

Linguistic processing in Attention Deficit and Hyperactivity Disorder (ADHD): An Integrative Review

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Abstract. Attention Deficit Hyperactivity Disorder (ADHD) is a common neurodevelopmental disorder primarily characterized by difficulties with attention and/or hyperactivity-impulsivity. Individuals with ADHD often exhibit deficits in executive functions, such as working memory, inhibition, and cognitive flexibility, that could be related to language deficits. **Objective** This integrative review provides a brief overview of the current state of the literature on syntactic language processing in ADHD. **Method** An integrative review was conducted in two academic databases (i.e Scopus and Web of Science). **Results** Three review articles and seven empirical studies were identified considering the relevance to the topic. **Conclusion** The literature supports an association between ADHD diagnosis and challenges with grammatical processing. However, the evidence thus far has primarily focused on the overall deficits observed in ADHD rather than on specific syntactic impairments.

Keywords. Attention Deficit Hyperactivity Disorder, Psycholinguistics, Language Tests, Language Development Disorders

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental condition characterized by high levels of inattention and/or hyperactivity and impulsivity [1]. The symptoms of ADHD should appear before the age of 12 and persist for a minimum of six months, with significant impairment observed in at least two different settings, such as home, academic, and social environments. [1]. Moreover, ADHD symptoms are associated with impairments in Executive Functions (EFs), which are cognitive abilities related to controlled processes (e. g. inhibitory control, working memory, and cognitive flexibility) [2].

Furthermore, the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) describes hyperactivity/impulsivity symptoms related to language production impairments [1]. These symptoms include excessive talking and providing answers before the completion of questions. However, considering the diagnostic criteria of ADHD, impairments in language components are not thoroughly characterized.

1.1 ADHD and Language Disorders

Language disorders, such as Language Disorders and Specific reading disabilities, may be also related to impairments in EFs, particularly in working memory

[3]. In addition, Attention Deficit Hyperactivity Disorder (ADHD) often presents comorbidity with other developmental disorders, and its symptoms of inattention and hyperactivity can be mimicked in other conditions of atypical development [3]. Despite the comorbidities presented, children diagnosed with ADHD may experience difficulties in language comprehension and production given the inattention/hyperactivity symptoms and executive deficits [2-5].

Although, the language deficits present in ADHD are still poorly detailed in the literature. An inconsistency in the results of empirical studies comparing language performance between individuals with and without a diagnosis of ADHD has been recognized [3, 5, 6]. Furthermore, researchers argue the differences between the impairments present in Language Disorders (i. e morphosyntactic process) compared with other language impairments present in ADHD conditions (i. e pragmatic deficits and reading impairments) [3].

1.2 Domain-specificity in language

In their review of the neurobiological of language processing, Campbell and Tyler [6] propose that syntactic processing may be specific to the language domain, corresponding to the left-lateralized frontotemporal system. However, other components of language comprehension, such as semantic and pragmatic, rely on domain-general cognitive systems

(e. g. attention and memory), which are not specific to language processing. This neurobiological evidence contributes to the understanding of Language Disorders, that is characterized by impairments in morphosyntactic components [7].

Considering the domain-general cognitive processes, individuals must deal with different lexical and syntactic interferences, thus, the executive functions (inhibitory control) recruit and select the words and meanings that enable communication or interpretation in the speech [9]. Furthermore, from the perspective of psycholinguistic theory, executive functions also contribute to sentence processing, especially those with temporary structural ambiguity; therefore, they can perform better in comprehension when it involves the use of complex sentences, such as non-canonical structures [10].

1.3 Components of Language

The components of language can be listed as syntax (i), lexical (ii), phonology (iii), morphology (iv), semantics (v), discourse (vi), pragmatics (vii), and prosody (viii). First, i. syntactic processing corresponds to the grammar of the language, being the hierarchical arrangement of words in sentences; ii. the lexical component contains the words and their cognitive representations in a specific language; iii. phonology refers to the production of sounds, closely related to articulation; iv. morphology involves the combination of phonemes, the microstructures that form a word, which allows for its derivation; v. semantics refers to the meaning of words and conceptual aspects; vi. in discourse the sentences are articulated to form the meaning in a communication setting, vii in pragmatics it corresponds to the social use of language; finally, viii prosody is closely related to phonological aspects, corresponds to intonation, tone of voice, speech rhythm. In this aspect, the morphosyntactic process will be mainly considered to explain the language difficulties present in ADHD.

