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Language Disorders in Multiple Sclerosis

Majid Soltani and Parvane Rahimifar

Abstract

Communicating ability is one of the necessary social needs in human, and language is a critical part of daily connections and communications. Language is impaired by different central nervous system (CNS) diseases such as multiple sclerosis (MS). MS leads to a language disorder by creating some plaques in subcortical constructions such as naming problems, semantic errors, and circumlocutory naming errors, semantic paraphasia, nonfluent speech, and grammatical and syntactic problems such as reduced mean maximum length of sentences and the number of spoken words and impairment in high-level language skills.

Keywords: multiple sclerosis, language, language disorder

1. Introduction

Communicating ability is one of the necessary social needs in human, and language is a critical part of daily connections and communications. Hence, any disorders in language result in inappropriate transferring of thoughts, idea, needing others, and finally inappropriate communication. According to studies, language is disrupted in different ways through the central nervous system (CNS), including Parkinson's, Alzheimer's, amyotrophic lateral sclerosis (ALS), and multiple sclerosis [1–6]. MS leads to language disorder by creating some plaques in language-related areas. If not treated, these disorders limit social life, professional life, mental life, and quality of life [7, 8]. If language disorders not treated, these disorders limit social, professional, mental, and quality of life. It is necessary to get involved with language interventions at the early stages of the disease and immediately after the detection of language disorders if life quality of MS patients is to be protected. Early detection and intervention in language disorders in these patients result in fast improvements in language functions, preventing the development of these disorders and finally preserving daily communication, social, functional, and professional life quality. Language interventions at the early stages of MS disease require accurate awareness of every kind of language disorders and the detection of various language disorders. Therefore, given the importance of language in daily communications, and social, professional, and functional lives, it is necessary to know language and its composing subsystems and various language disorders in MS disease. Note that detecting these disorders helps language and speech pathologists, neurologists, and other rehabilitation and MS-related specialists to be useful in early intervention and prevention of quality of life decreasing in MS patients. Therefore, in this chapter, we discuss language disorders in MS, language disorder detection history, and various language disorders in these patients.

2. What is language?

Language is a social code or a conventional system to reflect concepts through using conventional symbols and the rules related to combining these symbols [9]. As shown in **Figure 1**, language is complex, and a multiple-level phenomenon consisted of three main aspects; form, content, and use [10]. In other words, language is a complex cognitive function including pragmatic, semantic, syntax, morphology, and phonology subsystems (more information in **Table 1**).
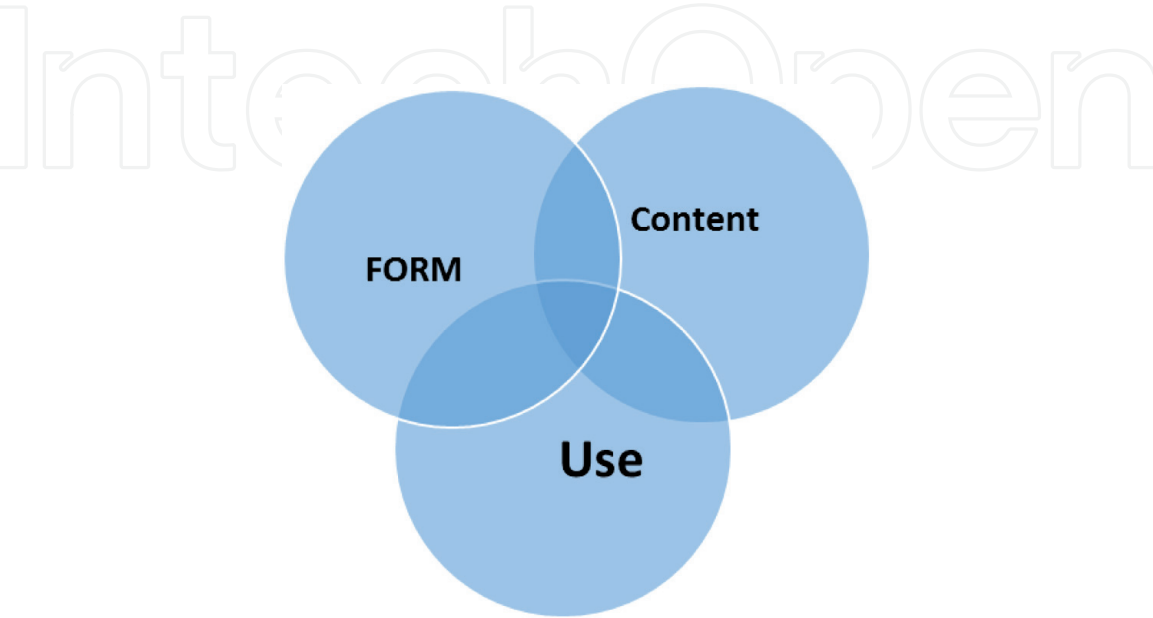

