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The interpretation of long-distance anaphora in attention-deficit/hyperactivity disorder

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Abstract: In this study, the performance of Turkish-speaking adolescents with attention deficit hyperactivity disorder (ADHD) in long-distance (LD) binding conditions of anaphors, a topic that remains insufficiently explored in the existing literature, was investigated. The relationship between their performance and theory of mind (ToM), as well as working memory (WM) skills, was also discussed. Adolescents aged 12–18 years with ADHD (n = 42) and typically developing adolescents (TD; n = 40) were tested on their interpretation of the reflexive *kendisi* 'self.3sg', which has logophoric features in Turkish, using comprehension and self-paced reading tasks. The ADHD group performed poorly on LD-anaphors for the end-of-trial questions, and their reading times were shorter compared to TD peers. It has been suggested that short reading times for sentences containing LD-anaphors indicate shallow processing and that the failure is linked to inadequate WM or (and) ToM skills. This study emphasizes that the interpretive performance of LD-anaphors is not only associated with WM limitations, but also strongly associated with empathy and pragmatic use of language. The study underlines the need for future research efforts to examine these complex relationships in ADHD in greater depth.

Keywords: long-distance anaphora; logophor; theory of mind; attention deficit hyperactivity disorder; adolescent; working memory

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1 Introduction

Principle A of Binding Theory asserts that an anaphor must be locally bound, requiring an antecedent within the same clause that c-commands it maintaining syntactic and semantic coherence (Chomsky 1981). Long-distance (LD) anaphora is defined as a feature allowing an antecedent to occur outside its local binding domain. A number of theoretical proposals have been put forward to explain LD anaphora: the first is to expand the notion of governing category (Manzini and Wexler 1987; Progovac 1993; Yang 1983), and the second is to reduce LD dependencies to local dependencies via head movement (Pica 1984; Battistella 1989; Cole et al. 1990; Huang and Tang 1991; Li 1993). LD anaphors have been shown to exhibit a dual status: in the context of local binding, they function as a plain anaphor; conversely, they transform into a logophor when they receive a non-local binding. Indeed, it has been observed that LD anaphors bear similarities to logophoric pronouns in terms of antecedent selection (Baker and Ikawa 2024; Charnavel 2020a, 2020b; Kuno 1987; Oshima 2004, 2006; Sells 1987). As logophoricity refers to the phenomenon that certain pronouns are equivalent to the author whose point of view the indirect discourse expresses (e.g., Hagège 1974; Clements 1975), LD-anaphors as perspective-sensitive anaphors are closely associated with empathic understanding, particularly in relation to Theory of Mind (ToM). Notably, in many languages, LD anaphors appear to be exempt from syntactic locality constraints, as defined by Condition A of Binding Theory, when governed by discourse conditions related to perspective. As demonstrated in the English examples in (1a) and (1b), *himself* is deemed acceptable only when its non-local antecedent, *John*, refers to the perspectival center.

(1) a. John$_i$ said to Mary [that there was a picture of himself$_i$ in the post office].
b. *Mary said about/of John$_i$ [that there was a picture of himself$_i$ in the post office].
(Kuno 1987: 126)

In the Turkish language, the distribution of LD-anaphors is also influenced by the point of view. In instance (2b), since the sentence is presented from the speaker's perspective, the use of LD-anaphor (*kendisi*), appears to be pragmatically unusual. Conversely, in instance 2a, which adopts the detainee's perspective, the use of LD-anaphor (*kendisi*) is more acceptable. Conversely, the use of the pronoun introduces ambiguity concerning the intended point of view.

(2) a. Tutuklunun beni görememesinin nedeni, polisin kendisini
detainee.GEN I.ACC see.ABIL.NEG.N.3SG.GEN reason.3SG police.GEN self.3SG.ACC
engellemesiydi.[1]
prevent.N.3SG.PST
'The reason the detainee could not see me was that the police prevented him.'

b. #Tutukluyu göremememin nedeni, polisin kendisini
detainee.ACC see.abıl.NEG.N.1PL.GEN reason.3SG police.GEN self.3SG.ACC
engellemesiydi.
prevent.N.3SG.PST
'The reason I couldn't see the detainee was that the police prevented him.'

Although language disorders are not included in the diagnostic criteria for attention deficit hyperactivity disorder (ADHD), research has consistently documented a high prevalence of social language impairments in this disorder (Carruthers et al. 2022; Çiray et al. 2022). There is mounting evidence supporting the notion that social cognition disorders, encompassing aspects such as theory of mind (Caillies et al. 2014; Maoz et al. 2019) and pragmatic language difficulties (Green et al. 2014; Kuijper et al. 2021; Purvis and Tannock 1997), are prevalent among individuals with ADHD. Individuals diagnosed with ADHD may also exhibit disorders associated with working memory (WM) (e.g., Alderson et al. 2007; Van Mourik et al. 2005; Lansbergen et al. 2007; Kofler et al. 2024). For instance, the functional WM model of ADHD suggests that deficits in WM are a core characteristic of the disorder (Kofler et al. 2010). It is therefore plausible to hypothesize that individuals diagnosed with ADHD face dual challenges when processing LD-anaphors. On the one hand, the processing of LD-anaphors may be challenging for individuals with ADHD due to WM deficits, as the distance between the antecedent and the anaphor exacerbates cognitive demands. On the other hand, given that LD-anaphors are often linked to empathic understanding, particularly ToM, individuals may experience additional difficulties in processing these anaphors. The present study investigates the ability of children with ADHD and typically developing (TD) children to make associations between anaphors and their antecedents in Turkish in both real-time and post-trial questions. Furthermore, this study constitutes foundational groundwork for future research aimed at systematically investigating the relationship between LD-anaphoric processing and both ToM and WM.

1 Glossing abbreviations: 1PL: first person plural; 1SG: first person singular; 2PL: second person plural; 3SG: third person singular; ABIL: abilatative; ABL: ablative; ACC: accusative; AOR: aorist; DAT: dative; GEN: genitive; LOC: locative; *N*: nominalizer; NEG: negation; NOM: nominative; PROG: progressive; PRO*n*: pronominal *n*; PST: past.

2 LD-anaphora and ADHD

2.1 LD-anaphora in the Turkish language

In the Turkish language, two types of reflexive pronouns are recognized: *kendi* 'self' and *kendisi* 'self.3sg'. *Kendi* is generally considered to be governed by Principle A of the Binding Theory. According to the literature, the anaphor should be bound by a local c-commanding antecedent, as illustrated in (3a) (Enç 1989; Kornfilt 2013; Özgen and Aydın 2016; Rudnev 2011; Sezer 1979). Although *kendi* 'self' is typically regarded as a strictly local anaphor, studies in the Turkish literature suggest that *kendi* can also take a long-distance antecedent, allowing it to refer to the non-local subject of a higher clause (3b) (Cem Değer 1996; Meral 2010; Meral 2013; Özbek and Kahraman 2016; Yakut 2015). Despite the divergent views in the extant literature regarding the status of the anaphor *kendi* 'self' as a LD-anaphor, there is a consensus on the anaphor *kendisi*, 'self.3sg'. This consensus establishes that *kendisi* can refer either to the subject of the embedded clause (i.e., the local subject) or to the subject of the matrix clause (i.e., the long-distance subject). In (3), both interpretations are deemed acceptable, with the additional possibility of reference to an extra-sentential antecedent (as posited by Enç 1989; Gürel 2004; Kornfilt 1997). Experimental studies (Aydın 1998; Gračanin-Yuksek et al. 2017; Gračanin-Yuksek et al. 2020; Özbek and Kahraman 2016) have also shown that, unlike the anaphor *kendi*, the anaphor *kendisi* has fewer restrictions on binding to long-distance antecedents than local antecedents. Consequently, this study examined the anaphor *kendisi*, whose antecedent occurred in a local or long-distance position in the sentence.

(3) a. Ben adamın$_i$ kendini$_i$/kendisini$_i$ anlattığını zannediyordum.
I.NOM man.GEN self.ACC/self.3SG.ACC tell.N.3SG.ACC think.PROG.PST.1SG
'I thought that the man was talking about himself.'

b. Adam benim$_i$ kendini$_{?i}$/kendisini$_i$ anlattığımı zannediyordu.
man.NOM I.GEN self.ACC/self.3SG.ACC tell.N.1SG.ACC think.PROG.PST.3SG
'The man thought that I was talking about him.'

As previously stated, LD anaphors bear a resemblance to logophoric pronouns in that they select non-local antecedents selection; however, there are discrepancies between the two in terms of the constraints on antecedent selection. While logophores are constrained by semantic factors, LD anaphors are constrained by syntactic factors. LD anaphors are morphologically simple, typically subject-oriented, and LD binding is only possible when all potential antecedents agree in person and number features (Helong 2024). As illustrated by the examples in (4), *kendisi* 'self.3SG' (2b), unlike the pronoun *kendi* 'self' (4a), is not morphologically

simple and subject-oriented, but rather exhibits logophoric features. Given the consistent interpretations of the anaphor *kendisi* 'self.3SG' in Turkish referring to the matrix clause in the extant literature and its non-subject orientation, the focus of this study is on the anaphor *kendisi* 'self.3SG'; as opposed to the anaphor *kendi* 'self'.

(4) a. ?*Ben kadına$_i$ kendini$_i$ sevdiğinizi *söyledim.*
I.NOM woman.DAT self.ACC love.N.2PL.ACC say.PST.1SG
'I told the woman that you love her.'

b. Ben kadına$_i$ kendisini$_i$ sevdiğinizi söyledim.
I.NOM woman.DAT self.3SG.ACC love.N.2PL.ACC say.PST.1SG
'I told the woman that you love her.'

2.2 Empathic use of the reflexive *kendisi*

In addition to the above-mentioned explanations (i.e., expanding the notion of governing category and head movement), which are based on standard binding theory for anaphoric binding outside the governing categories, it has been a common line of reasoning in the literature to explain LD-anaphora using a non-syntactic, especially discourse-based, pragmatic approach (Kishida 2011; Kuno and Kaburaki 1977; Oshima 2004, 2007; Reinhart and Reuland 1993). Underlying such discourse-based accounts is the concept of empathy.[2] According to these approaches, the non-local interpretation of long-distance reflexives is available only with a premise that includes the concept of empathy. According to Kuno and Kaburaki (1977), who introduced the concept of empathy, empathy is the speaker's identification which may vary in degree, with a person or entity that participates in the event or state he is describing in a sentence. Sezer (1979), who adopts the concept of empathy in Turkish, as illustrated in examples such as (5), distinguishes between *kendi* 'self' and *kendisi* 'self.3SG' based on the narrator's psychological distance from the referent in the given context. According to him, in the sentence formed by the anaphor *kendi* 'self' in (5), the narrator puts himself in the mind of the person he is narrating about, and

2 In many languages, intensifiers (i.e. emphatic markers) differ from reflexive pronouns in both form and distribution. However, in some languages, including Turkish and English, intensifiers and reflexive pronouns are identical in form but not in distribution. In those languages where intensifiers and reflexives are the same, reflexives mark a relation that does not change the argument structure but still maintains a core relation to an argument. The present study does not concern itself with 'emphatic' markers of this kind (see i), but rather with the 'empathic' use of anaphors that result in a change to argument structure, as illustrated in (ii).

(i) The rector herself opened the new library.

(ii) Mary saw herself in the mirror.

conveys the character's inner feelings in the event of becoming someone else. In other words, the narrator conveys the young girl's feelings rather than her observations. According to Sezer, there is no such meaning in the anaphor *kendisi* 'self.3SG'.

