Evaluation of Executive Functions in Dysphasia Patients -Planning and Cognitive Flexibility as a Model-

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Received: 16/05/2025 **Revised:** 16/05/2025 **Accepted:** 21/09/2025

Abstract

The current study aims to evaluate the level of executive functions represented in both planning skills and cognitive flexibility in dysphasia patients, by using two tests to collect data: Figure de Rey A and Trail Making B. The study was conducted on a sample of two dysphasia cases, using the descriptive approach in the case study style. In light of the results obtained, it became clear to us that the executive functions represented in both cognitive flexibility and planning are disturbed in dysphasia patients.

Keywords: Dysphasia, executive functions, planning, cognitive flexibility.

تقييم الوظائف التنفيذية لدى المصاب بالدسفازيا
– التخطيط والمرونة المعرفية نموذجا –

ملخص

هدفت الدراسة الحالية إلى تقييم مستوى الوظائف التنفيذية المتمثلة في مهارتيْ التخطيط والمرونة المعرفية لدى المصاب بالدسفازيا، باستعمال اختبارين لجمع البيانات و هما: اختبار رأي الشكل المعقد (A) واختبار تتبع المسار(B)، وتم اجراء الدراسة على حالتين مصابتين بالدسفازيا، وذلك باتباع المنهج الوصفي بأسلوب دراسة الحالة. وفي ضوء النتائج المتحصل عليها تبين لنا أن الوظائف التنفيذية المتمثلة في المرونة المعرفية والتخطيط مضطربة لدى المصاب بالدسفازيا.

الكلمات المفاتيح: دسفازيا، وظائف تنفيذية، تخطيط، مرونة معرفية.

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Introduction:

In recent years, researchers have shown increasing interest in the concept of executive functions, which is a relatively new concept in the field of cognitive psychology, in particular, and psychology, in general. The attention to this concept has grown rapidly, particularly in the field of special education due to its connection with many essential linguistic and life skills for children with disabilities.

Executive functions can be defined as a set of higher-order processes that intervene in novel, unfamiliar tasks directed toward a specific goal. These are central processes that play a key role in behavior regulation and decision-making. Proper performance of these executive skills is considered as an indicator of success in various aspects of life and is essential for organizing intellectual, emotional, and social abilities. Executive functions are the ability to make decisions and plan steps that help individuals control their behavior. They allow the initiation of new task sequences by inhibiting automatic responses that are inappropriate to the context while adapting and monitoring behavior and new processes to achieve the set goal. They also simultaneously coordinate, monitor, and execute multiple tasks.

However, neurodevelopmental disorders can impair the dynamic growth of these executive functions in children. Among these disorders are developmental language disorders.

Developmental Dysphasia:

Developmental dysphasia falls under the category of neurodevelopmental disorders that hinder a child's development as a social and emotional being. The specificity of this disorder lies in the fact that the obstacles to this development exist at the level of linguistic tools, which prevent language from fulfilling its role as a mediator and support for thinking(1).

Since language is a means of knowledge and its production, linguistic or language disorders will have an impact on decision-making pathways that involve verbal strategies in performing activities (such as mental arithmetic). Although one of the diagnostic criteria for dysphasia is that non-verbal cognitive abilities are intact. Other theories suggest that cognitive impairment may be the cause of its emergence. Since the early 1990s, hypotheses have been developed about cognitive disorders that could be the origin of developmental dysphasia (TSDL). These disorders have been identified in the following areas: speed of information processing, general information processing capacity, and working memory (especially phonological memory)(2).

Researchers have also pointed to numerous pieces of evidence linking executive functions and language. The relationship between executive functions and language frequently occurs through the actual use of language by children. Children's use of language facilitates their performance in executive functions. This is evident in the level of children with impaired executive functions who exhibit slow and weak language use compared to other children who use language more frequently in daily life activities.

The relationship between executive functions and language skills is complementary. The more advanced the level of executive functions in children is, the more advanced their language development will be. Similarly, the weaker the executive functions are, the slower and more deteriorated the language level will be.

Statement of the Problem:

Dysphasia is one of the developmental communication disorders affecting children. It is referred to by several terms, including "complex language delay," "specific developmental language disorder," and "developmental language disorder." All these terms indicate a chronic impairment in linguistic performance that follows the child through all stages of development, manifesting differently according to the child's age.