In terms of linguistic processing, particularly regarding syntactic impairments, the first question is addressed "Do individuals diagnosed with ADHD experience problems in the language domain?"; and secondly, "How specific are the language difficulties encountered in ADHD, compared to individuals with language disorders?".

Thus, this review aims to provide an introduction to the topic and present a brief conceptual overview of the findings in the literature.

2. Methodology

2.1 Inclusion criteria

An integrative literature review was conducted to investigate language processing in ADHD. The integrative method was chosen to promote critical analysis of the recent studies in the field and gain insights into language impairments in ADHD [11]. The search was conducted in two academic databases, Web of Science and Scopus, using the

following search string: ("ADHD" OR "Attention deficit hyperactivity disorder") AND ("Language impairment" OR "language comprehension" OR "language processing").

The review includes empirical and review articles published between January 2009 and March 2023 written in English. The inclusion criteria required that experimental studies contained at least one language assessment measure or a linguistic experimental task. The studies selected must investigate the morphosyntactic processing with diagnosed ADHD (experimental group) compared with at least one control group (without diagnostic and/or Language Disorders).

3. Results

Eight articles were selected considering the relevance of the topic. Three were review articles, including one systematic/meta-analysis about the language impairments in ADHD [5], and one scoping review detailing the reading difficulties using a different types of tasks [6]. One integrative review [3] explores the difference in identifying Specific Language Disorders (DLD) from ADHD, focusing on different language symptoms described in Diagnostic Assessments for these developmental disorders.

Five were experimental articles, investigating language processing in ADHD compared with a healthy control group or adding a group with language impairments. Four studies explore oral language production in ADHD using the priming paradigm (thematic or syntactic) [12 -15], in English [12, 13], and in French [14, 15]. One study investigates morphosyntactic comprehension in ADHD, using a grammatical judgment task in Hebrew sentences with adults [16].

4. Discussion

The review articles focused on the language difficulties presented in ADHD, considering expressive and comprehensive (i. e oral and reading comprehension) language. Different language tests used in a clinical context, and experimental psycholinguistics tasks, are utilized to access language impairments in children with that ADHD and other developmental disorders, such as Language Disorder, which are often present in comorbidity or misdiagnosed [3].

Korrel and cols. [5] emphasize the importance of discriminating the type of task used to access language difficulties in ADHD. Furthermore, it presents the language domains that may exhibit impairment in ADHD and other language-disordered conditions. These language domains may include comprehensive language, expressive language, vocabulary, grammatical processing, pragmatics, and other related domains. The meta-analysis findings indicate that children with ADHD experience challenge in expressive, receptive, and pragmatic language compared to their non-ADHD peers.

Through that, most studies investigate the pragmatic domain in ADHD, which are briefly described as related symptoms of hyperactivity/impulsivity described in DSM-V [1, 5].

Regarding reading deficits in children with ADHD, the type of task required to assess these difficulties may have an impact on this population [6]. The review suggests that in story-retelling tasks, ADHD children encounter difficulties in recounting the key elements of a narrative that was previously read. It remains uncertain whether such difficulty in reading comprehension is related to codification impairments, involving different linguistic components, or difficulties in retelling the story due to attentional or working memory limitations. Similarly, in gap-filling tasks such as cloze tests, used to assess reading comprehension – the studies show that making modifications to the task, such as extending the time allotted or displaying the text in print form instead of digital, has been found to enhance the accuracy of children with ADHD [5].

Few studies investigate the syntactic impairments in ADHD. Regarding expressive language in adults and adolescents with ADHD, studies evaluate oral sentence production with experimental psycholinguistics tasks. Engelhardt, Ferreira, and Nigg [12, 13] used a priming task with two pictures (an inanimate and animate object) and a verb (ambiguous verbs and participle verbs). The first study found that adults and adolescents with ADHD of the combined subtype had a higher tendency to produce ungrammatical sentences, particularly in situations with ambiguous verbs and inanimate objects displayed first – who induce to produce more complex sentences (i. e passives) [12]. The second study investigated the number of disfluencies in oral language (i.e filled pauses, unfilled pauses, repetitions, and repairs). Similarly, the number of disfluencies was higher when the inanimate object was presented first, providing the use of passive sentences. As for individuals with combined subtype ADHD, they produced a greater number of repairs compared to individuals with predominantly inattentive ADHD and the control group. The authors explain that individuals with ADHD tend to start speaking before planning the grammatical structure. This could be related to the deficits in EFs, such as Inhibitory Control [12, 13].