(5) Genç kız onların kendinden/kendisinden bahsettiklerini
young girl they.GEN self.ABL/self.3SG.ABL talking.about.N.3PL.ACC
zannediyor.
think.PROG.3SG
'The young girl thinks that they are talking about her'
(Sezer 1979:750)

However, we do not believe that there is such a clear distinction between *kendi* 'self' and *kendisi* 'self.3SG'. Similar to *kendi* 'self', a comparable interpretation can be applied to the anaphor *kendisi* 'self.3SG' in (5). For example, in one interpretation of (6a), *ben* 'I' can refer to Zeynep and not to the speaker, because the distinction between the speaker and the person she is describing disappears through empathy. This interpretation also applies to (6b), in which the anaphor *kendisi* 'self.3SG' is used, although not as strongly as in (6a). However, when pro is used instead of *kendisi* 'self.3SG' (as in (6c)), it becomes clear that the speaker does not fully empathize with any of the people described. On the basis of all these descriptions, we claim that the Turkish LD anaphor *kendisi* 'self.3SG' also has an empathic use, which can be described as involving ToM skills.

(6) a. Zeynep$_i$ ben$_i$ her şeyi bilirim sanıyor.
Zeynep I.NOM everything.ACC know.AOR.1SG think.PROG.3SG
b. Zeynep$_i$ *kendisinin*$_i$ her şeyi bildiğini sanıyor.
Zeynep self.3SG.GEN everything.ACC know.N.3SG.ACC think.PROG.3SG
c. Zeynep$_i$ *pro*$_i$ her şeyi bildiğini sanıyor.
Zeynep everything.ACC know.N.3SG.ACC think.PROG.3SG
'Zeynep thinks she knows everything'

Hendriks and Spenader's (2006) framework, situated within Optimality Theory, provides a thorough account of the role of ToM in pronoun interpretation. Their analysis encompasses both production and comprehension data, emphasizing that the capacity to evaluate alternative linguistic choices available to one's interlocutor emerges relatively late in children's cognitive development. As the anaphor *kendisi* 'self.3SG' in Turkish functions similarly to a pronominal, Hendriks and Spenader's (2006) explanation of pronominals can be applied to its instances. When adult listeners encounter the anaphor *kendisi* 'self.3SG', they interpret it as LD by considering the speaker's point of view. Children, on the other hand, may not be capable of considering the speaker's perspective in interpreting pronouns consistently

(Hendriks and Spenader 2006). It is well-known that such perspective-taking abilities require ToM (Hendriks 2014). The development of ToM usually occurs before children display proficiency in pronoun interpretation akin to adults (de Villiers et al. 2006).

It is well known that the LD binding of anaphors in different languages is a challenge for young children. Studies suggest that young children, unlike adults, prefer local reading rather than LD (Jakubowicz and Lis 1988 for Danish; Lee and Wexler 1987 for Korean). However, research findings remain inconclusive regarding whether children acquiring anaphors initially exhibit a preference for a local interpretation, in contrast to adults, who typically favor a LD interpretation. Some studies have reported that both young children and adult control groups demonstrated a preference for the local antecedent over the LD antecedent (Chien et al. 1993; Lee 1990; Okabe 2008).

2.3 Linking ADHD with the LD-anaphora

The absence of antecedents for LD-anaphors within the local domain constitutes an effortful process that is significantly constrained by WM capacity. Research has indicated that individuals diagnosed with ADHD may also experience impairments related to WM function (e.g., Alderson et al. 2007; Van Mourik et al. 2005; Lansbergen et al. 2007; Kofler et al. 2024). Barkley's response inhibition model suggests that inadequate response inhibition is the primary disorder in ADHD, leading to subsequent deficits in executive function, which encompasses WM abilities (Barkley 1997a, 1997b). In contrast, Baddeley and Hitch's multi-component theory positions WM deficits as a core feature of ADHD (Rapport 2001); individuals with ADHD often display heightened motor activity compared to TD peers, a behavior that is thought to enhance the cortical arousal necessary for fulfilling task demands associated with central executive functions (Rapport et al. 2009).

While the examination of LD-anaphoric processing primarily centers on syntactic analysis, particularly with regard to WM, it also entails the activation of various cognitive processes, including information integration, inference generation, coherence construction, and evaluation, and the updating of situation models (Barkley 1997a, 1997b). These processes are hypothesized to be associated with empathy and ToM (Zhang et al. 2023). Existing functional neuroimaging studies have highlighted associations between ToM networks and anaphoric processing (Molenberghs et al. 2016; Schurz et al. 2014; Van Overwalle et al. 2019). Despite this established link, research on anaphoric processing in special populations with deficits in empathy and ToM remains limited (Kuijper et al. 2015; Ladányi et al. 2017;

Rakhlin et al. 2015). In this context, ADHD is of particular significance due to its strong association with impairments in both ToM and empathy.

ToM, a specific component of social cognition, encompasses empathy and is described as the capacity to comprehend distinct emotional and cognitive processes for self and others (Bora and Pantelis 2016). ToM pertains to the socio-cognitive capacity to understand other people's thoughts and intentions. ToM ability bears significance for various facets of children's development, encompassing social competence and peer relations alongside pragmatic language skills (Carlsson et al. 2018). Hence, ToM has been widely investigated in the last few decades in both clinical and non-clinical samples of children and adolescents (Carlson et al. 2013; Loukusa et al. 2014).

A substantial body of literature has established that ToM deficits, which are characteristic of autism spectrum disorder, contribute to social-communicative challenges by impairing the ability to interpret others' beliefs, feelings, and attitudes, thereby hindering the formation and maintenance of social relationships and empathy (Cardillo et al. 2021; Frith et al. 1991; Rosello et al. 2020). More recent research also examines ToM skills in individuals with ADHD (Geurts et al. 2010). While some studies have concluded that ToM abilities remain intact in people with ADHD (Maoz et al. 2019), a recent review suggests that children with ADHD may face challenges in ToM tasks (Pineda-Alhucema et al. 2018). Given the notable heterogeneity in ToM evaluation tests across studies assessing ToM skills of children with ADHD, inconsistencies in research findings have arisen. Nevertheless, the majority of studies have consistently shown that the ADHD group tends to perform poorly on ToM assessments (Pineda-Alhucema et al. 2018). Lastly and importantly, thus far, within a linguistic hypothesis framework, there has been no study evaluating long interval and local binding conditions of anaphors and their relation to ToM skills of the ADHD group with a linguistic task.

3 Research questions

Despite the high prevalence of WM and ToM deficits in children with ADHD, to date, no research has compared the anaphoric processing abilities of ADHD children with those of TD peers using a self-paced reading task. In the current study, we aimed to investigate both offline and online processes (real-time processing and end-of-trial questions) by comparing local and long-distance binding conditions during silent reading, assessed through a self-paced reading task in this population.

Our first research question pertains to the responses at the end of the trial, which are based on the predictions mentioned above.

(i) Is there a performance discrepancy in accuracy rates (offline processing) in terms of local or long-distance binding between children diagnosed with ADHD and their TD peers?

The literature on reading time in children diagnosed with ADHD includes eye-tracking studies, revealing divergent findings. While some studies indicate similarities in oculomotor patterns between children with ADHD and those with TD (Caldani et al. 2022; Thaler et al. 2009), other studies suggest a longer duration of fixations, a higher number of backward saccades, and a longer reading time in children with ADHD compared with their TD counterparts (Deans et al. 2010; Molina et al. 2020). There is only one study that used self-paced reading which yielded no significant differences in reading time between individuals with ADHD and TD groups (Ward 2021). Assuming that there is no significant difference in reading times between the two groups, our second research question concerns real-time processing:

(ii) Is there a discrepancy in reading times between children diagnosed with ADHD and their TD peers during real-time processing (online processing), particularly regarding local or long-distance binding?

4 Materials and methods

4.1 Participants

A total of 111 children (66 with ADHD and 45 TD) were recruited from Ankara University Faculty of Medicine for this study. The ADHD group consisted of children who had previously been diagnosed with ADHD and were under follow-up at the child and adolescent psychiatry outpatient clinic. Of the 66 children with ADHD, 15 did not complete the full protocol because of incomplete standardized testing. Because of their concurrently using psychotropic medication during the testing phase, nine children with ADHD were excluded. The control group comprised TD children of similar age, without any diagnosed psychiatric disorders, who were selected from general pediatric outpatient clinics. These children were admitted to the clinic for minor acute conditions such as common cold, constipation, and other similar ailments. Due to the presence of psychiatric disorders in three adolescents referred from the pediatric clinic – two diagnosed with anxiety disorder and one with depressive disorder – these individuals were subsequently excluded from the study. Of the 82 remaining children, 40 were TD (ages 13–18, M = 15.05, SD = 1.54), while 42 had been previously diagnosed with ADHD (ages 13–18, M = 14.12, SD = 1.56).

The TD group comprised 15 females and 25 males, whereas the ADHD group comprised 10 females and 32 males. The exclusion criteria for both groups included having received any psychotropic drugs, having any neurological (i.e., epilepsy) or chronic diseases (i.e., type 1 diabetes), or uncorrected visual or hearing impairments. The ADHD group did not have any comorbid psychiatric disorders (i.e., autism spectrum disorder, specific learning disorder, communication disorder) and was currently not receiving medication or had discontinued medication treatment (two days for psychostimulants) before the testing.

The research protocol was approved by the Ethics Committee of Ankara University Faculty of Medicine (Ethics approval number: 2023/186). The children who agreed to participate in this study, along with their parents, were invited and informed about the research procedures. Informed consent was obtained from all participants and their parents.

4.2 Procedure

The participants' sociodemographic characteristics were evaluated using a sociodemographic questionnaire. Comprehensive psychiatric evaluation was conducted by an experienced child and adolescent psychiatrist who is certified in the application of the Schedule for Affective Disorders and Schizophrenia for School-Age Children-Present and Lifetime Version-DSM-5 (K-SADS-PL-DSM-5). Furthermore, parents were asked to complete the Conners' Parent Rating Scale-Revised: Short Form (CPRS-R:S) for their children. Simultaneously, a self-paced reading task was administered to children. In the self-paced reading task, child participants were seated at a comfortable reading distance from a monitor on which they read each sentence in a naturalistic setting. They were instructed to read the presented sentences at a normal speed. We implemented the non-cumulative linear format self-paced reading task with phrase-by-phrase segmentation. Each phrase was advanced by pressing the spacebar; the next region was revealed, and these key presses were time logged. The experiment began with eight training items that exhibited the same structure as the experimental items. During the practice trial, the participants received feedback on their responses. In addition, responses to the following comprehension questions are checked for accuracy. The experiment was conducted using Ibex Farm (Drummond et al. 2016). the clinical assessment scale and self-paced reading task lasted approximately 1 h for each participant.

4.3 Materials

4.3.1 Clinical measurements

A sociodemographic questionnaire was administered to gather information on various social and demographic factors. These factors included the child's age, medical history, number of siblings, parental age, educational attainment, family structure, and family income. The researchers obtained the required information by conducting an initial interview with the parents and asking them specific questions.

K-SADS-PL-DSM-5, a semi-structured interview that was originally developed by Kaufman and colleagues, is widely used for diagnosing child psychiatric disorders. An updated version according to DSM-5 diagnostic criteria, called "K-SADS-PL-DSM-5", it includes three components: an unstructured introductory interview at the beginning, followed by a screen interview evaluating more than 200 symptoms, and ending with diagnostic supplements (Kaufman et al. 2016). K-SADS-PL-DSM-5 Turkish version has been found to be valid and reliable (Ünal et al. 2019). In this study, it was administered individually to screen for psychiatric diagnosis (ADHD) and comorbidities.

CPRS-R:S serves as a screening tool for ADHD, encompassing statements related to attention, activity level, and oppositional behavior. Parents were asked to evaluate the degree to which each of the 27 items presented challenges for their child during the previous month. This assessment should be performed using a 4-point scale ranging from 0 (not true at all) to 3 (very much true). The scale comprises four subscales: Oppositional (6 items), Hyperactivity (6 items), Cognitive Problems/Inattention (6 items), and ADHD Index (12 items) (Kumar and Steer 2003). Kaner et al. (2013) conducted a thorough evaluation within the Turkish population to establish the reliability and validity of the Turkish version of the scale. In the current study, this scale was used to screen ADHD symptoms and symptom severity.

