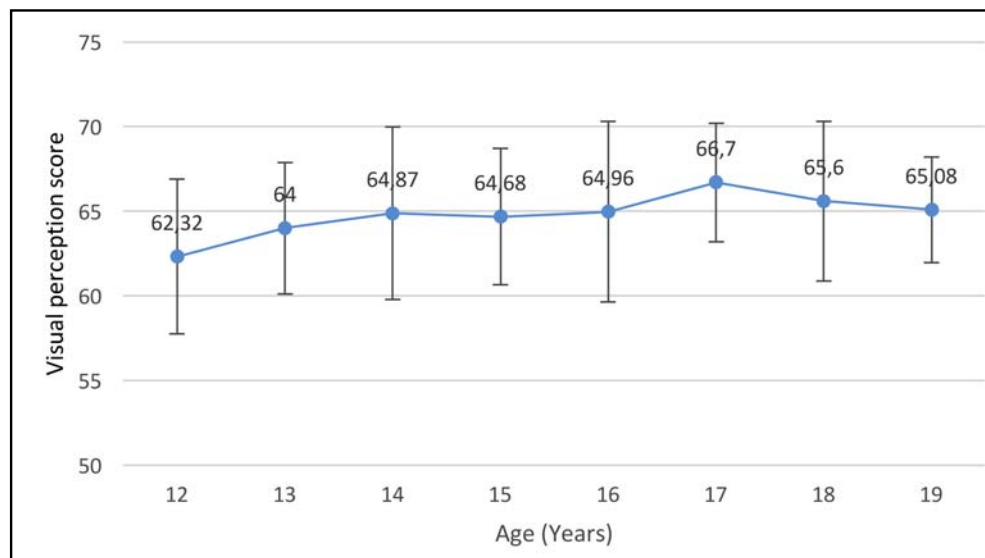


Fig. 3. Distribution of visual perception scores by student age

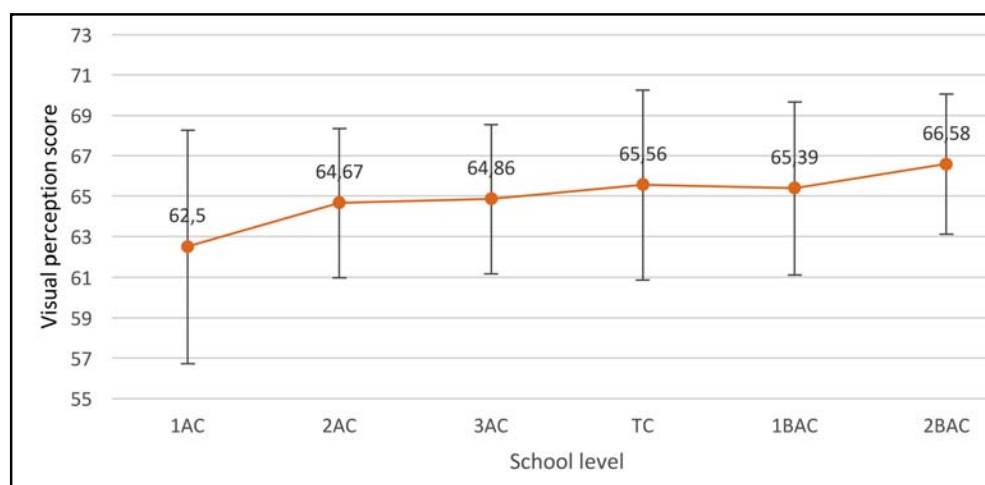


Fig. 4. Distribution of visual perception scores according to students' grade level

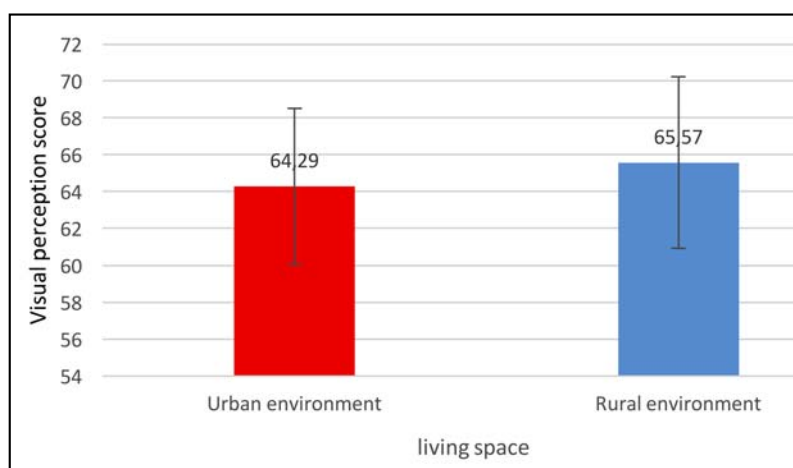


Fig. 5. Distribution of visual perception scores according to students' living space

a-2) Overall motor performance results

The motor performance study showed an overall average of 15.91 ± 1.80 (min = 8.69; max = 19.67) out of 20, a fairly good average (good/very good) (Figure 7).

b) Correlation between perception and academic and motor performance

We carried out correlational analyses between the different scales used in this study. The results presented in Table 2 show that:

- Visual perception and academic performance show a significant positive association ($r = 0.108$; $p < 0.05$).
- As well as visual perception and motor performance show a significant positive association ($r = 0.125$; $p < 0.05$).

