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Personal Pronoun Comprehension in Addressed and Non-Addressed Situations in Autistic and Nonautistic Preschoolers

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ABSTRACT

This research paper explores the role of speaker, listener and real-time social attention for pronoun comprehension in autistic and nonautistic children in the northeast United States. We assessed the pronoun comprehension of 22 autistic children (average age of 62 months, range 46–80 months) and 22 nonautistic children (average age 44 months, range 30–57 months) matched on expressive vocabulary scores. We evaluated the first- and second-person possessive pronoun comprehension ("my" and "your") using a game in which two experimenters hid stickers and provided clues to their location by providing a verbal clue (e.g. "It's in your box") with accompanying gaze to the addressee. We also coded each child's gaze to the speaker during the pronoun comprehension task. Findings suggest that both autistic and nonautistic children comprehend first- and second-person pronouns at levels above chance. Nonautistic children performed better at comprehending second-person pronouns than autistic children. For both groups, children were more accurate in their comprehension of the second-person pronoun "your" when it referred to themselves versus when it referred to the experimenter; errors more commonly reflected "self-bias" rather than pronoun reversal errors. Children who gazed at the speaker performed better in comprehending second-person pronouns than children who did not. Our results reveal considerable overlap in the strengths and challenges of young language learners with and without autism. Our findings suggest that children may benefit from repeated experiences across varied conversational settings – including addressed and non-addressed speech – to practice the synchronization of semantics and pragmatics in their ongoing mastery of language.

Introduction

Children learn language through their everyday experiences in the world, including one-on-one interactions in which language is spoken directly to the child by caregivers, other adults, and older children. Everyday experience also conventionally offers children the opportunity to hear language that is not addressed to the child, including language spoken by a caregiver to another adult or child. The former is widely accepted to be a factor in the timing and quality of child language acquisition (e.g., Rowe, 2012). The latter has somewhat less

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consensus in the literature: the role of speech that is not directly addressed to the child in children's language development is a key point of empirical and theoretical debate (e.g., Akhtar et al., 2019; Golinkoff et al., 2019; Sperry et al., 2019).

On the one hand, for children in many cultures, non-addressed speech constitutes a much larger percentage of their language exposure than speech directly addressed to them, and these children acquire language on a similar timeline to children from cultures where they are often directly addressed (e.g., Cristia et al., 2017; Ochs & Schieffelin, 1984). A recent study testing the word knowledge of children with high levels of exposure to non-addressed speech appears to confirm children's ability to learn through non-addressed input because children showed knowledge of words for which exposure must *only* be overheard, not child-directed – specifically, greetings that are only directed to adults (Foushee & Srinivasan, 2024). Moreover, numerous laboratory-based experimental studies have shown that children can learn new words by overhearing others' conversations (e.g., Akhtar et al., 2001; Gampe et al., 2012; see; Akhtar et al., 2019 for review). On the other hand, studies that have directly evaluated whether children's exposure to speech that is not directed to them predicts children's language skills have reported that it does not, (1) even for children whose cultural experiences offer far more access to non-addressed than child-directed speech (Shneidman & Goldin-Meadow, 2012), and (2) even though exposure to child-directed speech *does* predict children's language skills (Shneidman & Goldin-Meadow, 2012; Weisleder & Fernald, 2013). Collectively, these findings suggest that speech that is not directed to the child may not play a substantial role in language development.

One possible resolution to this debate lies in a closer examination of the varied contexts of non-addressed speech, which include such disparate situations as hearing a television playing in the background versus a multiparty interaction, such as playing a game with siblings – the child is part of the game, but some utterances will not be directed to them. In the context of child-directed speech, researchers pay a great deal of attention to the "quality" of that speech. Quality can be characterized in terms of the features of the speech itself – for example, whether it uses the exaggerated intonation characteristic of "parentese" (Grieser & Kuhl, 1988; Ramírez-Esparza et al., 2014, 2017) – as well as the ways in which the language is being used within the social context, e.g., whether the parent is following the child's attention (McDuffie & Yoder, 2010; Tamis LeMonda et al., 2001; Tomasello & Farrar, 1986) or providing an opportunity for the child to engage in a to-and-fro interaction (Roseberry et al., 2014). However, far less attention has been paid to the quality of non-addressed speech. We must consider, however, that for non-addressed speech, the "quality" of that input is sure to play a role in children's ability or tendency to learn from it (Akhtar et al., 2019; Girouard-Hallam & Norris, 2024). More specifically, the degree to which non-addressed speech is accessible, interesting, relevant or provides motivation and/or affordances for engagement (among countless other factors) is likely to shape the likelihood of children's learning from that input (Foushee et al., 2021, 2023).

Another often overlooked factor in the debate about the role of non-addressed speech for child language learning is the particular elements of language being studied. Some elements of language, in fact, can *only* be fully acquired from situations in which the child is not being directly addressed. Personal pronouns, specifically first- and second-person pronouns, are a case in point. Personal pronouns are a challenging class of words for children to learn, because unlike proper nouns, they are deictic; this means that their use (and meaning) changes depending on the context. First- and second-person pronouns, more specifically, are indexical pronouns which mark the role that the referent has in the conversation: first-person pronouns refer to the speaker and second-person pronouns to the addressee. We might expect, then, that children would benefit from exposure to interactions when they have opportunities to hear different personal pronouns used in different conversational roles.

Nevertheless, the challenges associated with first- versus second- person pronouns are somewhat distinct. First-person pronouns could arguably be learned effectively through a series of experiences with child-directed speech from different speakers, which would (cumulatively) offer the child a chance to witness the shifting meaning of "I" or "me," for instance. However, second-person pronouns must be learned from both addressed and non-addressed speech. That is, in order to learn that "you" does not only refer to oneself, children must observe "you" being addressed to a person other than themselves (Macnamara, 1982). Multiparty contexts, then, provide a critical source of information for children's acquisition of second-person pronouns (e.g., Oshima-Takane et al., 1996, 1999). But these contexts also pose a challenge because the referent of second-person pronouns is ambiguous, and thus children must actively seek out information about whether they are being addressed or not (i.e., whether "you" is being delivered as child-addressed speech or non-addressed speech). Because a speaker will conventionally look at (i.e., orient her face and often gaze) the person she is addressing, speaker gaze often signals the intended referent of the second-person pronoun; therefore, children may need to simultaneously listen to and look at the speaker in order to correctly disambiguate the pronoun's contextual meaning.

In this sense, deciphering the referents of personal pronouns via non-addressed speech places uniquely convergent social and linguistic demands on the child. For other kinds of words, non-addressed and addressed speech may be more comparable sources of input because minimal social attention is required. For example, in some studies, children successfully discern word meanings by attending to syllabic and phrasal distribution patterns from a stream of ambient speech, without any indication that they are being directly spoken to (e.g., Arunachalam, 2013; Lany, 2014; Lany & Saffran, 2011). Here, there is no social context that children need to monitor. In one classic experimental paradigm used to study word learning, children are "overhearers" to an adult conversation that contains distributional information about a novel verb's syntactic affordances, and children effectively use this distributional information to draw inferences about the novel verb's meaning (e.g., Yuan & Fisher, 2009). But here too, children need not actively attend to the social interaction per se; the linguistic stimuli alone provide the necessary information to decipher meaning. Even novel object label learning tasks in which children have been shown to learn from non-addressed speech place minimal demands on the child's social attention; children could in principle visually attend to the object and associate it with the verbal label without actively attending to the social context qua social context (This is not to say that children *aren't* attending to the social context – see, for instance, Fitch et al., 2020—only that, in principle, they need not in order to correctly learn the novel word.) For personal pronouns, however, children must attend directly to the social context to determine speaker and addressee roles on a moment-to-moment basis.

Given the complexity inherent in learning personal pronouns, it is perhaps not surprising that children's mastery of personal pronouns is tied to protracted developmental advancements in broader linguistic, cognitive, and social skills (Dale & Crain-Thoreson, 1993; Fay, 1971, 1979; Smolik & Chroma, 2023). Children often begin producing pronouns early in toddlerhood, but pronoun mastery is gradual, such that children are prone to a variety of errors in pronoun use, including "reversals" in which children invert the use of first- and second-person pronouns (e.g., Evans & Demuth, 2012). These errors have been attributed to difficulties with word meaning itself as well as difficulties with processing social and linguistic information (e.g., Chiat, 1982; Dale & Crain-Thoreson, 1993; Evans & Demuth, 2012; Naigles et al., 2016). For example, children may have incorrect lexical representations for pronouns because they begin to produce pronouns before their perspective-taking skills have fully allowed them to appreciate the deictic nature of the pronominal system (e.g., Evans & Demuth, 2012). However, children's use and comprehension of pronouns refines as they age (Charney, 1980b; Evans & Demuth, 2012; Moyer et al., 2015), with children slowly broadening their early and narrow understanding to better reflect the deictic nature of pronouns over time and with experience (e.g., Charney, 1980b; Köder & Maier, 2016). Moreover, some research has reported broad associations between the use of gaze and pronoun production (Hobson et al., 2010; Kelty-Stephen et al., 2020; Naigles et al., 2016; Naigles, 2021), highlighting the intertwined nature of social behaviors and personal pronoun mastery.

