Neuropsychological functions and reading competence in medical students

Funciones neuropsicológicas y competencia lectora en estudiantes de medicina

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Abstract

Introduction. Medical students require a high capacity for comprehension; therefore, one of the main competencies required by these students during their training is reading comprehension, which allows them to obtain and adequately process the necessary information that corresponds to the progress of their training. Deficiency in this reading competence limits learning and causes them to resort to short-term rote learning, limiting its use in the future. Objective. To describe the behavior of neuropsychological functions and reading competence of medical students. Methods. Documentary, descriptive, quantitative, retrospective and cross-sectional study of a database with the results of the neuropsychological evaluation with NEUROPSI Brief in Spanish, applied to medical students. Results. Moderate and severe impairments were observed in up to 41% of the analyzed sample showing impairment in recall memory, attention and concentration and encoding. Conclusion. In the sample studied, the neuropsychological variables affected contribute to impair inferential reading comprehension, which demonstrates the need to provide attention to university students in order to improve mental functioning for learning.

Resumen

Introducción. El estudiante de medicina requiere alta capacidad de comprensión, debido a esto, una de las principales competencias que requieren estos estudiantes durante su formación es la comprensión lectora, la cual les permite obtener y procesar de forma adecuada la información necesaria que corresponda a los avances propios de su formación. La deficiencia en esta competencia lectora limita el aprendizaje y ocasiona que se recurra a un aprendizaje memorístico a corto plazo, limitando que pueda ser utilizado en un futuro. Objetivo. Describir el comportamiento de las funciones neuropsicológicas y de la competencia lectora de los estudiantes de medicina. Métodos. Estudio documental, descriptivo, cuantitativo, retrospectivo y transversal, de una base de datos con los resultados de la evaluación neurosicológica con NEUROPSI Breve en Español, aplicado a estudiantes de medicina. Resultados. Se observaron deficiencias moderadas y severas hasta en un 41% de la muestra analizada mostrando afectación en la memoria de evocación, atención y concentración y codificación. Conclusión. En la muestra estudiada las variables neuropsicológicas afectadas contribuyen a demeritar la comprensión lectora inferencial, lo cual demuestra la necesidad de brindar atención a los estudiantes universitarios con la finalidad de mejorar el funcionamiento mental para el aprendizaje.

Neuropsychological functions, Reading competence, Medical students

Funciones neuropsicológicas, Competencia lectora, Estudiantes de medicina

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Introduction

Reading is a cognitive activity of great importance used in the acquisition of knowledge (Pulido, 2020), with a formative and social function, it is a complex and systematic process where several cognitive elements participate that allow deciphering the code of the printed letter to then give it a meaning that allows understanding a text (Montaña et al. 2017).

The efficient process and understanding of a reading requires prior knowledge that allows generating the meaning of certain words (Romo, 2019).

Lexical access and reading comprehension are important components for the development of learning (González, 2008) and these are manifested during the cognitive development of each individual (Aznárez et al., 2017).

Lexical access is the process in which a word is recognized through visual perception, where graphic features are identified (González, 2008). In reading comprehension, the information extracted from the text manages to be associated with the information held in long-term memory (Zapata & Rodicio, 2017) and all the information is integrated, to form a coherent representation of what is being read, this level is conscious and not automated (González, 2008).

To obtain a true understanding of a text it must be interpreted at different levels: inferential, literal and critical, where inferential comprehension occurs when the global meaning of a text is understood through relationships and associations (Montaña et al., 2017), when this process activates knowledge structures that are stored in long-term memory and without the need to be explicit in the text, the mental representation of the meaning is created (Iglesias and Veiga, 2004).

To understand a text literally, the reader must resort to all the vocabulary he/she possesses, and to the different meanings that a word may have according to the context or culture in which it is found, also resorting to his/her intuitive knowledge of how his/her language works, how sentences and paragraphs are structured and how certain relationships between ideas are established (Carriazo et al., 2011).

To understand a text critically the reader must resort to his common sense, his ability to establish logical relationships, his knowledge about the text, his life experience, his scale of values, his personal criteria about the subject matter of the text and other readings he has done previously (Carriazo et al., 2011).

During reading several neuropsychological processes are carried out starting with the visual stimulus, which reaches the primary areas in the visual cortex of the occipital lobe, here the visual analysis system is responsible for identifying and encoding the letters, and can follow two different paths; One of them is known as the lexical route, in which the stimulus received is compared with the existing words in it and identified; the other is the phonological route, where the information from the visual analysis passes directly to the encoding of the grapheme-phoneme (Viquez et al. , 2013).