Stanford and Delage compared the performance of three groups: children with Developmental Language Disorder (DLD), children with ADHD, and adults without a developmental disorder. The thematic priming psycholinguistic task was also used. The task contained two images depicting an action containing two characters, one agent and one patient, of the same gender. Two types of cues were used, visual cues, which direct the participant's attention to one of the characters (i.e. referential cues - displaying the image of the character beforehand; or perceptual cues - presenting the stimulus highlighting one of the characters); and linguistic cues, which use topicalization of the referent in the

sentence (i. e. displaying questions about one of the characters; presenting or not a sentence that should be completed). The results indicated that children with ADHD were more sensitive to linguistic cues (which involved a question related to one of the referents) than to visual cues (referents in color/black white, displayed in order) than children with DLD. Related to the difficulties present in working memory, ADHD children may have difficulties involving the manipulation of visual and linguistic information in the production of a higher-cost grammatical sentence. On the other hand, children with DLD were less favored by linguistic cues due to specific difficulties in the syntactic domain [14].

Moreover, in previous studies, the authors evaluated clinical markers of DLD in French, such as the production of 3rd person clitics, which indicates the impairments in morphosyntactic [15]. French children with ADHD didn't present difficulties in this type of task, so it is elucidated that the impairments in syntactic processing would not be characteristic of this population. Therefore, they consider that the performance of individuals with ADHD in expressive language tests, regarding different sentences: passives, verbal temple, and irregular plural forms; may be impaired due to the deficits in alternating attention. Given this, possible difficulties in ADHD would be predictable not as a result of difficulties with syntactic processing, but as a function of the task's demands on recruited executive functions (i. e inhibitory control and cognitive flexibility) [15]. Similarly, Redmond [3] elucidates the language deficits present in Language Disorders (DLD) compared to the difficulties present in Attention Deficit Hyperactivity Disorder (ADHD), discussing the importance of using measures that have a satisfactory level of specificity to differentiate atypical populations that present with language difficulties [3].

As for comprehension, there is evidence of difficulties in the morphosyntactic domain in adults with ADHD. A study in Israel considered the linguistic structure in Hebrew to evaluate two dimensions: the number and gender agreement of adjectives with nouns (morpho-phonological variable) and the position of adjectives in the sentence (grammatical variable) in a grammaticality judgment task. Individuals with ADHD obtained lower accuracy and longer response time in grammaticality judgment tests with sentences constructed in Hebrew (attributive adjectives in initial position and/or with ambiguous suffixes) [16].

5. Conclusion

The review finds evidence of a link between ADHD attention and hyperactivity deficits and language problems. Regarding Domain-Specificity [6], ADHD appears not to have impairments in the syntactic process per se. The difficulties present in reading tasks or oral language production regarding the grammatical structure could be related to the

reported difficulties in Executive Functions. Depending on the type of task, it could require different cognitive abilities not only related to the language process, such as Inhibitory Control, Cognitive Flexibility, and Working Memory, which interferes in the majority of controlled processes that involves planning [2]. In language production, authors argue that must be interference in working memory related to visual cues exhibited with linguistic information to syntactic processing. Deficits in Inhibitory Control are related to disfluencies in speech, individuals with ADHD tend to correct their agrammatical utterances during the articulation [13]. Moreover, impairments in generating complex sentences, particularly passives, require the production of a non-canonical sentence structure where the subject of the action is placed in the patient's role. So cognitive interferences related to domain-general processes could be related to those impairments depending on the type of task [13, 14]. So, ADHD individuals seem to have difficulty processing two types of information to produce a sentence (i. e visual and linguistic).

The language impairments in syntactic processing are not entirely described, considering few articles that explore the language specificity related to ADHD symptoms. Most of the researchers focus on Language Impairments, Reading disorders, or EFs interferences in language production and comprehension. Exploring the linguistic factors that are affected in individuals with ADHD is crucial not only for accessing language impairments that are underrepresented in diagnostic manuals and rating scales/psychiatric instruments but also for collaborating with the identification and differentiation of developmental disorders that manifest language processing difficulties [3, 8].

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