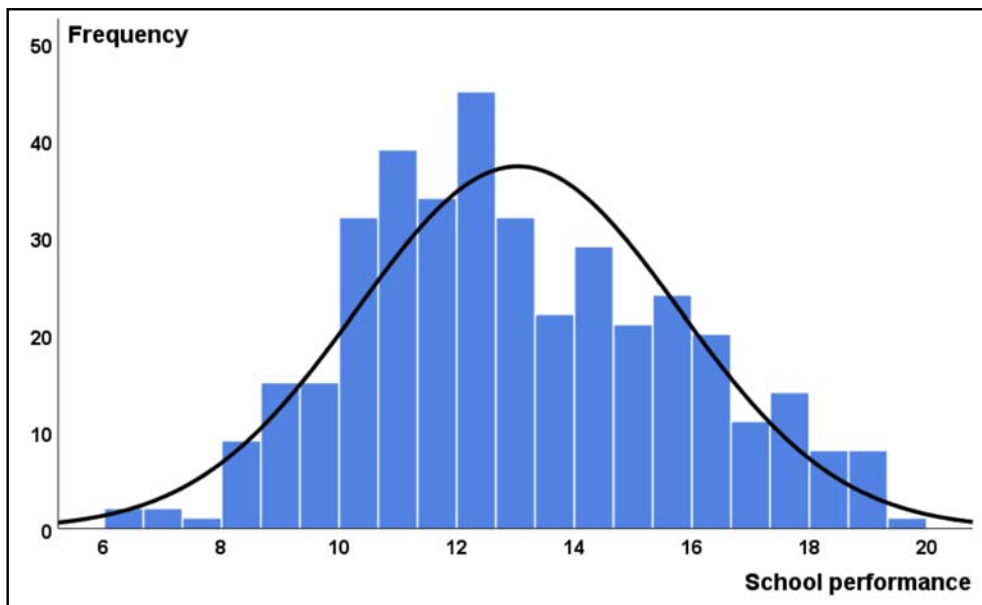


Fig. 6. Sample distribution by school performance

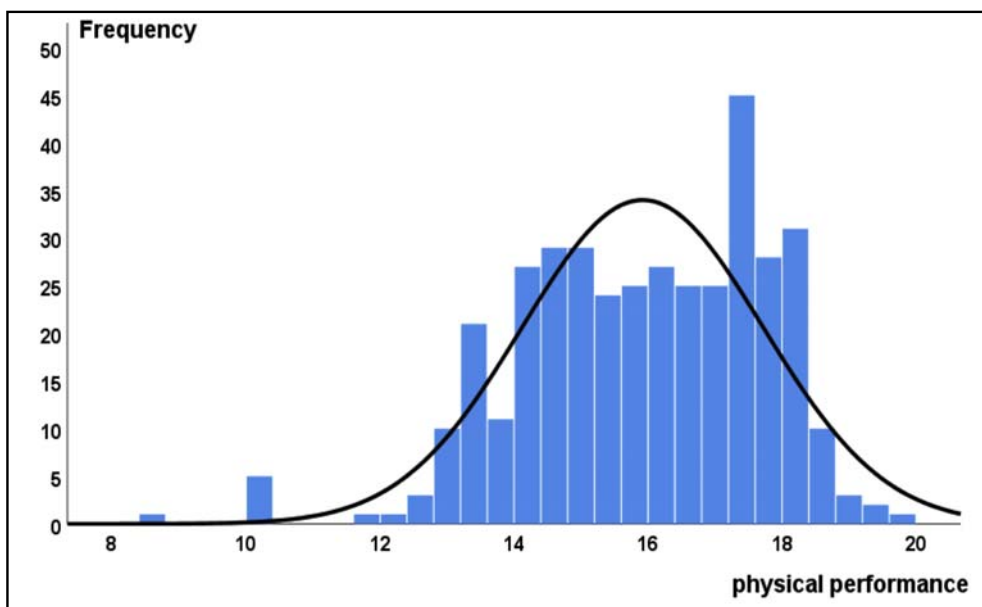


Fig. 7. Sample distribution by motor performance

Tab. 2. Correlations between visual perception and academic and motor performance

Correlations			
		Motor performance	School performance
Rho of Spearman	Visual perception	Correlation coefficient	0.125*
		Sig. (two-tailed)	0.015
		N	384

*. The correlation is significant at the 0.05 level (two-tailed).

