Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

Assessment of Executive Functions (Inhibition, Planning, and Mental Flexibility) in Patients with Multiple Sclerosis: A Study in Cognitive Neuropsychology

Fathi Ouada[1]

Abstract

The present study aimed to assess executive functions (inhibition, planning, and mental flexibility) in patients with multiple sclerosis. The study used a sample consisting of three cases selected intentionally, applying the case study method. The researcher applied the following study tools, taken from the Brief Cognitive Assessment Battery for patients with multiple sclerosis (BC COG SEP): the Go/No-Go test, the Trail Making Test (TMT), and the Clock Drawing Test (CDT).

The results of the study concluded that:

- Patients with multiple sclerosis suffer from cognitive impairment at the level of inhibition function.

- Patients with multiple sclerosis suffer from cognitive impairment at the level of planning function.

- Patients with multiple sclerosis suffer from cognitive impairment at the level of mental flexibility function.

Keywords: *Executive Functions, Inhibition, Planning, Mental Flexibility, Multiple Sclerosis.*

Received : 15/12/ 2025 ; Accepted : 21/04/2026 ; Published : 24/05/2026

Introduction

Multiple sclerosis is one of the most common chronic neurological diseases. It usually affects young adults aged 20-40 years. It is an autoimmune disease that leads to inflammatory neurodegeneration of the white matter within the brain and spinal cord. The characteristic symptoms include loss of axons and neurons and demyelination, thereby leading to a set of sensory, motor, and cognitive disorders. The cognitive profile of multiple sclerosis is generally characterized by impairment in processing speed, attentional executive performance, and memory.

Despite the significant progress made in understanding the possible mechanisms of the disease, identifying biomarkers with sufficient accuracy for regular clinical use remains a challenge. Diagnosis depends mainly on clinical symptoms, which may be mild in the early stages and often overlap with other neurological disorders.

Therefore, physicians rely heavily on clinical tests and medical records to identify and monitor the disease, which leads to major challenges during initial diagnosis as well as in monitoring disease progression. This calls for increasing attention to the development of more effective diagnostic and therapeutic strategies. Although there is still no curative treatment, continuous developments in pharmacological therapies and multiple therapeutic interventions offer growing hope for improving patients' quality of life.

This scientific paper aims to assess executive functions by analyzing the current diagnostic challenges of multiple sclerosis, while exploring promising therapeutic prospects and recent developments in early

[1] Abdelhamid Mehri University - Constantine 2, Algeria, Email: Fathi.ouada@univ-constantine2.dz

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

diagnosis and treatment in light of modern scientific updates, in order to take them into consideration in rehabilitation and therapeutic plans.

Problem of the Study

Multiple sclerosis is a degenerative disease, a chronic inflammatory disease, and one of the autoimmune diseases, in which the immune system attacks the central nervous system, targeting the myelin sheath, the protective covering of nerve fibers, which leads to deterioration of the white matter. According to the National Institute of Health and Medical Research INSERM (2014), multiple sclerosis is the leading cause of non-accidental (non-traumatic) disability among young people. The first symptoms most often appear between the ages of 20 and 40 years, with a predominance among females, while rare cases are observed among children or older adults. A patient with multiple sclerosis often suffers from motor, sensory, or cognitive disorders (Bruno Brochet, Sèze, and Lebrune-Frenay, 2017).

Cognitive disorders affect between 40% and 60% of patients with multiple sclerosis. These disorders appear from the onset of the disease and are usually more severe in progressive forms of the disease compared with forms that develop in relapses. They also seem to progress faster than motor disorders. The most affected and most studied cognitive domains are episodic memory, information processing speed, working memory, and executive functions. These changes lead to negative repercussions on daily life activities, social life, and quality of life in MS (Lebkuecher et al., 2021).

In recent years, researchers and physicians have paid attention to the neuropsychological aspects of patients with multiple sclerosis. Among the cognitive processes that have received attention are executive functions, which are defined as a set of processes whose primary function is the individual's adaptation to new situations, as every new situation requires executive control. They are also the basis of social, professional, and personal behavior, and any disorder affecting these higher functions has consequences both at the cognitive level and at the level of general behavior.

Studies have shown that executive functions, including inhibition, planning, and mental flexibility, are among the cognitive processes that are impaired in patients with multiple sclerosis, and that their severity increases in the late progressive stages of the disease compared with its initial stages. This is what was concluded by the results of the study by Ghazali Djahida (2012) and the study by Ben Bouzrid Meriem (2019), which aimed to assess various cognitive abilities among this group, including executive functions. Likewise, the study by Boucha Nawal and Hassian Mohamed (2023), entitled: The Effect of Executive Function Disorders (Mental Flexibility) on Information Processing Speed among Patients with Multiple Sclerosis, concluded that executive function disorder affects information processing speed in patients with multiple sclerosis. The results of the study by Baaziz Arezki & Chaibi Sabrina (2020) revealed that there is no relationship between executive functions and the process of mental rotation among patients with multiple sclerosis.

Through the field study and based on all the above, we attempt to assess the most important higher cognitive processes represented in executive functions (inhibition, planning, mental flexibility) and production in patients with multiple sclerosis. From this standpoint, the following question was raised: Do patients with multiple sclerosis suffer from cognitive impairment at the level of executive functions?

