RESEARCH ARTICLE

The role of executive functions in sentence processing in children with mild autism spectrum disorder

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Abstract

The study aimed to know the role of executive functions in the Sentence processing among children with autism spectrum disorder. For this reason, the study was conducted on children with autism spectrum disorder with a slight degree, and they reached 23 children, ranging in age from 4 years and a half and 10 years, and to collect information in the past, using a set of tools, which were: Karz test, Oral comprehension test O52, and sentence processing test, which was designed in this study.The descriptive method was used in this study with some statistical methods, including the Pearson correlation coefficient.

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Definition of study terms:

Executive functions: it is the extent to which the child is able to adapt to the situations and situations he faces through the tasks he performs.

Sentence processing: it is the ability to formulate a sentence taking into account its rules and sequence to enable the recipient to understand its meaning, through our application of the sentence processing test that will be built in this study.

Autism spectrum disorder: is the category of children to be evaluated for their ability to process sentences, aged between 4 years to 10 years, who were diagnosed through the application of the CARS test.

Introduction:

The interest of specialists in psychology, especially cognitive psychology, is to study executive functions as a cognitive process based on a set of tasks, the most important of which are: activation, working memory, cognitive flexibility, planning, because they are interrelated processes among themselves.

Executive functions help the individual to adapt to new situations, cope with them, and many authors have agreed that executive functions include a set of interrelated processes responsible for goal-oriented behavior. (Gioia,Isquith&Guy,2001)

In their studies, specialists focused on the task of working memory,in order to interest working memory in maintenance and retrieval of information when it is recalled and information is processed, baddelli and hitch (Baddelli et Hitch, 1974) were among the first cognitive psychologists who were interested in the study of working memory. They noted that working memory represents a control system with limits for both storage and processing capabilities. They suggested that he has access to voice-encoded information, that he is responsible for the limited range of memory, but does not represent the effect of repetition in retrieval. Perhaps the most specific function identified so far with working memory is the transfer of information to long-term memory. (Baddelley,2018, p76)

According to the model proposed by baddelli ET Hitch (Baddelli et Hitch,1996), working memory consists of three systems (the phonological loop, the visual-spatial notepad, the source of events) and a central executive who directs the work of these systems and is responsible for monitoring and regulating these systems. (Jonni L. Johnson, 2018, p. 55)

Other studies have pointed to the role of working memory in language processing, as language is a cognitive process governed by areas in the brain, and it is based on language production (expressive language) located in Broca's area, which is located in the third frontal gyrus, and linguistic understanding (receptive language) is located in Wernicke's area at the level of the temporal lobe. Where the language has rules through which various letters, words and sentences are linked in order to give a clear meaning and significance to the spoken language listener and the reader of the written language, it is through a set of different linguistic rules that help in the latter to give a useful verbal sentence by its sender. Language disorders are also a hallmark of ASD and include deficits in understanding and expression of phonology, morphology, language semantics, syntax and usage, both verbal and non-verbal. (Froma P. Roth and Colleen K. Worthington, 2016, p. 272)

As Kanner(Kanner,1943-1946) highlighted unusual patterns of communication and still has a fundamental role in the diagnosis according to the American Psychiatric Association (2013), autism spectrum disorder, whether verbal or non-verbal, communication deficit is one of the main symptoms of autism spectrum disorder. Some people with ASD may start speaking at a later age than usual, or they may remain speechless for life, others may acquire minimally productive verbal skills, learn to produce words and sentences, but have difficulty using them.(Sam Goldstein, 2018, p. 147)

A study has indicated (Thomas et al,2009). To assess the understanding of several grammatical constructions at the level of the main sentence, with the additional goal of determining the extent to which lexical difficulties contribute to poor understanding of children on the autism spectrum. One of the ways to understand the contributions of lexical knowledge to the development of language in this category of children is to examine the comprehension of sentences that differ in the extent to which they are superimposed on lexical or grammatical knowledge. In addition, the study clarified the types of mistakes made during understanding whether children with ASD use atypical strategies that lead to misinterpretation of sentence meanings.

A study by Laurie J.B and Sarah A.Kai-deleria (Sara T. Kover & all, 2013) that sentence comprehension is a crucial skill in today's literate society. Recent evidence suggests that the treatment and understanding of the linguistic foundations of cognitive and linguistic abilities is a discovery of great importance for doctors who have cases with language disorders. To enhance awareness of the impact of cognition, especially executive function and working memory, the result of these studies was awareness of the possible role of executive functions and working memory in sentence comprehension will help doctors to be more aware of possible cognitive language deficits in cases.