DISCUSSION

The work we have carried out concerns adolescents attending school in two areas (urban and rural), Sidi Slimane province, Rabat, Salé, Kenitra region. Our main aim was to study and highlight possible interactions between Visuo-perceptual skills and their relationship with academic and motor performance in school-going adolescents.

This study involved a sample of 384 secondary school pupils. The gender breakdown of this sample showed that 49.7% were girls and 50.3% boys. The average age of the students was 15.22 ± 2.01 years. The distribution according to place of residence was 50% urban and 50% rural. Analysis of these data by the ELIAN test showed that visual perception in our sample had

a mean score of 64.93 ± 4.481 , out of a maximum of 73. Indicating high visual perception. This result is almost similar to the study carried out by Eloirdi *et al.* (2019) in Sidi Slimane, northwest Morocco, which involved a sample of 146 pupils (mean age = 17.29 ± 1.40 years). This study revealed a mean score of 66.14 on the Rey-Osterrieth Complex Figure (ROCF) test. Another study by Rouane *et al.* (2022). Took place in the province of Skhirat Témara, with a sample of 149 girls (56.9%) and 113 boys (43.1%), with an average age of 16.99 ± 1.17 years. This study showed a mean visual perception score (68.81) higher than that recorded in our study.

Comparative analysis of FCR-A (visual perception) test scores among the students who took part in this study showed that scores varied according to gender, grade and age. Boys' scores (65.01 ± 4.327) were slightly higher than girls' (64.85 ± 4.642). There was a progressive increase in visual perception scores with age, but after the age of 17, there was a slight decrease. The study also showed that students from rural areas (65.57 ± 4.655) had higher scores on average than those from urban areas (64.29 ± 4.216).

In this regard, Eloirdi found opposite results: he showed that gender and age had no significant impact on visual perception. Previous research (King, 1981; Bennett, 1984) found no difference between the visual performance of the two sexes in the ROCF-A test. With regard to age, the results showed that younger students performed better than older students in terms of visual perception. Several other studies (Ardila *et al.* 1989; Boone *et al.* 1993) have established a significant relationship between age and performance in the copying and reproduction phase of the ROCF-A. According to Quaid and Simpson (2013), cognitive and learning phenomena, as well as the planning of oculomotor movements, depend on precise encoding of environmental stimuli. This explains why impaired sensory perception can affect higher cognitive functions, such as reading, memory, emotional awareness and impulse control. In addition, visual impairment can affect reading ability, leading to impaired school performance (Orssaud *et al.* 2008).

In terms of academic and motor performance, the results of this study revealed that, in the sample studied, academic performance had an overall mean of 13.04 ± 2.73 (min = 6.00; max = 19.35) out of 20, while motor performance showed an overall mean of 15.91 ± 1.80 (min = 8.69; max = 19.67) out of 20.

Correlation analyses between the different measures used in this study indicate that there is a significant positive correlation between visual perception and academic performance ($r = 0.108$; $p < 0.05$), Eloirdi *et al.* (2019) also showed correlations exist between three variables. Visual perception and working memory are significantly correlated with each other and with academic performance (Zhou *et al.* 2015). (Hopkins

et al. 2020) show that students with low academic performance are more likely than their peers to have problems with visual acuity, binocular vision and visual message integration. Consequently, the quality of vision is key to learning, and a major concern.

Moreover, visual perception and motor performance were positively and significantly associated ($r = 0.125$; $p < 0.05$). Indeed, the visual system can use the kinematic information contained in a movement to identify it and also anticipate the identity of these movements (Bidet-Ildei 2006). In addition, several studies have shown a relationship and link between motor and perceptual difficulties. Researchers have shown that apraxic patients have conceptual disorders concerning knowledge of the use of isolated objects, and also production disorders with orientation errors (Pradat-Diehl, 2006). Similar results have been found in patients with motor difficulties and dysgraphia following a parietal lesion (Chary *et al.* 2004).

Studies have shown that students involved in physical activities and sports perform significantly better at school than non-practitioners. Recent research has revealed that students participating in physical and sporting activities outside of school achieve significantly higher overall academic averages than their non-engaged peers (Kheira and Belkacem, 2019; Bekhechi and Khiat, 2019). Regular physical exercise has been shown to improve academic performance, students' productivity, and their ability to concentrate for long periods (De Greeff *et al.* 2018).

CONCLUSION

The present study examined the role of visual perception in the academic and motor performance of secondary school pupils, highlighting significant differences in visual perception across different environments. The results indicate that visual perception is significantly correlated with academic and motor performance. It is important to raise awareness of the importance of screening and treating visual perception problems in secondary school students.

However, more research with a larger population is needed to better assess the impact of visual perception on neurocognitive function problems and to improve academic success.

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