Dysphasia is a specific disorder in the development of oral language characterized by a significant and persistent linguistic deficit. This disorder is not due to any hearing impairment, malformation of the vocal organs, intellectual disability, acquired neurological disorders during childhood, or severe educational or emotional deficiencies(3).

Language is one of the higher brain functions and is a complex neural activity involving multiple functions, including executive functions. These functions allow the speaker to select the appropriate word and inhibit words that are not suitable for the linguistic context while coordinating ideas and transitioning flexibly from one idea to another. The analysis, storage, retrieval, and execution of linguistic information cannot occur without the intervention of executive functions, which ensure the integration of various mental processes. Therefore, executive functions play an important role in the stages of language acquisition and significantly influence language development, positively or negatively, depending on the level of executive function achievement in the child.

These executive functions consist of a set of cognitive abilities that include and control other abilities. They are essential for any goal-directed behavior and include planning, shifting, flexibility, inhibition, working memory, and self-monitoring. It is worth noting that executive functions are diverse, operate interdependently, yet each has its own specificity.

Cognitive flexibility and mental planning are executive functions that develop rapidly during the preschool period, especially between the age of three and five. These functions are related to language development, as demonstrated by numerous studies. Among the studies that examined the relationship between cognitive flexibility and language is the study by Boukhedenna Mounir (2020-2021) on the relationship between cognitive flexibility and syntactic language level in children with language delay aged between 4 to 6 years. The results concluded a partial correlation between cognitive flexibility and linguistic structures. Another study by Oriane Landry and Natalie Russo (2013) examined the impact of verbal and non-verbal development on executive functions in individuals with Down syndrome and Williams syndrome. The results indicated that verbal development is linked to cognitive flexibility and working memory and that verbal development is the best predictor of cognitive flexibility and working memory.

To the researcher's knowledge, no local studies have specifically addressed the assessment of these executive functions in individuals with dysphasia. Therefore, this study aims to evaluate two executive functions, namely cognitive flexibility and planning, in individuals with dysphasia. The following questions were raised:

- Are executive functions (cognitive flexibility and planning) impaired in individuals with dysphasia?
- Is cognitive flexibility impaired in individuals with dysphasia?
- Is planning impaired in individuals with dysphasia?

Hypotheses:

- Executive functions (cognitive flexibility, planning) are impaired in individuals with dysphasia.
- Cognitive flexibility is impaired in individuals with dysphasia.
- Planning is impaired in individuals with dysphasia.

Objectives of the Study:

- To identify the nature of executive functions in individuals with dysphasia.
- To assess the level of cognitive flexibility in individuals with dysphasia.
- To assess the level of planning in individuals with dysphasia.

Significance of the Study:

- To open avenues for research on dysphasia in the Algerian context and enrich the scientific literature, given the scarcity of studies on this population.
- This study adds to the understanding of the cognitive aspect in individuals with dysphasia, an area with limited research.

1- The current study contributes to helping specialists working with individuals with dysphasia better understand the cognitive aspect, particularly executive functions related to oral language, and thus develop effective therapeutic protocols to improve these functions and, consequently, oral language disorders.

1- Definition of Concepts:

1-1- Executive Functions:

Executive functions refer to a set of cognitive abilities that regulate and control other abilities and behavior. They are essential for any goal-directed behavior and include the ability to initiate or inhibit actions, monitor and modify behavior as needed, and plan future behavior when facing new tasks or situations. These functions help us anticipate the outcomes of our behavior and adapt to changing circumstances[(4)].

Researchers have differed in defining executive functions. The simplest definition was provided by Anderson (1998), who stated: "Executive functions are the skills necessary for performing any purposeful behavior aimed at a specific goal."

Definitions in this field emphasize the following elements:

1- Setting and planning future goals and actions.

2- Planning to achieve these goals and recalling appropriate procedures for the task, with a problem-solving orientation.

3- Initiating the necessary steps to achieve the goal and transitioning between them while monitoring partial goal achievement.

4- Retaining the plan in working memory during task execution until completion.

5- Organizing emotional responses and attention to achieve flexibility in plan execution.

6- Evaluating behavioral outcomes to use the plan in future similar activities.

7- Maintaining mental readiness to solve future problems and balancing current situations with short- or long-term goals.

8- Self-monitoring to recognize progress toward the desired goal.