As a result of what has been discussed in various studies on executive functions and sentence processing, we will devote this study to: the role of executive functions in sentence processing in children with autism spectrum disorder, and therefore we have raised the following question:

Does executive function have a role in sentence processing in children on the autism spectrum to a mild degree ?

Objectives of the study:

The research objectives are as follows :

- Knowledge of the role that executive functions play in the cognitive processing of the sentence

- Evaluation of sentence processing in terms of comprehension and production in children of the autism spectrum

- Search for sentence evaluation measures and tests for autism spectrum disorder and other language disorders that have problems in sentence processing .

The importance of the study:

The importance of the study lies in the fact that it helps to open the field for researchers to develop their research, and the studies are not confined to a limited field, and it is an addition to the research that has been addressed in the cognitive neurosciences, and the importance of the research in revealing the role of executive functions in sentence processing, and how this cognitive process may affect children with autism spectrum disorder (ASD).

1. Main areas of study:

The temporal domain of the study:

The study was conducted at the Hamadoua Hussein Public Hospital in Sidi Ali, Mostaganem, starting from 20/01/2020 and the Basal Treatment Unit in Bresanville, Mostaganem, starting from 26/01/2020.

2. Main study tools:

A. Sentence processing test:

It is a test that diagnoses sentence processing disorders in children with autism spectrum disorder, which was designed by the researcher, due to the lack of tools to diagnose this disorder in the clinical environment, and it is a test that measures sentence comprehension and production in children with autism spectrum disorder.

- Steps in constructing a sentence processing test:

Theoretical background of the test:

Background reference on the topic of sentence processing in ASD after reviewing the tests that can help us, including the adapted Baddeley test by Professor Derghini Mariam, which contains the following axes:

1) **Clown test:** Which measures the spatial-visual diary, it contains several stages:

- Violet model stage
- The coloured model phase

2) **Sentence test:** It measures the phonological loop and contains a set of sentences, these sentences contain missing words and the examinee has to complete them

3) **Ab test:** It measures the central portal.

From these axes, we chose the sentence axis that we felt served the processing of the sentence, from which we extracted the missing word dimension.

We also referred to the O52 Oral Comprehension Test for Khamsi translated by researcher Dahal Siham, from which we extracted the oral comprehension dimension by asking the following instruction: Show me a picture ..... Example: Show me a picture of the girl sleeping.

As for the other dimensions, they were extracted from the problems and difficulties faced by children with ASD, namely the dimension of sentence production, communication and linking events.

The dimensions of the test were as follows:

- After sentence comprehension.
- After sentence production.
- After word deficiency.
- After communicating and linking events.

Objective of the test:

To diagnose and evaluate sentence comprehension and production in children with ASD.

Age of application of the test:

The test is applied to children aged 4 to 10 years

Total test time: 30 minutes

3. Determine the psychometric properties of the sentence processing test:

Calculation of internal consistency reliability: After reviewing the test by the referees and the supervising professor, as all dimensions of the test were accepted, we will calculate the internal consistency reliability of the test:

paragraphs	Correlationcoefficient	Sig value	significance
01	**0.52	0.019	significant
02	**0.77	0.000	significant
03	**0.54	0.014	significant
04	**0.60	0.005	significant
05	**0.86	0.000	significant
06	*0.44	0.49	significant
07	**0.78	0.000	significant
08	**0.79	0.000	significant
09	*0.47	0.036	significant
10	**0.61	0.004	significant

Table (01): Correlation coefficients of the test items after sentence comprehension

- ** Correlation coefficients are statistically significant at the 0.01 level of significance.
- *Correlation coefficients are statistically significant at the 0.05 level of significance.

It is clear from the above table that all paragraphs of the sentence comprehension dimension are significant at the significance level (0.01-0.05).

paragraphs	Correlation coefficient	Sig value	significance
01	**0.66	0.001	significant
02	**0.70	0.001	significant
03	*0.47	0.36	significant
04	**0.63	0.003	significant
05	**0.66	0.001	significant
06	**0.58	0.07	significant
07	**0.83	0.000	significant
08	**0.59	0.006	significant

Table (02): Showing the Post-production reliability

- ** Correlation coefficients are statistically significant at the 0.01 level of significance
- *Correlation coefficients are statistically significant at the 0.05 level of significance

It is clear from the above table that all paragraphs of the sentence production dimension are significant at the significance level (0.01-0.05).

paragraphs	Correlation coefficient	Sig value	significance

01	**0.68	0.001	significant
02	**0.69	0.001	significant
03	**0.65	0.002	significant
04	**0.74	0.000	significant
05	**0.67	0.001	significant
06	**0.59	0.006	significant
07	**0.77	0.000	significant
08	**0.86	0.000	significant
09	**0.70	0.001	significant
10	**0.67	0.001	significant
11	**0.87	0.000	significant
12	**0.67	0.001	significant

Table (03): Correlation coefficients are statistically significant at the level of significance.