Figure 1.
The three main aspects.

Linguistic system	Deficits
Phonology Phonology is the study of the sound system of language, and includes the rules that govern its spoken form. Phonology analyzes which sound units are within a language and examines how these sounds are arranged, their systematic organization and rule system.[17]	• Frequently appear as articulation disorders. • Subject omits a consonant: "oo" for you • Subject substitutes one consonant: "wabbit" for rabbit • Discrimination: subject hears "go get the nail" instead of mail
Morphology Morphology is the study of the structure of words; it analyzes how words are built out of morphemes, the basic unit of morphology. Morpheme is the smallest meaningful unit of a language.[17]	• Subject may not use appropriate inflectional endings in their speech (e.g.,"He walk" or "Mommy coat"). • Subject may lack irregular past tense or irregular plurals (e.g., "drived" for "drove" or "mans" for "men"). Be aware of "Black English": "John cousin" "fifty cent", or "She work here".
Syntax Syntax consists of organizational rules denoting word, phrase, and clause order. It also examines the organization and relationship between words, word classes, grammar of the language and other sentence elements.[17]	• Lack the length or syntactic complexity (e.g., "Where Daddy go?"). • Problems comprehending sentences that express relationship between direct or indirect objects. Difficulty with wh questions. Difficulty with grammar of language (e.g. " mum went to work everyday)
Semantics Semantics is the study of linguistic meaning and includes the meaning of words, phrases, and sentences.[17]	• Limited vocabulary especially in adjectives, adverbs, prepositions, or pronouns. • Longer response time in selecting vocabulary words. • Fail to perceive subtle changes in word meaning: incomplete understanding and misinterpretations. • Figurative language problems.
Pragmatics Pragmatic is the study of knowledge and ability to use language functionally in social or interactive situations and integrates all the other language skills, but also requires knowledge and use of rule governing the use of language in social context.	• Problems understanding indirect requests (e.g., may say yes when asked "Must you play the piano?"). • May enter conversations in a socially unacceptable fashion or fail to take turns talking. • Difficulty staying on topic.

Ref. [55].

Table 1. *Description of language measures. Ref. [55].*

3. What is language disorder?

The American Speech-Language-Auditory Association (ASHA) considers any disorder in comprehension and applying symbolic speech, writing, and another symbolic system as a language disorder. This may occur in any of the three main language aspects (form, content, use) in semantic, syntax, morphology, phonology, and pragmatic subsystems (**Table 1**).

4. Language disorders in MS disease

Multiple sclerosis (MS) is a type of progressive central nervous system disease in which myelin sheaths are destroyed, and plaques are created in some parts of the brain and spinal cord's white material [11]. MS is the most common neurologic disease in people aging 20–45, and its prevalence is four times more in women than in men. Depending on the country and its special population, its prevalence is 2–150 individuals per 100,000 individuals [12]. According to the Multiple Sclerosis International Federation report in 2015, 2,300,000 million people in the world suffer from the MS disease [3]. Common symptoms of the disease include physical and sensory movement problems, speech disorders such as dysarthria, cognitive disorders, and language disorders [11].