According to Luria's neuropsychological model, interpreted by Manga & Ramos (2000); reading aloud a word would imply the following process: first the image formed in the retina is projected in the primary visual cortex (area 17 of Brodmann) all this through the visual geniculate-striate pathway, then this information passes to the visual association cortex (areas 18 and 19 of Brodmann) where all its characteristics are analyzed (Manga & Ramos, 2000).

Then an interhemispheric communication takes place through the corpus callosum, which allows the information to reach the angular gyrus (Brodmann's area 39), where the association of graphemes with their corresponding phonemes takes place. This information is then shared with Wernicke's area and here words are recognized and understood once auditory images are associated with visual stimuli (Manga & Ramos, 2000).

Finally, for oral reading to occur, Broca's area intervenes through the arcuate fasciculus, in this area the articulation of words and their emission aloud is programmed, this activity is carried out with the participation of the motor area (4 of Brodmann) which controls the speech musculature (Manga and Ramos, 2000).

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As can be seen, the reading process is complex due to the involvement of numerous sensory, motor, language, cognition, attention and memory processes, all these components form a functional system integrated in the cortical structures (Escribano, 2019).

The reading system is located in the left hemisphere, where three main brain areas can be identified: the ventral area (occipito-temporal), the dorsal area, which basically corresponds to Wernicke's area, and the left frontal area, which includes Broca's area, the inferior frontal gyrus and the insular cortex. These three areas are involved in critical functions of reading: visual orthographic processes in the ventral region, phonological decoding in the dorsal region, and articulatory-phonological and semantic processes in the frontal region (Escribano, 2019).

Cognitive processes are also involved in reading comprehension and word recognition, achieving an association with concepts stored in memory, with the development of the main ideas of a text the drawing of conclusions and the relationship between what is read and what is already known, it also demands active attention to many things at the same time in order to coordinate the psychological processes that occur in the detection of written codes (Arándiga, 2005).

Cognitive processes are essential in reading comprehension, since the act of reading implies an interaction between the information obtained and the information stored in the reader's brain. Perception, attention and memory make it possible to capture all the data presented during reading, then fix attention specifically on some of them, represent them mentally through thought and relate them to previous information stored in memory to finally interpret and externalize them with an appropriate language (Fuenmayor and Villasmil, 2008).

The reader's mind processes information, and in this process different cognitive activities are used, some allow the entry and storage of information, such as attention and memory. Other activities help to accompany it and use it to solve problems or perform tasks; the cognitive processes that are activated when reading are perceptual, lexical, syntactic and semantic (Cotto et al., 2017).

For the evaluation of these cognitive functions, the use of an instrument that allows measuring them in a brief, reliable and objective way is recommended, such as the brief neuropsychological battery in Spanish NEUROPSI, which was developed in 1999 by Dr. Feggy Ostrosky, Dr. Alfredo Ardila and Dr. Mónica Rosselli, and its objective is to make an early diagnosis of cognitive alterations (Ostrosky-Solís et al, 2012).

The scoring system of this test provides quantitative and qualitative data, this system allows to have a total score and an individual profile of the cognitive functions of the subject of study, which indicates the skills and disabilities in each of the cognitive areas evaluated. Thus, taking into account the schooling and age of the subject to be evaluated, its execution can be classified as: normal, mild alterations, moderate alterations and severe alterations. Similarly, this test has high reliability indices, which indicates that the responses and errors are stable and that there are no defects of practice or deterioration in a normal population (Ostrosky-Solís et al, 2012).

The cognitive functions evaluated by the NEUROPSI are: orientation, attention and concentration, encoding and recall memory, language, reading, writing and executive functions (Ostrosky-Solís et al, 2012). For the purposes of this study, only those involved in the reading comprehension process were considered, which is the result of the combination of previous knowledge, decoding, strategies, vocabulary and the inferential ability of the individual to understand a written text (Martínez-Cubelos and Salceda, 2022).

For the choice of the variables studied, it was considered that the recognition of a written word is integrated from the visual, spatial and temporal information generated by the stimulation resulting from the identification of the straight and curved strokes that form the graphic linguistic signs (visuospatial process); the lexical information stored in the long-term memory that is activated and compared with that obtained from the visual stimulus being perceived at the moment (attention and concentration, encoding and recall memory) (Iglesias and Veiga, 2004), which, according to Alonso Ortiz T. (1997), memory is one of the most important aspects of the visual stimulus, (1997), memory is one of the base processes for the acquisition of reading, allowing to retain the shape of visual stimuli, recognizing graphemes and giving semantic meaning (Alonso Ortíz T, 1997, as cited in Rodríguez-Ríos et al, 2016); and finally the linguistic contextual information obtained from the text and extralinguistic information found in the reader's memory (reading and language) (Iglesias and Veiga, 2004).

