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Research Article

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Clinical Assessment of Linguistic Abilities in Patients with Multiple Sclerosis

Theofilidis Antonis

Cognitive - Clinical psychologist, Neuropsychologist, Githiou 1, Thessaloniki, Greece

Corresponding author
Theofilidis Antonis, Cognitive - Clinical psychologist, Neuropsychologist, Githiou 1, Thessaloniki, Greece.

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ABSTRACT
The objective of the present study was to investigate the linguistic profile of patients with multiple sclerosis and to establish a connection between the corresponding linguistic deficits and specific brain regions. Specifically, for the purposes of this research, 12 adults diagnosed with secondary progressive multiple sclerosis were examined and compared with healthy participants. The Boston Aphasia Naming Test, a standardized linguistic tool, was administered, focusing on the subtests for auditory comprehension, repetition, and reading comprehension. The results demonstrated that the group of participants with multiple sclerosis exhibited significantly lower performance in the comprehension subtest compared to the control group. The findings are discussed.

Keywords: Multiple Sclerosis, Linguistic Deficits, Processing Time

Introduction

Multiple Sclerosis (MS), also known as demyelinating disease, is a chronic multifactorial neurological disorder that appears to predominantly affect young adults. It is the most prevalent neurological condition [1]. MS behaves as an autoimmune disease, a term that indicates the organism fails to recognize certain tissues as its own and subsequently attacks them, causing damage. The condition is characterized by both acute and chronic lesions of the white matter, inflammation within the white matter where remnants of mononuclear infiltration, primarily comprising T-cells and macrophages, are found. Consequently, this inflammatory process leads to the demyelination of nerve axons. Remyelination is facilitated by cells derived from precursor forms of oligodendrocytes. Thus, it is evident that MS is a demyelinating disease marked by recurrent focal and multifocal attacks on the central nervous system (CNS) in a manner that is both persistent and unpredictable [2]. It is defined by acute and chronic lesions of the CNS white matter, with the terminology stemming from the multiple plaque-like areas indicative of the disease process [3].

A review of the literature reveals that various pathophysiological processes, such as inflammation, demyelination, neuroaxonal injury-degeneration, gliosis, and repair mechanisms, contribute to the complex manifestation of the disease [4]. Over time, these processes do not present uniformly across all patients and can selectively dominate at different stages of the disease and in specific individuals. This observation results in the noted heterogeneity and personalization in the phenotypic expression of the disease, its prognosis, and ultimately the response to treatments.

It is noteworthy that personalized recognition and treatment could be refined through the use of biomarkers that would aid in identifying the predominant mechanisms, selecting appropriate patient populations, and determining suitable therapeutic regimens. The detection, assessment, and management of neuroaxonal injury is of particular significance as a pivotal point in the disease correlated with the emergence of increased disability. This very neuroaxonal degeneration is also linked to the cognitive deficits experienced by patients.

Neuroaxonal degeneration is not exclusive to MS. Numerous diseases, such as Alzheimer's disease, Lewy body dementia, amyotrophic lateral sclerosis, and multiple system atrophy, are characterized by the release of cytoskeletal components into the extracellular space [5]. Among these components are neurofilaments [6]. From the extracellular space, chains of neurofilaments are released into the cerebrospinal fluid (CSF)

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and subsequently gradually into the bloodstream [7]. Therefore, analyzing the CSF can identify this biomarker, which in turn reflects the degree and rate of pathological changes occurring in these neurodegenerative disorders.

A review of international literature reveals that numerous studies indicate that patients with multiple sclerosis exhibit, in addition to other somatic manifestations, a variety of cognitive impairments. Notably, cognitive deficits are observed from the early stages of the disease and should be regarded as primary manifestations of MS [8].

The connection between cognitive deficits—specifically in executive functions, memory, and attention—and the disease has been affirmed in a recent study by Kirac Ekmekci, Yuseyar, and Kocaman [9]. The proportion of patients with cognitive dysfunction in MS has been estimated to range from 40% to 70%, depending on the studied population, the tests employed, and the cutoff values utilized [10]. The areas most significantly affected include memory capacity, particularly in retaining new information, the speed of information processing with a subjective sense of slow thinking, difficulties in processing incoming information from multiple sources concurrently, and the execution of dual tasks. Additionally, slowed executive difficulties manifest, exhibiting an inability to organize, plan, and prioritize effectively. Lastly, visual-spatial processing is also impacted, resulting in challenges distinguishing between right and left, difficulties in navigation, and reading diagrams.