9- The ability to control activation and inhibition of responses unrelated to the goal during the individual's response sequence[(5)].

Operational Definition: Executive functions are a set of higher brain functions that control goal-directed behavior requiring planning. They include planning, cognitive flexibility, inhibition, working memory, and self-monitoring.

Components of Executive Functions:

Researchers still disagree on the classification of executive function components. They include a set of dimensions that operate interdependently to achieve the desired goal or task. Some researchers have classified executive functions into two categories:

- **Lower Cognitive Processes:** Include initiation, working memory, and inhibition. These processes develop early in childhood and can be observed between the age of 2 and 4.
- **Higher Cognitive Processes:** Include planning, organization, cognitive flexibility, and self-monitoring. These processes develop later in childhood and can be observed between the ages of 4 and 7.

In this study, the researcher focuses on two functions: planning and cognitive flexibility, which are related to language development, as demonstrated in several studies, and are relevant to the research topic[(6)].

1-1-1- Planning:

Planning is the general ability to identify and organize the necessary steps to perform a desired action. It includes several sub-abilities, such as formulating concepts related to changes in the current situation, rationally considering the environment, perceiving options, and organizing sequential and old ideas necessary for developing the conceptual framework of the plan.

1-1-2- Cognitive Flexibility:

Cognitive flexibility is our ability to change the way we process things. It is the means by which we can perform an action in a specific situation that was previously processed differently. It is also the ability to redirect the content of thinking for a better response in new situations, finding new answers in new and appropriate ways when conventional methods are unsuitable[(7)].

1-2- Dysphasia:

Definition of Dysphasia:

Dysphasia is a serious developmental disorder characterized by deviant, slow, and non-harmonious structuring or organization of speech and oral language. It also involves difficulties in processing symbols, leading to persistent disorders in linguistic organization at various levels: phonological, lexical, syntactic, morpho-syntactic, semantic, and pragmatic, without any specific known causes at present.

Operational Definition: Dysphasia is a severe and specific disorder affecting the development of oral language in both production and comprehension, though production is more affected. Its cause is unspecified but is unrelated to sensory, organic, or intellectual impairments. It is classified into types based on the most affected linguistic level[(8)].

Types of Dysphasia:

Gérard (1996) classified dysphasia into five types based on Crosson's model:

1- Phonological-Syntactic Dysphasia: The most common type, attributed to a deficit in the connection between formulation and programming. Children with this type have better receptive than expressive abilities, and their language production is limited and unclear.

2- Phonological Production Dysphasia: Difficulties in this type are primarily expressive, similar to the first type, but not at the syntactic level. The problem lies not in programming information but in the auditory control of the verbal sequence[(9)].

3- Receptive Dysphasia: Encoding processes are severely impaired, with deficits in comprehension and expression. Children struggle to create and use verbal images based on auditory models, with recognition difficulties at the phonemic level and shared difficulties in recognizing familiar non-verbal sounds.

4- Lexical-Syntactic Dysphasia: Also known as "amnesic dysphasia," the hallmark of this type is a deficit in accessing the mental lexicon, referred to as "word-finding difficulty."

5- Semantic-Pragmatic Dysphasia: This type involves a disorder in the formulation function. During the early stages of language development, this disorder may not be noticeable as it affects the formal aspects of phonological and syntactic development[(10)].

2- Methodological Framework of the Study:

2-1- Study Methodology:

This study describes the level of executive functions, specifically cognitive flexibility and planning, in individuals with dysphasia. Therefore, the appropriate methodology is a descriptive case study approach.

2-2- Study Location:

The fieldwork was conducted at a private school for children with special needs affiliated with the Association for the Future of Dysphasia (ADWA) in the case of Algiers, which includes dysphasic children integrated into special classes.

2-3- Study Group:

The study group consisted of two male cases with dysphasia, aged between 15 and 16, integrated into a special class at the private school affiliated with ADWA.