4.3.2 Self-paced reading task

The materials included 60 sentences with two conditions. To prevent participant fatigue and ensure a sufficient number of observations, filler sentences were excluded, given the limited attention span typically observed within the ADHD group. In both conditions, the anaphor *kendisi* 'self.3SG' of interest always appeared as the direct object of the embedded verb. The experimental sentences were structured as in (7)–(8). In the local antecedent condition (n = 30), the anaphor in the object position of an embedded clause refers to a local subject (i.e., *adamın* 'man.gen' in 4), whereas in the LD antecedent condition (n = 30), it refers to the subject of the main

clause (i.e., *adam* 'man.nom' in 5). In both conditions, we manipulated the person congruence between an anaphor and one of the potential antecedents. The reason for doing so was to control for LD and local binding conditions; thus, we did not use ambiguous sentences. To manipulate person agreement, the main subject in the local binding condition (see 7) is chosen from the first-person singular (*ben*), first-person plural (*biz*), second-person singular (*sen*) pronouns. The reason for not employing second-person plural (*siz*) and third person pronouns (*o* or *onlar*) in this instance is to regulate the length of the main verb. In the LD condition (see 8), the embedded subject was identified as second-person singular in all conditions. The rationale behind this phenomenon is that in Turkish, both the second-person singular verbal noun (i.e., *anlat-tığ-ın-ı* tell-N-2SG-ACC' in 8), and the third-person singular verbal noun (i.e., *anlat-tığ-ı-n-ı* 'tell-N-3SG-PRO*n*-ACC' in 7) are homophones when used with case morphemes. Consequently, the length of the embedded verb was controlled in the two conditions.

An experimental sentence was followed by a question ('Who did you think he was talking about?' or 'Who did he think you were talking about?') with two responses: (i) man (correct answer) and (ii) woman (irrelevant response).

(7) *Local binding*

1	2	3	4	*5*	*6*
Sen	dün akşam	yemekte	adamın	*kendisini*	*anlattığını*
you	last evening	dinner.LOC	man.GEN	self.3SG.ACC	tell.N.3SG.ACC

7

zannediyordun.

think.PROG.PST.2SG

'I thought that the man was talking about himself at dinner last night.'

(8) *Long-distance binding*

1	2	3	4	*5*	*6*
Adam	dün akşam	yemekte	senin	*kendisini*	*anlattığını*
man	last evening	dinner.LOC	you.GEN	self.3SG.ACC	tell.N.2SG.ACC

7

zannediyordu.

think.PROG.PST

'The man thought that you were talking about him at dinner last night.'

For each experimental item, we analyzed the reading times of the critical word (anaphor region) and the spillover regions, (embedded and main verb regions) that follow the critical region (see 9). All the sentences and conditions have the same number of regions, and the critical interest areas are in the same position (see Table A3 in the Appendix). The critical interest areas in (9) are in the fifth, sixth, and

seventh segments, as seen in (7) and (8) (in italics). The words employed in the fifth (anaphor region) and sixth (embedded verb region) critical interest areas remain consistent across both conditions, and the letter count (M = 10.93, SD = 2.12 for embedded verb), syllabic count (M = 5.03, SD = 0.85 for embedded verb), and bigram values (M = 100.52, SD = 74.18 for embedded verb) are equivalent in all cases. In the seventh region of interest, the main verb region, there are differences in the number of letters and bigram values between the two conditions (local and LD binding) due to differences in agreement morphology (see Appendix Table A3). While a significant discrepancy exists between the local binding condition (M = 12.67, SD = 1.30) and the LD binding condition (M = 11.67, SD = 1.30) with regard to the number of letters, $t(58) = -2.99$, $p < 0.01$, no such significant difference is observed in terms of bigram values (M = 99.40, SD = 57.20 for local binding and M = 107.19, SD = 61.74 for LD binding), $t(58) = 0.51$, $p = 0.614$. The number of syllables in the main verb region is equal in both conditions (M = 4.57, SD = 0.56).

(9) *Critical interest areas*

…	*kendisini*	*anlattığını*	*zannediyordu(n).*
…	self.3SG.ACC	talking.about.N.2/3SG.ACC	think.PROG.PST.(2SG)
	ANAPHOR REGION	EMBEDDED VERB REGION	MAIN VERB REGION

4.4 Data analysis

Accuracy rates were analyzed using generalized linear mixed effects (GLME) regression models, and self-paced reading data were analyzed with linear mixed effects regression models the lme4 package in R (Bates 2016). Statistical significance was set at $p < 0.05$, and the p-values for linear mixed models were obtained using the Satterthwaite approximation for denominator degrees of freedom with the *lmerTest* package (Kuznetsova et al. 2014). We performed these analyses with two fixed factors and their interactions: Group (TD and ADHD) and Condition (local and long-distance). Individual participants and items were included as random intercepts and slopes where appropriate (Baayen et al. 2008). Sum-coding was used for categorical variables (i.e., –0.5 vs. 0.5 instead of binary 1–0 coding for Group and Condition) to avoid potential bias. We excluded outliers deviating more than 2.5 SD from each participant's mean (1.19 %) by using *trimr* package in R (Grange 2016). Normality of residuals was assessed using quantile–quantile plots, histogram visualization, and skewness and kurtosis values. Reading times that deviated from a normal distribution ($p < 0.001$) were subsequently transformed using the *BestNormalize* package (Peterson 2021), which applied ordered quantile normalization (Peterson and Cavanaugh 2019). After transformation, the histogram appeared to be normal, and

skewness and kurtosis were approximately zero ($p > 0.94$). We also performed pairwise comparisons using the *emmeans* package in R to compute the Tukey HSD test to correct for multiple comparisons (Lenth 2023).

Spillover effects play a critical role in self-paced reading experiments. Self-paced reading requires participants to retain previously encountered words in memory while preventing them from previewing subsequent words. Since the preceding region includes the embedded genitive subject, any significant differences observed at the critical region (i.e., *kendisi*) may reflect, at least in part, the processing difficulty of this region (Vasishth and Lewis 2006). To address this issue, we incorporated the reading times of the embedded genitive subjects as a fixed effect in the mixed-effects regression models for continuous self-paced reading data, thereby controlling for variations in reading times.

5 Results

5.1 Comparisons of sociodemographic characteristics of the groups

As presented in Table 1, children in both groups are similar in terms of age, gender, maternal age, paternal age, socioeconomic status, and family type. The ADHD group had significantly higher CPRS-R:S subscale scores than the TD group ($p < 0.001$).

5.2 Analysis of the accuracy data

The analysis of the accuracy rates reveals that the TD children resolved the anaphor *kendisi* 'self.3sg' to both local and LD subjects with similar success rates, achieving 93 % accuracy for local antecedents and 94 % accuracy for LD antecedents, respectively. Conversely, the ADHD group demonstrated better performance on local antecedents (92 % accuracy) than LD antecedents (81 % accuracy), as shown in Table 2. The results of the statistical analysis of the accuracy data are outlined in Table 3.

The model outputs indicated significant effects of both Condition and Group, suggesting that LD binding was more challenging than local binding and that children with ADHD performed less well than their TD peers (see Figure 1, panel A). Additionally, significant interactions between the two factors were observed, with post hoc comparisons indicating that children with ADHD performed worse than TD children in the LD condition ($p < 0.001$; see Figure A1 and Table A1 in the Appendix for detailed comparisons). Furthermore, the ADHD group experienced greater difficulty

Table 1: Sociodemographic and clinical characteristics of groups.

Sociodemographic variables	ADHD (*n* = 42) M (SD)/Mdn (IQR)/*n* (%)	TD (*n* = 40) M (SD)/Mdn (IQR)/*n* (%)	*p*
Participants' age (years)[a]	14 (13–15)	15 (14–16)	0.133
Gender[b]			
Female	10 (23.8)	15 (37.5)	0.178
Male	32 (76.2)	25 (62.5)	
Mothers' age (years)[c]	42.43 (5.63)	42.03 (4.35)	0.719
Fathers' age (years)[c]	45.98 (5.60)	45.53 (4.65)	0.694
Family type[d], *n* (%)			
Intact family	39 (92.9)	38 (95)	1
Single-parent family	3 (7.1)	2 (5)	
SES[b], *n* (%)			
Low	9 (21.4)	10 (25)	
Medium	24 (57.1)	25 (62.5)	0.558
High	9 (21.4)	5 (12.5)	
CPRS[a]			
Oppositional	6.5 (3.25–9.75)	4 (1.25–6.75)	0.037
Hyperactivity	5.5 (1.25–9.75)	0 (0–2)	<0.001
Cognitive problems/Inattention	11.5 (7.5–15.5)	1(0–3)	<0.001
ADHD index	21.5 (14.875–28.125)	7 (2.375–11.625)	<0.001
Total	42.5 (31–54)	12 (4.75–19.25)	<0.001

Means are shown with standard deviations in parentheses; and medians are shown with inter-quartile range in parantheses. ADHD, attention deficit hyperactivity disorder; TD, typically developing; SD, standard deviation; M, mean; Mdn, median; IQR, inter-quartile range; SES, socioeconomic status; CPRS, Conners' parent rating scale. [a]Mann-Whitney *U* Test, [b]Pearson's Chi-squared Test, [c]Independent Samples *t*-Test, [d]Fisher's Exact Test.

Table 2: Descriptive outcomes of accuracy rate and self-paced reading durations per condition in the ADHD and TD groups.

	Accuracy		Anaphor region		Embedded verb region		Main verb region	
	Mean (SD)	CIs (95 %)	Mean (SD)	CIs (95 %)	Mean (SD)	CIs (95 %)	Mean (SD)	CIs (95 %)
TD group								
Local	0.93 (0.26)	0.91–0.94	700 (396)	677–722	740 (418)	716–764	822 (589)	788–855
Long-distance	0.94 (0.25)	0.92–0.95	755 (766)	712–798	843 (759)	800–886	896 (950)	843–951
ADHD group								
Local	0.92 (0.27)	0.90–0.93	666 (314)	648–683	723 (374)	702–744	655 (359)	635–675
Long-distance	0.81 (0.39)	0.79–0.83	701 (500)	674–729	817 (646)	782–853	713 (618)	679–748

Means with standard deviations are shown for accuracy and self-paced reading durations. The accuracy rate is displayed as a percentage, basically is the number of correct answers to the number of questions. Self-paced reading durations are shown as milliseconds for three regions, including the anaphor, embedded verb, and main verb. SD, standard deviation; CI, confidence interval.

Table 3: Fixed effects from generalized linear mixed-effects regression models computed with accuracy percentage and self-paced reading data.

