# Preliminary Findings of Similarities and Differences in the Signed and Spoken Language of Children with Autism

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## ABSTRACT

Approximately 30% of hearing children with autism spectrum disorder (ASD) do not acquire expressive language, and those who do often show impairments related to their social deficits, using language instrumentally rather than socially, with a poor understanding of pragmatics and a tendency toward repetitive content. Linguistic abnormalities can be clinically useful as diagnostic markers of ASD and as targets for intervention. Studies have begun to document how ASD manifests in children who are deaf for whom signed languages are the primary means of communication. Though the underlying disorder is presumed to be the same in children who are deaf and children who hear, the structures of signed and spoken languages differ in key ways. This article describes similarities and differences between the signed and spoken language acquisition of children on the spectrum. Similarities include echolalia, pronoun avoidance, neologisms, and the existence of minimally verbal children. Possible areas of divergence include pronoun reversal, palm reversal, and facial grammar.

**KEYWORDS:** Sign language, autism, language acquisition, echolalia, pronouns

**Learning Outcomes:** As a result of this activity, the reader will be able to (1) describe the major linguistic phenomena in autism, and (2) explain which of these are modality independent and which are specific to sign or speech.

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Autism spectrum disorder (ASD) is characterized by deficits in social communication and interaction and the presence of repetitive behaviors and restricted interests.[1] Deficits in language are not the primary or defining impairment in ASD, although language is often impaired: up to 30% of children with ASD do not acquire expressive language,[2] and those who do often show impairments related to their social deficits, using language instrumentally rather than socially, with a poor understanding of pragmatics and a tendency toward repetitive content.[3,4] Linguistic abnormalities can be clinically useful as diagnostic markers of ASD and as a focus of intervention.

To date, the vast majority of studies on language acquisition by children with ASD have focused on hearing children exposed to various communicative systems: speech, manual signs, or augmentative and alternative communication devices. However, it is clear that ASD also affects children with hearing loss,[5] despite a lack of diagnostic instruments designed specifically or adapted for this population (see Mood and Shield, in this issue).[6] Children with hearing loss are a heterogeneous group with a wide variety of linguistic experiences depending on their family background (parents who are deaf or parents with hearing), degree of hearing loss (severely or profoundly deaf, hard of hearing), medical intervention (cochlear implantation), and educational method (manual or oral). Although clinical cases are complex, it is important to describe what is currently known about the acquisition of sign language by children with ASD (both deaf and hearing), highlighting how the sign language of children with ASD manifests in ways both similar and dissimilar from speech. It might seem intuitive that signing children with ASD will exhibit a similar linguistic profile as speaking children with ASD, because the underlying disorder is the same, regardless of the language modality. However, the structures of signed and spoken languages differ in significant ways, and recent work has uncovered some possible areas of divergence that clinicians should be aware of when treating signing children with ASD.

## WHAT IS KNOWN ABOUT THE SIGN LANGUAGE OF CHILDREN WITH ASD?

It is important first to define what is meant by *sign* or *sign language*. By using these terms, the author intends the naturally occurring manual communication systems of the deaf, such as American Sign Language (ASL), British Sign Language (BSL), among others, which possess multiple levels of structure (phonology, morphology, syntax) and are acquired naturally from birth by the children exposed to them. The author does not intend the systems by which spoken languages are encoded on the hands (e.g., manually coded Englishes), nor attempts to supplement or enrich the speech signal with manual signs (sign-supported speech). Despite startlingly little research on the acquisition of ASL or other signed languages by children with ASD, dozens of studies in the 1970s and 1980s investigated the use of augmentative sign systems with low-verbal hearing children with severe autism.[7,8] It was initially hypothesized that signs might succeed where speech had failed: nonspeaking children with ASD generally showed some ability to learn manual signs, though it is likely that their reported sign vocabularies were considerably overstated.[9] For most of these children, the data indicate that sign learning is limited to a small number of simple signs, after which they make limited progress in terms of acquiring more complex structures.[7] The relative success of sign with these children was attributed to several factors: the ability of caregivers to mold the sign articulators (i.e., the hands) directly, thus helping children who might have motor or imitation problems[10]; the possibility of slowing sign production down without losing intelligibility,[11] which could be advantageous for children with processing impairments; and the resemblance between many signs and their referents (i.e., their iconicity), which may help children with ASD learn symbolic relationships.[12]

However, none of these early studies looked at children who were exposed to naturally occurring signed languages such as ASL. It has therefore been unclear until very recently what language acquisition looks like in children with ASD whose first language is a natural

signed language. In the sections that follow the author will describe several of the notable linguistic characteristics of children with ASD, and what is currently known about how such phenomena present in signing children. The author will draw on the existing literature as well as on new data from a nationwide study the author recently conducted on native-signing children with a confirmed ASD diagnosis.