Here, it is fruitful to consider how research might capitalize on naturally occurring variability across both (1) personal pronoun understanding and (2) social behaviors in order to better illustrate these complex influences on and contexts for child language learning. We propose that the unique experiences of autistic individuals may help us to understand the challenges of *all* children in mastering personal pronouns. Elsewhere, we have detailed our stance that although many autistic individuals experience a variety of challenges in language learning, there are broad commonalities in the lexical acquisition strategies used by autistic and nonautistic individuals (Arunachalam & Luyster, 2016, 2018). Nevertheless, personal pronouns have long been noted as an area of difficulty, with the unique characteristics of autism (e.g., challenges in perspective-taking) potentially playing a role (e.g., Conson et al., 2015).

In Kanner's (1943) seminal paper on autism, his description of the language skills of autistic individuals included multiple examples of differences in personal pronoun usagein particular, reversal of second-person "you" and first-person "I." Since this paper, multiple studies have explored autistic individuals' personal pronoun production; results have not always been consistent with Kanner's findings, with some studies failing to find substantial difficulties in the first and second-person pronoun production of autistic individuals (e.g., "I," "me," and "you") (Barokova & Tager-Flusberg, 2020; Finnegan et al., 2021), while others have evidenced apparent challenges in pronoun usage, even across languages and modalities (e.g., Mazzaggio & Shield, 2020; Shield et al., 2022, but see; Chanchaochai & Schwarz, 2023). One study found that although autistic children reversed first- and second-person pronouns (e.g., using "you" in place of "I") significantly more often than nonautistic children, reversals were nevertheless relatively uncommon across autistic and nonautistic groups (Naigles et al., 2016). A recent review also concluded that with respect to production of personal pronouns, there was no significant difference between autistic and nonautistic samples (Finnegan et al., 2021). Interestingly, to the extent that pronoun errors *do* occur, there are widely variable explanations. Some scholars describe characteristics of their language production (e.g., echolalia; Bartak & Rutter, 1974) as the cause of the errors, and other scholars point to difficulties in social cognition (Charney, 1980a; Mazzaggio & Shield, 2020; Overweg et al., 2018), joint attention (Kelty-Stephen et al., 2020, Naigles et al., 2016), and/or linguistic challenges (Naigles et al., 2016; Zane et al., 2021a, 2021b). Other explanations propose differences in speaker intentionality; for instance, Sterponi and Shankey (2014) suggest that some autistic speakers may intend to preserve the initial pronoun as an unambiguous "quotation," while autistic individuals themselves have invoked factors such as social or emotion processing (e.g., Grace, 2013; "Pronoun reversal and confusion," 2014).[1]

The research on personal pronoun *comprehension* is scarcer, despite first-person accounts of both intermittent and persistent challenges (Grace, 2013; "Pronoun reversal and confusion," 2014). Earlier experimental studies that explored comprehension (vs. production) of personal pronouns failed to show consistent diagnostic group differences between autistic and nonautistic (English-speaking) children (Jordan, 1989, Hobson et al. 2010; A. Lee et al., 1994); these reports are limited both by sample size and sample characteristics. More recent studies have revealed pronoun comprehension challenges in Thai-speaking autistic children (Chanchaochai & Schwarz, 2023), and some single-subject designs have explored intervention protocols for autistic children experiencing difficulties in pronoun understanding (e.g., Morgenstern et al., 2019). To our knowledge, however, there has been a dearth of studies that have simultaneously measured pronoun comprehension accuracy and social attention, which we invoked above as critical for identifying the referents of (particularly) second-person pronouns.

Social attention is an area of development that is notably heterogeneous in autism. Some children with autism, including in the early years of development, show reduced gaze to speakers (e.g., Irwin & Brancazio, 2014; Shic et al., 2020). When specifying "gaze to speakers," we intend only to refer to the extent to which the child gazes toward a speaker (even if briefly) in this case, to determine the speaker's focus or attention. We do not intend to refer to the maintenance of eye-contact between the child and an interlocutor during social interactions (which, although also a highly variable feature in autistic individuals, is not our focus here). Moreover, as above, the extent to which a child coordinates gaze to a speaker in real time to determine the referent of a word could be a predictor of learning from language input. Oshima-Takane and Benaroya (1989) explored the role of real-time visual referencing in pronoun comprehension and reported that, in their sample of four autistic children, the second-person pronoun advantage observed for non-addressed (vs. addressed) speech was accounted for by children's visual attentiveness to the speaker when the pronoun was uttered; a similar finding was reported for first and third-person pronouns by Hobson and colleagues (2010). This finding presents the hypothesis that in order for children to fully benefit from non-addressed speech for pronoun learning, they must habitually synchronize visual attention to the speaker when the second-person pronoun is spoken.

Therefore, children on the autism spectrum provide both an example of considerable within-group variability in (1) language mastery – specifically, in this case, personal pronoun mastery; and (2) language learning strategies – in this case, visual attention to a speaker. In this way, an autistic sample provides the potential for new insights into how children may be learning complex words like pronouns through complex situations like overhearing speech that is not directly addressed to them. The

[1]We find first-person accounts, which are historically excluded from scientific literature, to be a valuable source of information for generating hypotheses, particularly when exploring hetero-/homo-geneity across individual experiences.

inclusion of both autistic and nonautistic children allows us to capture a wider range of performance, providing an enriched understanding of which pronouns seem to be harder versus easier for children to interpret correctly (i.e., first- versus second-person ? Those referring to the self versus those referring to someone else?), as well as the role of visual attention to the speaker at the moment that the pronoun is uttered, an important *in vivo* factor. We also asked what types of errors children made in pronoun interpretation – whether they were primarily the well-documented reversal errors (e.g., interpreting second-person pronouns as referring to the speaker) or whether they were primarily errors stemming from a failure to look to the speaker when the pronoun is uttered (e.g., interpreting second-person pronouns as referring to the wrong addressee). If children primarily make pronoun reversal errors, they may have not yet mastered the pronominal system, but if they primarily make errors in determining speaker and addressee role, we may conclude that their linguistic representations are likely intact, but that they have not yet mastered the skill of deploying their visual attention in real-time to discover the intended pronoun referent.

Therefore, in the current study, we examined personal pronoun comprehension in young autistic and nonautistic children in both addressed and non-addressed situations. We asked the following research questions: (1) Do children in each group demonstrate understanding (i.e., perform at above-chance levels) of first-person pronouns, second-person pronouns when the child is the addressee, and second-person pronouns when the child is not being addressed? (2) Are there group differences between nonautistic and autistic children in comprehending first- or second-person pronouns, and within second-person pronouns, those that are addressed vs. not addressed to the child? (3) Focusing on second-person pronouns, are there group differences in children's use of gaze to accurately identify the referent in addressed and non-addressed situations? (4) What kinds of errors do children make in comprehension of first- and second-person pronouns?

Methods

Participants

We recruited participants in two large urban areas in the northeast United States. These participants were recruited through online advertisements, laboratory participant databases, and the Simons Foundation Powering Autism Research for Knowledge (SPARK) database (Feliciano et al., 2018). For all participants, exclusion criteria included hearing, vision, or speech impairments. For inclusion, we required that all children hear English more than 60% of the time. Children in the autism sample were recruited on the basis of having an existing medical or educational diagnosis of autism, which was confirmed during study participation. The full research battery included a variety of standardized and non-standardized measures used for diagnostic confirmation, but the measures available changed over the course of the COVID-19 pandemic in response to public health mandates (see Measures for more details). For children in our nonautistic sample, we required caregiver confirmation that the child did not have a diagnosis of autism or any other developmental disorder; moreover, none of the children in our nonautistic sample scored in the "autism" range on the SCQ (Rutter et al., 2003) using an age-appropriate cutoff of 12 (Corsello et al., 2007).

