LANGUAGE COMPREHENSION IN CHILDREN WITH ATTENTION DEFICIT – HYPERACTIVITY DISORDER AND AUTISM SPECTRUM DISORDER: IS THERE AN OVERLAP?

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ABSTRACT Language disorders involve a deficit in the understanding or using written, and spoken words or other symbolic systems and are frequent comorbidities in various Neurodevelopmental Disorders, including Attention Deficit Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD). Our main goal was to evaluate language comprehension, through the use of 6 PALPA-P subtests, in a sample of children and adolescents with ADHD and a sample of children and adolescents with high functioning ASD, and thus evaluating if these groups differ in their comprehensive language profile. A total of 73 children and adolescents were evaluated, of which 34 had a diagnosis of ADHD, 18 had a high functioning ASD, along 21 controls. ADHD significantly affected language comprehension compared to the control group, although to a lesser extent than children with ASD. Language comprehension impairment may be an additive factor for the school failure of children with ADHD and ASD. It should not be neglected by health professionals who work with these children daily.

KEYWORDS Attention Deficit, Autism, Comprehension, Hyperactivity, Language

Introduction

Communication is inherent to people's relationship, and we use it to get information from the world and share experiences with others. The communicative process involves emitting signals like sounds, written words and other non-linguistic parameters such as gestures and eye contact [1], intending to transmit a message. For the communication to be successful, the receiver must decode and correctly interpret the message [2]. We know that communicative competencies play a fundamental role in children's learning, thinking and developing social relationships [3]. A language is a form of communication involving small units like syllables and words, all of which can be combined to create larger units such as phrases that have a certain meaning in the same group or community. Speech is the verbal expression of language, involving oral production and the articulation of words, resulting from a complex interaction between cognition, neuromuscular coordination, breathing, phonation and articulatory resonance [2].

Communication disorders are the most frequent neurodevelopmental disorders, with an incidence of approximately 8% in the group of children and adolescents between 3 and 17 years old [4]. The two main types of communication disorders are Speech Sound Disorder and Language Disorder [5]. The latter is a deficit in the understanding or use of written, verbal or other symbolic systems, which may involve the form (grammar, syntax, morphology), content (vocabulary) or function (pragmatics) of the language. Communication disorders are very common comorbidities in several Neurodevelopmental Disorders, including Attention Deficit - Hyperactivity Disorder (ADHD) [6] and Autism Spectrum Disorder (ASD) [7]. ADHD is the most frequent neurodevelopment disorder with an estimated 5 to 7% prevalence in pediatric age [5]. It is characterized by a persistent pattern of inattention and hyperactivity and impulsivity, with an intensity higher than that, observed in children with a similar level of development [5]. Symptoms may vary to a

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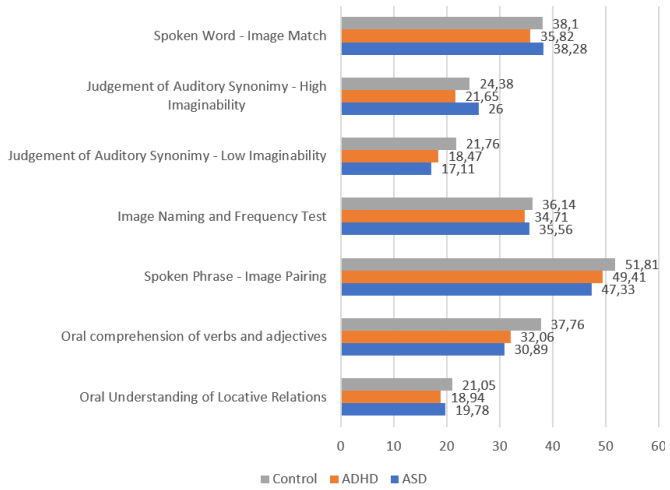

greater or lesser extent depending on the subtype of ADHD and are usually present since preschool age. Still, they can occur throughout the individual's life, including adulthood [8], and cause significant dysfunction in the child's social, educational or occupational functioning [5]. In addition to its high prevalence, ADHD has a high incidence of comorbidities, such as anxiety and mood disorders [9], substance abuse [10], deficits in executive functions [11] and language disorder [12]. Regarding the latter, although the diagnosis of ADHD does not include any item related to language impairment, up to 50% of children with ADHD may have difficulties in some aspect of language and communication [13], being a frequent reason for evaluation by a Speech and Language Therapist. Even when language comprehension, reading and writing are normal, many children with ADHD have difficulties in pragmatics [14].