	Accuracy			Anaphor region				Embedded verb region				Main verb region			
	β (SE)	*z*	*p*	*β* (SE)	*t*	*p*	η^2	*β* (SE)	*t*	*p*	η^2	*β* (SE)	*t*	*p*	η^2
(Intercept)	2.20 (0.11)	19.35	<0.001	−0.01 (0.02)	−0.30	0.76	–	0.10 (0.03)	3.90	<0.001	–	−0.03 (0.03)	−0.99	0.32	–
Group	0.74 (0.13)	5.34	**<0.001**	0.06 (0.06)	2.04	**<0.05**	0.02	0.05 (0.03)	1.59	0.11	0.01	0.34 (0.04)	8.55	**<0.001**	0.02
Cond.	0.41 (0.12)	3.42	**<0.001**	0.06 (0.06)	2.39	**<0.05**	0.07	−0.04 (0.02)	−1.56	0.13	0.03	0.03 (0.03)	1.17	0.25	0.02
Group × Cond.	−1.10 (0.24)	−4.53	**<0.001**	−0.06 (0.05)	−1.15	0.26	0.02	−0.11 (0.05)	−2.35	0.05	0.07	−0.06 (0.06)	−1.08	0.28	0.01
CPRS-ADHD	0.00 (0.01)	0.07	0.94	0.00 (0.00)	−0.56	0.58	–	−0.01 (0.00)	−3.01	<0.05	–	−0.01 (0.00)	−3.50	**<0.001**	–
CPRS-CP/I	−0.01 (0.02)	0.56	0.57	0.01 (0.00)	1.36	0.18	–	0.03 (0.00)	6.14	<0.01	–	0.04 (0.01)	6.43	**<0.001**	–
Spillover 1	–	–	–	0.43 (0.01)	34.30	**<0.001**	–	0.41 (0.01)	31.44	<0.001	–	0.20 (0.02)	11.10	**<0.001**	–
Spillover 2	–	–	–	0.18 (0.01)	14.83	**<0.001**	–	0.16 (0.01)	11.02	<0.001	–	0.15 (0.02)	7.35	**<0.001**	–
Spillover 3	–	–	–	0.19 (0.01)	16.82	**<0.001**	–	0.23 (0.01)	15.38	<0.001	–	0.18 (0.02)	9.10	**<0.001**	–

Bold values indicate statistical significance. Accuracy is displayed as a percentage, basically the number of correct answers to the number of questions. Self-paced reading durations are shown as milliseconds for three regions, including anaphor, embedded verb, and main verb. SE, standard error; Cond, condition; CPRS, Conners parent rating scale; CP/I, cognitive problems/inattention; ADHD, attention deficit hyperactivity disorder. Values in bold represent p-values significant.

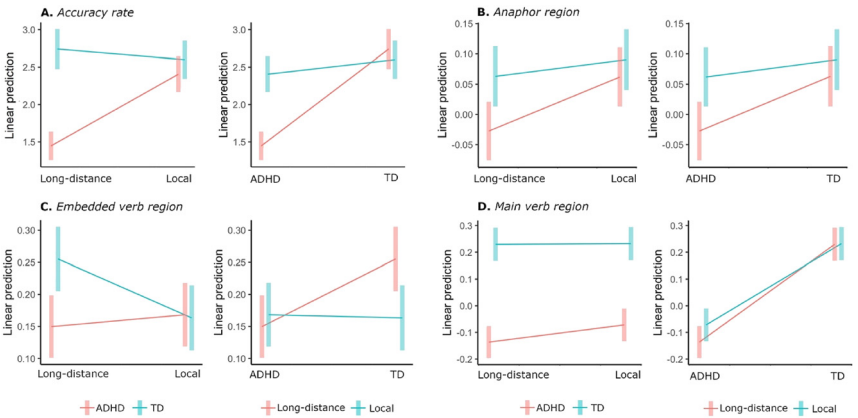

Figure 1: Interaction plot of estimated marginal means based on the model presented in Table 3 of the interaction between condition and group for accuracy data and self-paced reading data. Bars represent 95 % confidence intervals generated by the emmip function in the emmeans R package.

with LD binding compared to local binding ($p < 0.001$) (see Figure 1, panel A). No significant differences were found between the groups in the local binding condition ($p = 0.31$), and between the local and LD conditions in TD children ($p = 0.45$).

5.3 Analysis of the self-paced reading data

The average total reading time was 5,007 ms (SD = 2,382, 95 % CIs, 4,912–5,103) for the TD group, whereas adolescents with ADHD had an average reading time of 4,743 ms (SD = 2035, 95 % CIs, 4,664–4,823). An independent sample *t*-test revealed a significant difference in reading time between the ADHD and TD groups [t(4,720) = 4.18, $p < 0.05$, effect size d = 0.12]. To assess whether there was a difference in reading times between the two groups, we compared the reading times in the pre-critical area (i.e., segments 1–4). In these segments, the TD group had a reading time of 2,649 ms (SD = 1,347, 95 % CI = 2,595–2,703), while the ADHD group had a reading time of 2,635 ms (SD = 1,251, 95 % CI = 2,586–2,683). There was no significant difference in reading times between the ADHD and TD groups [$t(4,843) = 0.38$, $p = 0.71$, effect size $d = 0.01$].

Table 2 presents the descriptive statistics for each selected variable in the self-paced reading data, while Table 3 displays the output from GLME regression models analyzed by critical interest areas for both the Condition and the Group. Regarding the anaphor region, the initial set of GLME regression models revealed significant fixed effects for Group, Condition, and Spillovers, with no interaction effects between

Group and Condition. For the embedded verb region, the interaction between Condition and Group was marginally significant. In the main verb region, significant fixed effects of Group were identified ($p < 0.001$). The fixed effect analysis of CPRS subscale scores revealed significant differences for the specific verb regions. In the embedded and main verb regions, reading times demonstrated a significant decrease with increasing CPRS-ADHD Index scores ($p < 0.05$ and $p < 0.001$, respectively), whereas higher CP/I scores were associated with a tendency toward increased reading times ($p < 0.01$ and $p < 0.001$, respectively). Lastly, statistically significant spillover effects were observed across all critical regions, indicating that the processing of preceding regions extended into the critical regions (all for $p < 0.001$, Table 3).

Multiple comparisons showed that the TD group had a significantly longer duration of anaphor reading than the ADHD group in the LD antecedent binding condition ($p < 0.05$), but there was no significant difference between the groups in the local antecedent binding condition ($p = 0.30$) (see Figure 1, panel B. See also Figure A1 and Table A2 in the Appendix for multiple comparisons). The difference in the LD binding condition was due to significantly shorter reading time in the ADHD group compared with the local binding condition ($p < 0.05$). For the embedded verb region, compared with local antecedent binding, LD binding attracted increased reading time for the TD group ($p < 0.05$ for group comparison in the LD condition and $p < 0.05$ for condition comparison in the TD group; see Figure 1, Panel C). Regarding the main verb region, as shown in Figure 1 (Panel D), there were significant differences between the groups in the LD and local binding conditions, with the TD group having increased reading durations compared to the ADHD group ($p < 0.001$ for the ADHD group, $p < 0.001$ for the TD group). In addition, the ADHD group exhibited shorter reading times for sentences with local binding compared to those with LD binding ($p < 0.05$).

5.4 The follow-up analysis of the effects of age

Given the wide age range of the participants in this study (13–15 years), it would be appropriate to include a follow-up analysis to detail individual variability by age in the TD and ADHD groups.[3] Table 4 presents the outputs from the GLME regression models for reading time of critical regions, and accuracy, including interactions for

3 An anonymous reviewer suggested that, given the wide age ranges of the individuals, the follow-up analysis presented in this paper would help to detail individual variability by age in both groups.

Table 4: Results of generalized linear mixed effect regression models for the age factor and the interaction of the age factor with the group and condition factors.

	Accuracy			Anaphor region				Embedded verb region				Main verb region			
	β (SE)	*z*	*p*	*β* (SE)	*t*	*p*	η^2	*β* (SE)	*t*	*p*	η^2	*β* (SE)	*t*	*p*	η^2
(Intercept)	5.28 (0.75)	7.01	<0.001	0.09 (0.07)	1.25	0.216	–	0.21 (0.08)	2.60	<0.05	–	0.08 (0.08)	0.98	0.333	–
Age	0.27 (0.16)	1.72	0.085	−0.10 (0.07)	−1.57	0.122	0.03	−0.06 (0.08)	−0.63	0.528	0.01	−0.02 (0.08)	−0.25	0.802	0.01
Age × Group	−0.24 (0.31)	−0.77	0.441	−0.25 (0.14)	−1.81	0.075	0.04	−0.13 (0.16)	−0.79	0.432	0.01	−0.09 (0.16)	−0.56	0.580	0.01
Age × Cond.	−0.64 (0.20)	−3.23	**<0.01**	0.06 (0.02)	2.77	**<0.01**	0.01	0.02 (0.02)	1.01	0.313	0.01	0.01 (0.02)	0.61	0.540	0.01

Bold values indicate statistical significance. Accuracy is displayed as a percentage, basically the number of correct answers to the number of questions. Self-paced reading durations are shown as milliseconds for three regions, including anaphor, embedded verb, and main verb. SE, standard error; Cond, condition.

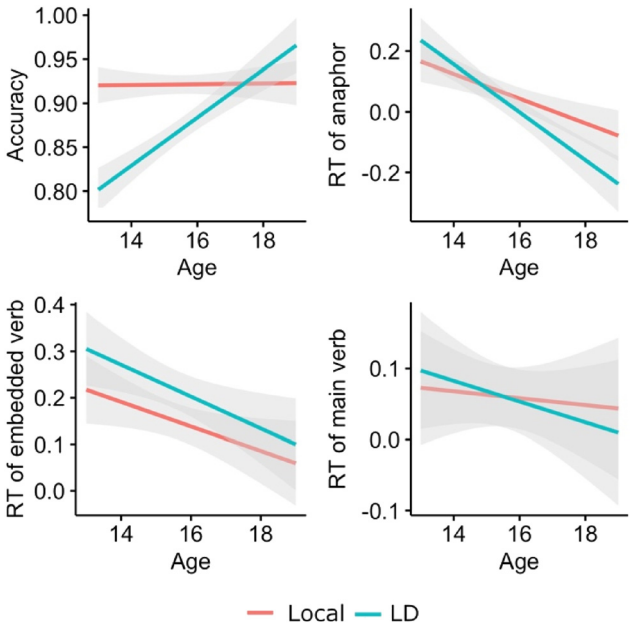

Figure 2: Correlations between age and accuracy and between age and reading times for anaphor, embedded verb and main verb. LD, long distance.

age, age by group, and age by condition. The model outputs reveal a statistically significant interaction between condition and age concerning both accuracy and reading time in the anaphor region of interest ($p < 0.01$ for both). No significant main effect of age was observed, and the interaction between age and other factors was not significant for regions of interest other than the anaphor region. As shown in Figure 2, an increase in age is associated with improved accuracy and a decrease in reading time in the anaphor region in the LD anaphora condition as age increases in the whole sample.

6 Discussion

In line with the first research question, in contrast to local distance, children with ADHD had lower accuracy rates compared with their TD peers at the end-of-trial questions in LD conditions. As expected, the analysis of end-of-trial questions revealed that in LD binding, children with ADHD made more errors than TD children.

Regarding the second research question, children diagnosed with ADHD showed significantly faster reading times than their TD peers in the LD binding condition, especially in the anaphor and embedded verb regions. The interpretation of reading time in relation to sentence comprehension accuracy is a topic of debate. While a shorter reading time can generally indicate a reasonable level of effort in comprehending difficult parts of sentences, it may also suggest shallow processing. Some researchers believe that shorter reading times indicate shallow online processing (Levine et al. 2000). Levine et al. (2000) proposed that if readers encounter challenging binding between an anaphor and its antecedent, and the context does not provide clarity, they may abandon attempts to understand the anaphor. That is, readers only shallowly process the anaphor, leading to an unclear link between the anaphor and the antecedent (Levine et al. 2000). The shorter reading times of children with ADHD compared with their TD peers in the LD binding condition suggest that only LD binding is shallowly processed in children with ADHD. Additionally, in the previous regions (i.e., the baseline area), the absence of a difference between the two groups indicates that the ADHD group also engages in shallow processing, especially after the critical words.