Study Hypotheses

Main Hypothesis

- Patients with multiple sclerosis suffer from cognitive impairment at the level of executive functions.

2.2. Partial Hypotheses:

- Patients with multiple sclerosis suffer from cognitive impairment at the level of inhibition function.

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

- Patients with multiple sclerosis suffer from cognitive impairment at the level of planning function.

- Patients with multiple sclerosis suffer from cognitive impairment at the level of mental flexibility function.

Importance of the Study

- Highlighting this type of disease and clarifying the extent of the suffering of patients with multiple sclerosis.

- Identifying the cognitive and linguistic aspect and the extent to which it is affected in patients with multiple sclerosis.

- Enriching the field of study in the area of multiple sclerosis, which lacks this type of research, especially in the Algerian clinical environment.

- Informing specialists about executive function disorder among patients with multiple sclerosis in order to prepare rehabilitation programs and develop appropriate therapeutic plans.

Objectives of the Study

- Assessing executive functions (inhibition, planning, and mental flexibility) in patients with multiple sclerosis.

- Determining the level of cognitive disorder in executive functions in patients with multiple sclerosis.

Basic Concepts of the Study and Their Operational Definitions:

Executive Functions:

Executive functions are considered among the higher and most complex cognitive functions in the brain. They organize and control all other abilities, as they coordinate, organize, plan, monitor, inhibit, and modify all neural connections in the brain. Thus, they help the individual manage and organize the tasks of daily life.

Inhibition:

It is a process that allows the suppression and inhibition of previous information, in addition to inhibiting stimuli that are not related to the current activity, in order to choose other responses that are more appropriate to a particular situation. It is represented by the results obtained by the examinee through the test applied in this study, namely the Go/No-Go test taken from the Brief Cognitive Assessment Battery for patients with multiple sclerosis BC COG SEP.

Planning:

It is a process that allows the organization of the essential stages for carrying out a task and an intentional act, and thus reaching the desired goal. It is represented by the results obtained by the examinee through the test applied in this study, namely the Clock Drawing Test (CDT).

Mental Flexibility:

It is the ability to change a mental schema, adapt to a new task, and alternate between several tasks or actions. It is represented by the results obtained by the examinee through the test applied in this study, namely Part B of the Trail Making Test (TMT).

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

Multiple Sclerosis:

It is a chronic progressive neurological disease that affects the central nervous system CNS (the brain and spinal cord). It is one of the autoimmune diseases, as it causes damage to the myelin substance (myelin sheath) that surrounds nerve fibers and facilitates the flow of nerve impulses. Thus, multiple sclerosis disrupts the transmission of nerve impulses.

Theoretical Framework:

❖ *Multiple Sclerosis:*

❖ *Definition:*

Multiple sclerosis (La sclérose en plaques - SEP) is a chronic autoimmune inflammatory disease that affects the central nervous system (CNS) and targets young people (Moreau & Pasquier, 2017).

❖ *Causes (Etiologies)*

The causes of this neurological disorder are still not precisely known to date, but it is likely that they are multifactorial.

• **Genetic predisposition:** First, the existence of a genetic predisposition cannot be denied; in 5% to 10% of cases, there is more than one individual with multiple sclerosis within the same family. Moreover, the prevalence of the disease in certain ethnic groups rather than others reinforces the hypothesis of genetic predisposition. The incidence rate of 3 women to 1 man also indicates a possible role of sex chromosomes or hormones.

• **Environmental factors:** The environment plays a role in triggering the onset of the disease. The distribution of prevalence rates according to geographical regions indicates that exposure to certain environmental factors may trigger pathological processes. Studies on migration phenomena have revealed that migration to a "high-risk" area before the age of 15 increases the likelihood of developing the disease. Similarly, migration to a "low-risk" area before the same age reduces that likelihood. The increased risk of infection in areas far from the equator (where sunlight exposure rates are low) also suggests the role of vitamin D deficiency as a triggering factor for the disease.

• **Infectious factors:** Finally, some researchers assume that an infectious factor may be partly responsible for the disease. Many viruses have been suspected, but no confirmed links have been established for most of them, except for Epstein-Barr virus (Epstein-Barr) (Bruno Brochet, Sèze, and Lebrune-Frenay, 2017).

❖ *Clinical Forms and Progression:*

Multiple sclerosis is considered a neurodegenerative disease. However, the progression of symptoms differs from one patient to another; therefore, several clinical forms have been distinguished based on the pattern of disease progression.

1- Relapsing-Remitting Form (SEP-RR):

This is the most common initial clinical form, affecting 80% of patients. Progression here is characterized by a "phase" pattern: the sudden onset of one or more symptoms, followed by complete or partial recovery within a few weeks. This period of the appearance of new symptoms is called a "relapse" (Poussée). Over time, the recovery process becomes less effective, and relapses leave behind residual effects that gradually increase, leading to worsening disability.

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

2- Primary Progressive Form (SEP-PP):

This type affects only about 10% of patients. In this form, the disease progresses in an ascending manner from the beginning; that is, once the disease appears, the symptoms begin to worsen gradually and continuously without clear periods of remission.