5. Language disorder history in MS

In the recent two decades, researchers believed that MS harms subcortical areas, and cortical disorder causes language deficits [7, 13]. For this, no research was done on MS cognitive functions in the language field. However, along with brain imaging developments, it is proved that not only are subcortical structures such as the thalamus, caudate nucleus, globus pallidus, subthalamic nucleus, substantia nigra, and cerebellum effective in adjusting and coordinating the movement aspects of speech, but also they play a role in the processing of cognitive and language functions [14]. Using PET scan, some researchers showed that the thalamus and basal ganglia start to work during doing language assignments like picture naming [15] and word repeating [14, 16]. Using FMRI, Crosson et al. found a remarkable activity in subcortical structures while doing some language skills [14, 17]. Therefore, considering the researches, we can conclude that not only brain cortical but also subcortical structures, including the thalamus and its other structures and cerebellum, play a role in language processing and cause language disorders in MS patients [14, 18]. Another issue showing the possibility of language deficits in MS patients is cognitive deficits, as cognitive skills (memory and attention) are related to language skills [19, 20]. Memory disorder is one of the MS's common symptoms causing problems in information retrieving and decoding [20, 21]. In addition, memory disorder affects language assignments including verbal fluency [22], naming [23], and language comprehension [21, 24].

6. Language disorder types in MS

Studies show that individuals with progressive neurologic diseases such as MS experience not only have speech production deficits but also language problems [7]. Although some researchers confirm various language disorders in MS, they believe that these disorders are prevalent [3].

Language disorder means any disorder to the semantic, syntax, morphology, phonology, and pragmatic abilities appearing in different forms with different severities.

Among the existing language disorders, naming problems [1, 23, 25–27], verbal fluency [1, 8, 23, 28] in language production, and syntax skills including maximum sentence length mean reduction, word number reduction [18, 29], and deficiency in high-level language skills [7, 18, 30] are disorders seen in MS patients. Thus, regarding the special definition of each language disorder, we discuss each language disorder in MS separately.

7. Naming problem and verbal fluency deficit

The naming process is one of the basic lingual processes related to speech content and concept transfer. Naming is the person's ability to comprehend a visual symbol and retrieve its name correctly [31].

Naming deficit is one of the language disorders resulted from deficit in message content production [32] causing individual disability in achieving phonology and semantic characteristics from mental lexical storage [33]. Naming ability disorder is caused by different diseases [34], one of which is MS [1, 23, 25–27, 35]. In structural and functional changes in the brain and language path disorder, MS results in naming deficit [21], semantic error, circumlocution [36], and semantic paraphasia [24]. There are different reasons for justifying the naming ability deficit. Some researchers found insufficient memory [23], depression, and medicine intake. However, a particular relationship between medicine and language disorder is not confirmed yet [21]. Murdoch et al. found that the naming deficit is related to semantic disorders [21]. Le Dorze et al. pointed that retrieving semantic information deficit is related to cognitive problems like attention and memory in these patients [37]. However the relationship between cognitive and naming disorders is a challenge [21].

The naming disorder's severity can be different depending on the disease progress; sometimes a more severe disease may cause a more severe naming disorder and directly affect individual's daily functions [21].

There are various tasks to evaluate naming disorders, including confrontational naming, naming semantic levels, automatic serial naming, repetition, and verbal fluency [38].

Verbal fluency is a cognitive function facilitating information retrieval from the memory. It is also sensitive to cognitive disorders caused by the brain's dysfunction [39], involving the evaluation of the related processes in the naming process, including accessing lexical and semantic information [40]. Verbal fluency is disrupted after various diseases such as MS [1, 8, 23, 28]. MS results in verbal fluency disorder through caudate nuclei atrophy [39, 41], thalamus disorder, and basal ganglia [7, 42]. Henry and Beatty consider verbal fluency disorder as a common language disorder in MS patients [43].

8. Language production and syntax skill deficit

As mentioned earlier, language consisted of three main aspects: form, content, and use. Form includes grammar. Grammar refers to the knowledge of examining a language structure. Grammar has two components: morphology and syntax. Morphology studies words and phrase construction and is related to words' inner structures. Syntax is related to the order of elements in speech.

The evaluation proposed for the syntax structure of sentences in neurologic patients provides important information about neural instantiation and the organization of language [44]. Any disorder in grammar affects an individual's ability in transferring concepts in an exact sentence form [45].