## PRIOR REPORTS

There are a few clinical reports about children who are deaf with ASD, most of which mention sign language only in passing, focusing instead on issues of diagnosis and clinical features. Jure and colleagues described 46 hearing-impaired children with ASD.[13] Of these, 27 had received sign language training, but none of the children were fluent signers, and only seven were able to sign phrases. Six children did not sign at all, and 14 children were only able to produce single signs. Only seven of the children (all with mild ASD) were able to show even marginally adequate comprehension of sign.

Roper and colleagues described 13 British adolescents and young adults who were deaf with a mean age of 19;3 (range 15;8–24;9).[14] Eleven used symbols or pictures to communicate; all used a restricted range of signs and gestures, but none used speech or finger spelling. More recently, Meinzen-Derr and colleagues reported on 24 children with ASD and hearing loss.[15] Only one child used ASL as his primary mode of communication, but his sign language proficiency was not assessed. Of the remaining children, nine used speech as their preferred mode of communication, eight used a combination of sign language and behavior (defined as acting out with communicative intent), and six used only behavior for communication. Eight children (all with a cochlear implant) used an augmentative communication system such as the Picture Exchange Communication System.[16]

There are exceedingly few studies describing the sign acquisition of children with ASD in more detail. Shield and Meier described five children with ASD exposed to ASL from birth by their parents who were deaf, focusing on formational errors in their sign production,[17] and Shield and colleagues (personal communication) analyzed the use of pronouns and pointing signs in 14 native signers with ASD. Denmark and colleagues tested the comprehension of emotional facial expressions in 13 British children and adolescents who were deaf and who had ASD.[18] These studies will be discussed in detail in subsequent sections.

## NEW DATA

The author recently conducted a nationwide study of 20 native-signing children diagnosed with ASD, the largest of its kind to date. All children in this sample had parents who were deaf, used sign language, and had exposed their children to ASL from birth. Although only a very small percentage of children who are deaf are born to parents who are deaf (~5%),[19] such children are of great interest to researchers because it is certain that any abnormalities in their signing cannot be due to delayed or absent language exposure. Children who are deaf and have parents who hear sometimes have language and cognitive delays due to late or insufficient exposure to sign,[20] so they are not ideal research subjects for understanding the effects of ASD on the language development process.

In recent work, parents who are deaf with children who have ASD were recruited via a video in ASL posted on social media. ASD diagnosis was verified using the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2) administered by a clinical psychologist fluent in ASL, and confirmed by a native-signing clinical psychologist expert in ASD.[21] In instances when the child had a history of ASD but did not meet criteria for ASD on the ADOS-2, the diagnosis of ASD was confirmed by the clinical psychologist. Parents also filled out the Social Communication Questionnaire (SCQ) as an additional source of information, though not a determining one.[22] Children were tested on a battery of linguistic and cognitive tasks. The Test of Nonverbal Intelligence, Fourth Edition (TONI-4) was used to estimate general intellectual ability.[23] Three children did not respond to the TONI-4; the other children demonstrated average intelligence, with a mean standard score of 94.6.

Children were tested for sign language comprehension level using the ASL Receptive Skills Test (RST).[24] Three children did not respond to the ASL RST; the other children had average to below-average language for their age, with a mean score of 86, close to one standard deviation below average. Table 1 shows the characteristics of the sample in terms of their sex, age, hearing status, parental hearing status, autism severity and classification, nonverbal intelligence (standard score on the TONI-4), and ASL receptive skills (standard score on the ASL RST).

In the sections that follow, the major linguistic characteristics of children with ASD are described, and the previous literature and contributing new insights from the author's own recent work are summarized, focusing on linguistic phenomena that appear to be similar in signing and speaking children, even with the limited data available: echolalia, pronoun avoidance, neologisms, and the presence of minimally verbal children. Some areas of divergence will be described, where the signing and speaking of children with ASD are different: pronoun reversal, palm reversal, and facial grammar. Finally, spatial grammar and pragmatics will be discussed. These phenomena have not yet been described in research, but they are expected to be impaired in signing children with ASD.