3- Secondary Progressive Form (SEP-SP):

After a period of progression through "relapses" (the relapsing-remitting form SEP-RR), symptoms begin to worsen gradually, with or without additional relapses. This form is considered a progression of the relapsing-remitting form; it affects 50% of patients with (SEP-RR) after 10 years of disease progression, and this percentage reaches 90% after 25 years.

4- Clinically Isolated Syndrome (CIS):

It was introduced by "Lublin" and colleagues in 2013, and it describes a disease condition in which only one focus of demyelination (Démyélinisation) appears on radiological imaging, without the occurrence of new attacks, with or without residual effects (Brochet et al., 2017).

❖ *Pathophysiological Mechanisms:*

The current state of knowledge concerning the pathophysiological mechanisms responsible for brain lesions remains fragmented. It is well established that they are inflammatory mechanisms of autoimmune origin, targeting myelin; the fatty membrane that surrounds the axons of neurons in the central nervous system and spinal cord, and which allows the rapid conduction of nerve impulses. For reasons that remain unknown, the immune system no longer recognizes myelin cells and begins to attack them, leading to the progressive demyelination (Démyélinisation) of axons, which causes the observed functional deficits (Tison, 2022).

The Plaque (La plaque):

The mechanism causing the relapsing forms of multiple sclerosis was the first to be described, and it is currently the clearest and most evident. Demyelination can be observed in the form of focal lesions in the white matter, which "Charcot" (1877) described as "plaques." They derive their name from their particular appearance when examining patients' brains after death. A plaque is considered "active" or "acute" when the process of demyelination is ongoing. Active plaques are characterized by their eroded appearance and the dense presence of macrophages and T-lymphocytes, which are the immune cells responsible for destroying myelin. Once the plaque becomes inactive, the process of remyelination (Remyélinisation) occurs, often partially, and is accompanied by the formation of scar tissue (fibrosis).

The Relapse (La poussée):

A relapse is the clinical expression of the inflammatory mechanism that occurs in the central nervous system. It is defined as the appearance of new symptoms for more than 24 hours, or the worsening of pre-existing symptoms, in the absence of fever or any infection. A relapse can last between two weeks and 6 weeks, and is followed by complete or partial recovery, either spontaneously or with the help of specific treatments (Stauffer, 2009).

Special Case: Progressive Forms

In progressive forms, symptoms appear gradually without recovery, which indicates the existence of a pathophysiological mechanism different from that found in relapsing-remitting forms, although it has not yet been precisely identified. The gradual worsening may result from more diffuse lesions and therefore be more difficult to identify compared with patients with (SEP-RR).

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

It may also involve an independent neurodegenerative mechanism; while relapsing forms respond well to immunomodulatory treatments, progressive forms are much less sensitive to them, which means that the autoimmune reaction may not be the main factor responsible for inflammation in these forms. In addition, progressive forms are characterized by the presence of cortical lesions, which is an additional sign that the mechanisms underlying these clinical forms are different (Roberts & Miller, 2004).

Applied Aspect:

Study Method:

Based on the presentation of the research problem, the importance of the topic, and the objective sought from it, it appears that the study falls within descriptive studies. Therefore, the descriptive method using the case study approach is considered appropriate for addressing the course of the research.

Study Sample:

The study consisted of 3 cases diagnosed with multiple sclerosis, who were selected intentionally and were affiliated with Al-Amal Association for Patients with Multiple Sclerosis, Mila Province, Algeria, where they are cared for at Houari Boumediene Hospital. Their ages ranged between 36 and 53 years, from both sexes. We relied on a set of criteria (conditions) to select the sample members, which therefore represent the characteristics of the studied group, the most important of which are:

- The cases do not suffer from sensory disorders such as hearing and vision problems.
- The cases do not suffer from motor disorders except in the lower limbs.
- We did not take the social and economic levels into consideration.
- We took into account the cultural or educational level.
- The case does not suffer from severe cognitive disorders. (This was done through the application of a test.)
- We also used the medical file to collect information about each case.

Table (01) Characteristics of the Study Sample

Cases	Sex	Age	Educational Level	Occupation	Year of Disease Onset	Duration of Illness
First	Female	52 years	Doctorate	Higher Education Professor	2009	16 years
Second	Male	38 years	Secondary	Employee	2020	5 years
Third	Female	36 years	Secondary	Housewife	2010	15 years

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

Table (2): Results of the Mini-Mental State Examination (MMSE)

	Case One	Case Two	Case Three
Temporal Orientation	5	5	5
Spatial Orientation	5	5	5
Registration	3	3	2
Attention and Calculation	5	5	5
Recall	1	1	3
Naming	2	2	2
Repetition	2	2	1
Oral Language Comprehension	3	3	3
Written Language Comprehension	0	0	1
Written Language	1	1	1
Copying	0	1	1
Total:	**27/30**	**28/30**	**29/30**

MMSE Test Results (Mini-Mental State Examination):

It is a test designed by "Folstein" in 1975 to assess the individual's cognitive abilities and determine the degree of their impairment, including spatial and temporal orientation, learning, memory, attention, mental calculation and recall, the use and comprehension of language, as well as the assessment of performance processes (through drawing), which came in the form of items totaling 30 questions. This test is considered one of the most widely used tests in the clinical field of dementia, as it has high sensitivity in identifying dementia and measuring the cognitive changes that occur in individuals over time (Ben Aarab Asia, 2012, pp. 84-85). It was applied in the study to ensure the absence of cognitive impairment among the study sample, and we obtained the following results:

- **Case 1:** obtained a score of 27, and therefore does not suffer from cognitive disorders.