Our study results indicated significant differences in the CPRS subscale scores for the reading times in the embedded and main verb regions across all groups. Specifically, as ADHD scores increased, reading times decreased, whereas higher CP/I scores were associated with longer reading times. This finding may indicate that while overall ADHD symptoms do not have a substantial impact on reading abilities, more specifically, inattention-related symptoms negatively affect reading performance in children. These findings are consistent with a previous study, which found that ADHD-inattention presentation was associated with reduced processing speed, which led to a notable increase in reading times, suggesting that attention deficits were uniquely associated with literacy skills among children (de la Peña et al. 2020; Sims and Lonigan 2013). A recent study reported findings that align with our results: indicating that children who had both inattentive and hyperactive symptoms of ADHD exhibited superior performance on reading tasks compared to other groups (Parks et al. 2024). However, the significant reduction in accuracy observed in the ADHD group compared to the TD group in our study suggests that their increased reading speed may not necessarily indicate successful performance but rather reflect shallow processing, as discussed below.

According to our study, the ADHD group shows poorer performance in LD-binding processing compared to the TD group, whereas no difference is observed in local binding. This discrepancy can be explained by the increased mental effort in

LD binding and the greater involvement of WM. Concurrently, a study investigated the effects of distance on anaphor resolution in children, revealing that individual differences in WM capacity significantly influenced how children processed LD-anaphors. Children with higher WM spans showed faster bonding and resolution, indicating that WM capacity is vital for managing the cognitive demands of LD anaphora binding (Joseph et al. 2015). Further research explored the maintenance of fillers in LD-dependencies, highlighting that holding an unresolved dependency in WM incurs costs, as evidenced by increased reading times due to interference. This finding underscores the impact of WM on processing syntactic structures involving LD anaphora (Ness and Meltzer-Asscher 2017).

Social cognition deficits have been widely investigated in children and adolescents with ADHD. Research has indicated that children with ADHD experience greater difficulty in processing social cues and recalling socially relevant information (Moore et al. 1992; Temeltürk et al. 2024). They exhibit notable challenges in the capacity to adopt another's perspective and effectively assess others' intentions (Dodge 2014). Comparably, Barkley (1994, 1997a, 1997b) stated that the ADHD group has social problems and language impairment. Researchers have argued that social dysfunction might be related to social cognition deficits (Haza et al. 2024; Uekermann et al. 2010), which may result from executive function deficits, including cognitive inflexibility (Bora and Pantelis 2016; Geurts et al. 2010), or might stem from social impairments due to inability to inhibit behavior (Barkley 1994, 1997a, 1997b). On the other hand, social cognition deficits might be associated with difficulties in reasoning about the mental states of others, referred to as ToM (Bora and Pantelis 2016). In other words, the ToM skill requires understanding another person's perspective and inferring mental states of self and others (Frith et al. 1991). Prototypical mental states employed for interpreting behavior include desires and beliefs (Tager-Flusberg and Sullivan 2000). It has been argued that there are two distinct subcomponents of ToM: a social-cognitive component and a social-perceptual component (Tager-Flusberg and Sullivan 2000). The social-cognitive component entails the conceptual understanding of the mind as a representational system, which is closely related to both general and specific aspects of language, especially syntactic components (de Villiers and de Villiers 2014). The current study indicated that children with ADHD had a problem in understanding intentions that might result from their inability to construct a special kind of mental representation. Accurate comprehension of references in LD binding conditions necessitates adequate social-cognitive ToM skills, a requirement not applicable in local binding conditions. Thus, the possible deficit in anaphoric processing performance may stem from the

observed lack of ToM in the ADHD group. To summarize in the current study, the failure in the LD-binding condition among the ADHD group might reflect the deficits in understanding other people's intentions, which is crucial for social communication.

The results for the main verb region were different from those for the other regions. Specifically, in the main verb region, which is the sentence-final position, reading time increased in both LD binding and local binding conditions more in the TD group than in the ADHD group. This phenomenon of sentence-final lengthening of reading time is related to increased cognitive load (Haberlandt et al. 1986). Haberlandt et al. found that processing time increases as the cumulative number of new arguments within a sentence increases. In addition, this effect is more pronounced in sentence-final positions compared to non-boundary words. The fact that this effect is not observed in children with ADHD may be related to poor attentional capacity. Higher-order skills rely on attentional capacity, which aligns with the intricate nature of cognitive load management during language processing (Schiff et al. 2015). Additionally, the shorter reading duration of the ADHD group might indicate that they skimmed that section without processing it, which is consistent with their incorrect responses to the questions in the LD condition. This is in line with a previous finding which indicated that the shorter response time of children with ADHD leads to a more error-prone performance in self-paced tasks (Koschack et al. 2003).

In our study, we noted that the distinction between the conditions in the TD group arose in the embedded verb region rather than in the anaphor region. We believe that this result is related to the blocking effect. The blocking effect, which has been claimed to guide the interpretation of LD reflexives in Chinese, does not lead to ungrammaticality in Turkish, as seen in (10b), but complicates processing. Let us now consider (10b). It is commonly asserted in theoretical literature (e.g., Huang and Lui 2001) that an anaphor is blocked from reaching the non-local subject ('the man' in 10b) when the local subject is the second person pronoun *sen* 'you,' According to Kuno (1972), analysis of Direct Discourse Complementation, the embedded clause in which the LD anaphor occurs is derived from a direct speech event (cf. 6). The underlying form of sentence (10b) is represented by (ii), where the anaphor is replaced by the first person, in the direct quotation. In direct speech, the second person pronoun *sen* 'you' refers to an addressee from the perspective of the speaker of the whole sentence, rather than from the perspective of the matrix subject *adam* 'man'. However, in direct speech, the first-person pronoun me is associated with the matrix subject *adam* 'man' (me = *adam*). Consequently, two distinct viewpoints create a conflict. This shows two different viewpoints, causing a perspectival conflict

and leading to processing difficulties. These findings align with He and Kaiser's (2016) study, indicating that person-featural cues play a critical role in regulating the online processing of reflexives in Chinese. Notably, this difference seen in the TD group was not observed in the ADHD group during real-time processing.

(10) a. Sen$_i$ adamın kendisini$_i$ anlattığını biliyorsun.
you.NOM man.GEN self.3SG.ACC tell.N.3SG.ACC know.PRES.2SG
(i) You know: the man was talking about himself (=the man)
'You thought that the man was talking about himself'

b. Adam$_i$ senin kendisini$_i$ anlattığını biliyor.
man.NOM you.GEN self.3SG.ACC tell.N.2SG.ACC know.PRES.3SG
(ii) The man knows: You (=addressee) were talking about me (=the man)
'The man thought that you were talking about him'

The follow-up analysis revealed that age has an independent influence on LD-anaphora, regardless of the group. This finding can be interpreted as evidence that WM or ToM abilities undergo developmental progression, which contributes to enhanced cognitive and social functioning with increasing age among children. It has been reported that the most rapid growth of WM occurred during childhood, with a brief accelerated period during adolescence (Ahmed et al. 2022). Similarly, prior research highlights that ToM abilities, encompassing both cognitive and affective components, undergo significant development during adolescence, contributing to enhanced social cognition and interpersonal understanding (Meinhardt-Injac et al. 2020). Research has shown that, depending on age, some core symptoms of ADHD may remit, or individuals may develop adaptive strategies to manage and cope with these symptoms, resulting in less disruption to WM compared to childhood (Barkley 1997a, 1997b; Faraone et al. 2000). Considering all these results, the age-related performance increase observed in children appears to be in line with the findings of the studies mentioned above, and it is suggested that the relationship between this improvement and the development of WM or ToM should be further investigated.

7 Limitations and conclusion

Although our study sheds light on the potential connection between social-cognitive ToM abilities and WM skills and the processing of anaphoric systems in adolescents with ADHD and those with TD, it is essential to acknowledge several limitations. First, our study primarily focused on the Turkish anaphor *kendisi*

'self.3SG', resulting in a limited linguistic context. Generalizing these findings to other languages and anaphoric expressions (such as *kendi* 'self.3SG', *o* 'him' in Turkish) should be done cautiously, as different linguistic structures may yield different results. Second, our study primarily used self-paced reading tasks that involved real-time processing and end-of-trial questions to assess anaphoric interpretation in the ADHD group by comparing them to their TD peers. Future studies could benefit from incorporating a wider array of assessment tools, such as eye-tracking or more extensive measures of WM and ToM, to provide a more comprehensive understanding of the underlying cognitive processes. Furthermore, the absence of assessment of intellectual levels constitutes a limitation. Additionally, we did not compare different clinical presentations of ADHD, including inattentive, hyperactivity-impulsive, and combined. The absence of filler sentences in the design was another limitation of the study. Lastly, the cross-sectional design of our study and the limited scope of assessment procedures restrict our ability to draw definitive conclusions about the causal relationships between anaphoric interpretation, ToM skills, and WM in ADHD. The nature of these relationships is intricate and multifaceted, and a more comprehensive understanding necessitates further research.

Overall, the study demonstrates that children diagnosed with ADHD perform poorly on end-of-trial questions and in shallow processing during reading tasks in the LD-binding condition. However, their performance under local binding conditions is comparable to that of their TD peers. These findings may be attributed to the WM deficits frequently observed in ADHD. On the other hand, our results support the interpretation of anaphora through perspective-taking whereby readers, upon encountering the LD-anaphora itself, assume the speaker's interpretation by considering the speaker's viewpoint. The deficiency in the LD-binding condition may also be attributed to insufficient social-cognitive ToM skills. Additionally, the distinction between conditions in the TD group arose in the embedded verb region rather than in the anaphor region and is related to the blocking effect. Unlike other languages, the blocking effect in Turkish does not cause ungrammaticality, but affects sentence processing. The fact that this situation does not occur in the ADHD group could be a result of shallow processing. As a result, the LD anaphor processing difficulties observed in children with ADHD can be interpreted as a deficit in WM or ToM. However, further research is needed to examine the correlations with measurements assessing WM and ToM for a deeper investigation.

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Data availability statement: Data used in statistical analyses are available. Research materials and data that can be made publicly available are accessible at https://osf.io/6dq2e/?view_only=9a0b83879d34432b81d366bc9c7ea03e.
Ethics approval: This study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was granted by the Human Research Ethics Committee of Ankara University Faculty of Medicine (Ethics approval number: 2023/186 date: 17.04.2023).

Appendix

After examining each interaction and main effect, a series of comparisons of accuracy scores (see Table A1) and normalized RTs (see Table A2) were performed, as detailed below. Multiple comparisons were adjusted for post hoc testing using Tukey's multiple contrasts (package "emmeans" in R; Lenth 2023). The corresponding *z*-scores and adjusted *p*-values [one-step method; *p* (>|?|)] are also provided. Figure S1 shows significant statistical comparisons (red arrows not overlapping) and non-significant comparisons (red arrows overlapping) between groups and conditions. Table A3 shows the word length, syllable length, and bigram values for each word in the embedded verb (EV) region and main verb (MV) region.

Table A1: Comparisons of the estimated marginal means among groups and conditions for accuracy data.

Contrasts	*β* (SE)	*Z*	*p*
Long-distance			
ADHD vs. TD	−1.29 (0.18)	*7.19	**<0.001**
Local			
ADHD vs. TD	−0.19 (0.19)	−1.02	0.31
ADHD			
Long-distance vs. Local	−0.96 (0.15)	−6.19	**<0.001**
TD			
Long-distance vs. Local	0.14 (0.19)	0.76	0.45

The estimates (±standard error, SE), *z*-ratios, and *p*-values are given. The Tukey method for comparing a family of three estimates was used for *p*-value adjustments. ADHD, attention deficit hyperactivity disorder; TD, typically developing. Values in bold represent p-values significant.

Table A2: Comparisons of the estimated marginal means among groups and conditions for self-paced reading data.