Similar patterns of research are evident in studies investigating cognitive functions [11-13]. Specifically, an examination of the international literature unveils a series of research studies focusing on cognitive deficits in patients in the initial stages of the disease (RRMS), or on linguistic deficits, as well as comparisons of cognitive performance among patients in the early stages of the disease and those in more advanced stages (RRMS vs SPMS), or lastly among patients who fall within the four distinct subtypes of the disease [14-19].

In an effort to illuminate the domain of cognitive deficits among patients with sclerosis, it becomes evident that despite the existence of numerous studies concerning the exploration of neuropsychological profiles of patients at various stages of the disease, research focusing on linguistic deficits appears to be considerably limited as far as we are aware [20].

This study seeks to investigate speech disorders in patients with secondary progressive MS. The aim of the research is to explore potential speech disturbances at the levels of production and comprehension in patients afflicted by multiple sclerosis (with a score greater than 4 on the EDSS scale). More specifically, this research endeavor examines linguistic deficits and their relationship to the centers of speech (Wernicke, Broca). In multiple sclerosis, the lesions are subcortical, and the arcuate fasciculus, which connects the Broca and Wernicke areas, operates at a subcortical level [21]. Based on this information, we posit that the subcortical centers of speech may be affected.

Method

For the purposes of this study, ten patients diagnosed with Multiple Sclerosis (six males and four females) (M.O. = 47 years and T.A. = 10.27) and ten participants who constituted the control group (five males and five females) (M.O. = 30 years and T.A. = 5.57) were examined. All patients hailed from the urban expanse of the Thessaloniki metropolitan area and were under the care of a private neurologist. The initial diagnosis of the disease was made approximately ten years ago. All patients were receiving pharmacological treatment. Cases of patients with mood disorders were excluded. The assessments of participants from both groups took place in a private setting at a predetermined meeting, arranged through personal communication. All participants signed a consent form to partake in the research. Prior to the commencement of the primary examination, participants were informed that the study would remain anonymous and that they could withdraw at any time without any repercussions.

	Age		Educational level	
	MA	SD	MA	SD
Healthy	30	5.57	12.3	0.9
Patients	47	10.27	12.1	0.7

Demographic characteristics of the participants

Tools

For the purpose of this research, the Boston Aphasia Naming Test was administered, chosen to assess the linguistic capabilities of the participants [22]. Specifically, auditory comprehension, the skill of repetition, as well as reading comprehension were evaluated. These tests necessitate the integrity of the arcuate fasciculus due to its extensive pathway through the white matter, connecting the Broca and Wernicke areas. This vulnerability renders the arcuate fasciculus more susceptible to lesions in these regions. The auditory comprehension test consists of three activities. The first activity is titled "Touching A with B." The examiner requests the examinee to indicate which image depicts a person, for instance, touching a pencil with a comb (selected from four distinct images), after having provided explanations regarding what may be illustrated in the images. This activity is divided into three subcategories. The first subcategory includes sentences containing "and," such as "The person touches the spoon and the scissors." The second subcategory pertains to sentences coded with "with +," for example, "With the comb, they touch the pencil." The third subcategory encompasses non-coded sentences, such as "They touch the fork with the spoon." During the subsequent subtest of auditory comprehension, the examinee, observing an image of a child with their father, is asked to first identify who the child's father is and then to indicate who the child is. Finally, the third activity in this domain is called "Embedded Sentences." Each card contains four images. The examiner describes the illustrations and asks the examinee to select the one image that corresponds to, for example, "The boy hits the girl who is sitting" and subsequently, "The girl who hits the boy is sitting." The repetition domain comprises three activities and assesses oral expression. In the first activity, simple words such as "chair" are requested for repetition, in the second, pseudo-words such as "grimma," and in the third, sentences such as "The father is coming home." The reading comprehension domain pertains to the understanding of sentences and paragraphs. The examiner presents two examples in which they audibly read each sentence and each choice, after

which the correct conclusion of the sentence is to be selected. The examinee is then invited to silently read the sentences and paragraphs provided to them and to identify the one correct completion (from four possible answers). Initially, the activities assessing auditory comprehension were applied, during which timing was recorded from the moment the question was dictated until the patient provided a response. Following this, the repetition activities were conducted, and finally, an evaluation of reading comprehension was administered.