The enrolled sample included 28 autistic children and 35 nonautistic children. An additional five autistic children and three nonautistic children were consented but excluded because the family never completed a laboratory visit (even though the caregiver signed an electronic consent form), two autistic children and two nonautistic children were excluded because the family came for a visit but did not start the task, four autistic children were excluded because their diagnostic status was not confirmed during study participation, one nonautistic child was excluded because of equipment failure (without a video recording, we could not verify pointing behavior offline) and one autistic child was excluded because they did not make a selection on any of the trials.

As is common in studies of autistic children's language (e.g., Ellis Weismer et al., 2011, Naigles et al., 2016), we recruited a language-matched comparison group. Therefore, we intentionally recruited a larger sample of younger nonautistic children as compared to autistic children in order to arrive at two groups with comparable language abilities. We expected to exclude additional children after matching the groups on language score – in this case, vocabulary score on the MacArthur-Bates Communicative Development Inventory III (MCDI III; Fenson et al., 2006), a caregiver-report checklist used to assess the expressive vocabulary of young children. The mean MCDI III score in the enrolled autism sample was 66.52 (SD = 26.27) and the mean in the enrolled nonautistic sample was 84.45 (SD = 15.37); MCDI data was not available for one autistic child and two nonautistic children. Therefore, in order to ensure that our groups were similar in overall expressive language level, we used a bootstrap process with the bootmatch package (Mahr, 2023) in R, requiring that each child in the autistic group be matched to a child in the nonautistic group within ± 10 spoken words on the MCDI III. Using this requirement, not all children in the autistic sample were able to be matched to a child in the nonautistic sample.

Therefore, our final sample included a sample of 22 autistic children matched to 22 nonautistic children; the mean MCDI III scores were 79 and 80.82 for the autistic and nonautistic groups, respectively (Cohen's $d = 0.07$). The average age of the autistic participants was 62 months and ranged from 46 to 80 months. The average age of the nonautistic participants was 44 months and ranged from 30 to 57 months. The majority of participants were male in the autistic ($n = 19$) and the nonautistic ($n = 17$) groups. Based on the parent-report, most of the participants were solely exposed to English (see link in the Data availability statement for a table of language(s) each parent reported their child was exposed to). See Table 1. Of these 44 total children, data were collected before the pandemic using traditional laboratory-based methods from 16 autistic children and 11 nonautistic; data were collected after the start of the pandemic using a combined remote and laboratory-based method from six children in the autistic group and 11 in the nonautistic group.

Measures

All participants' caregivers completed the MCDI III. It consists of 100 items, and it asks caregivers to indicate the words that their child produces. It was designed to assess the vocabulary production of children ages 30–37 months but also "may be used with older,

Table 1. Sample characteristics.

	Autistic ($n = 22$)	Nonautistic ($n = 22$)
Sex ***n*****(%)**		
Male	19 (86%)	17 (77%)
Female	3 (14%)	5 (23%)
Race ***n*****(%)**		
White	12 (55%)	15 (68%)
Black	6 (27%)	0 (0%)
Multiple races (Asian and White)	3 (14%)	1 (5%)
Asian	0 (0%)	2 (9%)
Missing	1 (5%)	2 (9%)
Ethnicity ***n*****(%)**		
Hispanic or Latine	4 (18%)	1 (5%)
Percentage of time participants heard English language ***n*****(%)**		
100%	14 (64%)	12 (55%)
90–99%	5 (23%)	5 (23%)
80–89%	2 (9%)	3 (14%)
70–79%	1 (5%)	2 (9%)
Age (in months)		
Mean age (SD)	62.18 (10.57)	43.94 (7.37)
Age range	46.29–79.43	30.52–56.83
MCDI III		
MCDI III mean (SD)	79 (23.38)	80.82 (25.46)
MCDI III range	7–100	0–100

developmentally delayed children" (CDI Advisory Board, n.d.).[2] We chose this checklist because of the MCDI checklists, it is most appropriate for our nonautistic age range.

Measures used to confirm autism diagnosis before the start of the COVID-19 pandemic included the Social Communication Questionnaire (SCQ, Rutter et al., 2003) and the Autism Diagnostic Observation Schedule – 2nd edition (Lord et al., 2012). The SCQ is a common screening tool for autism. SCQ validity studies indicate an optimum cutoff score of 15 for children 4 years and older (Berument et al., 1999; Rutter et al., 2003); however, subsequent research has identified a lower cutoff score of ≥ 11 to yield best sensitivity and specificity for children younger than age 4 years (Allen et al., 2007; Corsello et al., 2007; Wiggins et al., 2007). Thus, because of the younger age of many of the children in the present sample, the current study utilized a cutoff score of 12. The ADOS-2 (Lord et al., 2012) is considered the "gold standard" observational assessment tool for autism; it yields diagnostic classifications of autism/autism spectrum or nonspectrum.

The ADOS-2 cannot be administered remotely nor while using personal protective equipment, and so the measures used to confirm diagnosis changed somewhat with the onset of the COVID-19 pandemic. We continued to use the Social Communication Questionnaire (SCQ, Rutter et al., 2003), but in lieu of the ADOS-2, we implemented a video recorded interaction based on an adaptation of the Childhood Autism Rating Scale–2nd edition (CARS-2; Schopler et al., 2010). Previous research published near the onset of the COVID-19 global pandemic demonstrated that the CARS-2 can be effectively adapted to a brief observation entitled "CARS-2$^{\text{obs}}$," with the examiner providing

[2]We also asked parents if their child was receiving therapy with a specific goal of working on pronouns; 11 parents of autistic children reported that they were, 7 reported that they were not, and 4 did not respond to this question. Preliminary analyses revealed no significant differences between those who were and were not (task accuracy: with pronoun intervention 84%, without pronoun intervention; 67%; gazing at the speaker during the clue: with pronoun intervention 71%, without pronoun intervention 74%), and therefore given the small sample sizes, we did not investigate this issue further.

prompts to the caregiver while observing their interaction to identify behaviors indicative of autism (Sanchez & Constantino, 2020). We also asked caregivers to complete the Vineland Adaptive Behavior Scales – 3rd edition (Vineland-3; Sparrow et al., 2016); this was added as an additional tool to support diagnostic confirmation and yielded information about adaptive functioning skills which was useful to the clinical review (that is, because autism is commonly associated with impairments in adaptive functioning). Finally, the results from these instruments were all reviewed by a licensed clinical psychologist using a Diagnostic and Statistical Manual – 5th Edition (DSM-5; American Psychiatric Association, 2013) checklist in order to confirm each child's autism diagnosis.

Procedure

All study activities were IRB approved, and caregivers provided informed consent on behalf of themselves and their child before completing any study activities. For participants seen in the laboratory before the start of the COVID-19 pandemic (16 autistic children and 11 nonautistic), all study activities were completed in the laboratory setting: children completed a pronoun comprehension task (described below) first, followed by the ADOS-2, and caregivers completed paper forms for the MCDI III (Fenson et al., 2006) and SCQ. Some children also participated in an unrelated task (He et al., 2022).

For children seen after the start of the pandemic (six children in the autistic group and 11 in the nonautistic group), study activities were completed through a combination of remote and laboratory activities. Remote activities included an adaptation of the Childhood Autism Rating Scale–2nd edition (CARS-2; Schopler et al., 2010. In addition, parents completed electronic forms for the MCDI III, as well as the Vineland Adaptive Behavior Scales, Third Edition (Vineland-3; Sparrow et al., 2016), which we added as an additional tool to support diagnostic confirmation by our clinical psychologist in the absence of the gold-standard ADOS-2. In the laboratory, children completed the pronoun task; experimenters wore clear face-shields as protective equipment so that their faces would not be obscured during the task.

The pronoun comprehension task was adapted from Moyer et al. (2015) (which in turn was inspired by Charney, 1980b). The task involved three people (two experimenters and the child) seated around a table or on the floor. Each person was assigned a colored box and given a corresponding colored badge to wear or hold to help the child to remember which box belonged to each person. See Figure 1. The boxes were arranged on a tray so that each person seated at the table had a box in front of them. Prior to the start of the task, each child was given the opportunity to select the type of stickers that they preferred (e.g., stars, cars, animals). We believed that offering the children a choice of sticker type would help to motivate them to engage in the task. Next, the child was told that a sticker would be hidden in one of the boxes and that they would be given a "clue" to help them find the sticker. On each trial, the experimenters used a large posterboard to obscure the child's view from where the sticker was placed. While the verbal clue was given, the tray was slid toward the experimenters and away from the child to prevent the child from "peeking" at where the sticker was hidden; after the clue, the tray was slid closer to the child.