Contrasts	Anaphor region			Embedded verb region			Main verb region		
	β (SE)	*Z*	*p*	*β* (SE)	*Z*	*p*	*β* (SE)	*Z*	*p*
Long-distance									
ADHD vs. TD	−0.09 (0.04)	−2.29	**<0.05**	−0.11 (0.04)	−2.70	**<0.01**	−0.37 (0.05)	−7.57	**<0.001**
Local									
ADHD vs. TD	−0.03 (0.04)	−0.72	0.47	−0.00 (0.04)	−0.12	0.90	−0.30 (0.05)	−6.24	**<0.001**
ADHD									
Long-distance vs. Local	−0.09 (0.04)	−2.48	**<0.05**	−0.02 (0.03)	−0.57	0.57	−0.07 (0.04)	−1.60	0.11
TD									
Long-distance vs. Local	−0.03 (0.04)	−0.75	0.46	0.09 (0.03)	2.73	**<0.01**	−0.00 (0.04)	−0.07	0.95

The estimates (±standard error, SE), *z*-ratios, and *p*-values are given. The Tukey method for comparing a family of three estimates was used for *p*-value adjustments. ADHD, attention deficit hyperactivity disorder; TD, typically developing. Values in bold represent p-values significant.

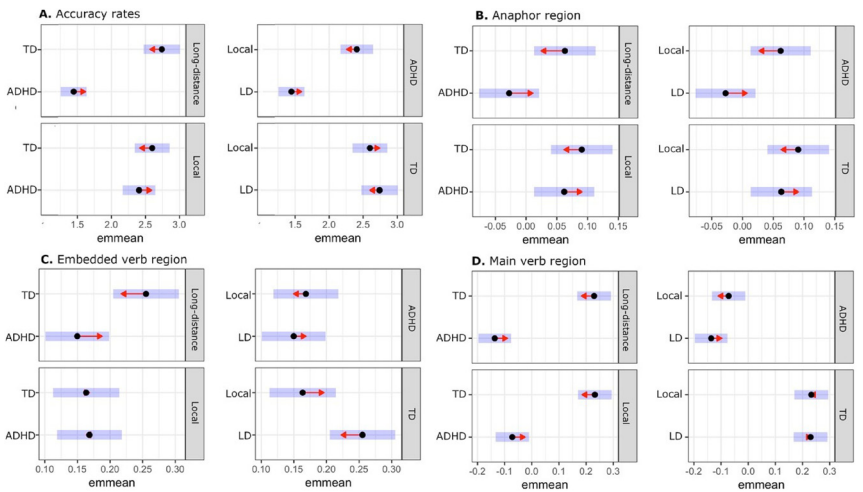

Figure A1: Pairwise comparisons of the group and condition for self-paced reading data. Estimated marginal means are displayed as black dots, with 95 % confidence intervals represented by purple bars. Red arrows allow statistical comparisons between groups or conditions, whereas non-overlapping arrows show that the comparison is significantly different at *p*.05.

Table A3: Stimulus list and properties for embedded verb and main verb regions.

Item	Cond	EV Region	MV Region	EV Region				MV Region			
				Let.	Syl.	Bigram (sum)	Bigram (mean)	Let.	Syl.	Bigram (sum)	Bigram (mean)
1	LD	anlattığını	zannediyordu	11	5	1396	139.60	13	5	1187	107.91
2	Local	anlattığını	zannediyordum	11	5	1396	139.60	14	5	1188	99.00
3	LD	gösterdiğini	düşünüyordu	12	6	1199	109.00	12	5	431	43.10
4	Local	gösterdiğini	düşünüyorduk	12	6	1199	109.00	13	5	443	40.27
5	LD	övdüğünü	biliyordu	8	4	71	10.14	10	4	1337	167.13
6	Local	övdüğünü	biliyorduk	8	4	71	10.14	11	4	1382	153.56
7	LD	savunduğunu	anlatıyordu	11	6	1317	131.70	12	5	1346	134.60
8	Local	savunduğunu	anlatıyorduk	11	6	1317	131.70	13	5	1358	123.45
9	LD	suçladığını	hatırladı	11	5	699	69.90	10	4	2148	268.50
10	Local	suçladığını	hatırladık	11	5	699	69.90	11	4	2362	262.44
11	LD	methettiğini	bilmiyordu	12	5	1349	122.64	11	4	1224	136.00
12	Local	methettiğini	bilmiyordum	12	5	1349	122.64	12	4	1227	122.70
13	LD	övdüğünü	sanıyordu	8	4	71	10.14	10	4	1552	194.00
14	Local	övdüğünü	sanıyordun	8	4	71	10.14	11	4	1558	173.11
15	LD	anlattığını	düşünüyordu	11	5	1396	139.60	12	5	431	43.10
16	Local	anlattığını	düşünüyordun	11	5	1396	139.60	13	5	431	39.18
17	LD	yaraladığını	anlatıyordu	12	6	3336	303.27	12	5	1346	134.60
18	Local	yaraladığını	anlatıyordun	12	6	3336	303.27	13	5	1346	122.36
19	LD	övdüğünü	anlatıyordu	8	4	71	10.14	12	5	1346	134.60
20	Local	övdüğünü	anlatıyordum	8	4	71	10.14	13	5	1346	122.36
21	LD	eleştirdiğini	söylüyordu	13	6	579	48.25	11	4	346	38.44
22	Local	eleştirdiğini	söylüyorduk	13	6	579	48.25	12	4	382	38.20
23	LD	yorduğunu	düşünüyordu	9	4	650	81.25	12	5	431	43.10
24	Local	yorduğunu	düşünüyorduk	9	4	650	81.25	13	5	443	40.27
25	LD	sevdiğini	anlatıyordu	9	4	1084	135.50	12	5	1346	134.60

Table A3: (continued)

Item	Cond	EV Region	MV Region	EV Region				MV Region			
				Let.	Syl.	Bigram (sum)	Bigram (mean)	Let.	Syl.	Bigram (sum)	Bigram (mean)
26	Local	sevdiğini	anlatıyordum	9	4	1084	135.50	13	5	1346	122.36
27	LD	ödüllendirdiğini	anlatıyordu	16	7	606	40.40	12	5	1346	134.60
28	Local	ödüllendirdiğini	anlatıyordum	16	7	606	40.40	13	5	1346	122.36
29	LD	zorladığını	düşünüyordu	11	5	1049	104.90	12	5	431	43.10
30	Local	zorladığını	düşünüyordum	11	5	1049	104.90	13	5	431	39.18
31	LD	güldürdüğünü	söylüyordu	12	5	563	51.18	11	4	346	38.44
32	Local	güldürdüğünü	söylüyorduk	12	5	563	51.18	12	4	382	38.20
33	LD	incittiğini	söylüyordu	11	5	741	74.10	11	4	346	38.44
34	Local	incittiğini	söylüyorduk	11	5	741	74.10	12	4	382	38.20
35	LD	beğendiğini	söylüyordu	11	5	1072	107.20	11	4	346	38.44
36	Local	beğendiğini	söylüyorduk	11	5	1072	107.20	12	4	382	38.20
37	LD	salladığını	biliyordu	11	5	2137	213.70	10	4	1337	167.13
38	Local	salladığını	biliyorduk	11	5	2137	213.70	11	4	1382	153.56
39	LD	üzdüğünü	anlatıyordu	8	4	93	13.29	12	5	1346	134.60
40	Local	üzdüğünü	anlatıyordum	8	4	93	13.29	13	5	1346	122.36
41	LD	yaraladığını	söylüyordu	12	6	3336	303.27	11	4	346	38.44
42	Local	yaraladığını	söylüyorduk	12	6	3336	303.27	12	4	382	38.20
43	LD	yağladığını	anlatıyordu	11	5	1377	137.70	12	5	1346	134.60
44	Local	yağladığını	anlatıyorduk	11	5	1377	137.70	13	5	1358	123.45
45	LD	yıprattığını	anlatıyordu	12	5	724	65.82	12	5	1346	134.60
46	Local	yıprattığını	anlatıyordum	12	5	724	65.82	13	5	1346	122.36
47	LD	yıkadığını	gizliyordu	10	5	660	73.33	11	4	899	99.89
48	Local	yıkadığını	gizliyorduk	10	5	660	73.33	12	4	935	93.50
49	LD	övdüğünü	hatırlatıyordu	8	4	71	10.14	15	5	2368	182.15
50	Local	övdüğünü	hatırlatıyorduk	8	4	71	10.14	16	5	2371	169.36

Table A3: (continued)

Item	Cond	EV Region	MV Region	EV Region				MV Region			
				Let.	Syl.	Bigram (sum)	Bigram (mean)	Let.	Syl.	Bigram (sum)	Bigram (mean)
51	LD	değerlendirdiğini	yazıyordu	17	7	1994	124.63	10	4	1017	127.13
52	Local	değerlendirdiğini	yazıyorduk	17	7	1994	124.63	11	4	1062	118.00
53	LD	çizdiğini	söylüyordu	9	4	560	70.00	11	4	346	38.44
54	Local	çizdiğini	söylüyorduk	9	4	560	70.00	12	4	382	38.20
55	LD	anlattığını	anımsatıyordu	11	5	1396	139.60	14	6	783	65.25
56	Local	anlattığını	anımsatıyordum	11	5	1396	139.60	15	6	783	60.23
57	LD	gösterdiğini	söylüyordu	12	5	1199	109.00	11	4	346	38.44
58	Local	gösterdiğini	söylüyorduk	12	5	1199	109.00	12	4	382	38.20
59	LD	affettiğini	hatırlatıyordu	11	5	662	66.20	15	5	2368	182.15
60	Local	affettiğini	hatırlatıyordum	11	5	662	66.20	16	5	2368	169.14

Bigram (sequence of two adjacent elements from a string of tokens) values were calculated in R using the *ngram_frequency()* function in the strngrams package. Cond., condition; EV, emebedded verb; LD, long-distance anaphora; Let., letter; Local, local anaphora; MV, main verb; Syl., syllable.

References

Ahmed, Shahid F., Anna Ellis, Katherine P. Ward, Naseer Chaku & Patricia E. Davis-Kean. 2022. Working memory development from early childhood to adolescence using two nationally representative samples. *Developmental Psychology* 58(10). 1962–1973.

Alderson, R. Matt, Mark D. Rapport & Michael J. Kofler. 2007. Attention-deficit/hyperactivity disorder and behavioral inhibition: A meta-analytic review of the stop-signal paradigm. *Journal of Abnormal Child Psychology* 35. 745–758.

Aydın, Özgür. 1998. İkinci dil olarak Türkçe ediniminde dönüşlü adıllara ilişkin yorumlar [Interpretations of reflexive pronouns in the acquisition of Turkish as a second language]. In Mustafa Aksan & Yeşim Aksan (eds.), *XII. Dilbilim Kurultayı Bildirileri*, 175–186. Mersin: Mersin University.

Baayen, Rolf H., Douglas J. Davidson & Douglas M. Bates. 2008. Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language* 59(4). 390–412.

Baker, Mark C. & Shiori Ikawa. 2024. Control theory and the relationship between logophoric pronouns and logophoric uses of anaphors. *Natural Language & Linguistic Theory* 42(3). 897–954.

Barkley, Russell. 1994. Impaired delayed responding: A unified theory of attention deficit hyperactivity disorder. In Donald K. Routh (ed.), *Disruptive behavior disorders*, 11–57. New York: Plenum.

Barkley, Russell A. 1997a. Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin* 121(1). 65–94.

Barkley, Russell A. 1997b. Age dependent decline in ADHD: True recovery or statistical illusion. *The ADHD Report* 5(1). 1–5.

Bates, Douglas. 2016. lme4: Linear mixed-effects models using Eigen and S4. *R Package Version* 1. 1.

Battistella, Edwin. 1989. Chinese reflexivization: A movement to INFL approach. *Linguistics* 27. 987–1012.

Bora, Emre & Christos Pantelis. 2016. Meta-analysis of social cognition in attention-deficit/hyperactivity disorder (ADHD): Comparison with healthy controls and autistic spectrum disorder. *Psychological Medicine* 46(4). 699–716.

Caillies, Stéphanie, Vincine Bertot, Jacques Motte, Christine Raynaud & Michel Abely. 2014. Social cognition in ADHD: Irony understanding and recursive theory of mind. *Research in Developmental Disabilities* 35(11). 3191–3198.