Autism Spectrum Disorder is a neurodevelopment disorder characterized by a persistent deficit in communication and social interaction in multiple contexts, along with the presence of a restricted, repetitive and stereotyped pattern of behaviours, interests or activities [5]. Its incidence has increased in the last two decades. However, it is still unclear whether this results from a real increase in incidence, modification of diagnostic criteria, increased knowledge of pathology by health professionals or a combination of all these factors [15, 16]. The language profile of children with ASD is characterized by great heterogeneity, from the total absence of language to the presence of a highly functional language [17]. However, difficulties in using language according to its context (pragmatics) is usually a hallmark of ASD, regardless of the child's cognitive function, often causing difficulties in communicating with peers [18]. Our main goal was to evaluate language comprehension in a sample of children and adolescents with ADHD and a sample of children and adolescents with high functioning ASD (ASD level 1 according to DSM-5 diagnostic criteria), verifying if these two groups may be differentiated terms of their comprehensive language profile.

Materials and Methods

Sample

A group of children and adolescents (aged 6 to 12 years old) with a "new" diagnosis of ADHD was selected from the consultation of clinical files of the Neurodevelopmental Unit of a tertiary care pediatric hospital in Portugal, in the period between January 1st 2017 and June 30th 2018. With regard to children with High Functioning Autism Spectrum Disorder (HFASD), children and adolescents from the same Unit were recruited.

Exclusion criteria were ongoing medication with psychostimulants, atomoxetine or anti-psychotics and the cognitive level below 75 on the Wechsler Intelligence Scale for Children III (WISC-III) or below the 10th percentile on Raven's Progressive Color Matrices (RPM). The control group consisted of healthy children from a school in the same district, age-matched to our study group.

Methods

In all cases, parents were informed of the objectives of the investigation and provided free, informed consent for their children's participation. At the selected school, a formal application was made to apply the PALPA-P tests. Terms of free and informed consent were also given to parents and Conners' Questionnaires - version for parents and teachers (to exclude the presence of ADHD in the control group). Authorization was obtained from the Hospital Ethics Committee to carry out this investigation.

Clinical Evaluation Tools Used

All of our patients in both study groups had clinical criteria for either ADHD or HFASD, according to DSM-5 criteria. Adjunct for the diagnosis of ADHD, we also used a behavioural questionnaire as recommended by several reference entities [19]. We used the Conners Questionnaire, Revised Edition (EC-R), short forms - versions for parents and teachers [20]. These questionnaires were completed by parents and teachers of all individuals in the sample, including the control group, in order to avoid children with undiagnosed ADHD.

Language and Aphasia Assessment Tests in Portuguese (PALPA-P)

These tests are based on the original English Psycholinguistic Assessments of Language Processing in Aphasia (PALPA), which appeared in 1992 [21], aiming to evaluate acquired language disorder. Both the original PALPA and the versions that descended from it as the adapted and validated version for the Portuguese population PALPA-P [22] allow professionals to carry out an in-depth psycholinguistic assessment, covering four areas of language (phonological processing, reading and writing, semantics of words and images and sentence). PALPA-P can be used for the assessment of aphasia, but also for other disorders that may involve, to a greater or lesser extent, language (ADHD, ASD, epilepsy, cerebral palsy, specific learning disorders, among others). This battery involves 60 psycholinguistic tests covering the four areas mentioned above of language.

For the accomplishment of this work, after analysis of the PALPA-P battery by the authors, 6 tests were selected, 3 of them aiming to evaluate the comprehension of words and images and 3 aiming at the understanding of sentences.

Regarding word and image comprehension, we selected test 47 (Pairing Spoken Word – Image), which assesses understanding through the pairing between a spoken word and an image. Four distracting images are used: a nearby semantic distractor (from the same category above), a distant semantic distractor, a visual distractor and an unrelated distractor. Test 49 (Judgment of Auditory Synonymy) was also used, as it measures the ability to assess whether two words have a similar meaning.

Since distracting items have different meanings, and the child is only asked to make a binary decision ("yes, similar" vs. "no, different"), this test seems extremely easy. However, it includes the word imaginability factor, which can clarify how access to meaning is made. Half of the stimuli are of high imaginability, and the other half are of low imaginability. The low imaginability (difficulty to associate to an image) can cause difficulty for people with language disorders. We also applied test 54 (Image Naming and Frequency), which examines the effect of frequency on image naming. Several studies have shown that word frequency affects naming. The words are paired one by one in terms of the number of syllables and, as much as possible, the number of letters.