The first trial functioned as a warm-up, in which the clue included the child's name: "It's in (child's name)'s box." There were no further trials that employed proper names. The

Figure 1. Screenshot from one trial depicting the two experimenters at left and right and the child selecting a box at center.

remainder of the trials included either the first-person pronoun “my” or the second-person pronoun “your;” there were a total of four “my” trials and four “your” trials. Importantly, the four trials which included the second-person pronoun “your” comprised two instances of “your” referring to the child (“your”-child) and two instances of “your” referring to the second experimenter (“your”-second experimenter).

The eight trials were administered in a set order.[3] First, each experimenter had a trial using the first-person pronoun “my.” On first-person trials, the speaker looked back-and-forth between the child and the other experimenter. For instance, the experimenter stated, “It’s in my box,” while shifting gaze between the child and the second experimenter. Then, the lead experimenter offered four trials using second-person pronoun “your,” alternating across “your”-child and “your”-second experimenter. On second-person trials, the lead experimenter looked at the addressee – that is, the intended referent of “your,” whether that was the child or the second experimenter. For instance, on a “your”-child trial, the lead experimenter stated, “It’s in your box,” while looking at the child. Then, each experimenter had another trial using the first-person pronoun “my,” resulting in two final “my” trials. In all trials, the experimenter stated the clue twice. For the trials in which the second experimenter stated the clue, the second experimenter would first ask the lead experimenter for the clue (“[Experimenter Name], can you give a clue?”). The lead experimenter would state

[3]We conducted an exploratory analysis to determine if the trial order predicted the accuracy on second-person pronouns, because we hypothesized that children might be able to learn over the course of the task. However, there was not a significant effect of trial number ($\beta = 0.06$, $p = 0.50$), so we did not include this factor in any other analyses.

that she forgot where the sticker was hidden and then the second experimenter stated the clue (“I remember. I can give a clue.”).

At the end of each trial, whether or not the child selected the correct box, one experimenter reinforced the color assignment by saying “It’s in the [color] box, because [child name/experimenter name]’s wearing a [color] badge! The color is the same, remember?” At the end of each trial, the child was given the sticker to keep even if they did not select the correct box.

Experimenters noted children’s selection in real-time on a coding sheet. The child’s first selection of a box was taken as their response; we intended to exclude trials in which children selected two boxes simultaneously, but this did not occur for any of the children in the final sample. Trials on which children did not select a box were excluded. From the analyzed subsample, we excluded five trials from four autistic children and three trials from three nonautistic children due to experimenter error (i.e., pointing, looking at the incorrect referent, $n = 3$), child lack of response ($n = 2$), coder error ($n = 1$), child selected a box before the clue was given ($n = 2$). We did not exclude trials on which the experimenter forgot to reinforce the color assignment (which affected two nonautistic participants on almost all trials) or trials on which the experimenter used their arm or hand to prevent the child from touching the boxes before the clue was given (which affected two trials from one autistic child).

Gaze coding

Trained coders watched the video recordings of the experimental sessions and noted for each trial whether the child looked up at the speaker at any point, while the speaker was producing the clue (e.g., “It’s in my box”). Each video was coded by one coder as a binary variable (1 = child looked at speaker, 0 = child did not look at speaker). We also had a second coder rate 20% of videos to confirm inter-rater reliability, yielding a percent agreement of 95.75% and Cohen’s kappa of 0.91.

Analyses

We analyzed the data using R version 4.2.3 (R Core Team, 2023). Mixed-effects modeling was conducted using the lme4 package (Bates et al., 2015) and the lmerTest package (Kuznetsova et al., 2017) was used to obtain *p*-values. The emmeans package (Lenth, 2023) was used to analyze interactions.

For our first research question, we used binomial tests to calculate the probability of the children within each group (i.e., autistic, nonautistic) understanding each pronoun (i.e., first person “my,” second person “your-child” and second person “your-experimenter”) at above chance levels (33%, given that there were three boxes to choose from). For the second question, we used mixed-effects regression to ask if there were group differences in comprehending first- and second-person pronouns. The models used a binary variable indicating if the child selected the correct box as the dependent variable, a random effect of participant, and fixed effects of group (autistic coded as 0.5, nonautistic coded as −0.5) and pronoun type (first person coded as −0.5, second person coded as 0.5). In one model, we compared first- and second-person pronouns, collapsing across “your-child” and “your-experimenter" trials. In a second model, we looked only at second-person pronouns, comparing "your-child" and "your-experimenter."

For the third research question, we focused specifically on second-person pronoun comprehension to ask if children's gaze to the speaker during the verbal clue predicted their accuracy of second-person pronoun comprehension; the fixed effects were group (autistic coded as 0.5, nonautistic coded as −0.5), pronoun type ("your-child" coded as −0.5, "your-experimenter" coded as 0.5), and our binary coded variable of gaze to the speaker on each trial (absence of gaze coded as −0.5, presence coded as 0.5).

For the fourth research question, to better understand the types of errors that children made, and specifically to evaluate reversal errors in comprehension (e.g., Overweg et al., 2018), we also used Fisher's exact tests to compare the number of different error types across groups. We considered two different types of errors: "reversal" errors (i.e., the child selecting their own box on a first-person trial) and "other" errors (in which the child chose the box that was neither correct nor reflecting a pronoun reversal interpretation—e.g, the child selecting the non-speaking experimenter's box on a first-person trial).

Results

The final sample included 22 autistic children and 22 nonautistic children. Overall, the children seemed motivated to find the stickers. The majority of the children selected a box following the prompt and some of the children continued to search for the sticker even after they had selected the wrong box initially. See Table 1 for more information about the characteristics of the final sample. The data and code are available at OSF: https://osf.io/bvewp/?view_only=a558b7ae08dd41ce9451f2a3b3e82006

Research question 1: comprehension of pronouns

Performance was compared to chance (i.e., 33%, because there were three boxes). Binomial tests showed that both groups performed above chance (both *p*s < .001) for the first-person pronoun "my" (nonautistic children: 89% correct; autistic children: 86% correct). For the second-person pronoun "your" when the child was the addressee, we found a similar pattern of results, with both groups performing above chance (nonautistic children: 93% correct; autistic children: 77% correct; both *p*s < .001). Results were also above chance in both groups for second-person pronoun "your" when the experimenter was the addressee (nonautistic children: 68% correct, $p < 0.001$; autistic children: 50% correct, $p = 0.03$). See Figure 2.

Research question 2: group differences in comprehension of pronouns

The mixed-effects regression examining first- vs. second-person pronoun comprehension across groups revealed a significant simple effect of pronoun type: children in both groups performed better on first-person pronouns than second-person pronouns ($\beta = -0.15$, $p < 0.01$). There was no significant simple effect of group ($\beta = -0.10$, $p = 0.079$) and no significant interaction between group and pronoun type ($\beta = -0.13$, $p = 0.10$) Thanks to an anonymous reviewer suggestion, we conducted post-hoc analyses to determine if there were

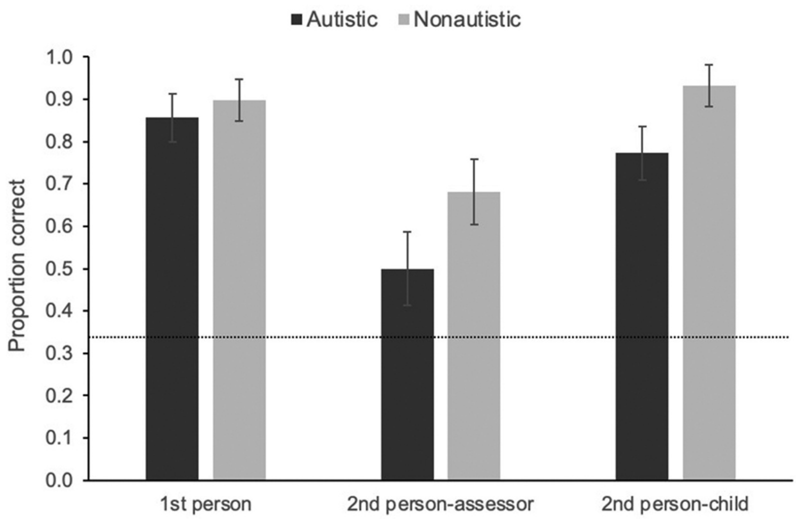

Figure 2. Accuracy of 1st and 2nd person pronoun comprehension by group. Dotted line indicates chance performance (0.33).

significant correlations between pronoun comprehension and MCDI scores. The correlation between pronoun comprehension and MCDI scores within the autistic group ($r = .43$, $p = 0.047$) was statistically significant, but not for the nonautistic group ($r = 0.0037$, $p = 0.99$). This moderate association for the autistic group is consistent with other studies showing that pronoun acquisition tracks with other aspects of language development (e.g., Kelty-Stephen et al., 2020, Naigles et al., 2016).