- ** Correlation coefficients are statistically significant at the 0.01 level of significance
- Correlation coefficients are statistically significant at the 0.05 level of significance.

It is clear from the above table that all paragraphs related to the memory and word deficiency dimension are significant at the significance level (0.01-0.05).

paragraphs	Correlation coefficient	Sig value	significance
01	**0.70	0.001	significant
02	**0.66	0.001	significant
03	*0.83	0.000	significant
04	**0.52	0.019	significant
05	**0.79	0.000	significant
06	**0.65	0.002	significant
07	**0.82	0.000	significant
08	**0.78	0.000	significant

Table (04): The reliability of the communication dimension

- ** Correlation coefficients are statistically significant at the 0.01 level of significance
- *Correlation coefficients are statistically significant at the 0.05 level of significance

It is clear from the above table that all paragraphs of the communication dimension are significant at the significance level (0.01-0.05).

paragraphs	Correlation coefficient	Sig values	significance
01	**0.74	0.000	significant
02	**0.87	0.000	significant
03	*0.86	0.000	significant
04	**0.75	0.000	significant

05	**0.80	0.000	significant
06	**0.74	0.000	significant
07	**0.81	0.000	significant

Table 05: The reliability of paragraphs linking events

- ** Correlation coefficients are statistically significant at the 0.01 level of significance
- *Correlation coefficients are statistically significant at the 0.05 level of significance

It is clear from the previous table that all the paragraphs of the juvenile linkage dimension are significant at the significance level (0.01).

dimension	Correlation rate	Sig value	significance
Sentence comprehense	**0.89	0.000	significant
Sentence production	*0.85	0.000	significant
Memory and word deficits	**0.73	0.000	significant
Communication	**0.92	0.000	significant
sequencing	**0.90	0.000	significant

Table (06): shows the truthfulness of the measuring instrument as a whole

- ** Correlation coefficients are statistically a function at the significance level of 0,01
- *Correlation coefficients are statistically a function at the level of signification0, 05

It is clear from the previous table that the correlation coefficients of the total degrees of the dimension with the total degree of the instrument is statistically a function at the level of(0,01), thus it becomes clear that the instrument is characterized by a degree of internal consistency honesty, that is, the instrument measures what it was designed to measure.

4. Calculating the stability of the sentence processing test:

We calculated the reliability using two methods: Cronbach's alpha and split-half corrected Spearman Brown.

Alphacronbach's alpha	semi-compartmentalisation	Spearman Brown's	Significance
0.95	0.73	0.84	significant

Table (07): Stability coefficients for the sentence processing test

According to the results obtained as shown in the previous table, using the equations of the tool, represented by the half-hash method (0,73), calculating the Spearman coefficient(0,84), and the facronbach equation(0,95).

After completing the assessment of the truthfulness of the stability of the sentence processing test, all the paragraphs and dimensions that showed good internal consistency were retained, and after that it was used in the basic study

View the results:

1. Presentation of the results of the sentence processing test:

After applying the sentence processing test on the main study sample of 23 cases of children with ASD, the following results were obtained:

cases / dimensions	After sentence comprehension	After sentence production	After word deficiency	After communication	After linking events
01	02	03	04	03	03
02	03	03	03	05	02
03	03	01	03	02	03
04	05	02	02	04	03
05	06	00	02	00	03
06	06	01	02	00	03
07	03	02	01	02	02
08	01	01	00	01	02
09	10	05	04	08	05
10	04	03	02	01	02
11	10	05	05	08	04
12	04	03	02	04	02
13	05	03	01	03	02
14	04	02	01	02	02
15	06	02	01	02	01
16	07	01	01	01	01
17	07	02	02	03	03
18	06	01	03	01	02
19	08	02	01	01	01
20	08	01	00	00	01
21	07	01	00	01	02
22	07	04	02	02	02
23	07	03	01	02	01

Table (08): Representing the results of the sentence processing test.