For assessing sentence comprehension, we also selected 3 subtests. The first one was test 55 (Pairing Spoken Phrase – Image), which uses images to determine the understanding of spoken phrases. Various types of sentences are used: reversible and non-reversible (either in the active or passive voice) in which the subject is not expressed, with verbs expressing reciprocal relationships (ex: buy-sell, offer-receive, deliver- accept). For each sentence, there are three images, the target and two distractors. Test 57 (Oral Understanding of Verbs and Adjectives) was also performed. It assesses understanding of verbs and adjectives used in phrase-image matching tasks using a simple question-answer format. Lastly, we also applied test 58 (Oral Understanding of Locative Relations). It uses images to assess the understanding of prepositions and adverbs of place in spoken sentences. The sentences consist of only three words, two referents and the spatial relationship between them and are reversible. Referents can be animated, inanimate or abstract. The comprehension of reversible phrases seems to be influenced by the degree of animation.

A cognitive assessment was also carried out using the WISC-III scale or through RPM. We excluded children with a cognitive level below 75 on the Full-Scale IQ of WISC-III or below the 10th percentile in the RPM test.

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) software, version 25.0 for Microsoft® Windows.

The results obtained in the applied tests were compared using appropriate statistical procedures, namely through analysis of variance (ANOVA) and Bonferroni correction. The differences were considered significant with a 95% confidence interval (5% significance level) with an error probability (p) of less than 0.05.

Results

Sample Characterization

A total of 73 children and adolescents were evaluated, of which 34 had a diagnosis of ADHD, 18 had a diagnosis of HFASD, and 21 controls. Regarding gender, boys accounted for 76.4% of children and adolescents with ADHD (n = 26), 77.8% of children and adolescents with HFASD (n = 14) and 52.3% of controls (n = 11). The average age was 10.1 years in the ADHD group (minimum = 7 years and maximum = 14 years), 10.6 years in the ASD group (minimum = 7 and maximum = 12 years) and 10.7 in the control group (minimum = 7 and maximum = 13 years). Table 1 shows the sample's characteristics (gender and age).

Word and Image Comprehension

Table 2 shows the results of the comparative analysis (ANOVA) and Bonferroni correction of all groups in Word and Image Comprehension Tests. On test 47, the Spoken Word – Image Match test, Children with ADHD had a statistically significant lower result than the other groups (35,82 ± 1.85). Test 49, Judgement of Auditory Synonymy, is divided into two sub-tests (words of low and high imaginability). Regarding the high imaginability scores, the group of children with ASD had the highest values (26.0 ± 0.97), significantly above the ADHD group (21.65 ± 2.97). In low imaginability scores, the group with the lowest values was the group of children with ASD (17.11 ± 1.71), followed by children with ADHD (18.47 ± 2.61).

In the Image Naming and Frequency Test (test 54), there was no statistically significant difference between the three groups, although the highest results were obtained in the control group (36.14 ± 1.65).

Sentences Understanding

Table 3 shows the results of the comparative analysis (ANOVA) and Bonferroni correction of all groups in Sentence Understanding Tests. In the Spoken Phrase – Image Pairing Test (test 5), the ASD group had significantly lower results (47.33 ± 2.54) than the ADHD group (49.41 ± 2.74) and the control group (51.81 ± 4.18). Concerning test 57 (Oral comprehension of verbs and adjectives), the control group had significantly higher values than the others (37.76 ± 2.53). The ASD group had lower values (30.89 ± 2.65) than the ADHD group (32.06 ± 4.95), although without significant difference between them. Oral Understanding of Locative Relations (test 58) showed that the control group had the highest values (21.05 ± 3.19), statistically different from the group with the lowest values (ADHD). Figure 1 shows the results in the various tests for all groups.