The mixed-effect regression examining comprehension of second-person pronouns (referring to child vs. referring to experimenter) revealed a significant simple effect of group and second-person pronoun type: nonautistic children comprehended second-person pronouns more accurately than autistic children ($\beta = -0.17$, $p = 0.019$). Overall, children in both groups performed better on "your-child" trials than "your-experimenter" trials ($\beta = -0.26$, $p < 0.001$). There was not a significant interaction between group and trial type ($\beta = -0.24$, $p = 0.85$).

Research question 3: the association between gaze and comprehension of second-person pronouns across groups

Children in the autistic group looked up at the speaker on 73% of trials in the "your-child" condition and 74% of trials in the "your-experimenter" condition; nonautistic children did so 91% of the time in the "your-child" condition and 88% of the time in the "your-experimenter" condition. Of trials when children did look up, autistic children were accurate 88% of the time in the "your-child" condition and 58% of the time in the "your-experimenter" condition, while nonautistic children were accurate when they looked up 100% of the time in the "your-child" condition and 79% of the time in the "your-experimenter" condition.

Statistical analysis revealed no simple effect of group ($\beta = 0.057$, $p = 0.50$), but significant simple effects of second-person pronoun type (children performed better on "your-child" than “your-experimenter,” $\beta = -0.25$, $p < 0.01$), and of gaze (gaze at the speaker was associated with better performance, $\beta = 0.55$, $p < 0.001$), and a significant interaction between group and gaze ($\beta = -0.43$, $p = 0.0094$). When including gaze in the model, the simple effect of group in second-person comprehension was no longer significant. To understand this interaction, we used post-hoc comparisons of estimated marginal means, which revealed that both groups were more accurate when they looked at the speaker than when they did not (autistic group: $t = -3.47$, $p = 0.0046$; nonautistic group: $t = -5.63$, $p < 0.0001$); however, autistic and nonautistic children did not significantly differ from each other in accuracy on trials when children did gaze to the speaker ($t = 2.40$, $p = 0.091$), nor when they did not ($t = -1.78$, $p = 0.29$) (despite the trend toward autistic children showing greater vulnerability even when they looked up than nonautistic children). That is, looking to the speaker supported both autistic and nonautistic children in identifying the referent of the pronoun, albeit to different degrees.

Research question 4: error types across groups

Next, we characterized the kinds of errors that children made, specifically to see whether these were pronoun reversal errors. We used Fisher’s exact test to compare the number of “reversal” errors vs. “other” errors across groups. This analysis revealed no statistically significant group difference in the number of reversal errors ($p = 0.058$), although the trend is in the direction of more reversal errors in autistic children (19 reversal errors, as compared to 20 other errors) than nonautistic children (5 reversal errors, as compared to 18 other errors).

Because performance on the second-person trials on which the referent was the other experimenter was the poorest, we were particularly interested in what kind of errors children were making on these trials. Interestingly, the overwhelming majority of these errors were not reversal errors (which would have resulted in the child choosing the speaker as the referent of the second-person pronoun) but self-bias errors, in which the child selected their own box instead of the experimenter being addressed: 71% of trials with errors in the autistic group and 93% of trials with errors in the nonautistic group followed this pattern. A Fisher’s exact test revealed no difference between the groups in the number of reversal errors on these trials ($p = 0.20$).

Discussion

This study employed a game adapted from Moyer et al. (2015) in which children located a sticker based on a verbal cue that included a first- or second-person pronoun. It was designed to address four research questions about the understanding of first- and second-person pronouns (across addressed and nonaddressed conditions) in autistic and nonautistic children living in the United States; we were also interested in the use of gaze to disambiguate pronoun reference, as well as the types of errors that children made. Our first inquiry focused on whether performance was above chance for first-person and second-person pronouns (across addressed and nonaddressed conditions) for both groups. Results suggested that both autistic and nonautistic children performed above chance across the board: for first-person pronouns, second-person pronouns when they were the addressee, and second-person pronouns when the other experimenter was the addressee. These findings are consistent with the trends reported for nonautistic children in Charney (1980b) and Moyer et al. (2015).

Our second research question compared performance across nonautistic and autistic groups. We did not find any group differences in performance in first-person pronoun "my." We did find that comprehension of second-person pronoun "your" was stronger in the nonautistic group than in the autistic group; however, there was no interaction between comprehension in addressed vs. nonaddressed conditions and diagnostic group. Relatedly, results suggested some important parallels across groups as well: both groups were significantly more accurate on first-person pronoun "my" than second-person pronoun "your," and both groups performed significantly better on "your" in the addressed vs. nonaddressed conditions. These findings are consistent with some previous studies showing no differences between autistic and nonautistic children in pronoun comprehension (Jordan, 1989; A. Lee et al., 1994), although those studies did not explicitly measure addressed vs. nonaddressed conditions.

Our third inquiry focused on second-person pronoun "your" specifically, asking whether there were group differences in children's use of gaze to accurately identify the referent in addressed and non-addressed situations. All told, our analyses revealed that both groups were more accurate when they coordinated gaze to the speaker.

Our fourth and final inquiry explored children's errors in pronoun comprehension. Children across groups commonly made errors that reflected a self bias (that is, to interpret "your" as referring to themselves rather than the other, adult addressee), and reversal errors were less common; error rate type was not significantly different across groups.

Unlike for first-person pronouns (for which accuracy was similar across groups), we found that accuracy for second-person pronouns was lower in autistic children than nonautistic children; this aligns with Oshima-Takane and Benaroya's (1989) findings that "your" may be more difficult to learn than "my" for autistic children. Why might this have been the case? On the one hand, all children's relative ease with first-person pronouns, as well as their above-chance performance even with second-person pronouns, disputes a wholesale challenge with the deictic nature of personal pronouns. On the other hand, auditory cues alone could be sufficient for accurately determining the referent of the first-person "my" pronoun, whereas the second person "your" pronoun necessitates the additional pursuit of nonverbal communicative cues using visual referencing. Gaze to speakers (or speech) has often been observed to be reduced in autistic children when compared to nonautistic children (e.g., Irwin & Brancazio, 2014; Shic et al., 2020), and adding gaze to the model did reveal that gaze to the speaker was a significant predictor of success in interpreting second-person pronouns. Although we did not find significant group effects, suggesting that any differences in visual attention to speakers did not substantially hinder autistic children's abilities to determine reference, the trend was in the direction of poorer performance in the autistic group. It could be that autistic children are slightly less effective at navigating the millisecond-by-millisecond cognitive demands of coordinating auditory information (spatial, prosodic, and/or linguistic) and visual information during the experimental task, which may impede their comprehension in more challenging interactional contexts.

A second, related interpretation has less to do with experimental task demands and more to do with everyday learning opportunities. It has previously been suggested that extensive linguistic experience in multi-party conversations can support the mastery of personal pronouns because these conversational contexts allow children repeated opportunities to witness the shifting nature of personal pronouns and rehearse their interpretation in both addressed and non-addressed speech (Oshima-Takane, 1988). It has also previously been affirmed that children with autism can learn through both addressed and non-addressed linguistic input (Luyster & Arunachalam, 2020), and some first person-accounts from autistic adults even imply that non-addressed speech might be *easier* to learn from than addressed speech (e.g., Harp, 2012). However, we might consider two factors that might influence the children's "real-world" learning opportunities across these conversational contexts. First, many autistic children are enrolled in interventions that emphasize 1:1 interactions between a clinician/caregiver and the autistic child (e.g., Frost et al., 2020; J. Lee et al., 2023). We do not intend to devalue these critical programs in any way; instead, we aim only to consider how the commonality of these dyadic contexts might shape autistic children's language input and whether and how clinicians/caregivers might also capitalize on varied everyday social contexts. Second, although children can learn from non-addressed language input (Luyster & Arunachalam, 2020) and it may be less overwhelming for some children or in some contexts than 1:1 interactions, it does pose challenges when it requires children to coordinate social attention in real-time, as is the case for pronouns.

In summary, this study was designed to pursue a paradox. On the one hand, it is clear that to fully acquire some types of words, including personal pronouns, children must experience them in a variety of social contexts including those in which they are not directly addressed. On the other hand, despite laboratory evidence that they can learn from such situations, there is scant evidence that children can do so in real-world learning. Correlational evidence suggests that children who have more access to situations in which they are not addressed – that is, children with older siblings – do have more success with personal pronouns (Oshima-Takane et al., 1996, 1999). But otherwise, the evidence suggests that both typically developing and autistic children are slow to acquire first- and second-person pronouns; though relatively infrequent within each child, errors (including reversals) are a common feature of early language development.