- **Case 2:** obtained a score of 28, and does not suffer from cognitive disorder.

- **Case 3:** obtained a score of 29, and does not suffer from cognitive disorder.

Thus, all cases do not suffer from cognitive disorders, which is our objective in selecting the study sample, as the sample members must not suffer from cognitive disorders.

Steps and Procedures for Applying the Basic Study:

Basic Study Tools:

❖ *Brief Cognitive Assessment Battery for patients with multiple sclerosis:*

Batterie courte d'évaluation des fonctions cognitives destinée aux patients souffrant de sclérose en plaques (BC COG SEP)

The BC COG SEP battery is one of the specialized batteries for assessing cognitive functions in persons with multiple sclerosis. It is a French battery inspired by an American battery (BRN-N), the latter of which was developed by RAO and his colleagues in 1990. It was adapted to the Algerian environment by Ghazali Djahida in 2012, as the researcher standardized it on a sample consisting of 30 individuals of both sexes and also calculated its psychometric properties in terms of validity and reliability. The battery consists of 07 tests that measure different types of cognitive processes (Lamouri, Riyabi, 2021, p. 447), namely: the learning and recall test, the symbol coding test, the verbal fluency test, the PASAT addition test, the digit memory test, the reversed commands test, and the Go/No-Go test.

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

We will select two tests from this battery that are compatible with the objectives of our study, namely:

❖ *Go/No-Go Test:*

This test is inspired by the Frontal Assessment Battery (FAB/BREF). It is based on inhibitory control contexts. In this test, the examinee is presented with single taps or double taps, and is asked to raise and lower the hand when hearing one tap, and not to make any movement when hearing two taps. We do the same thing ten times according to the following model: (2- 1- 1- 1- 2 -2 -1- 2- 1- 1).

Instruction:

Raise your hand and lower it if you hear one tap, and do not make any movement if you hear two taps. The examiner provides an example of this.

Scoring:

A score of (03) is given if there is no error, a score of (02) if the examinee makes one or two errors, and if there are more than two errors, a score of (01) is given. If the examinee is unable to respond, that is, unable to perform the test, or follows the examiner's rhythm, the score is (00) (Ghazali, 2012, pp. 87-88).

❖ *Clock Drawing Test or Test de l'horloge (CDT):*

The Clock Drawing Test (CDT) is widely used in neuropsychology and related fields to assess neurological and cognitive impairments. It is a simple neuropsychological measurement tool that is easily administered to assess several neurological and psychological functions (Aprahamian et al., 2009, p. 75). It focuses on practical application, attention, executive skills, orientation in time and space, in addition to visual disorders.

This test assesses cognitive processes, namely: short-term memory, understanding of verbal instructions, temporal-spatial orientation, abstract thinking, planning process, and concentration. This test is not affected by the factors of language, educational level, and cultural level. It is also characterized by ease and simplicity, and is well accepted by patients (INESSS, 2015, p. 01).

In this test, the examiner gives the examinee a sheet of paper, often with a pre-drawn circle on it, and asks them to draw the numbers and hands on the clock face. The hands must show a specific time. The evaluation is based on identifying defects in the drawings, which may include poor placement of numbers, forgetting numbers, incorrect sequencing, absence of clock hands, and the presence of irrelevant writing (Seferoglu et al., 2022, p. 81).

The studies of Tekin Selma et al. (2022) and Seferoglu Meral et al. (2022) showed that the CDT is a practical, inexpensive, and easy-to-use test for cognitive assessment among patients with multiple sclerosis.

Instruction:

The examiner gives the examinee a sheet of paper with a circle drawn on it, approximately 10 cm in diameter. This circle represents the clock frame, and the examinee is asked to place the numbers inside this circle so that it looks like a clock face. Then they are asked to draw hands indicating 11:10 a.m. There is no time limit, and the person must refrain from looking at their watch or the wall clock. We must also avoid mentioning the word "clock hands" (INESSS, 2015, p. 3).

Scoring:

There are many different methods for evaluating this test, including:

Mendez et al. method (1992).

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

Wolf-Klein et al. method (1989).

Sunderland et al. method (1989).

Shulman et al. method (1986).

Shulman et al. method (2000).

The 10-point scoring method (Mias, 1997, pp. 1-2).

The 7-point scoring method:

Seven criteria are studied:

- The clock numbers from 1 to 12 are present.
- The order of the numbers is correct.
- The position of the numbers is correct.
- The two hands are present.
- The hour hand is positioned correctly.
- The minute hand is positioned correctly.
- The size of the two hands is different from each other.

Thus, a total of 7 points is obtained (Panisset, 2022, p. 17).