Caldani, Simona, Eric Acquaviva, Ana Moscoso, Hugo Peyre, Richard Delorme & Maria P. Bucci. 2022. Reading performance in children with ADHD: An eye-tracking study. *Annals of Dyslexia* 72(3). 552–565.

Cardillo, Ramona, Irene C. Mammarella, Ellen Demurie, David Giofre & Herbert Roeyers. 2021. Pragmatic language in children and adolescents with autism spectrum disorder: Do theory of mind and executive functions have a mediating role? *Autism Research* 14(5). 932–945.

Carlson, Stephanie M., Melissa A. Koenig & Madeline B. Harms. 2013. Theory of mind. *Wiley Interdisciplinary Reviews: Cognitive Science* 4(4). 391–402.

Carlsson, Emilia, Carmela Miniscalco, Christopher Gillberg & Jakob Åsberg Johnels. 2018. Assessing false-belief understanding in children with autism using a computer application: A pilot study. *Journal of Psycholinguistic Research* 47. 1085–1099.

Carruthers, Sophie, Lauren Taylor, Hafiza Sadiq & Gail Tripp. 2022. The profile of pragmatic language impairments in children with ADHD: A systematic review. *Development and Psychopathology* 34(5). 1938–1960.

Cem Değer, Ayşen. 1996. Türkçedeki dönüşlü adılların yönetici ulamlarının tanımlanması [Defining the governing categories of reflexive pronouns in Turkish]. In Lütfiye Oktar & Ayşen Cem Değer (eds.), *X. Dilbilim Kurultayı Bildirileri*, 41–47. İzmir: Ege Üniversitesi Edebiyat Fakültesi.

Charnavel, Isabelle. 2020a. *Locality and logophoricity: A theory of exempt anaphora*. Oxford: Oxford University Press.

Charnavel, Isabelle. 2020b. Logophoricity and locality: A view from French anaphors. *Linguistic Inquiry* 51(4). 671–723.

Chien, Yu-Chin, Kenneth Wexler & Hsing-Wu Chang. 1993. Children's development of long-distance binding in Chinese. *Journal of East Asian Linguistics* 2(3). 229–259.

Chomsky, Noam. 1981. *Lectures on government and binding*. Dordrecht: Foris.

Çiray, Remzi O., Gonca Özyurt, Serkan Turan, Ezgi Karagöz, Çağatay Ermiş, Yusuf Öztürk & Aynur Akay. 2022. The association between pragmatic language impairment, social cognition and emotion regulation skills in adolescents with ADHD. *Nordic Journal of Psychiatry* 76(2). 89–95.

Clements, George N. 1975. The logophoric pronoun in Ewe: Its role in discourse. *Journal of West African Languages* 2. 141–177.

Cole, Peter, Gabriella Hermon & Li-May Sung. 1990. Principles and parameters of long-distance reflexives. *Linguistic Inquiry* 21(1). 1–22.

de la Peña, Ike C., Michael C. Pan, Chau G. Thai & Tamara. Alisso. 2020. Attention-deficit/hyperactivity disorder predominantly inattentive subtype/presentation: Research progress and translational studies. *Brain Sciences* 10(5). 292.

de Villiers, Jill, Jacqueline Cahillane & Emily Altreuter. 2006. What can production reveal about principle B. *The Proceedings of the Inaugural Conference on Generative Approaches to Language Acquisition–North America* 1. 89–100.

de Villiers, Jill & Peter A. de Villiers. 2014. Linguistic determination and the understanding of false beliefs. In Peter Mitchell & Kevin Riggs (eds.), *Children's reasoning and the mind*, 205–242. London: Psychology Press/Taylor & Francis.

Deans, Pamela, Liz O'Laughlin, Brad Brubaker, Nathan Gay & Damon Krug. 2010. Use of eye movement tracking in the differential diagnosis of attention deficit hyperactivity disorder (ADHD) and reading disability. *Psychology* 1(4). 238–246.

Dodge, Kenneth A. 2014. A social information processing model of social competence in children. In Marion Permutter (ed.), *Cognitive perspectives on children's social and behavioral development*, 85–134. New York: Psychology Press.

Drummond, Alex, Titus Von Der Malsburg, Michael Y. Erlewine, Fumo Yoshida & Mahsa Vafaie. 2016. Psycholinguistic experiments online. *Ibex Farm*. Https://Github.Com/Addrummond/Ibex (accessed 29 April 2021).

Enç, Mürvet. 1989. Pronouns, licensing, and binding. *Natural Language & Linguistic Theory* 7(1). 51–92.

Faraone, Stephen V., Joseph Biederman, Thomas Spencer, Tim Wilens, Larry J. Seidman, Eric Mick & Alysa E. Doyle. 2000. Attention-deficit/hyperactivity disorder in adults: An overview. *Biological Psychiatry* 48(1). 9–20.

Frith, Uta, John Morton & Alan M. Leslie. 1991. The cognitive basis of a biological disorder: Autism. *Trends in Neurosciences* 14(10). 433–438.

Geurts, Hilde M., Mark Broeders & Mante S. Nieuwland. 2010. Thinking outside the executive functions box: Theory of mind and pragmatic abilities in attention deficit/hyperactivity disorder. *European Journal of Developmental Psychology* 7(1). 135–151.

Gračanin-Yuksek, Martina, Sol Lago, Duygu F. Şafak, Orhan Demir & Bilal Kırkıcı. 2017. The interaction of contextual and syntactic information in the processing of Turkish anaphors. *Journal of Psycholinguistic Research* 46. 1397–1425.

Gračanin-Yuksek, Martina, Sol Lago, Duygu F. Şafak, Orhan Demir & B. Kırkıcı. 2020. The interpretation of syntactically unconstrained anaphors in Turkish heritage speakers. *Second Language Research* 36(4). 475–501.

Grange, James A. 2016. flankr: An R package implementing computational models of attentional selectivity. *Behavior Research Methods* 48. 528–541.

Green, Benita C., Katherine A. Johnson & Lesley. Bretherton. 2014. Pragmatic language difficulties in children with hyperactivity and attention problems: An integrated review. *International Journal of Language & Communication Disorders* 49(1). 15–29.

Gürel, Ayşe. 2004. Selectivity in L2-induced L1 attrition: A psycholinguistic account. *Journal of Neurolinguistics* 17(1). 53–78.

Haberlandt, Karl F., Arthur C. Graesser, Nancy J. Schneider & Judith Kiely. 1986. Effects of task and new arguments on word reading times. *Journal of Memory and Language* 25(3). 314–322.

Hagège, Claude. 1974. Les pronoms logophoriques (Exemples en mundang, tuburi, éwé et langues oubanguiennes| cas du japonais et du coréen). [Logophoric pronouns (Examples in Mundang, Tuburi, Ewe and Ubangian languages| case of Japanese and Korean)]. *Bulletin de la Société de Linguistique de Paris* 69(1). 287–310.

Haza, Belen, Corentin J. Gosling, Flavia Ciminaghi, Laurence Conty & Charlotte Pinabiaux. 2024. Research review: Social cognition and everyday social skills in children and adolescents with attention-deficit/hyperactivity disorder: A meta-analysis of case–control studies. *Journal of Child Psychology and Psychiatry* 65(9). 1245–1254.

He, Xiao & Elsi Kaiser. 2016. Processing the Chinese reflexive "ziji": Effects of featural constraints on anaphor resolution. *Frontiers in Psychology* 7. 284.

Helong, Tong. 2024. The development of binding theory. In *The development of Chomskyan generative grammar*, 236–282. UK: Routledge.

Hendriks, Petra. 2014. *Asymmetries between language production and comprehension*. Dordrecht: Springer.

Hendriks, Petra & Jennifer Spenader. 2006. When production precedes comprehension: An optimization approach to the acquisition of pronouns. *Language Acquisition* 13(4). 319–348.

Huang, C.-T. James & C.-S. Luther Lui. 2001. Logophoricity, attitudes, and ziji at the interface. In Peter Cole & Gabrriella Hermon (eds.), *Long-distance reflexives (Syntax and Semantics 33)*, 141–195. Cambridge: Academic Press.

Huang, C.-T. James & C.-C. Jane Tang. 1991. The local nature of the long-distance reflexive in Chinese. In Jan Koster & Eric Reuland (eds.), *Long-distance anaphora*, 263–282. Cambridge: Cambridge University Press.

Jakubowicz, Celia & Lis Olsen. 1988. Reflexive anaphors and pronouns in Danish: Syntax and acquisition. Paper presented at the 13th Annual Boston University Conference on Language Development, Boston, MA. Katada.

Joseph, Holly S., Georgina Bremner, Simon P. Liversedge & Kate Nation. 2015. Working memory, reading ability and the effects of distance and typicality on anaphor resolution in children. *Journal of Cognitive Psychology* 27(5). 622–639.

Kaner, Sema, Şener Buyukozturk & Elvan Iseri. 2013. Conners parent rating scale-revised short: Turkish standardization study/Conners anababa dereceleme olcegi-yenilenmis kisa: Turkiye stardardizasyon calismasi. *Archives of Neuropsychiatry* 50(2). 100–110.

Kaufman, Joan, Boris Birmaher, David Axelson, Francheska Perepletchikova, David Brent & Neal Ryan. 2016. *K-SADS-PL DSM-5*. Pittsburgh: Western Psychiatric Institute and Clinic.

Kishida, Maki. 2011. *Reflexives in Japanese*. College Park: University of Maryland Ph.D. dissertation.

Kofler, Michael J., Mark D. Rapport, Jennifer Bolden, Dustin E. Sarver & Joseph S. Raiker. 2010. ADHD and working memory: The impact of central executive deficits and exceeding storage/rehearsal capacity on observed inattentive behavior. *Journal of Abnormal Child Psychology* 38. 149–161.

Kofler, Michael J., Elia F. Soto, Leah J. Singh, Sherelle L. Harmon, Emma M. Jaisle, Jessica N. Smith, Kathleen E. Feeney & Erica D. Musser. 2024. Executive function deficits in attention-deficit/hyperactivity disorder and autism spectrum disorder. *Nature Reviews Psychology* 3(10). 701–719.

Kornfilt, Jaklin. 1997. On the syntax and morphology of relative clauses in Turkish. *Dilbilim Araştırmaları Dergisi* 8. 24–51.

Kornfilt, Jaklin. 2013. *Turkish*. London: Routledge.

Koschack, Janka, Hanns-Juergen Kunert, G. Derichs, Godehard Weniger & Eva Irle. 2003. Impaired and enhanced attentional function in children with attention deficit/hyperactivity disorder. *Psychological Medicine* 33(3). 481–489.

Kuijper, Sanne J. M., Catharina A. Hartman & Petra Hendriks. 2015. Who is he? Children with ASD and ADHD take the listener into account in their production of ambiguous pronouns. *PLoS One* 10(7). e0132408.

Kuijper, Sanne J. M., Catharina A. Hartman & Petra Hendriks. 2021. Children's pronoun interpretation problems are related to theory of mind and inhibition, but not working memory. *Frontiers in Psychology* 12. 610401.

Kumar, Geetha & Robert A. Steer. 2003. Factorial validity of the Conners' parent rating scale-revised: Short form with psychiatric outpatients. *Journal of Personality Assessment* 80(3). 252–259.

Kuno, Susumu. 1972. Functional sentence perspective: A case study from Japanese and English. *Linguistic Inquiry* 3(3). 269–320.

Kuno, Susumu. 1987. *Functional syntax: Anaphora, discourse and empathy*. Chicago/London: University of Chicago Press.

Kuno, Susumu & Etsuko Kaburaki. 1977. Empathy and syntax. *Linguistic Inquiry*. 627–672.