By probing the differences in pronoun comprehension when children are versus are not the addressee, we found many commonalities that held across our two samples: (1) young autistic and nonautistic children in the US understand personal pronouns and are able to adjust the referent of the words based on the conversational context by the time they reach school age, if not before, (2) first-person pronouns are easier to understand than second-person pronouns, (3) second-person pronouns that refer to the self are easier to understand than ones that refer to another person, (4) children are more inclined to mistakenly interpret a pronoun as referring to themselves (i.e., show an ego-centric "self-bias") than they are to systematically reverse the referent, and (5) they make fewer errors when they successfully "check in" with the speaker using gaze to determine the referent of the word. We found only one-group difference, which was that within second-person pronouns, the autistic sample was less accurate overall than the nonautistic sample.

Overall, our findings support prior speculations that pronoun errors, including reversal errors, do not result from incorrect semantic representations of pronoun meanings, but rather, difficulty deploying their knowledge during complex interactions to identify the intended addressee. Moreover, autistic children may generally have more difficulty coordinating their linguistic skills and social attention in real-time (Kelty-Stephen et al., 2020; Oshima-Takane & Benaroya, 1989), which results in more variance in their performance.

Our results broadly suggest that language learning follows a similar course across non-autistic and autistic children and that – in the context of non-addressed speech – individual variability in social pragmatic skills may shape children's understanding of these conversational contexts; we have previously referred to this general observation of the role of both linguistic and non-linguistic domains in language learning as variations in "intake from the input" (Arunachalam & Luyster, 2016, 2018).

More broadly, however, our findings suggest that non-addressed speech offers a meaningful opportunity for children to navigate semantically complex words – such as personal pronouns – that are uniquely suited to be showcased in these conversational settings. However, children may find words delivered in non-addressed contexts somewhat more challenging to decipher than language delivered in addressed contexts, though this likely depends on a variety of factors, including (but not limited to) the meaning of word or words themselves and the need for concomitant "data gathering" about the referent of word using real-time gaze or other social communication skills. Indeed, research has suggested that although children are masterful at learning in addressed situations from infancy onwards (e.g., Waxman & Markow, 1995), children become better at learning in non-addressed situations as they age through the preschool years (Foushee & Xu, 2016). That is, learning through non-addressed speech is a capability that shows a more protracted developmental timeline than learning from addressed speech, perhaps precisely because of the added cognitive and linguistic demands.

Limitations

The challenges of the pandemic imposed some limitations on our work, notably its small sample size and the use of different approaches to confirm autism diagnosis across pre- and post-pandemic data collection. One limitation of the task is that children were introduced to it as an opportunity for them to collect stickers. This may have encouraged them to see the game as being "for them" and expecting that they would always be addressed, and it may partially explain their bias to interpret the second-person pronoun as referring to themselves. We did our best to mitigate this with the warm-up trial, in which the child was referred to by proper name, as well as by having multiple trials with each pronoun. It is also notable that of the 22 children who made self-bias errors, only six children made this error on both trials of this type. Moreover, this may be a relatively common experience in early childhood, for example, when two caregivers play a game with the child.

We also lacked data about parents' use of pronouns, which would be expected to affect children's comprehension. However, we think the "input" aspect of "intake from the input" is unlikely to have a substantial impact on children's performance on our task, in part because language input to autistic and nonautistic children is generally similar (e.g., Nadig & Bang, 2017), and in part because there is no evidence that parents of autistic children avoid using pronouns (e.g., He et al., 2018). Moreover, there is no evidence of large causal effects of parental pronoun use on children's own pronoun use (Barokova & Tager-Flusberg, 2020).

Conclusions

Both autistic and nonautistic children demonstrate an understanding of first- and second-person pronouns, on average, by the early school-age years. This shows that children understand the deictic nature of pronouns and are becoming increasingly proficient at paying attention to the person producing the pronoun to understand who the pronoun refers to. In addition, although autistic children and nonautistic children often differ in social interaction and communication skills, autistic children are also able to attend to social cues to understand who the speakers are referring to when they use pronouns. The differences in second-person pronoun comprehension that were observed in the autistic sample relative to the nonautistic sample suggest differences in degree rather than kind; in other words, although we see that children with autism may demonstrate more difficulty comprehending certain types of words, we did not find any evidence of qualitative differences in performance or strategy. These results provide evidence of many parallels between the strengths and challenges of young language learners with and without autism, and suggest that all children undergo protracted language learning processes for many words. Children may benefit from repeated experiences across varied conversational settings – including addressed and unaddressed speech – to practice the synchronization of semantics and pragmatics in their ongoing mastery of language.

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Data availability statement

The datasets for this study are available in the OSF repository, https://osf.io/bvewp/?view_only=a558b7ae08dd41ce9451f2a3b3e82006

Open scholarship

This article has earned the Center for Open Science badge for Open Data. The data are openly accessible athttps://osf.io/bvewp/?view_only=a558b7ae08dd41ce9451f2a3b3e82006

References

Akhtar, N., Jipson, J., & Callanan, M. A. (2001). Learning words through overhearing. *Child Development*, *72*(2), 416–430. https://doi.org/10.1111/1467-8624.00287

Akhtar, N., Tolins, J., & Fox Tree, J. E. (2019). Young children's word learning through overhearing: Next steps. In J. S. Horst & J. von Koss Torkildsen (Eds.), *International handbook of language acquisition* (pp. 427–441). Routledge/Taylor & Francis Group. https://doi.org/10.4324/9781315110622-22

Allen, C. W., Silove, N., Williams, K., & Hutchins, P. (2007). Validity of the social communication questionnaire in assessing risk of autism in preschool children with developmental problems. *Journal of Autism & Developmental Disorders*, *37*(7), 1272–1278. https://doi.org/10.1007/s10803-006-0279-7

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Arunachalam, S. (2013). Two-year-olds can begin to acquire verb meanings in socially impoverished contexts. *Cognition*, *129*(3), 569–573. https://doi.org/10.1016/j.cognition.2013.08.021

Arunachalam, S., & Luyster, R. (2018). Lexical development in young children with autism spectrum disorder (ASD): How ASD may affect intake from input. *Journal of Speech, Language, & Hearing Research*, *61*(11), 2659–2673. https://doi.org/10.1044/2018_JSLHR-L-RSAUT-18-0024

Arunachalam, S., & Luyster, R. J. (2016). The integrity of lexical acquisition mechanisms in autism spectrum disorders: A research review. *Autism Research*, *9*(8), 810–828. https://doi.org/10.1002/aur.1590

Barokova, M., & Tager-Flusberg, H. (2020). Person-reference in autism spectrum disorder: Developmental trends and the role of linguistic input. *Autism Research*, *13*(6), 959–969. https://doi.org/10.1002/aur.2243

Bartak, L., & Rutter, M. (1974). The use of personal pronouns by autistic children. *Journal of Autism and Childhood Schizophrenia*, *4*(3), 217–222. https://doi.org/10.1007/BF02115227

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Berument, S. K., Rutter, M., Lord, C., Pickles, A., & Bailey, A. (1999). Autism screening questionnaire: Diagnostic validity. *British Journal of Psychiatry*, *175*(5), 444–451. https://doi.org/10.1192/bjp.175.5.444

CDI Advisory Board. (n.d.). *English long forms*. https://mb-cdi.stanford.edu/eng_long.html

Chanchaochai, N., & Schwarz, F. (2023). Difficulties with pronouns in autism: Experimental results from Thai children with autism. *Language Acquisition*, 1–38. https://doi.org/10.1080/10489223.2023.2262457