There are various methods to study morpho-syntax skills, such as studying continuous speech and the elicitation procedure.

In most studies, continuous speech and sentence completion analysis methods are used to examine morpho-syntax skills so far. The continuous speech method can be administered in two ways: soliloquy and conversation. Researchers believe that soliloquy is better, as speech-language pathologists speak less and soliloquy writing is easier [18]. Being able to define language problems through this method, soliloquy needs a high degree of linguistic-cognitive interactions [29, 46].

Some clinical measures for syntactic complexity are used to analyze continuous speech in these studies, including the mean length of utterance in morphemes (MLU), mean clauses per utterance (MCU), developmental sentence scoring (DSS), remediation and screening procedure analysis (LARSP), the syntactic complexity score (SCS), and the picture-elicited scoring procedure for LARSP (PSL). MLU is one of the informal measures in continuous speech analysis applied in several studies to examine adults' syntax complexity [47–50]. Some scholars reported a meaningful difference between patients and healthy people's syntax skills. These measures are also used to study syntax skills in MS patients compared to healthy people [18, 29]. Some mentioned no deficit in syntax skills [51, 52]. In the following, we will discuss this in more details.

MCU is a useful measure and shows the number of conjoined and embedded clauses in a speech used to study syntax complexity in speaking in adults [48–51].

DSS is a valuable tool to evaluate grammar growth, help diagnostic judgments, help plan treatment, and evaluate treatment results [53]. This measure is used to examine syntax complexity skills in adults in various studies [48–50]. Another group of researchers applied this measure to study syntax skills in MS patients [51, 52]. This is mentioned in MLU findings.

Being useful for kids and adults, LARSP is a method to describe syntax complexity in a language sample, ability on the clauses, subordinate clause, phrase and word levels, and grammatical abilities [54]. Two scales, SCS and PSL, are used in this method. SCS calculates the number of grammatical categories (subject, verb, object, and complement) in a speech. Single-word speech does not include syntax skills, and syntax is composed of the relationship between morphemes. SCS is only used to calculate multiword utterances [51]. PSL is another measure of syntax complexity applied to facilitate the scoring of the Renfrew Action Picture Test (RAPT) [51]. Only one study used the LARSP profile and SCS and PSL to examine syntax skills in MS patients and showed no deficit in these patients [51].

The investigations showed that grammar deficit is one of the language disorders in MS patients [18, 29, 55, 56]. In defining syntax deficits, they also showed that MS patients demonstrate a combination of syntax-semantic disorders [55]. Morphology is one of the language components playing an important role in syntax phrase, since there is a relationship between morphology and syntactic components and they can appear as syntax [55]. To show this, various studies demonstrated that MS patients have syntactic errors resulted from morphologic errors [29, 55]. Studies on grammar in MS patients each showed a type of deficit in syntax skills. One of these deficits was shorter sentences, decrease in the word number mean, and the most spoken words in a sentence. Researchers pointed that MS patients have language structure deficits related to cognitive impairment, especially administrative function impairment. However, the role of aphasia on such disorders cannot be denied [18]. In another study, researchers showed that

the number of sentences mean and the length of the longest sentence decrease. However, there was not a meaningful difference in sentence length mean between MS patients and healthy people. This is because of mild severity of the disease and no cognitive impairment [57] .

The elicitation procedure is another method to investigate morpho-syntax skill, one of which is sentence repetition skill being a fast method to provide information from an individual speech. The individual is asked to repeat whatever the pathologist says [58]. Although this method is criticized, evidence shows that with a high compatibility in their sentence repetition function with their self-motivated grammar level, if kids or adults have brain impairment, they will have better progress in the treatment. In cases where there is time limitation in evaluation and detection of patients' abilities, sentence repetition is a useful strategy for pathologist to gain information about individual ability in a short time [58].