## SIMILARITIES BETWEEN SIGNING AND SPEAKING CHILDREN WITH ASD

### Echolalia

Echolalia, the repetition of the linguistic productions of others, often without communicative intent, is a frequently cited characteristic of hearing children with ASD.[25] There are several reports of echolalia in signing children that suggest that this phenomenon is modality

**Table 1 Summary of Characteristics of Participants with ASD**

| Sex | Age | Hearing Status | Parental Hearing Status | ADOS-2 Severity/ Classification | TONI-4 | ASL RST |
|---|---|---|---|---|---|---|
| M | 4;4 | Deaf | Deaf | 7/autism | n/a | n/a |
| M | 5;1 | Deaf | Deaf | 6/autism | 88 | 92 |
| M | 5;1 | Deaf | Deaf | 6/autism | n/a | n/a |
| M | 5;3 | Deaf | Deaf | 1/not ASD* | 100 | 84 |
| M | 5;3 | Hearing | Deaf | 6/autism | n/a | n/a |
| M | 6;0 | Deaf | Deaf | 4/autism spectrum | 100 | 78 |
| F | 7;1 | Deaf | Deaf | 7/autism | 98 | 70 |
| M | 8;5 | Deaf | CODA | 6/autism spectrum | 100 | 95 |
| M | 9;0 | Deaf | Deaf | 2/not ASD* | 92 | 104 |
| M | 9;5 | Deaf | Deaf | 6/autism | 80 | 70 |
| M | 9;6 | Deaf | Deaf | 7/autism | 86 | 84 |
| M | 9;8 | Deaf | Deaf | 6/autism | 117 | 79 |
| M | 10;10 | Deaf | Deaf | 5/autism spectrum | 102 | 90 |
| M | 10;2 | Hearing | Deaf | 6/autism | 69 | 70 |
| M | 11;0 | Deaf | Deaf | 5/autism spectrum | 100 | 99 |
| F | 11;1 | Deaf | Deaf | 8/autism | 104 | 98 |
| F | 11;8 | Deaf | Deaf | 5/autism | 87 | 78 |
| M | 12;6 | Hearing | Deaf | 10/autism | 101 | 78 |
| M | 12;7 | Deaf | Deaf | 6/autism | 96 | 81 |
| F | 14;4 | Deaf | Deaf | 9/autism | 100 | 96 |

Abbreviations: ADOS-2, Autism Diagnostic Observation Schedule; ASD, autism spectrum disorder; ASL RST, American Sign Language Receptive Skills Test; CODA, child of deaf adults; n/a, not available; TONI-4, Test of Nonverbal Intelligence, Fourth Edition.
*These children did not meet ADOS-2 criteria for autism spectrum; however, they were judged to meet a clinical picture of ASD by a clinical psychologist (a native signer of American Sign Language) who reviewed their educational and medical records as well as their videotaped data sessions.

independent, occurring in both speech and sign, and is not a byproduct of the vocal-auditory modality. Sign echolalia was first reported in 1990 by Poizner and colleagues,[26] who described the signing of an adult woman who was deaf and had ASD. Despite lifelong exposure to ASL from her parents who were deaf, her signing consisted largely of imitations of signs produced immediately before by her interlocutor, and exhibited little communicative intent or grammatical structure. Jure and colleagues reported that 5 of 21 (24%) children who were deaf with ASD in their sample who could sign words or phrases produced echolalic signed utterances.[13] Finally, in this sample of native-signing children with ASD, 5 of 20 children (25%) produced echoed signs during the ADOS-2. One child in particular, a male age 9;5, showed a strong tendency toward sign echolalia: of 63 total signs produced during the ADOS-2, 47 (75%) were echolalic and 16 (25%) were spontaneous. Of the 47 echoes, three were judged to have communicative intent, whereas 44 were purely echolalic. All of the spontaneous signs were nouns related to personal demands (e.g., JUICE*).

It is clear that sign echolalia exists and is characteristic of a certain subset of children with ASD. Clinicians, therefore, should consider sign echolalia to be a potential diagnostic marker of ASD when evaluating signing children. Although it is normal for children who are deaf to imitate the signs of others as part of the sign learning process, the exact and often uncommunicative nature of echoed signs is unusual, and as such can distinguish typical signing from the signing of a child with ASD.