One or more errors during drawing indicate the presence of a disorder in executive function.

❖ *Trail Making Test (TMT):*

It is a neuropsychological test developed by Halstead Reitan in 1944 in response to the requirements of the American military authorities during World War II, to assess cognitive disorders resulting from brain injuries. In 1950, research on it increased and it was developed. It consists of four cards, each two cards forming one part, and thus it contains two parts: Part (A) and Part (B) (Sefran, 2017, p. 268).

In Part A, the person is given a sheet containing circles with numbers from 1 to 25 arranged semi-randomly. The task is to connect the series of numbers from 1 to 25 with a pencil as quickly as possible and in ascending order. The sheet given in Part B includes 13 circles containing the numbers from 1 to 13 and 12 circles containing the letters from A to L, distributed semi-randomly on the page (Amieva et al., 2009, p. 212).

Part A assesses visual search and motor speed, while Part B assesses higher-level cognitive skills such as mental flexibility or executive function. This test is characterized by ease of application and administration (Canonne, 2019, p. 14). Accordingly, we use only Part B, which is specific to measuring mental flexibility.

The stopwatch (Chronomètre) is also started to calculate the time taken to complete the task. Reitan determined the time required to complete each card, and indicated that if the individual is unable to complete one card within a maximum of five minutes, the test is cancelled.

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

Table (03): Time Required to Complete Each Card in the Trail Making Test According to Reitan.

	Average Rate	In Case of Deficit or Impairment
Part A	29 to 78 seconds	> 78 seconds
Part B	75 seconds	> 75 seconds

MMSE Test Results (Mini-Mental State Examination):

It is a test designed by "Folstein" in 1975 to assess the individual's cognitive abilities and determine the degree of their impairment, including spatial and temporal orientation, learning, memory, attention, mental calculation and recall, the use and comprehension of language, as well as the assessment of performance processes (through drawing), which came in the form of items totaling 30 questions. This test is considered one of the most widely used tests in the clinical field of dementia, as it has high sensitivity in identifying dementia and measuring the cognitive changes that occur in individuals over time (Ben Aarab Asia, 2012, pp. 84-85). It was applied in the study to ensure the absence of cognitive impairment among the study sample, and we obtained the following results:

- **Case 1:** obtained a score of 27, and therefore does not suffer from cognitive disorders.

- **Case 2:** obtained a score of 28, and does not suffer from cognitive disorder.

- **Case 3:** obtained a score of 29, and does not suffer from cognitive disorder.

Thus, all cases do not suffer from cognitive disorders, which is our objective in selecting the study sample, as the sample members must not suffer from cognitive disorders.

Steps and Procedures for Applying the Basic Study:

Basic Study Tools:

❖ *Brief Cognitive Assessment Battery for patients with multiple sclerosis:*

Batterie courte d'évaluation des fonctions cognitives destinée aux patients souffrant de sclérose en plaques (BC COG SEP)

The BC COG SEP battery is one of the specialized batteries for assessing cognitive functions in persons with multiple sclerosis. It is a French battery inspired by an American battery (BRN-N), the latter of which was developed by RAO and his colleagues in 1990. It was adapted to the Algerian environment by Ghazali Djahida in 2012, as the researcher standardized it on a sample consisting of 30 individuals of both sexes and also calculated its psychometric properties in terms of validity and reliability. The battery consists of 07 tests that measure different types of cognitive processes (Lamouri, Riyabi, 2021, p. 447), namely: the learning and recall test, the symbol coding test, the verbal fluency test, the PASAT addition test, the digit memory test, the reversed commands test, and the Go/No-Go test.

We will select two tests from this battery that are compatible with the objectives of our study, namely:

❖ *Go/No-Go Test:*

This test is inspired by the Frontal Assessment Battery (FAB/BREF). It is based on inhibitory control contexts. In this test, the examinee is presented with single taps or double taps, and is asked to raise and lower the hand when hearing one tap, and not to make any movement when hearing two taps. We do the same thing ten times according to the following model: (2- 1- 1- 1- 2 -2 -1- 2- 1- 1).

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

Instruction:

Raise your hand and lower it if you hear one tap, and do not make any movement if you hear two taps. The examiner provides an example of this.

Scoring:

A score of (03) is given if there is no error, a score of (02) if the examinee makes one or two errors, and if there are more than two errors, a score of (01) is given. If the examinee is unable to respond, that is, unable to perform the test, or follows the examiner's rhythm, the score is (00) (Ghazali, 2012, pp. 87-88).

❖ *Clock Drawing Test or Test de l'horloge (CDT):*

The Clock Drawing Test (CDT) is widely used in neuropsychology and related fields to assess neurological and cognitive impairments. It is a simple neuropsychological measurement tool that is easily administered to assess several neurological and psychological functions (Aprahamian et al., 2009, p. 75). It focuses on practical application, attention, executive skills, orientation in time and space, in addition to visual disorders.

This test assesses cognitive processes, namely: short-term memory, understanding of verbal instructions, temporal-spatial orientation, abstract thinking, planning process, and concentration. This test is not affected by the factors of language, educational level, and cultural level. It is also characterized by ease and simplicity, and is well accepted by patients (INESSS, 2015, p. 01).