2-4- Study Tools: Executive Function Tests:

a. **Trail Making Test (TMT):**

This version is derived from the Army Individual Test Battery (1994). It consists of two parts: Part A and Part B. Part A contains numbered circles from 1 to 25 scattered on a worksheet and assesses cognitive-motor speed. Part B contains numbered circles from 1 to 13 and lettered circles in the French alphabet randomly distributed on a worksheet. This part measures mental flexibility. The test includes four sheets: a practice sheet for Part A and Part B, and a test sheet for Part A and Part B. It is designed for adults and is highly sensitive to brain injuries. It is administered using a stopwatch.

b. **Rey Complex Figure Test (A):**

Developed by André Rey in Geneva in 1942, this test measures visual perception, visual memory, and planning skills. It involves copying a complex geometric figure and then reproducing it from memory. It is divided into the Rey Complex Figure (Rey A), applicable to children and adults aged between 4-15 and above, and the Rey Simple Figure (Rey B), applicable to children aged between 4-8.

2-5- Presentation and Analysis of Results:

2-5-1- Trail Making Test Part B Results:

Case 1:

Table N° 01: Trail Making Test Part B Results

Time Taken	Errors	Part B
180 s.	10	Measuring cognitive flexibility

- **Time Taken:** 180 seconds (3 minutes and 8 seconds).
- **Errors:** 10 out of 25 (13 letters and 12 numbers).

Case 2:

Table N° 02: Trail Making Test Part B Results

Time Taken	Errors	Part B
352 s.	18	Measuring cognitive flexibility

- **Time Taken:** 352 seconds (5 minutes and 52 seconds).
- **Errors:** 18 out of 25 (13 letters and 12 numbers).

Analysis: Both cases exceeded the cognitive impairment threshold (180 seconds) and made numerous errors, indicating impaired cognitive flexibility.

2-5-2- Rey Complex Figure Test (A) Results:

Case 1:

Table N° 03: Rey Complex Figure Test (A) Results (Case 01)

Reproducing	
87.5%	31.5/36

- **Score:** 31.5/36 (87.5%).

Case 2:

Table N° 04: Rey Complex Figure Test (A) Results (Case 02)

Reproducing	
%47	17/36

- **Score:** 17/36 (47%).

Analysis: Both cases took a long time to complete the task, and Case 2 showed significant deficiencies in reproducing the figure, indicating impaired planning.

Discussion:

The results of this study reinforce the idea that individuals with dysphasia face specific challenges in the domains of cognitive flexibility and planning. These deficits appear to be linked to the particularities of language development, which plays a key role in structuring executive functions. Indeed, cognitive flexibility—the ability to adapt thinking and behavior to new or unexpected situations—and planning—the capacity to organize and execute goal-directed actions—are both closely tied to language processing.

The findings align with previous research, such as the studies by Oriane Landry and Natalie[11] Russo, which established a connection between verbal development, cognitive flexibility, and working memory. This suggests that language impairments in dysphasia may disrupt the cognitive processes that rely on verbal mediation, such as problem-solving, task-switching, and the ability to plan and sequence actions.

These insights highlight the importance of addressing both linguistic and cognitive aspects in therapeutic interventions for individuals with dysphasia. By fostering language skills and simultaneously targeting executive functions, it may be possible to mitigate some of the cognitive challenges associated with this condition. Further research could explore the specific mechanisms underlying these relationships and develop tailored strategies to support cognitive and linguistic development in this population.

Conclusion:

This study highlights the impairment of executive functions, specifically cognitive flexibility and planning, in individuals with dysphasia. Given the critical role of executive functions in language acquisition, these findings contribute to a deeper understanding of the cognitive dimensions of dysphasia. Cognitive flexibility, which allows individuals to adapt to new information or shifting demands, and planning, which involves organizing and executing goal-directed actions, are both essential for effective communication and learning. Their impairment in dysphasia underscores the interconnectedness of language and cognition.

The results suggest that language difficulties in dysphasia may not exist in isolation, but are intertwined with broader cognitive challenges. This aligns with previous research, such as the studies by Oriane Landry and Natalie Russo which emphasize the relationship between verbal development, working memory, and cognitive flexibility. These insights pave the way for more comprehensive approaches to intervention, which could simultaneously target language skills and executive functions to address the multifaceted nature of dysphasia.

Furthermore, this study opens avenues for future research to explore the underlying mechanisms linking language and executive functions in dysphasia. For example, longitudinal studies could investigate how early language interventions might influence the development of executive functions, or neuroimaging studies could examine the neural correlates of these cognitive processes in individuals with dysphasia. By deepening our understanding of these relationships, researchers and clinicians can develop more effective strategies to support individuals with dysphasia in both their linguistic and cognitive development.

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