## Pronoun Avoidance

Hearing children with ASD sometimes use proper names in contexts where pronouns are typically used (pronoun avoidance). There are two prior studies demonstrating this phenomenon in hearing children with ASD, both on a picture identification task. Jordan found that 8 of 11 (72.7%) autistic children (ages 6;8 to 16;5) produced their own name rather than the pronoun *me* when asked to identify a picture of themselves, whereas only 4 of 22 (18.2%) language-matched control children did so.[27] Lee and colleagues reported that on a similar task, 9 of 12 (75%) lower-ability ASD participants (ages 8;4 to 19;6) referred to themselves by name only, whereas just 3 of 12 (25%) non-ASD lower-ability participants did so.[28] They concluded that pronoun avoidance could reflect abnormalities in how such children experience the self, with a less-secure anchoring in a sense of "me-ness" than typically developing (TD) children.

One recent study found that signing children with ASD appear to respond identically to speaking children with ASD on similar pronoun elicitation tasks.[29] Shield and colleagues found that only 5 of 14 (35.7%) native-signing children with ASD produced the ASL pronoun ME (i.e., a point to self) when asked to identify a picture of themselves. The nine children with ASD (64.3%) who did not produce the pronoun ME each produced their name sign or finger spelled their English name. Similarly, only 7 of 14 (50%) ASD children produced the ASL pronoun YOU when asked to identify a picture of the experimenter (i.e., a point to the experimenter). The other seven children (50%) produced either the experimenter's name sign or finger spelled name (three children; 21.4%) or idiosyncratic nouns such as MAN or DOCTOR (four children; 28.6%).

The proportion of signing children who produced names rather than pronouns in this study was nearly identical to the two prior studies with hearing ASD children using similar tasks.[27,28] This is perhaps surprising given the fact that sign language pronouns point transparently to the people they represent. Yet signing and speaking children with ASD alike tend to avoid these pronouns in favor of names, at least in certain contexts. Given the robustness and consistency of these findings in both sign and speech, clinicians might consider whether a picture identification task similar to those described previously be incorporated into an ASD screening procedure for both children who are deaf and children who hear. Although referring to oneself with a name rather than a pronoun is not direct evidence of an ASD—TD children also sometimes do it, too—it could signal abnormalities in the child's developing sense of self, which is hypothesized to occur in ASD.[30]

* *As is conventional in the literature, we denote signs by their English translations in small caps.*

### Idiosyncratic Language: Neologisms

Idiosyncratic language is sometimes characteristic of hearing children with ASD. Volden and Lord found that children with ASD used more neologisms (nonwords or words not found in the standard lexicon) and idiosyncratic language than matched TD children and children with intellectual disability.[31] Though there has yet to be a formal study of neologisms in signing children with ASD, 11 of 20 parents (55%) in the sample used for this study indicated on the SCQ that their children invented new signs, and 13 of 20 parents (65%) indicated that their children would sign odd phrases. Shield also reported that one mother who was deaf of a child who was deaf with ASD stated in an interview that her son would make up new signs for anything that he did not know the sign for.[32] For example, he invented a novel sign for *Taco Bell* that made reference to the long pole holding the Taco Bell sign (rather than finger spelling #T-A-C-O-B-E-L-L, as was conventional in their family). It therefore appears that neologisms occur in both the sign and speech of children with ASD, and as such could be a red flag for clinicians evaluating such children.

### Minimally Verbal ASD

It is estimated that ~30% of hearing children with ASD never produce expressive language,[2] although their receptive (comprehension) abilities may be relatively intact. Research is currently under way at several laboratories investigating the receptive language skills of this portion of the population, which until now has not been studied in depth.

It is not well understood why such children do not produce expressive language. The inability to produce language does not necessarily imply an absence of language, but rather an impairment in the systems required to produce language, which can sometimes be circumvented with assistive technology. In a recent autobiography,[33] one child with autism described overcoming his inability to speak by learning to type. For other children, however, the inability to produce expressive language could reflect a true lack of language acquisition.

There is one case study in the literature of a nonverbal child who was deaf and had autism, a 10-year-old Greek boy, who used the Picture Exchange Communication System to communicate.[34] Despite having parents who were deaf and who used Greek Sign Language to communicate, and exposure to total communication, written Greek and finger spelling at school, the boy produced almost no signs (with the exception of the sign COME) and presented an extremely limited, nonfunctional communicative profile.