Discussion

Our main goal was to evaluate the understanding of language in two aspects (image/word and sentence comprehension) in a sample of children with ADHD and a sample of children with HFASD. Regarding word and image comprehension, the group of children with high functioning ASD showed overlapping results (or slightly higher) to the other groups, except for words of low imaginability (words in which it is difficult to associate an image, even if it is a concrete word), in which this group showed significantly lower results. In fact, despite the relationship between ASD and the effect of significant language characteristics, it has been the subject of debate for several years. Most studies consistently report that the social use of language, especially figurative language (the ability to decode in addition to what is explicitly said), is universally affected in children with ASD [23]. Particularly, literal interpretation of phrases with intentionally non-literal meanings is considered characteristics of children with high functioning ASD [24], as well as difficulties in metonymy [25], which is characterized by the use of a word out of its usual semantic context given its conceptual contiguity with another word [26]. These data suggest that the cognitive means for understanding figurative language are present from the time the child learns to speak. As he gets older, his linguistic abilities, knowledge of the world, and cultural experiences optimize his abilities to decode language, improving it even in adulthood.

Regarding sentence comprehension, the group with globally lower values was the group of children with ASD. Recently, Normand et al. [27] demonstrated, in a group of French children with ASD, greater difficulty in understanding verbs, adjectives

Table 1 Sample Characterization.

		Control n = 21 n (%)	ADHD n = 34 n (%)	ASD n = 18 n (%)	Total n = 73 n (%)
Sex	Male	11 (52.4%)	26 (76.5%)	14 (77.8%)	51 (69.9%)
	Female	10 (47.6%)	8 (23.5%)	4 (22.2%)	22 (30.1%)
Age	Average	10.7	10.1	10.6	10.3
	Minimum	7	7	7	7
	Maximum	13	14	12	14
	Mode	11	10	11	11

Table 2 Word and Image Comprehension test results.

TEST	CONTROL Mean (SD)	ADHD Mean (SD)	ASD Mean (SD)	F (ANOVA)	P
47	38.10a (1.51)	35.82b (1.85)	38.28a (1.78)	13.52	<0.05
49 HI	24.38ac (2.25)	21.65b (2.97)	26.0c (0.97)	14.86	<0.05
49 LI	21.76a (2.70)	18.47b (2.61)	17.11b (1.71)	13.46	<0.05
54	36.14 (1.65)	34.71 (2.28)	35.56 (1.72)	2.37	0.075

SUBTITLE: HI = High Imaginability; LI = Low Imaginability; NOTE: Different letters in superscript signify statistically significant differences between pairs (Bonferroni correction)

Table 3 Test results, comparative analysis (ANOVA) and Bonferroni correction.

TEST	CONTROL Mean (SD)	ADHD Mean (SD)	ASD Mean (SD)	F (ANOVA)	P
55	51.81a (4.18)	49.41b (2.74)	47.33b (2.54)	12.98	<0.05
57	37.76a (2.53)	32.06bc (4.95)	30.89c (2.65)	12.81	<0.05
58	21.05a (3.19)	18.94b (2.75)	19.78ab (2.16)	3.41	0.02

Different letters in superscript signify statistically significant differences between pairs (Bonferroni correction).

and names. One possible explanation for this phenomenon appears to be a deficit in surface morphology and deep syntax, which is consistent with the hypothesis of learning these strands of language at an early stage of development. Although there is a consensus in the literature that children with high functioning ASD have some degree of language impairment [28], this French study reveals a dysfunction at the lexical and grammatical level. It is, therefore, another type of affectation of language with ASD. Our work demonstrates a similar effect in a sample of Portuguese children. In addition to an adequate knowledge of the language (ex: to know the meaning of the word you just heard), there is another variable (also widely studied in children with ASD) that is fundamental for a better understanding: that the child can properly direct his gaze to either the emitter of the word or a certain object that is being shown [29]. The avoidance (although partial) of eye contact seems to be an important determinant in language comprehension. It may have been a determinant of the low results children and adolescents with high-level ASD obtained in the spoken phrase - image matching test.

Regarding ADHD, the tendency was clearly to show inferior results, compared to the control group, including statistically significant differences in the spoken word - image matching tests, auditory synonymy and in all sentence comprehension tests. The occurrence of comorbidities in ADHD is very frequent, occurring in about 2/3 of children and adolescents with ADHD. School-age children have a high prevalence of various language disorders compared to children of the same age group without ADHD [30]. Among the various strands of language that seem to be affected in ADHD, there are delays in language acquisition, difficulties in expressing and understanding language, as well as affecting pragmatics [6]. There does not seem to be a consensus on the nature of linguistic difficulties in children with ADHD, probably being secondary to the behavioural complex of impulsivity, hyperactivity, inattention and deficit in executive functions, which potentially limits the development of self-regulatory capacities, resulting in rapid and impulsive answers to the questions [31]. Pragmatic deficits also interfere with verbal and non-verbal aspects of language comprehension in children with ADHD since communication requires the ability to initiate, respond, and maintain attention, including staying on topic and maintaining proper physical proximity [32].