Comment on the table:

The results of the sentence processing test were limited to the dimension of the cases' answers in each dimension and the results of the sentence comprehension dimension were between (02-10) of the total score (10), and we notice that the cases obtained results close to the full score, and we find in the production dimension that the scores were limited between (01-05) of the total score (08), while in the memory and word deficiency dimension the results of this dimension were limited between (00-05) of the total score (12), and we notice in the communication dimension that the scores were limited between (00- 05) of the total score (08). (08) of the total score (08), that is, there are those who took full marks in this dimension, while in the sequence of events dimension, the scores were between (00-05) of the total score (07), we noticed that most of the results of the answers of the sample members are different and at the same time close as a result of the disorder and its severity, the extent of the child's response to foster care, and we notice that the sample members have problems at the level of retrieval and memory.

2. Discuss the hypotheses through the results obtained:

variables	sample	Correlation coefficient	Sig values	.Significance leve
Working memory Sentence Processing Test	23	**0.88	0.000	Significant at 0.01

Table (09): Correlation coefficient results between working memory test scores and sentence processing test scores.

3. ** Correlation coefficients are statistically significant at the 0.01 level of significance.

4. * Correlation coefficients are statistically significant at the 0.05 level of significance.

5. It is clear from the above results that the value of Pearson's correlation coefficient between the scores of the study sample by answering the dimensions of the working memory test and their scores by answering the sentence processing test from the sentence processing test in the current study, where its value amounted to **0, 88, which is statistically significant, because the probability value of sig is equal to 0.000, which is the lowest level of significance of 0.01; confirming a correlation between working memory and sentence processing in the main study sample, which confirms the hypothesis that executive functions have a role in sentence processing in children with mild autism spectrum disorder.

variables	sample	Correlation coefficient	Sig values	.Significance leve
Working memory Understanding the sentence	23	**0.59	0.001	Significant at 0.01

Table (10): Correlation coefficient results between working memory test scores and sentence comprehension dimension scores.

** Correlation coefficients are statistically significant at the 0.01 level of significance.

* Correlation coefficients are statistically significant at the 0.05 level of significance.

It is clear from the results recorded above that the value of the Pearson correlation coefficient between the scores of the study sample members by answering the dimensions of the working memory test and their scores by answering the sentence comprehension dimension of the sentence processing test in the current study, where its value amounted to **0, 59, which is statistically significant, because the probability value of sig is equal to 0.001, which is the lowest level of significance of 0.01, which confirms a correlation between working memory and sentence comprehension in the main study sample, which confirms the hypothesis that working memory has a role in sentence processing in children with mild ASD.

variables	sample	Correlation coefficient	Sig values	.Significance leve
Working memory Sentence production	23	**0.72	0.000	Significant

Table (11): The results of the correlation coefficient between working memory test scores and sentence production dimension scores.

** Correlation coefficients are statistically significant at the 0.01 level of significance

* Correlation coefficients are statistically significant at the 0.05 level of significance.

It is clear from the results recorded above that the value of the Pearson correlation coefficient between the scores of the study sample members by answering the dimensions of the working memory test and their scores by answering the sentence production dimension of the sentence processing test in the current study, where its value reached **0.72, which is statistically significant, because the probability value of sig is equal to 0.000, which is the lowest level of significance 0.01; confirming the hypothesis that the source of events has a role in sentence processing in children with mild autism spectrum disorder.

variables	sample	Correlation coefficient	Sig values	.Significance leve
Waring memory Word shortage	23	**0.66	0.001	Significant

Table (12): Correlation coefficient results between working memory test scores and word deficiency dimension scores.

** Correlation coefficients are statistically significant at the 0.01 level of significance

* Correlation coefficients are statistically significant at the 0.05 level of significance.

It is clear from the results recorded above that the value of the Pearson correlation coefficient between the scores of the study sample members by answering the dimensions of the working memory test and their scores by answering the word deficiency dimension of the sentence processing test in the current study, where its value reached **0.66, which is statistically significant, because the probability value of sig is equal to 0.001, which is the lowest level of significance 0.01; confirming the hypothesis that the phonological loop has a role in sentence processing in children with mild autism spectrum disorder.

variables	sample	Correlation coefficient	Sig values	.Significance leve
Waring memory Communication	23	**0.80	0.000	Significant

Table (13): Correlation coefficient results between working memory test scores and communication dimension scores.

** Correlation coefficients are statistically significant at the 0.01 level of significance

* Correlation coefficients are statistically significant at the 0.05 level of significance.