In this test, the examiner gives the examinee a sheet of paper, often with a pre-drawn circle on it, and asks them to draw the numbers and hands on the clock face. The hands must show a specific time. The evaluation is based on identifying defects in the drawings, which may include poor placement of numbers, forgetting numbers, incorrect sequencing, absence of clock hands, and the presence of irrelevant writing (Seferoglu et al., 2022, p. 81).

The studies of Tekin Selma et al. (2022) and Seferoglu Meral et al. (2022) showed that the CDT is a practical, inexpensive, and easy-to-use test for cognitive assessment among patients with multiple sclerosis.

Instruction:

The examiner gives the examinee a sheet of paper with a circle drawn on it, approximately 10 cm in diameter. This circle represents the clock frame, and the examinee is asked to place the numbers inside this circle so that it looks like a clock face. Then they are asked to draw hands indicating 11:10 a.m. There is no time limit, and the person must refrain from looking at their watch or the wall clock. We must also avoid mentioning the word "clock hands" (INESSS, 2015, p. 3).

Scoring:

There are many different methods for evaluating this test, including:

Mendez et al. method (1992).

Wolf-Klein et al. method (1989).

Sunderland et al. method (1989).

Shulman et al. method (1986).

Shulman et al. method (2000).

The 10-point scoring method (Mias, 1997, pp. 1-2).

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

The 7-point scoring method:

Seven criteria are studied:

- The clock numbers from 1 to 12 are present.
- The order of the numbers is correct.
- The position of the numbers is correct.
- The two hands are present.
- The hour hand is positioned correctly.
- The minute hand is positioned correctly.
- The size of the two hands is different from each other.

Thus, a total of 7 points is obtained (Panisset, 2022, p. 17).

One or more errors during drawing indicate the presence of a disorder in executive function.

❖ *Trail Making Test (TMT):*

It is a neuropsychological test developed by Halstead Reitan in 1944 in response to the requirements of the American military authorities during World War II, to assess cognitive disorders resulting from brain injuries. In 1950, research on it increased and it was developed. It consists of four cards, each two cards forming one part, and thus it contains two parts: Part (A) and Part (B) (Sefran, 2017, p. 268).

In Part A, the person is given a sheet containing circles with numbers from 1 to 25 arranged semi-randomly. The task is to connect the series of numbers from 1 to 25 with a pencil as quickly as possible and in ascending order. The sheet given in Part B includes 13 circles containing the numbers from 1 to 13 and 12 circles containing the letters from A to L, distributed semi-randomly on the page (Amieva et al., 2009, p. 212).

Part A assesses visual search and motor speed, while Part B assesses higher-level cognitive skills such as mental flexibility or executive function. This test is characterized by ease of application and administration (Canonne, 2019, p. 14). Accordingly, we use only Part B, which is specific to measuring mental flexibility.

The stopwatch (Chronomètre) is also started to calculate the time taken to complete the task. Reitan determined the time required to complete each card, and indicated that if the individual is unable to complete one card within a maximum of five minutes, the test is cancelled.

Table (03): Time Required to Complete Each Card in the Trail Making Test According to Reitan.

Test	Case	Number of Errors	Score	Percentage
GO/NO-GO	Case 1	3 errors	1/3	33.33%
	Case 2	7 errors	0/3	00%

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

Test	Case	Number of Errors	Score	Percentage
	Case 3	2 errors	2/3	66.66%

Table (05): Clock Drawing Test (CDT) Results

Test	Case	Score	Percentage
Clock Drawing Test (CDT)	First	5/7	71.43%
	Second	3/7	42.86%
	Third	7/7	100%

Table (06): Trail Making Test (TMT) Results

TMT Test	Case	Number of Errors	Number of Corrected Errors	Percentage
Part B	First	09	0	106 seconds
	Second	19	0	300 seconds
	Third	01	01	seconds

Table (07): Average Results of the Three Cases in the Applied Tests

Test	Arithmetic Mean
GO/NO-GO Test	33.33
Clock Drawing Test (CDT)	71.43
Part B of the Trail Making Test (TMT)	267

Analysis, Interpretation, and Discussion of the Study Results:

Analysis, Interpretation, and Discussion of the Results in Light of the First Partial Hypothesis:

The hypothesis states: A person with multiple sclerosis suffers from cognitive impairment at the level of inhibition function.

To verify this hypothesis, we applied the GO/NO-GO test taken from the Brief Cognitive Assessment Battery for patients with multiple sclerosis (BC COG SEP), adapted to the Algerian environment by Ghazali Djahida, and inspired by the Frontal Assessment Battery (BREF), in order to assess one of the most important executive functions, namely inhibition.

The results revealed the presence of severe cognitive disorder at the level of the inhibition process, with differences in the results among the three cases diagnosed with multiple sclerosis (SEP), where the highest percentage was estimated at (66.66%) and the lowest at (00%).

This difference is explained by the developmental stages of the disease, as the severity of these disorders increases in the advanced stages compared with the initial stages. It can also be explained by the age factor, duration of illness, in addition to the educational and cultural level and the location of the lesion.