The cognitive functions of the NEUROPSI that were studied in this work, in statistical terms are called variables, because these functions are precisely a characteristic of interest of the sample studied, which can be measured. Now, variables can be quantitative and qualitative, where the former are those where their values are numerical and are represented in quantity and the qualitative ones their values as their name says represent a quality (Rincón, 2017).

Similarly, variables are classified in terms of their characteristics as dependent or independent variable depending on the role it plays in the research question; the number of possible values which can be continuous or discrete; and their measurement scale which is classified as nominal, ordinal, intervals and ratios (Sangrador, 2018).

In order to perform a statistical analysis of the results of the neuropsychological test, the levels of measurement of the variables can be taken into account by means of a descriptive analysis, since in this case what is sought is to obtain information on the characteristics of the variables involved in reading comprehension in the group under investigation, focusing mainly on the measures of central tendency, mode and mean, and on the distribution of frequencies that allow identifying the scores with greater and lesser constancy and how their distribution is with respect to each variable (Sampieri et al., 2014).

There are several computer programs that are used to perform statistical analysis, one of them is SPSS which is a statistical computer program used for the analysis of records generated through surveys or research projects, it allows consulting data, formulating hypotheses, executing procedures to clarify the relationships between variables, identifying trends and making predictions (Sampieri et al., 2014).

The reliability of a measurement instrument can be defined as the accuracy with which it can measure an instrument without errors or with small errors (Martínez-Cubelos and Salceda, 2022). When the instruments intended for qualitative research and evaluation are only for research purposes, for reliability to be considered good it should not be less than 0.75. This allows us to show that the results obtained in the application of any instrument are truly useful, solid and consistent (Martínez-Cubelos and Salceda, 2022).

However, in order to carry out any research work that requires the participation of human beings, it is necessary to ensure respect for the integrity of the participants, protect their health and their individual rights, which is safeguarded in the Declaration of Helsinki adopted by the World Medical Association in 1964 (Cantera et al., n.d.). Similarly, the General Health Law, in Art. 100/4, states that:

Informed written consent must be obtained from the subject on whom the research will be performed, or from his/her legal representative in case of legal incapacity, once he/she has been informed of the objectives of the experimentation and of the possible positive or negative consequences for his/her health (General Health Law, 2022).

Similarly, Art. 98/2 of the General Health Law mentions that in the case of research on human beings, a Research Ethics Committee must be set up to oversee the practice of technical and auxiliary health professionals (General Health Law, 2022).

The objective of this work is to describe the efficiency of neuropsychological functions and reading competence in medical students of the Faculty of Medicine and Nutrition of the Universidad Juárez del Estado de Durango, knowing the trend in the efficiency of reading comprehension evaluated in the study group and identifying the neuropsychological function with the highest and lowest scores in the evaluation of reading competence.

Results

The validation results of the instrument reflect a reliability level of 0.773 in Cronbach's alpha. Of the documents reviewed, the most frequent population is female, as can be seen in the following table.

	Frequency	Percent	% accumulated
Male	126	43.8	43.8
Female	162	56.3	100.0
Total	288	100.0	

Table 1 Gender distribution
Source: Own elaboration

With respect to age, this is concentrated between 20 and 23 years of age, which can be seen in Table 2.

Age	Frequency	Percent	% accumulated
18	3	1.0	1.0
19	28	9.7	10.8
20	62	21.5	32.3
21	56	19.4	51.7
22	60	20.8	72.6
23	35	12.2	84.7
24	21	7.3	92.0
25	12	4.2	96.2
26	6	2.1	98.3
27	1	.3	98.6
28	1	.3	99.0
29	1	.3	99.3
34	1	.3	99.7
43	1	.3	100.0
Total	288	100.0	

Table 2 Distribution by age
Source: Own elaboration

Table 3 shows that the highest percentage is in the 5th semester.

Semestre	Frequency	Percent	% accumulated
1	6	2.1	2.1
2	25	8.7	10.8
3	44	15.3	26.0
4	19	6.6	32.6
5	67	23.3	55.9
6	27	9.4	65.3
7	25	8.7	74.0
8	10	3.5	77.4
9	37	12.8	90.3
10	28	9.7	100.0
Total	288	100.0	

Table 3 Semesters completed by the sample of documents reviewed
Source: Own elaboration

The results obtained from the neuropsychological evaluation corresponding to digits in regression, 20-3, visual detection, naming, repetition, comprehension, verbal fluency, reading, visuospatial memory, spontaneous verbal memory, verbal memory by cues, and memory by recognition are as follows:

The scores observed in the variables studied show a symmetrical distribution in the values of central tendency, as can be seen in Table 4.