It is clear from the results recorded above that the value of the Pearson correlation coefficient between the scores of the study sample by answering the dimensions of the working memory test and their scores by answering the communication dimension of the sentence processing test in the current study, where its value reached **0.80, which is statistically significant, because the probability value of sig is equal to 0.000, which is the lowest level of significance 0.01, which confirms the hypothesis that the central port has a role in sentence processing in children with mild autism spectrum disorder (ASD).

variables	sample	Correlation coefficient	Sig values	.Significance leve
Waring memory Sequence of events	23	**0.72	0.000	Significant

Table (14): Correlation coefficient results between the working memory test scores and the event sequencing dimension scores.

** Correlation coefficients are statistically significant at the 0.01 level of significance

* Correlation coefficients are statistically significant at the 0.05 level of significance.

It is clear from the results recorded above that the value of the Pearson correlation coefficient between the scores of the study sample members by answering the dimensions of the working memory test and their scores by answering the event-relatedness dimension of the sentence processing test in the current study, where its value reached **0.72, which is statistically significant, because the probability value of sig is equal to 0.000, which is the lowest level of significance 0.01; which confirms the hypothesis that visual-spatial memory plays a role in sentence processing in children with autism spectrum disorder.

General discussion:

Autism Spectrum Disorder (ASD) is one of the most important disorders that have occupied the attention of students and researchers in various fields and disciplines such as psychology, linguistics, medicine and sports, considering that ASD is one of the disorders that are difficult to diagnose, and we in this study will try to address one of the aspects in which the child suffering from ASD finds as an attempt to contribute in the field, a study entitled "The role of executive functions in sentence processing in children with ASD, with the aim of knowing the role played by executive functions in sentence processing, by identifying the sample represented by ASD.

3. General discussion of the hypotheses:

Autism Spectrum Disorder (ASD) is one of the most important disorders that have occupied the attention of students and researchers in various fields and disciplines such as psychology, linguistics, medicine and sports, considering that ASD is one of the disorders that are difficult to diagnose, and we in this study will try to address one of the aspects in which the child suffering from ASD is found as an attempt to contribute in the field, a study entitled "The role of executive functions in sentence processing in children with mild ASD (working memory as a model), with the aim of identifying the role played by executive functions in sentence processing, by identifying the eye.

- Discussion of the general hypothesis:

The general hypothesis states that "Executive functions have a role in sentence processing in mild ASD".

From the results obtained in the above table (09), which found that the sig. value = 0.000, we prove that executive functions have a role in sentence processing in children with mild autism spectrum disorder. Therefore, our study confirms that it explains the cognitive and linguistic issues experienced by children with mild ASD, as proven by the study of Sanja Šimleš (Sanja Šimleša & All, 2017), in their study of the role of executive functions in sentence comprehension, demonstrated the importance of activation and working memory in sentence comprehension in preschool children aged 4-5 years.

- Discussion of the third partial hypothesis:

The third partial hypothesis stated that "the visual-spatial diary has a role in sentence processing in mild ASD".

From the results obtained in the above table (12), which found that the value of sig.=0.000, which proves that the visual-spatial diary has a role in sentence processing in children with mild autism spectrum disorder.

- Discussion of the fourth partial hypothesis:

The fourth partial hypothesis stated that "the central portal has a role in sentence processing in mild ASD".

Through the results obtained in the above table (13), which found that the value of sig.=0.000, which proves that the central portal has a role in sentence processing in children with mild ASD.

- Discussion of the fifth partial hypothesis:

The fifth partial hypothesis stated that "the juvenile source has a role in sentence processing in mild ASD".

From the results obtained in the above table (14), which found that the value of sig.=0.000, which proves that the source of events has a role in sentence processing in children with mild ASD.

General conclusion:

In light of the results we reached through our study, and after presenting, analysing and discussing the results, and based on the theoretical background that we discussed in the theoretical chapters of the current study, we concluded that children with ASD have issues at the level of executive functions, especially working memory, which made them find difficulties in retrieving and processing sentences, through our study of "the role of executive functions in sentence processing in children with mild ASD (working memory as a model) on a sample of 23 cases in Mostaganem state, and after applying tests, we obtained the following results

- Executive functions have a role in sentence processing in children with mild autism spectrum disorder.
- Working memory has a role in sentence processing in children with mild autism.
- The phonological loop has a role in sentence processing in children with mild ASD.
- Visual-spatial memory has a role in sentence processing in children with mild ASD.
- The juvenile source has a role in sentence processing in children with mild autism.
- The central manager has a role in sentence processing in mildly autistic children.

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