Comparing the 2 main groups (ADHD and high functioning ASD), ADHD appears to significantly affect sentence comprehension compared to the control group, albeit to a lesser extent than children with ASD. Some works, such as the one by Geurts et al. [33], demonstrate similar results, although more directed to only one aspect of language (pragmatics). In this work, the difficulties were more global, not dependent on pragmatics (a consequence of the type of tests applied). However, most studies in this area are based on questionnaires reported by parents and not on language tests directly applied to children, which we think have contributed to the overall lower results of these children compared to previously reported data.

As one of the main limitations of this work, we point out the restricted selection criteria and the resulting small sample size, which conditions the extrapolation of these results. It would therefore be useful to replicate this work in a larger sample of children and adolescents. A larger sample size would also allow the differentiation of results according to the subtype of ADHD (predominantly inattentive, predominantly hyperactive-impulsive and combined subtype), which could be interesting data for the conclusions of this study and possible generalization of the results.

Conclusion

This work intends to alert to the importance of understanding language in the global approach of children and adolescents with ADHD and ASD, and their impact on the global functioning of these children, being therefore useful and informative the inclusion of the evaluation of the communicative profile in the clinical tools for the assessment of children with ADHD and ASD. Children and adolescents with ADHD are at significant risk of school failure and social difficulties, especially at the expense of major symptoms of ADHD. However, we emphasize that the documented dysfunction in language comprehension may be an addictive factor for school failure and should not be neglected by health professionals (e.g., neurodevelopment paediatricians, speech therapists) who work daily with these children.

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Conflict of interest

There are no conflicts of interest to declare by any of the authors of this study.

References

1. Grigoroglou, M., Johanson, M., & Papafragou, A. (2019). Pragmatics and spatial language: The acquisition of front and back. Developmental Psychology, 55 (4), 729–744.
2. Bloom, L., & Lakey, M. (1978). Language development and language disorders. New York: John Wiley & Sons.
3. Guler Yildiz, T., Gonen, M., Ulker Erdem, A., Garcia, A., Raikes, H., Acar, IH,... Davis, D. (2019). Examining the associations between children's receptive language skills and developmental domains in the United States and Turkey. Journal of Child Language, 46 (3), 480–500.
4. Lindsey, I., Black, M., Vahratian, A., Howard, J., & Hoffman, M. (2015, June). Communication Disorders and Use of Intervention Services Among Children Aged 3–17 Years: United States, 2012. Retrieved April 22, 2019, from https://www.cdc.gov/nchs/products/databriefs/db205.htm
5. American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Washington, DC.
6. Mueller, KL, & Tomblin, JB (2012). Examining the comorbidity of language disorders and ADHD. Topics in Language Disorders, 32 (3), 228–246.
7. Bishop, DVM (2010). Overlaps Between Autism and Language Impairment: Phenomimicry or Shared Etiology? Behavior Genetics, 40 (5), 618–629.
8. Polanczyk, G., from Lima, MS, Horta, BL, Biederman, J., & Rohde, LA (2007). The worldwide prevalence of ADHD: a systematic review and metaregression analysis. The American Journal of Psychiatry, 164 (6), 942–948.

9. Becker, SP, Schindler, DN, Holdaway, AS, Tamm, L., Epstein, JN, & Luebbe, AM (2019). The Revised Child Anxiety and Depression Scales (RCADS): Psychometric Evaluation in Children Evaluated for ADHD. Journal of Psychopathology and Behavioral Assessment, 41 (1), 93–106.

10. Mochrie, KD, Whited, MC, Cellucci, T., Freeman, T., & Corson, AT (2018). ADHD, depression, and substance abuse risk among beginning college students. Journal of American College Health: 1–5.

11. Guardiano, M., Candeias, L., Eça Guimarães, J., Viana, V., & Almeida, J. (2017). Neuropsychological Profile in Children with Hyperactivity Disorder with Attention Deficit: Assessment of Working Memory. Acta Pediátrica Portuguesa, 48, 229–235.

12. Guardiano, M., Candeias, L., Eça Guimarães, J., Viana, V., & Almeida, J. (2013). Phonological processing and comprehension assessment of children with adhd. Psicologia, Saúde & Doenças, 14(3), 420-436.