The total percentage score of the GO/NO-GO test was estimated at (33.33%), which represents a low result. This is explained by the presence of a disorder in controlling impulses and behaviors, in addition to problems in stopping and modifying personal behavior at the appropriate time. Thus, the abilities of the three cases diagnosed with multiple sclerosis (SEP) are impaired, with an increase in the number of errors related to suppressing and inhibiting movements.

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

These results are consistent with the study of the researcher Ghazali Djahida (2012), which found disorders at the level of inhibitory executive processes among patients with multiple sclerosis (SEP). It also showed differences in the severity of this disorder and explained them by disease progression. They are also consistent with the study of Marta Cerezo Garciao et al. (2015), which showed that cognitive impairment at the level of inhibition function is high among patients with multiple sclerosis (SEP) compared with other executive functions, and that this impairment is severe in advanced stages compared with the initial stages.

Accordingly, based on the above, it can be said that the first partial hypothesis, which states that a person with multiple sclerosis suffers from cognitive impairment at the level of inhibition function, has been confirmed.

Analysis, Interpretation, and Discussion of the Results in Light of the Second Partial Hypothesis:

The hypothesis states: A person with multiple sclerosis suffers from cognitive impairment at the level of planning function.

To verify the validity of this hypothesis, we applied the Clock Drawing Test (CDT) to measure planning function, as many studies have shown that it is a practical and easy test for cognitive assessment among patients with multiple sclerosis (SEP).

Through the obtained results, it was found that there is a moderate cognitive disorder at the level of the planning process, as the overall percentage of the test was estimated at (71.43%). This is due to the loss of the ability to identify and organize the basic stages required to perform an intentional action and reach the desired goal.

We also find differences in the results among the three study samples diagnosed with multiple sclerosis, where the highest percentage was estimated at (100%), while the lowest percentage was (42.86%). This difference is explained by the developmental stages of the disease, as the severity of these disorders increases in the advanced stages compared with the initial stages (Ghazali, 2012, pp. 136-137). It can also be explained by the age factor, duration of illness, in addition to the educational and cultural level and the location of the lesion.

The study agreed with the study of Sonia Batista et al. (2017), which showed that patients with multiple sclerosis suffer from relative executive impairment in planning function, and the study of Peter A. Arnett et al. (1997), which confirmed that planning function is impaired among patients with multiple sclerosis (SEP), especially in the advanced stages of the disease. In addition, the study of Aneta R. Borkowska et al. (2021) showed that executive impairment among patients with multiple sclerosis (SEP) affects planning function.

Accordingly, based on the above, it can be said that the second partial hypothesis, which states that a person with multiple sclerosis suffers from cognitive impairment at the level of planning function, has been confirmed.

Analysis, Interpretation, and Discussion of the Results in Light of the Third Partial Hypothesis:

The hypothesis states: A person with multiple sclerosis suffers from cognitive impairment at the level of mental flexibility function.

To verify this hypothesis, we applied Part B of the Trail Making Test (TMT), because it is the part responsible for assessing mental flexibility. The results showed the presence of a disorder at the level of this function, due to the time taken, which exceeded the threshold set by Reitan. In addition, there were errors in moving from the number to the letter and lifting the pen from the paper before completion, which is due to the symptoms resulting from multiple sclerosis (SEP), including tremor, fatigue, etc.

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

The arithmetic mean result of the three cases was estimated at (267), which is a result that exceeds the threshold of cognitive impairment set by Reitan. This indicates a disorder in flexibly and more adaptively shifting focus between attentional sources, in addition to slow information processing, and thus the presence of severe cognitive impairment at the level of mental flexibility. There is also a difference in the severity of this disorder, which is explained by the developmental stages of the disease, as the severity of these disorders increases in the advanced stages compared with the initial stages. It can also be explained by the age factor, duration of illness, in addition to the educational and cultural level and the location of the lesion.

These results are consistent with the study of the researcher Ghazali Djahida (2012), which confirmed the presence of disorders affecting mental flexibility function among patients with multiple sclerosis (SEP), and showed that this impairment is associated with slow information processing. They are also consistent with the study of Boucha Nawal and Hassian Mohamed (2023), whose results revealed a relationship between mental flexibility disorder and information processing speed among patients with multiple sclerosis (SEP). In addition, the study of Marta Cerezo Garcia et al. (2015) showed that cognitive impairment at the level of mental flexibility function is high among patients with multiple sclerosis (SEP) compared with other executive functions, and that this impairment is severe in advanced stages compared with the initial stages.

Accordingly, based on the above, it can be said that the third partial hypothesis, which states that a person with multiple sclerosis suffers from cognitive impairment at the level of mental flexibility function, has been confirmed.

Analysis, Interpretation, and Discussion of the Results in Light of the General Hypothesis:

The hypothesis states: A person with multiple sclerosis suffers from cognitive impairment at the level of executive functions and oral language production.

Based on the results obtained from a set of tests applied in this study to three cases suffering from multiple sclerosis (SEP), represented in three tests measuring executive functions, namely the GO/NO-GO test taken from the Brief Cognitive Assessment Battery for patients with multiple sclerosis (BC COG SEP), adapted to the Algerian environment by Ghazali Djahida, to measure inhibition function; the Clock Drawing Test (CDT), to measure planning function; in addition to Part B of the Trail Making Test (TMT), which measures mental flexibility. After reviewing various studies and theoretical models of researchers, we discussed and analyzed the results in light of previous studies and theoretical knowledge.