Variable	Mode	Average	Máx.	Mín.	Freq.	% of frequency	High Normal value	Normal Value
Digits in regressión	4	4.07	6	2	101	35.1	6	3 a 5
Visual detection	16	15.36	16	0	202	70.1	-	11 a 16
20-3	5	4.27	5	0	203	70.5	-	4 a 5
Coding-Spontaneous verbal memory	5	4.91	6	2	106	36.8	-	4 a 6
Coding-Process Spatial View	12	11.72	12	6	224	77.8	-	11.5 a 12
Visual-spatial memory	12	10.93	12	4	126	43.75	-	9.5 a 12
Spontaneous Verbal Memory	5	4.27	6	0	106	36.8	-	4 a 6
Verbal memory by keys	5	4.48	6	0	101	35.1	-	5 a 6
Verbal memory by recognition	6	5.61	6	1	202	70.1	-	5 a 6
Denomination	8	7.94	8	6	273	94.8	-	8
Repetition	4	3.99	4	3	285	99	-	4
Comprehension	5.84	6	6	2	250	86.8	-	6
Semantic verbal fluency	25	24.5	40	2	26	9	30 a 32	16 a 28
Phonological verbal fluency	12	12.5	23	4	38	13.2	21 a 25	8 a 20
Reading	3	2.85	3	0	254	88.19	-	3

Table 4 Central tendency values of the variables studied.
Source: Own elaboration

Of the total number of documents reviewed (288), the variables with the lowest and highest scores can be seen in Table 5, with the highest frequency of minimum value, verbal memory by cues in 41% of the sample and with the highest frequency of maximum value, semantic verbal fluency and repetition with 99%.

Variable	Highest scores obtained	Frequency	% frequency	Normal Value	High normal value	Classification	Minimum scores obtained	Frequency	% de frequency	Moderate disturbance value	Severe disturbance value	Classification
Language - Semantic verbal fluency	>14	286	99.3	30 a 32	14 al 29	Normal and high normal	<10	2	0.69	10 a 13	0 a 9	Moderate and severe
Language-Repetition	4	285	99.0	4		Normal	<3	3	1.04	-	0 a 3	Severe
Attention and concentration-Visual detection	>11	284	98.6	11 a 16		Normal	<8	4	1.39	8 a 10	7 a 0	Moderate and severe
Encoding-Spontaneous verbal memory	>4	278	96.5	4 a 6	-	Normal	<3	10	3.47	3.00	0 a 2	Moderate and severe
Language-Phonologic al verbal fluency	>8	275	95.5	21 a 25	8 a 20	Normal and high normal	<7	13	4.51	4 a 7	0 a 3	Moderate and severe
Language-Denomination	8	273	94.8	8	-	Normal	<7	15	5.21	-	0 a 7	Severe
Evocation-Verbal memory by recognition	>5	267	92.7	5 a 6	-	Normal	<4	21	7.29	4.00	0 a 3	Moderate and severe
Attention and concentration- Digits in regression	>3	266	92.4	3 a 5	6	Normal and high normal	<2	22	7.64	2.00	0 a 1	Moderate
Reading	3	254	88.2	3		Normal	<2	34	11.81	2.00	0 a 1	Moderate and severe
Language-Comprehension	6	250	86.8	6	-	Normal	<5	38	13.19	-	0 a 5	Severe
Evocation-Visual-spatial memory	>9.5	248	86.1	9.5 a 12	-	Normal	<9	40	13.89	8 a 9	7.5 a 0	Moderate and severe
Evocation-Spontaneous Verbal Memory	>4	225	78.1	4 a 6	-	Normal	<3	63	21.88	3.00	0 a 2	Moderate and severe
Encoding-Visual-spatial processes	>11.5	224	77.8	11.5 a 12		Normal	<10.5	64	22.22	11.00	0 a 10.5	Moderate and severe
Atention and concentration-20-3	>4	216	75.0	4 a 5	-	Normal	<3	72	25.00	3.00	0 a 2	Moderate and severe
Evocation-verbal memory x keys	>5	170	59.0	5 a 6	-	Normal	<4	118	40.97	3 a 4	0 a 2	Moderate and severe

Table 5 Maximum and minimum scores obtained in the variables that intervene in reading competencies
Source: Own elaboration

Acknowledgments

Discussion

The importance of the study of reading comprehension in university students is due to the fact that good school performance depends mostly on the abilities and strategies they have to achieve good reading comprehension (Pulido, 2020; Rodríguez-Ríos, Ríos-Valles, Hernández-Tinoco, & Acevedo-Martínez, 2016).