Kuznetsova, Alexandra, Per B. Brockhoff & Rune H. B. Christensen. 2014. *lmerTest: Tests for random and fixed effects for linear mixed effect models (lmer objects of lme4 package)*. R package version 2.0-6.

Ladányi, Enikő, Bence Kas & Ágnes Lukács. 2017. The role of cognitive control in anaphor resolution in children with specific language impairment. *Applied Psycholinguistics* 38(5). 1173–1199.

Lansbergen, Marieke M., J. Leon Kenemans & Herman van Engeland. 2007. Stroop interference and attention-deficit/hyperactivity disorder: A review and meta-analysis. *Neuropsychology* 21(2). 251–262.

Lee, Heoin-Jin & Kenneth Wexler. 1987. The acquisition of reflexives and pronouns in Korean: From a cross-linguistic perspective. Paper presented at the 12th Annual Boston University Conference on Language Development, Boston.

Lee, Hyeonjin. 1990. *Logical relations in the child's grammar: Relative scope, bound variables, and long-distance binding in Korean*. Irvine: University of California Ph.D. dissertation.

Lenth, Rusell V. 2023. *emmeans: Estimated marginal means, aka least–squares means*. R package version 1.8.7. https://CRAN.R–project.org/package=emmeans.

Levine, William H., Alexandria E. Guzmán & Celia M. Klin. 2000. When anaphor resolution fails. *Journal of Memory and Language* 43(4). 594–617.

Li, Yafei. 1993. What makes long distance reflexives possible? *Journal of East Asian Linguistics* 2(2). 135–166.

Loukusa, Soile, Leena Mäkinen, Sanna Kuusikko-Gauffin, Hanna Ebeling & Irma Moilanen. 2014. Theory of mind and emotion recognition skills in children with specific language impairment, autism spectrum disorder and typical development: Group differences and connection to knowledge of grammatical morphology, word-finding abilities and verbal working memory. *International Journal of Language & Communication Disorders* 49(4). 498–507.

Manzini, Maria R. & Kenneth Wexler. 1987. Parameters, binding theory, and learnability. *Linguistic Inquiry* 18. 413–444.

Maoz, Hagai, Hila Z. Gvirts, Maya Sheffer & Yuval Bloch. 2019. Theory of mind and empathy in children with ADHD. *Journal of Attention Disorders* 23(11). 1331–1338.

Meinhardt-Injac, Bozana, Moritz M. Daum & Günter Meinhardt. 2020. Theory of mind development from adolescence to adulthood: Testing the two-component model. *British Journal of Developmental Psychology* 38(2). 289–303.

Meral, Hasan M. 2010. *Resumption, A'-chains and implications on clausal architecture*. Istanbul, Turkey: Boğaziçi University Ph.D. dissertation.

Meral, Hasan M. 2013. Binding as an A'-phenomenon? Some remarks from Turkish. *IBERIA: An International Journal of Theoretical Linguistics* 5(1). 45–68.

Molenberghs, Pascal, Halle Johnson, Julie D. Henry & Jason B. Mattingley. 2016. Understanding the minds of others: A neuroimaging meta-analysis. *Neuroscience & Biobehavioral Reviews* 65. 276–291.

Molina, Rubén, Beatriz Redondo, Jesús Vera, José A. García, Antonio Muñoz-Hoyos & Raimundo Jiménez. 2020. Children with attention-deficit/hyperactivity disorder show an altered eye movement pattern during reading. *Optometry and Vision Science* 97(4). 265–274.

Moore, Lisa A., Jan N. Hughes & Maryann. Robinson. 1992. A comparison of the social information-processing abilities of rejected and accepted hyperactive children. *Journal of Clinical Child Psychology* 21(2). 123–131.

Ness, Tal & Aya Meltzer-Asscher. 2017. Working memory in the processing of long-distance dependencies: Interference and filler maintenance. *Journal of Psycholinguistic Research* 46. 1353–1365.

Okabe, Reiko. 2008. *Child causatives: Acquisition of bi-clausal structures in Japanese*. Los Angeles: University of California Ph.D. dissertation.

Oshima, David Y. 2004. Zibun revisited: Empathy, logophoricity, and binding. *Proceedings of the 20th NWLC* 23. 175–190.

Oshima, David Y. 2006. *Perspectives in reported discourse*. Stanford: Stanford University Ph.D. dissertation.

Oshima, David Y. 2007. On empathic and logophoric binding. *Research on Language and Computation* 5. 19–35.

Özbek, Aydın & Barış Kahraman. 2016. Interpretations of Turkish reflexive pronouns kendi and kendisi. *Mersin Üniversitesi Dil ve Edebiyat Dergisi* 13. 71–94.

Özgen, Murat & Özgür Aydın. 2016. What type of defective feature do exceptionally case-marked clauses of Turkish bear? *Open Journal of Modern Linguistics* 6(04). 302.

Parks, Kaitlyn M., Janis O. Cardy & Marc F. Joanisse. 2024. Language and reading in attention-deficit/hyperactivity disorder and comorbid attention-deficit/hyperactivity disorder+ developmental language disorder. *JCPP Advances* 4(2). e12218.

Peterson, Ryan A. 2021. Finding optimal normalizing transformations via best normalize. *The R Journal* 13(1). 310–329.

Peterson, Ryan A. & Joseph E. Cavanaugh. 2019. Ordered quantile normalization: A semiparametric transformation built for the cross-validation era. *Journal of Applied Statistics* 47(13–15). 2312–2327.

Pica, Pierre. 1984. Tense and truth: Towards a modular approach to binding. In Jacqueline Guéron, Hans-Georg Obenauer & Jean-Yves Pollock (eds.), *Grammatical representation*, 259–292. Dordrecht: Foris.

Pineda-Alhucema, Wilmar, Edith Aristizabal, Johana Escudero-Cabarcas, Johan E. Acosta-Lopez & Jorge I. Vélez. 2018. Executive function and theory of mind in children with ADHD: A systematic review. *Neuropsychology Review* 28. 341–358.

Progovac, Ljiljana. 1993. Long-distance reflexives: Movement-to-Infl versus relativized SUBJECT. *Linguistic Inquiry* 24(4). 755–772.

Purvis, Karen L. & Rosemary Tannock. 1997. Language abilities in children with attention deficit hyperactivity disorder, reading disabilities, and normal controls. *Journal of Abnormal Child Psychology* 25. 133–144.

Rakhlin, Natalia, Sergev A. Kornilov, Jodi Reich & Elena L. Grigorenko. 2015. Interpretation of anaphoric dependencies in Russian-speaking children with and without developmental language disorder. *Language Acquisition* 22(4). 355–383.

Rapport, Mark D. 2001. Bridging theory and practice: Conceptual understanding of treatments for children with attention deficit hyperactivity disorder (ADHD), obsessive-compulsive disorder (OCD), autism, and depression. *Journal of Clinical Child & Adolescent Psychology* 30(1). 3–7.

Rapport, Mark D., Jennifer Bolden, Michael J. Kofler, Dustin E. Sarver, Joseph S. Raiker & R. Matt. Alderson. 2009. Hyperactivity in boys with attention-deficit/hyperactivity disorder (ADHD): A ubiquitous core symptom or manifestation of working memory deficits? *Journal of Abnormal Child Psychology* 37. 521–534.

Reinhart, Tanya & Eric Reuland. 1993. Reflexivity. *Linguistic Inquiry* 24(4). 657–720.

Rosello, Belen, Carmen Berenguer, Inmaculada Baixauli, Rosa García & Ana Miranda. 2020. Theory of mind profiles in children with autism spectrum disorder: Adaptive/social skills and pragmatic competence. *Frontiers in Psychology* 11. 567401.

Rudnev, Pavel. 2011. Why Turkish kendisi is a pronominal. *Урало-Алтайские Исследования* 01(4). 76–92.

Schiff, Rachel, Dorit Ravid & Adi Gur. 2015. Morpho-syntactic load in judging adjective plural agreement: Comparing adults with and without ADHD. *Communication Disorders Quarterly* 36(2). 79–89.

Schurz, Matthias, Joaquim Radua, Markus Aichhorn, Fabio Richlan & Josef Perner. 2014. Fractionating theory of mind: A meta-analysis of functional brain imaging studies. *Neuroscience & Biobehavioral Reviews* 42. 9–34.

Sells, Peter. 1987. Aspects of logophoricity. *Linguistic Inquiry* 18(3). 445–479.

Sezer, Engin. 1979. On reflexivization in Turkish. *Harvard Ukrainian Studies* 3. 748–759.

Sims, Darcey M. & Christopher J. Lonigan. 2013. Inattention, hyperactivity, and emergent literacy: Different facets of inattention relate uniquely to preschoolers' reading-related skills. *Journal of Clinical Child & Adolescent Psychology* 42(2). 208–219.

Tager-Flusberg, Helen & Kate Sullivan. 2000. A componential view of theory of mind: Evidence from Williams syndrome. *Cognition* 76(1). 59–90.

Temeltürk, Rahime D., Özgür Aydın, Belgin Üstün Güllü & Birim G. Kılıç. 2024. Dynamic eye-tracking evaluation of responding joint attention abilities and face scanning patterns in children with attention deficit hyperactivity disorder. *Development and Psychopathology* 36(3). 1190–1201.

Thaler, Verena, Karolina Urton, Angela Heine, Stefan Hawelka, Verena Engl & Arthur M. Jacobs. 2009. Different behavioral and eye movement patterns of dyslexic readers with and without attentional deficits during single word reading. *Neuropsychologia* 47(12). 2436–2445.

Uekermann, Jennifer, Martin Kraemer, Mona Abdel-Hamid, Bernd G. Schimmelmann, Johannes Hebebrand, Irene Daum, Jan Wiltfang & Beata Kis. 2010. Social cognition in attention-deficit hyperactivity disorder (ADHD). *Neuroscience & Biobehavioral Reviews* 34(5). 734–743.

Ünal, Fatih, Ferhunde Öktem, Füsun Çetin Çuhadaroğlu, Sadriye E. Çengel Kültür, Devr M. Akdemir, Dilşad Foto Özdemir, Halime T. Çak, Dilek Ünal, Kevser Tıraş, Cihan Aslan & Abdülbaki Artik. 2019. Reliability and validity of the schedule for affective disorders and schizophrenia for school-age children-present and lifetime version, DSM-5 November 2016-Turkish adaptation (K-SADS-PL-DSM-5-T). *Turkish Journal of Psychiatry* 30(1). 42–50.

Van Mourik, Rosa, Jaap Oosterlaan & Joseph A. Sergeant. 2005. The stroop revisited: A meta-analysis of interference control in AD/HD. *Journal of Child Psychology and Psychiatry* 46(2). 150–165.

Van Overwalle, Frank, Frederik Van de Steen & Peter Mariën. 2019. Dynamic causal modeling of the effective connectivity between the cerebrum and cerebellum in social mentalizing across five studies. *Cognitive, Affective, & Behavioral Neuroscience* 19. 211–223.

Vasishth, Shravan & Richard L. Lewis. 2006. Argument-head distance and processing complexity: Explaining both locality and antilocality effects. *Language* 82(4). 767–794.

Ward, Olivia J. 2021. *Using a self-paced reading task to examine the comprehension monitoring abilities of children with and without ADHD*. Canada: The University of Western Ontario. Masters of Degree dissertation.

Yakut, Ayşe B. 2015. The logophoric behavior of the strict local anaphor kendi 'self'in Turkish. In *Proceedings of the 9th workshop on altaic formal linguistics*. MIT Working Papers in Linguistics 76.

Yang, Dong-Whee. 1983. The extended binding theory of anaphors. *Language Research* 19(2). 169–192.

Zhang, Qian, Ruo-Han Chang & Zhen-Dong Wang. 2023. A review on the cognitive neural mechanisms of anaphor processing during language comprehension. *Psychological Reports* 128(4). 2191–2223.