Charney, R. (1980a). Pronoun errors in autistic children: Support for a social explanation. *International Journal of Language & Communication Disorders*, *15*(1), 39–43. https://doi.org/10.3109/13682828009011369
Charney, R. (1980b). Speech roles and the development of personal pronouns. *Journal of Child Language*, *7*(3), 509–528. https://doi.org/10.1017/S0305000900002816
Chiat, S. (1982). If I were you and you were me: The analysis of pronouns in a pronoun-reversing child. *Journal of Child Language*, *9*(2), 359–379. https://doi.org/10.1017/S0305000900004761
Conson, M., Mazzarella, E., Esposito, D., Grossi, D., Marino, N., Massagli, A., & Frolli, A. (2015). "Put myself into your place": Embodied simulation and perspective taking in autism spectrum disorders. *Autism Research*, *8*(4), 454–466. https://doi.org/10.1002/aur.1460
Corsello, C., Hus, V., Pickles, A., Risi, S., Cook, E. H., Leventhal, B. L., & Lord, C. (2007). Between a ROC and a hard place: Decision making and making decisions about using the SCQ. *Journal of Child Psychology and Psychiatry*, *48*(9), 932–940. https://doi.org/10.1111/j.1469-7610.2007.01762.x
Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (2017). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development*, *90*(3), 759–773. https://doi.org/10.1111/cdev.12974
Dale, P. S., & Crain-Thoreson, C. (1993). Pronoun reversals: Who, when, and why? *Journal of Child Language*, *20*(3), 573–589. https://doi.org/10.1017/S0305000900008485
Ellis Weismer, S., Gernsbacher, M. A., Stronach, S., Karasinksi, C., Eernisse, E. R., Venker, C. E., & Sindberg, H. (2011). Lexical and grammatical skills in toddlers on the autism spectrum compared to late talking toddlers. *Journal of Autism & Developmental Disorders*, *41*(8), 1065–1075. https://doi.org/10.1007/s10803-010-1134-4
Evans, K. E., & Demuth, K. (2012). Individual differences in pronoun reversal: Evidence from two longitudinal case studies. *Journal of Child Language*, *39*(1), 162–191. https://doi.org/10.1017/S0305000911000043
Fay, W. H. (1971). On normal and autistic pronouns. *The Journal of Speech and Hearing Disorders*, *36*(2), 241–249. https://doi.org/10.1044/jshd.3602.242
Fay, W. H. (1979). Personal pronouns and the autistic child. *Journal of Autism & Developmental Disorders*, *9*(3), 247–260. https://doi.org/10.1007/BF01531739
Feliciano, P., Daniels, A. M., Green Snyder, L., Beaumont, A., Camba, A., Esler, A., Gulsrud, A. G., Mason, A., Gutierrez, A., Nicholson, A., Paolicelli, A. M., McKenzie, A. P., Rachubinski, A. L., Stephens, A. N., Simon, A. R., Stedman, A., Shocklee, A. D., Swanson, A., . . . SPARK Consortium. (2018). SPARK: A US cohort of 50, 000 families to accelerate autism research. *Neuron*, *97*(3), 488–493. https://doi.org/10.1016/j.neuron.2018.01.015
Fenson, L., Marchman, V. A., Thal, D. J., Dale, P. S., Reznick, J. S., & Bates, E. (2006). *The MacArthur-bates communicative development inventories* (2nd ed.). Brookes.
Finnegan, E., Asaro-Saddler, G., Zajic, K, & Zajic, M. C. (2021). Production and comprehension of pronouns in individuals with autism: A meta-analysis and systematic review. *Autism*, *25*(1), 3–17. https://doi.org/10.1177/1362361320949
Fitch, A., Lieberman, A. M., Luyster, R. J., & Arunachalam, S. (2020). Toddlers' word learning through overhearing: Others' attention matters. *Journal of Experimental Child Psychology*, *193*, 1–8. https://doi.org/10.1016/j.jecp.2019.104793
Foushee, R., & Srinivasan, M. (2024). Infants who are rarely spoken to nevertheless understand many words. *Proceedings of the National Academy of Sciences*, *121*(23), e2311425121. https://doi.org/10.1073/pnas.2311425121
Foushee, R., Srinivasan, M., & Xu, F. (2021). Self-directed learning by preschoolers in a naturalistic overhearing context. *Cognition*, *206*, 104415. https://doi.org/10.1016/j.cognition.2020.104415
Foushee, R., Srinivasan, M., & Xu, F. (2023). Active learning in language development. *The Current Directions in Psychological Science*, *32*(3), 250–257. [preprint] https://doi.org/10.1177/09637214221123920
Foushee, R., & Xu, F. (2016). Active overhearing: Development in preschoolers' skill at 'listening in' to naturalistic overheard speech. In A. Papafragou, D. Grodner, D. Mirman, & J. C. Trueswell (Eds). *Proceedings of the 38th Annual Conference of the Cognitive Science Society: Recognizing and Representing Events*, Philadelphia, Pennsylvania, USA. (pp. 2178–2182). Cognitive Science Society.

Frost, K. M., Brian, J., Gengoux, G. W., Hardan, A., Rieth, S. R., Stahmer, A., & Ingersoll, B. (2020). Identifying and measuring the common elements of naturalistic developmental behavioral interventions for autism spectrum disorder: Development of the NDBI-Fi. *Autism*, *24*(8), 2285–2297. https://doi.org/10.1177/1362361320944011

Gampe, A., Liebal, K., & Tomasello, M. (2012). Eighteen-month-olds learn novel words through overhearing. *First Language*, *32*(3), 385–397. https://doi.org/10.1177/0142723711433584

Girouard-Hallam, L. N., & Norris, M. N. (2024). Overheard and understood: A systematic review of children's learning from overhearing. *Translational Issues in Psychological Science*. Advance online publication. https://doi.org/10.1037/tps0000399

Golinkoff, R. M., Hoff, E., Rowe, M. L., Tamis LeMonda, C. S., & Hirsh-Pasek, K. (2019). Language matters: Denying the existence of the 30-million-word gap has serious consequences. *Child Development*, *90*(3), 985–992. https://doi.org/10.1111/cdev.13128

Grace, E. J. (2013). *Pronoun problems (asides on self-loathing and gender)*. https://tinygracenotes.blogspot.com/2013/05/pronoun-problems.html

Grieser, D. L., & Kuhl, P. K. (1988). Maternal speech to infants in a tonal language: Support for universal prosodic features in motherese. *Developmental Psychology*, *24*(1), 14–20. https://doi.org/10.1037/0012-1649.24.1.14

Harp, B. (2012). Are you listening? In J. Bascom (Ed.), *Loud hands: Autistic people, speaking* (pp. 306–307). The Autistic Press.

He, A. X., Luyster, R. & Arunachalam, S. (2022). Parental tuning of language input to autistic and nonspectrum children. *Frontiers in Psychology*, *13*, 1–15. https://doi.org/10.3389/fpsyg.2022.954983

He, A. X., Luyster, R., Hung, S. J., & Arunachalam, S. (2018). Personal pronoun usage in maternal input to infants at high vs. low risk for autism spectrum disorder. *First Language*, *38*(5), 520–553. https://doi.org/10.1177/0142723718782634

Hobson, R. P., Lee, A., & Hobson, J. A. (2010). Personal pronouns and communicative engagement in autism. *Journal of Autism & Developmental Disorders*, *40*(6), 653–664. https://doi.org/10.1007/s10803-009-0910-5

Irwin, J. R., & Brancazio, L. (2014). Seeing to hear? Patterns of gaze to speaking faces in children with autism spectrum disorders. *Frontiers in Psychology*, *5*, 397. https://doi.org/10.3389/fpsyg.2014.00397

Jordan, R. R. (1989). An experimental comparison of the understanding and use of speaker-addressee personal pronouns in autistic children. *International Journal of Language & Communication Disorders*, *24*(2), 169–179. https://doi.org/10.3109/13682828909011954

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child*, *2*(2), 217–250.

Kelty-Stephen, E., Fein, D. A., & Naigles, L. R. (2020). Children with ASD use joint attention and linguistic skill in pronoun development. *Language Acquisition*, *27*(4), 410–433. https://doi.org/10.1080/10489223.2020.1769626

Köder, F., & Maier, E. (2016). Children mix direct and indirect speech: Evidence from pronoun comprehension. *Journal of Child Language*, *43*(4), 843–866. https://doi.org/10.1017/S0305000915000318

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13), 1–26. https://doi.org/10.18637/jss.v082.i13

Lany, J. (2014). Judging words by their covers and the company they keep: Probabilistic cues support word learning. *Child Development*, *85*(4), 1727–1739. https://doi.org/10.1111/cdev.12199

Lany, J., & Saffran, J. R. (2011). Interactions between statistical and semantic information in infant language development. *Developmental Science*, *14*(5), 1207–1219. https://doi.org/10.1111/j.1467-7687.2011.01073.x

Lee, A., Peter Hobson, R., Chiat, S., & Allison School, H. (1994). I, you, me, and autism: An experimental study. *Journal of Autism & Developmental Disorders*, *24*(2), 155–176. https://doi.org/10.1007/BF02172094

Lee, J., Sone, B., Rooney, T., & Roberts, M. Y. (2023). The role of naturalistic developmental behavioral interventions in early intervention for autistic toddlers: An observational study.

American Journal of Speech-Language Pathology, *32*(2), 439–451. https://doi.org/10.1044/2022_AJSLP-22-00190

Lenth, R. (2023). _*emmeans: Estimated marginal means, aka least-squares means*_. R package version 1.8.5. https://CRAN.R-project.org/package=emmeans

Lord, C., Rutter, M., DiLavore, P. C., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism diagnostic observation schedule* (second ed.). Western Psychological Services.