According to Calderón-Ibáñez and Quijano Peñuela (2010), the study of reading comprehension, reading skills and verbalization of texts in university students has shown certain deficiencies in these aspects. A study conducted by these authors shows the problems that students have for inferential reading as well as the reduced lexicon of readers (Calderón-Ibañez and Quijano Peñuela, 2010, as cited in Ríos-Valles et al., 2017).

Pulido (2020), during his research at a university in northwestern Mexico, where his objective was to determine whether it is possible to improve reading comprehension through reading strategies, found that one of the problems presented by the study group was the difficulty in selecting relevant information from a text, which he relates to the fact of not using effective strategies to extract the main ideas (Pulido, 2020), this study shows that most of the participants present problems in inferential reading comprehension.

On the other hand, Gonzalez & Machado (2020), during an investigation at a university in Barranquilla, Colombia, obtained results that show a very low level of literal comprehension, with a basic and limited interpretation of the text, and regarding the inferential level, difficulties are observed in adding elements that are not found in the text and relating them to their experiences or deducing ideas that are not explicit (Gonzalez & Machado, 2020).

For their part Macay-Zambrano & Véliz-Castro (2019), conducted a study of reading comprehension levels in university students in Ecuador, where it could be observed that the sample studied shows difficulty in comprehending readings from the literal, inferential and critical points of view (Macay-Zambrano & Véliz-Castro, 2019).

Among the neuropsychological functions involved in the reading comprehension process, selective attention stands out, since the reader must focus his attention on the text he is reading and thus block external stimuli that could create a distraction, this process requires self-regulation of attention (Arándiga, 2005).

Similarly, evocation memory is another neuropsychological factor involved in reading comprehension, which allows inferences to be made when reading (Domínguez, 2010). Also language, participates in the association of auditory images with visual stimuli that allow recognizing phonemes or words that are reading (Viquez et al., 2013), so that reading comprehension improves as language comprehension also increases (Tunmer and Hoover, 2019).

Perceptual processes also play an important role in the comprehension of a text, since they are responsible for gathering information from a text and transmitting it to the cortical structures of the brain, one of these processes is visual perception, since a correct visual discrimination will contribute to achieve a good reading comprehension (Arándiga, 2005).

In the present investigation it can be observed that the scores of the variables considered for this study tend to be located within normal values, however there are variables where scores below the normal limit can be observed according to the Neuropsi manual and which are classified in moderate to severe alterations, these variables are: of evocation the simple variables of verbal memory by cues and spontaneous verbal memory, of encoding the simple variable of visuospatial processes and of the attention and concentration variable the simple variable of 20-3, all of them with a frequency percentage ranging from 41% to 22% of the documents studied.

With respect to the variables where a better performance of the studied sample with results from normal to high normal is observed in the language functions, specifically in repetition and semantic verbal fluency, representing 99.3% and 99% of the frequency of the sample, respectively.

According to Montaña, Cárdenas, Orduz & Caro (2017), in order for inferential comprehension to be carried out, it is necessary the activation of knowledge structures that are stored in long-term memory, (Montaña et al, 2017), this neuropsychological function is evaluated in the NEUROPSI in the evocation functions section (Ostrosky-Solís et al., 2012).

Carriazo, Andrade & Martínez (2011), refer that in order to understand a text literally, the reader resorts to all the vocabulary he/she has and to the different meanings that a word has according to the context in which it is found (Carriazo et al., 2011). For the evaluation of this neuropsychological function in the NEUROPSI, the language section is used (Ostrosky-Solís et al., 2012).

According to Betancourth Zambrano et al. (2012), research conducted worldwide shows that there is a need to improve critical and analytical skills in university students. (Betancourth Zambrano et al., 2012, as cited in Ríos-Valles et al., 2017) which is coincident with the observation that recall memory presented results that show an area of opportunity to be improved and thus contribute to a more efficient reading comprehension.

Conclusions

In the sample studied there is a considerable percentage of participants, up to 41%, who present alteration in neurocognitive functions at the moderate and severe level, observing important failure in the neuropsychological functions involved in reading comprehension, highlighting with greater frequency the variable of evocation, respectively, in the variables of verbal memory by cues and spontaneous verbal memory; Likewise, in the attention and concentration variable the simple variable 20-3 and in the coding variable the simple variable of visuospatial processes; the above allows identifying, based on the information studied by the authors consulted, that the sample presents inferential comprehension problems.

Article

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