Another advantage of sentence repetition is that it is easily implemented. Moreover, control, implementation, and analysis are more allowed in this method [59]. This method allows concentration on special grammar and phonology aspects, and they can be studied accurately. Researchers believe that sentence repetition assignment is a method with a high validity and reliability to evaluate general grammar knowledge (morphology, syntax) [59], and it is a valid language-psychology representation to detect language impairments [60]. So, we should use easy-implemented methods and immediately detect speech and language disorders to evaluate grammar structure. Based on this, among studies on syntax skill investigation, a study was implemented on MS patients using the long sentences repetition test (the first subtest of the Persian test of investigating high-level language skills). The results showed that, compared to a healthy person, the number of spoken words by an MS patient decreases meaningfully, and a meaningful decrease in the number of functional words (proposition, conjunction, and plural sign) and of content words (noun and verb) is a syntax deficit in MS patients. Compared to healthy people, they omit these words more often [61].

However, some researchers concluded that MS patients are not different with the ordinary people in using syntax structures [51, 52]. It is because of MS mild severity or being in recover period. Meanwhile, if a deficit is seen in complex language structures in MS, it is approvable through natural language measurement tools [51].

9. High-level language skills

High-level language skills mean language production in sentence or discourse level compared to single-word level [62]. These skills include several assignments, ambiguous sentences, sarcastic comprehension and explanation, proverb, conclusion, sentence making, long sentence repetition, celebrity naming, word definition, complex grammatical sentence comprehension, and comprehension and explanation of differences and similarities, and they use many language fields and cognitive processes [30].

Another aspect affected by neurologic diseases is high-level language skills. These skills are created following the amount of myelin decrease and subcortical paths simpairment. In addition, a possible reason of high-level language skill deficit in MS is disconnection of cortical and subcortical areas [30]. The primary symptoms of high-level language skills in MS patients are comprehension and explanation deficits. They are along with deficit symptoms in ambiguous sentences comprehension, sarcastic comprehension and explanation, proverb, conclusion, sentence making, long sentence repetition, celebrity naming, word definition, complex grammatical sentence comprehension, and comprehension and explanation of

differences and similarities [7, 63]. Deficit in these skills may be predictive of brain impairments and certain degenerative dementias [64, 65].

There are a few studies on MS that influence on high-level language skills so far. Primary studies evaluate high-level language skills based on standard aphasia tests. Although these tests investigate language skills, they are not complex and sensitive enough to exactly define language disorders and high-level language skills in MS patients [27, 66]. Thus, high-level language skills were studied using the test of language competence (TLC) and the word test (TWT). The results showed that, compared to healthy people, MS patients had lower scores in these skills, and there are more severe language problems in chronic progressive MS patients than in recrudescent-recovering one [30]. It is worth noting that TCL and TWT only study four high-level language skills, including the comprehension of ambiguous sentences, conclusion, proverb, and sentence making, and are useful for the ages of 9–11/18 [7, 30, 66]. A test named BESS was used in another study in Sweden showing impairment in high-level language skills. This is the only Swedish test investigating all high-level language skills and is complex and sensitive enough to evaluate all high-level language skills in MS patients with no age limitation [7]. Laakso et al. investigated high language functions in Swedish MS patients. They found that MS patients have language difficulties in repetition of long sentences, inference, metaphor, logico-grammatical sentence comprehension, comprehension of ambiguous sentences, and word definition. BESS validity was investigated in the Persian language in 2017. Rahimifar et al. studied its Persian version's validity and reliability. After confirming this test as a valid and matched tool with racial, linguistic, cultural, social, and geographical features in Persian people, they study high-level language skills in Persian MS patients and found out that, like other languages, high-level language skills were impaired in MS patients [56]. These studies show that we can use BESS test for clinical goals and we can detect language deficits sooner. As a result, language deficits of patients with progressive diseases will be treated faster [7, 56].

10. Conclusion

The study conducted on MS patients shows that the linguistic skills of these patients are damaged. Language disorders in MS include naming, verbal fluency disorder, syntax skills, and lack of high-level language skills. Researchers have focused more on the naming and verbal fluency, which are related to semantic component of language, and other areas of the language, including the form and language use, have been neglected. Therefore, it is imperative that all language skills, including high-level language skills, be addressed in MS patients.

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