When conducting the quantitative analysis of the tests that measure executive functions (inhibition, planning, and mental flexibility), it was found that the three cases diagnosed with multiple sclerosis (SEP) suffer from executive impairment. This was confirmed by the study of Ghazali Djahida (2012) and the study of Ben Bouzid Meriem (2019), whose results found disorders at the level of cognitive abilities, most importantly executive functions, among patients with multiple sclerosis (SEP). In addition, the study of Aneta R. Borkowska et al. (2021) revealed the presence of executive cognitive impairment among patients with multiple sclerosis (SEP). We also find the study of Cristina A. F. Roman and Peter A. Arnett (2016), which showed the presence of impairment in executive performance among this group, due to the relationship between structural brain damage (white matter) and executive performance.

Accordingly, based on the above, it can be said that the general hypothesis, which states that patients with multiple sclerosis suffer from cognitive impairment at the level of executive functions, has been confirmed.

Conclusion:

The present study falls within the scientific studies in the field of neuropsychological sciences, which pay great attention to shedding light on one of the immune diseases that affect the central nervous system (CNS), namely multiple sclerosis (SEP). Cognitive disorder is common in this disease and can be observed in every type and stage of the disease. This cognitive disorder negatively affects the daily activities of patients

Journal of Ecohumanism
2026
Volume: 5, No: 1, pp. 211–226
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v5i1.7232

with multiple sclerosis. Even if there is great variability, cognitive functions deteriorate over time and with disease progression.

The importance of the study lies in achieving the desired objectives and reaching the most important results, namely that multiple sclerosis has an impact on cognitive abilities, especially executive functions represented in inhibition, planning, and mental flexibility. The results also showed that executive function disorder affects oral language production, as executive functions play a role in organizing ideas during communication and understanding ambiguous sentences. Accordingly, it can be said that executive cognitive impairment affects oral language production among patients with multiple sclerosis.

Based on the results reached, the following are some recommendations and suggestions that may contribute to opening new horizons in scientific research, the most important of which are:

- The necessity of conducting similar studies concerned with assessing and studying cognitive abilities among patients with multiple sclerosis.

- Continuous training from the beginning of the appearance of cognitive impairment symptoms, through plans and programs for rehabilitation.

- Developing neuropsychological rehabilitation programs based on improving the performance of cognitive abilities, especially executive functions.

- Adapting and standardizing tests and tools to the Algerian environment in a way that helps specialists in diagnosis.

- Drawing specialists' attention to the topic of executive functions in order to include it within the therapeutic plans for multiple sclerosis.

References

Hélène Zéphir Bruno Brochet, Jérôme de Sèze, and Christine Lebrune-Frenay. (2017). La sclérose en plaques - Clinique et thérapeutique. Elsevier Health Sciences.

Bruno Brochet, Defer Gilles, and Pelletier Jean. (2005). Neuropsychologie de la sclérose en plaque. Elsevier Health Sciences.

David Brassat. (2010). Physiopathologie de la SEP. 39, 341-348.

Mona Ebrahimipour, Jenabi Mehrnaz, and Saeed Shahbeigi. (2008). Verbal fluency performance in patients with multiple sclerosis. Iranian Journal of Child Neurology, Vol. 7(No. 21&22), 138-162.

Barois, E., Sagawa, Y., Yilmaz, S., Magnin, E., & Decavel, P. (2021). What (more) can verbal fluency tell us about multiple sclerosis? Annals of Physical and Rehabilitation Medicine, 64(2), 101394. (https://doi.org/10.1016/j.rehab.2020.05.002)

Moreau, T., & Pasquier, R. D. (2017). La sclérose en plaques. John Libbey Eurotext.

Roberts, L., & Miller, T. (2004). Beginner's guide to multiple sclerosis (2nd ed.). Multiple Sclerosis Society of NZ.

Tison, F. (2022). Les maladies neurodégénératives et maladies apparentées en pratique CAMPUS. Elsevier Health Sciences.

INESSS (2015). Tool Sheet: Clock Drawing Test. Quebec. Institut national d'excellence en santé et en services sociaux.

Ben Bouzid, Meriem (2019). Assessment of Cognitive Abilities in Patients with Multiple Sclerosis. Journal of Linguistics. 26(01). 46-60.

Boucha, Nawal. Hassian Mohamed (2023). The Effect of Executive Function Disorders (Mental Flexibility) on Information Processing Speed in Patients with Multiple Sclerosis. Journal of Social and Human Sciences. 24(01). 187-202.

Sefran, Rima (2017). The Effect of Differences in Self-Awareness on the Ability to Perform Executive Functions. Unpublished Master's Thesis. Lounici Ali University Blida 2: Blida.

Ghazali, Djahida (2012). Neuropsychological Assessment of Cognitive Skills in Patients with Multiple Sclerosis. Unpublished Master's Thesis. University of Algiers 2: Algiers.