Luyster, R. J., & Arunachalam, S. (2020). Brief report: Learning language through overhearing in children with ASD. *Journal of Autism & Developmental Disorders*, *50*(7), 2616–2624. https://doi.org/10.1007/s10803-018-3672-0

Macnamara, J. (1982). *Names for things: A study of human learning*. MIT Press.

Mahr, T. (2023). *Bootmatch: Bootstrap group matching*. Repository. https://github.com/tjmahr/bootmatch

Mazzaggio, G., & Shield, A. (2020). The production of pronouns and verb inflections by Italian children with ASD: A new dataset in a null subject language. *Journal of Autism & Developmental Disorders*, *50*(4), 1425–1433. https://doi.org/10.1007/s10803-019-04349-7

McDuffie, A., & Yoder, P. (2010). Types of parent verbal responsiveness that predict language in young children with autism spectrum disorder. *Journal of Speech, Language, & Hearing Research*, *53*(4), 1026–1039. https://doi.org/10.1044/1092-4388(2009/09-0023)

Morgenstern, B. D., Causin, K. G., & Weinlein, J. L. (2019). Teaching pronouns to individuals with autism. *Behavioral Interventions*, *34*(4), 525–533. https://doi.org/10.1002/bin.1685

Moyer, M., Harrigan, K., Hacquard, V., & Lidz, J. (2015). 2-year-olds' comprehension of personal pronouns. Online *Proceedings of the 29th Annual Boston University Conference on Language Development (BUCLD)*, Boston University, Boston, MA.

Nadig, A., & Bang, J. (2017). Parental input to children with ASD and its influence on later language. In L. R. Naigles (Ed.), *Innovative investigations of language in autism spectrum disorder* (pp. 89–113). Walter de Gruyter GmbH; American Psychological Association. https://doi.org/10.1037/15964-006

Naigles, L. R. (2021). It takes all kinds (of information) to learn a language: Investigating the language comprehension of typical children and children with autism. *The Current Directions in Psychological Science*, *30*(1), 11–18. https://doi.org/10.1177/0963721420969404

Naigles, L. R., Cheng, M., Rattanasone, N. X., Tek, S., Khetrapal, N., Fein, D., & Demuth, K. (2016). "You're telling me!" the prevalence and predictors of pronoun reversals in children with autism spectrum disorders and typical development. *Research in Autism Spectrum Disorders*, *27*, 11–20. https://doi.org/10.1016/j.rasd.2016.03.008

Ochs, E., & Schieffelin, B. B. (1984). Language acquisition and socializations: Three developmental stories and their implications. In R. A. Shweder & R. A. LeVine (Eds.), *Culture theory: Essays on mind, self and emotion* (pp. 276–320). Cambridge University Press.

Oshima-Takane, Y. (1988). Children learn from speech not addressed to them: The case of personal pronouns. *Journal of Child Language*, *15*(1), 95–108. https://doi.org/10.1017/S0305000900012071

Oshima-Takane, Y., & Benaroya, S. (1989). An alternative view of pronominal errors in autistic children. *Journal of Autism & Developmental Disorders*, *19*(1), 73–85. https://doi.org/10.1007/BF02212719

Oshima-Takane, Y., Goodz, E., & Derevensky, J. L. (1996). Birth order effects on early language development: Do secondborn children learn from overheard speech? *Child Development*, *67*(2), 621–634. https://doi.org/10.1111/j.1467-8624.1996.tb01755.x

Oshima-Takane, Y., Takane, Y., & Shultz, T. R. (1999). The learning of first and second person pronouns in English: Network models and analysis. *Journal of Child Language*, *26*(3), 545–575. https://doi.org/10.1017/S0305000999003906

Overweg, J., Hartman, C. A., & Hendriks, P. (2018). Children with autism spectrum disorder show pronoun reversals in interpretation. *Journal of Abnormal Psychology*, *127*(2), 228–238. https://doi.org/10.1037/abn0000338

Pronoun reversal and confusion. (2014). https://musingsofanaspie.com/2014/03/14/pronoun-reversal-and-confusion/

Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2014). Look who's talking: Speech style and social context in language input to infants are linked to concurrent and future speech development. *Developmental Science*, *17*(6), 880–891. https://doi.org/10.1111/desc.12172
Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2017). Look who's talking NOW! Parentese speech, social context, and language development across time. *Frontiers in Psychology*, *8*, 1008. https://doi.org/10.3389/fpsyg.2017.01008
R Core Team. (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/
Roseberry, S., Hirsh-Pasek, K., & Golinkoff, R. M. (2014). Skype me! Socially contingent interactions help toddlers learn language. *Child Development*, *85*(3), 956–970. https://doi.org/10.1111/cdev.12166
Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development*, *83*(5), 1762–1774. https://doi.org/10.1111/j.1467-8624.2012.01805.x
Rutter, M., Bailey, A., & Lord, C. (2003). *The Social Communication Questionnaire*. Western Psychological Services.
Sanchez, M. J., & Constantino, J. N. (2020). Expediting clinician assessment in the diagnosis of autism spectrum disorder. *Developmental Medicine & Child Neurology*, *62*(7), 806–812. https://doi.org/10.1111/dmcn.14530
Schopler, E., Van Bourgondien, M. E., Wellman, G. J., & Love, S. R. (2010). *Childhood autism rating scale - 2 (CARS-2)*. Western Psychological Services.
Shic, F., Wang, Q., Macari, S. L., & Chawarska, K. (2020). The role of limited salience of speech in selective attention to faces in toddlers with autism spectrum disorders. *Journal of Child Psychology and Psychiatry*, *61*(4), 459–469. https://doi.org/10.1111/jcpp.13118
Shield, A., Igel, M., & Meier, R. P. (2022). Are palm reversals the pronoun reversals of sign language? Evidence from a fingerspelling task. *Frontiers in Psychology*, *13*, 1–17. https://doi.org/10.3389/fpsyg.2022.953019
Shneidman, L. A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: How important is directed speech? *Developmental Science*, *15*(5), 659–673. https://doi.org/10.1111/j.1467-7687.2012.01168.x
Smolik, F., & Chroma, A. (2023). About me, you and her: Personal pronouns are developmentally preceded by mental state language. *Journal of Child Language*, *50*(3), 537–554. https://doi.org/10.1017/S030500092100091X
Sparrow, S. S. Cicchetti, D. V., Saulnier, C. A. (2016). *Vineland adaptive behavior scales* (3rd ed.). Pearson.
Sperry, D. E., Sperry, L. L., & Miller, P. J. (2019). Reexamining the verbal environments of children from different socioeconomic backgrounds. *Child Development*, *90*(4), 1303–1318. https://doi.org/10.1111/cdev.13072
Sterponi, L., & Shankey, J. (2014). Rethinking echolalia: Repetition as interactional resource in the communication of a child with autism. *Journal of Child Language*, *41*(2), 275–304. https://doi.org/10.1017/S0305000912000682
Tamis LeMonda, C. S., Bornstein, M. H., & Baumwell, L. (2001). Maternal responsiveness and Children's achievement of language milestones. *Child Development*, *72*(3), 748–767. https://doi.org/10.1111/1467-8624.00313
Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development*, *57*(6), 1454–1463. https://doi.org/10.2307/1130423
Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology*, *29*(3), 257–302. https://doi.org/10.1006/cogp.1995.1016
Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, *24*(11), 2143–2152. https://doi.org/10.1177/0956797613488145
Wiggins, L. D., Bakeman, R., Adamson, L. B., & Robins, D. L. (2007). The utility of the social communication questionnaire in screening for autism in children referred for early intervention.

Focus on Autism & Other Developmental Disabilities, *22*(1), 33–38. https://doi.org/10.1177/10883576070220010401

Yuan, S., & Fisher, C. (2009). "Really? She blicked the baby?" two-year-olds learn combinatorial facts about verbs by listening. *Psychological Science*, *20*(5), 619–626. https://doi.org/10.1111/j.1467-9280.2009.02341.x

Zane, E., Arunachalam, S., & Luyster, R. (2021a). Caregiver-reported pronominal errors made by children with and without autism spectrum disorder. *Proceedings of the 45th Annual Boston University Conference on Language Development*, Boston, MA. (pp. 845–859). Somerville, MA: Cascadilla Press.

Zane, E., Arunachalam, S., & Luyster, R. (2021b). Personal pronoun errors in form versus meaning produced by children with and without autism spectrum disorder. *Journal of Cultural Cognitive Science*, *5*(3), 389–404. https://doi.org/10.1007/s41809-021-00087-4