13. Bruce, B., Thernlund, G., & Nettelbladt, U. (2006). ADHD and language impairment: A study of the parent questionnaire FTF (Five to Fifteen). European Child & Adolescent Psychiatry, 15 (1), 52–60.

14. Timler, G. (2013). Use of the Children's Communication Checklist — 2 for Classification of Language Impairment Risk in Young School-Age Children With Attention-Deficit / Hyperactivity Disorder. American Journal of Speech-Language Pathology, 23.

15. Blaxill, MF (2004). What's going on? The question of time trends in autism. Public Health Reports (Washington, DC: 1974), 119 (6), 536–551.

16. Rutter, M. (2005). Incidence of autism spectrum disorders: changes over time and their meaning. Acta Paediatrica (Oslo, Norway: 1992), 94 (1), 2–15.

17. Kjellmer, L., Fernell, E., Gillberg, C., & Norrelgen, F. (2018). Speech and language profiles in 4- to 6-year-old children with early diagnosis of autism spectrum disorder without intellectual disability. Neuropsychiatric Disease and Treatment, 14, 2415–2427 .

18. Paul, R., Orlovski, SM, Marcinko, HC, & Volkmar, F. (2009). Conversational behaviors in youth with high-functioning ASD and Asperger syndrome. Journal of Autism and Developmental Disorders, 39 (1), 115–125.

19. Attention deficit hyperactivity disorder: diagnosis and management | Guidance | NICE. (na). Retrieved May 7, 2019, from https://www.nice.org.uk/guidance/cg72

20. Rodrigues, A. (2000). Conner scales for parents and teachers: Translation and adaptation for research. Department of Special Education and Rehabilitation of Faculty Human Motricity.

21. Kay, J., Lesser, R., & Coltheart, M. (1992). PALPA: Psycholinguistic assessments of language processing in aphasia. Psychology Press. Retrieved from https://trove.nla.gov.au/version/27659122

22. Castro, Caló and Gomes. (2007). PALPA-P, Adaptation for Portuguese.

23. Dennis, M., Lazenby, AL, & Lockyer, L. (2001). Inferential language in high-function children with autism. Journal of Autism and Developmental Disorders, 31 (1), 47–54.

24. MacKay, G., & Shaw, A. (2004). A Comparative Study of Figurative Language in Children with Autistic Spectrum Disorders. Child Language Teaching & Therapy 20, 13–32.

25. McKenna, PE, Glass, A., Rajendran, G., & Corley, M. (2015). Strange Words: Autistic Traits and the Processing of Non-Literal Language. Journal of Autism and Developmental Disorders, 45 (11), 3606–3612 .

26. Pouscoulous, N. (nd). Metaphor: For adults only? Retrieved August 26, 2019, from https://benjamins.com/catalog/bjl.25.04pou

27. Le Normand, M.-T., Blanc, R., Caldani, S., & Bonnet-Brilhault, F. (2018). Disrupted behavior in grammatical morphology in French speakers with autism spectrum disorders. Clinical Linguistics & Phonetics, 32 (8), 706–720.

28. Rapin, I., & Dunn, M. (2003). Update on the language disorders of individuals on the autistic spectrum. Brain & Development, 25 (3), 166–172.

29. Wenker CE, Bean A, Kover ST. (2018). Auditory–Visual Misalignment: A Theoretical Perspective on Vocabulary Delays in Children With ASD. Autism Research 2018 December ; 11(12): 1621–1628.

30. Sciberras, E., Mueller, KL, Efron, D., Bisset, M., Anderson, V., Schilpzand, EJ, ... Nicholson, JM (2014). Language problems in children with ADHD: a community-based study. Pediatrics, 133 (5), 793–800.

31. Barini, NS, Hage, SR. (2015). Vocabulary and verbal comprehension of students with Attention Deficit Hyperactivity Disorder. CoDAS, 27 (5), 446–451.

32. Staikova, E.; Gomes, H.; Tartter V.; McCabe A.; Halperin JM (2015). Pragmatic Deficits and Social Impairment in Children With ADHD. Journal of Child Psychology and Psychiatry 2013 (54); 1275-1283

33. Geurts, HM, Verté, S., Oosterlaan, J., Roeyers, H., & Sergeant, JA (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? Journal of Child Psychology and Psychiatry, and Allied Disciplines, 45 (4), 836–854.