In the author's own data, 4 of 20 (20%) parents indicated on the SCQ that their children could not use short signed phrases, and three children did not produce a single sign during the administration of the ADOS-2. These children were among the youngest participants, ranging in age from 4;4 to 5;3, and had moderate to high severity scores on the ADOS-2. Therefore, it appears clear that a subset of children who are deaf and children who hear with severe ASD symptoms do not produce expressive language. The underlying causes of minimally verbal ASD are unknown in both hearing and children who are deaf but are worth examining in both populations, given the unique modality differences between speech and sign. It remains to be seen, in children who are deaf and are unable to produce language, if the inability to produce language is caused by the same underlying impairments as in hearing children. In particular, it is possible that motor sequencing impairments could affect the arms and hands differently than the vocal tract.

Thus, several areas of overlap have emerged in the comparison of signing and speaking children with ASD. Yet the modalities of sign and speech can also lead to different linguistic phenomena. Recent research has uncovered a few such areas, which will be described in the next section.

## DIFFERENCES BETWEEN SIGNING AND SPEAKING CHILDREN WITH ASD

### Pronoun Reversal

Person pronouns are words used to designate speaker roles in conversations (e.g., *I/me* and *you* in English). The tendency of some children with ASD to reverse first- and second-person

pronouns, especially to use the second-person pronoun (*you*) in reference to self, has been noted in many studies.[35–38] Such reversals, though still relatively infrequent, are more common in children with ASD than in any other group.[28]

To understand whether signing children who are deaf with ASD also reverse sign pronouns, it is first necessary to understand what a sign pronoun reversal would look like. Pronouns in ASL are points to self and other (Fig. 1). Therefore, a reversed pronoun would consist of a point to other to indicate self, or vice versa.

Petitto documented exactly this type of signed pronoun reversal in the signing of two very young TD children who are deaf, who used the pronoun YOU to refer to themselves for a brief period of time prior to the second birthday.[39] These two children appear to have interpreted the pronoun YOU as their name sign.

Shield and colleagues analyzed a corpus of 393 sign pronouns produced by 16 native-signing children during the ADOS-2, and found only two possible reversals (0.51%), both in an echolalic context (personal communication, A. Shield, R.P. Meier, H. Tager-Flushberg).[29] By contrast, Tager-Flusberg found 220 reversal errors in a corpus of 1673 (13.15%) spoken English pronouns produced by six hearing children with ASD between the ages of 3;4 and 7;7 during home-based mother–child play interactions.[38] This large discrepancy is striking, and suggests that spoken language pronouns could be more susceptible to reversal than sign language pronouns. This could be because sign language pronouns are transparent: they point toward the person to whom they refer. Thus, clinicians who work with signing children should be aware that pronoun reversal appears to be less common in sign, both for TD children and children with ASD.

## Palm Reversal

Some young hearing children with ASD have been found to make reversal errors when copying the gestures of others, such that, for example, a gestured hand wave with the palm facing outward would be copied by the ASD child with an inward-facing palm.[40–42] This type of error has been theorized to be a reflection of a deficit in "self–other mapping,"[43] that is, a deficit in translating the body movements of others into one's own body movements. In other words, children with ASD sometimes imitate gestures *as they appear from their own perspective*, leading to the reversed palm in the example of a wave gesture described previously.

Shield and Meier also found palm orientation reversals in the signing of children with ASD exposed to ASL from birth by their parents who are deaf.[17] In a series of experiments, they observed 10 native-signing children (nine children who were deaf and one child with hearing of parents who were deaf; ages 4;7 to 16;3) with ASD and 13 TD native-signing children who were deaf. Three of the younger children, all under age 10, produced numerous articulatory

**Figure 1** The American Sign Language (ASL) pronouns ME (left) and YOU (right).

hand errors in interaction with their teachers or parents, particularly reversals in palm orientation from inward to outward and vice versa. Finger spelling appeared to be especially susceptible to palm orientation reversals: these three children reversed between 47 and 71% of all finger spelled hand shapes. This finding is striking considering that these errors have not been reported in prior work on the acquisition of the finger spelling system of ASL,[44–46] nor did any of the children in the control group produce any palm reversals. Shield and Meier attributed these errors to the same self–other mapping deficit at work in gesture imitation errors by hearing children with ASD. However, in the case of signing children, it appears that an initial learning error then becomes part of the child's linguistic repertoire (e.g., an imitation error crystallizes into a production error).