Demographic characteristics of the participants.

	Age		Educational level	
	MA	SD	MA	SD
Healthy	30	5.57	12.3	0.9
Patients	47	10.27	12.1	0.7

	Healthy		Patients		
	MA	SD	MA	SD	P
Listening comprehension	29.7	1.59	26.37	4.68	0.05
Repetition	24.3	3.12	23.68	2.19	0.01
Reading comprehension	8.9	.91	7.94	1.78	0.05

Results

In order to investigate the comparison of the average performance between the two groups, a t-test was conducted. Specifically, the statistical analysis revealed that concerning auditory comprehension, the average performance of the two groups differs significantly. More precisely, the application of the t-test yielded statistically significant differences in the overall performance of the two groups in the auditory comprehension test for the first sub-test ($p = 0.01$) and in the third sub-test ($p = 0.005$). However, no statistically significant difference was found between the average scores of the two groups in relation to performance on the second sub-test of auditory comprehension. Regarding the disparity in the averages on the repetition test, a statistically significant difference between the two groups was identified ($p = 0.01$). Lastly, there was a statistically significant difference in the average scores of the two groups ($p = 0.05$). Table 2 presents the results of the comparison of the average performances of the two participating groups.

Discussion

The analysis of the findings from this research reveals that, in most tests, the differences between patients and healthy individuals are statistically significant, with the exception of subcategory 3 of the first activity of auditory comprehension (comparing A and B) and the second activity of repetition (repeating pseudowords). In only one test, specifically the second activity of auditory comprehension (reversible possessive constructs), the responses of patients and the control group participants are remarkably similar. Overall, through the analysis and processing of results, it becomes evident that patients with Multiple Sclerosis exhibit deficits in auditory comprehension, repetition, and reading comprehension. Notably, challenges arise in the task of sentence repetition and auditory comprehension, while the repetition of pseudowords appears to be less impacted, as indicated by the average performance scores of the two groups.

A review of the literature uncovers that studies involving patients with Multiple Sclerosis who exhibit clinically significant aphasic syndromes are limited, typically addressing cases of patients presenting an acute manifestation of aphasia during a relapse of the disease. Concurrently, it is observed that Multiple Sclerosis is associated with mild to moderate impairments in higher cognitive functions, whereas dementia or specific cortical function impairments, such as speech disturbances, are less frequent [23]. Cognitive disturbances in patients with Multiple Sclerosis range from 43% to 59%, primarily affecting thought processes and logical reasoning abilities. Cognitive impairments are often observed in individuals who have been ill for many years but may also manifest in the early stages of the disease, potentially as the initial symptom. Furthermore, the extent of demyelination correlates with the severity of cognitive disturbances.

Moreover, one of the most common challenges faced by patients is the retrieval of appropriate words. Between 20% and 42% of patients experience difficulty in the spontaneous recall of verbal and visual elements. Significant impairments have been noted in tests assessing immediate recall from long-term memory, while recent memory appears to remain largely unaffected. A substantial number of patients exhibit attention deficits, particularly in complex tasks, along with slower processing of the information presented to them. Studies have demonstrated a reduced capacity for problem-solving, planning, sequencing, and hierarchical classification. Additionally, research has illustrated that severe visual agnosia and aphasia may occur in Multiple Sclerosis. These patients show a slowdown in language tasks and make more errors than healthy controls in naming and reading tests. Similar findings indicate difficulties in comprehending sentences and delays in reaction times [24].

This research endeavors to illuminate specific linguistic deficits in patients with Multiple Sclerosis. The findings indicate deficiencies in both sentence comprehension and auditory understanding. A cursory review of the international literature reveals that, despite numerous studies investigating cognitive deficits in patients at various stages of the disease, investigations focusing exclusively on linguistic deficits remain relatively limited as far as we are aware [20].

One of the primary limitations of this study is the failure to record the response time of participants to measure the processing speed of information. The speed of information processing appears to be linked to the function of the frontal lobes. Finally, it would be intriguing to study the different types of Multiple Sclerosis to illuminate the realm of linguistic deficits and to document the linguistic impairments that present themselves across the various manifestations of the disease

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