Clinicians who work with signing children on the spectrum, therefore, should consider whether children they are evaluating produce any signs with a reversed orientation, as such productions could be a positive symptom of ASD and could warrant referral to a specialist. In the typical development of children who are deaf, these types of errors are virtually unattested past the second year. It should be noted, however, that these errors were found only in a subset of younger children. Therefore, it appears likely that such errors may appear at a certain point in development, but will not be observed in all signing children with ASD. With regard to intervention, it is possible that a palm-reversing child may find it useful to share the same perspective as the therapist, for example, side by side rather than across from each other. However, palm-reversal errors do not typically interfere with functional communication and as such may have only minor importance as a focus of intervention.

## Facial Grammar

Children with ASD have well documented deficits in their ability to produce facial expressions[47] and to understand the facial expressions of others.[48–52] For hearing children, these are purely social deficits, but for signing children, facial expressions are also part of the structure of the language. Signed languages encode a variety of grammatical structures on the face, including questions,[53] relative clauses,[54] conditionals,[55] topics,[56] and adverbial and lexical information.[57,58] These impairments pose a unique problem for the child who is deaf with autism acquiring sign, because the eyes and mouth sometimes encode different linguistic information.[59,60] For example, in ASL the mouth can encode lexical information (as in the sign NOT-YET, which is differentiated from the sign LATE by a mouth movement alone), adverbial information (e.g., a protruding tongue accompanied by exhalation THH indicates carelessness when produced with a verb), and adjectival information (e.g., puffed cheeks to indicate large size). The eye region is key for the signaling of questions (with raised or furrowed eyebrows), topicalized noun phrases (raised eyebrows), and conditionals (raised eyebrows and slight head tilt). Several studies have shown that individuals with ASD look more at the mouth area of the face while neglecting the eyes.[61,62] If children who are deaf with autism are impaired in their ability to gain/process information from the eye region but not the mouth, then this could differentially impact linguistic structures encoded in the eye region.

Parental responses to the SCQ in the author's data sample indicate that face gaze and facial expressions are indeed problematic for some children who are deaf, use sign, and have ASD. Nine of 20 (45%) respondents indicated that their children did not look directly at them while signing to them, 8 of 20 (40%) parents indicated that their children did not show a normal range of facial expressions, and 5 of 20 (25%) parents indicated that their children's facial expressions were inappropriate. Children also appeared to be impaired in their ability to nod their head yes (9 of 20 parents; 45%) and shake their head no (10 of 20 parents; 50%).

There is only one published study of facial expressions in signers who were deaf with ASD. Denmark and colleagues investigated how well British adolescents who were deaf with and without ASD comprehend emotional facial expressions during the signing of BSL sentences.[18] They compared a group of 13 children and adolescents who are deaf with ASD (age range 9;0 to 17;0, mean = 13;1) to a group of

12 TD deaf children (age range 8;5 to 16;5, mean = 12;3) matched for chronological age, BSL receptive and productive skills, and nonverbal intelligence. Children were shown signed sentences of neutral content (e.g., "Next week my brother is coming to visit"), which had been filmed eight times, each with a different facial expression (surprise, happy, sad, angry, neutral, annoyance, disgust, and mischief). Sentences were then presented to participants in two conditions: with the face and hands visible, or with the face digitally masked so that only the hands were visible. Participants were asked to then identify the emotion that was conveyed by the signed sentence, regardless of condition.

Both groups performed better in the unmasked condition, indicating that both TD children and children with ASD use the face to glean emotional information during signing. However, TD children recognized more emotions overall (68%) than children with ASD (46.5%), and there was a significant interaction between group and condition, suggesting that TD children were more affected by masking the face during signing than children with ASD. The participants with ASD performed more poorly than TD participants on three emotions in particular: mischief, happy, and angry; there were no significant differences between the groups for the other five emotions. Because children had been matched for age, BSL ability, and nonverbal intelligence, these results suggest that signers who are deaf and have ASD are less accurate at judging emotional facial expressions during signing. However, in this study the authors did not investigate linguistic facial expressions, such as those used to indicate questions or negation. In an unpublished work, Denmark investigated the comprehension and production of grammatical facial expressions by these same children.[63] TD children who are deaf were significantly more accurate than the ASD group in comprehending adverbial facial expressions, but the two groups performed similarly for facial expressions indicating questions or negation. Denmark concluded that people who are deaf and have autism may be specifically impaired in their ability to comprehend and produce adverbial facial markers. Furthermore, the equal performance on negative and interrogative facial expressions suggests that exposure to sign language could lead to improved facial expression recognition ability due to the need to attend to faces to perceive sign language (though these findings should be replicated, particularly with younger children, before a definitive conclusion can be drawn). Nevertheless, her surprising findings suggest that repeated exposure to a sign language may counteract underlying social deficits in autism and that at least some children who are deaf with autism are capable of acquiring facial grammar.

## OTHER POSSIBLE AREAS OF WEAKNESS FOR SIGNING CHILDREN WITH ASD

### Spatial Grammar

Several studies have shown that children with ASD are impaired in their ability to understand the differing visual perspectives of others.[64–66] If this is so, then sign language constructions that depend on an appreciation of another's perspective may also suffer as a result. Two areas of sign language grammar that could be particularly susceptible are the use of classifier constructions (e.g., the use of the 1 hand shape [the index finger] to represent a person moving through space) and agreement verbs (e.g., verbs such as ASL ASK, the movement of which indicates *who* is asking *whom*). When signers use both of these structures, the signer's perspective is assumed; therefore, perspective taking is necessary to understand the correct meaning.[67] For example, if a signer describes the spatial layout of a house and indicates that the living room is on the right after entering the house, the signer will indicate the living room on his or her right, not the addressee's right. A failure to take the signer's perspective could lead to comprehension errors. The author recently tested signing children with ASD and mental age-matched TD children who are deaf on the comprehension of classifier structures. Children were shown stimuli involving objects moving on either a vertical (up–down) plane or a horizontal (toward–away) plane. It was hypothesized that perspective taking is needed to properly comprehend horizontal, but not vertical, movements. Analyses are ongoing, but preliminary results showed that both children with ASD and TD children were able to understand vertical

classifier movements, but only children who also passed an independent, low-verbal perspective-taking task were able to comprehend horizontal classifier movements. This finding strengthens the hypothesis that perspective-taking skills are needed to understand sign, and that children with ASD may have particular difficulty with these structures.

### Pragmatics

Pragmatics refers to the ability to make and interpret utterances appropriately in context. Individuals with ASD tend to be overly literal and have difficulty understanding the unspoken implications in people's utterances, as well as sarcasm, humor, metaphor, prosody, and irony.[68] Similarly, people with ASD often use language in more limited ways and with less flexibility than TD children, making more requests, commenting less often, and being less likely to point, show objects, or use eye gaze to communicate.[69] It is likely that the pragmatic and functional impairments found in the speech of children with ASD will also be present in the signing of children with ASD, because the ability to understand context-dependent meanings and use language functionally is independent of language modality. However, there have been no studies of the pragmatic or functional abilities of signing children with ASD to date.

## SUMMARY OF IMPLICATIONS FOR CLINICIANS

Linguistic deficits are common in ASD. Overall, children with ASD tend to lag behind their peers in language acquisition, and signing children are no exception. This article is a preliminary attempt to describe the linguistic characteristics of signing children with ASD and the similarities and differences compared with speaking children with ASD. Of course, clinicians assessing these children should evaluate the entire clinical picture, with a focus on social engagement and reciprocity; restricted interests; and repetitive, stereotyped behaviors. However, it may be helpful for clinicians to understand how signed languages are structured, and how differences in the linguistic structure of sign and speech can lead to distinct surface-level phenomena. In this regard, clinicians should be aware that not all of the linguistic characteristics of speaking children with ASD will necessarily appear in the signing of children with ASD; the very low number of pronoun reversals in sign documented thus far is one chief example. Similarly, it is helpful to note that palm reversals in manual signs appear to be fairly common in signing children with ASD. This is a new type of error that has no obvious analog in speech.

Finally, some phenomena clearly manifest in both sign and speech. Echolalia, the use of neologisms, pronoun avoidance, and a lack of expressive language appear to be independent of language modality, and clinicians should be on the lookout for them equally in children who are deaf and children who hear.

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