Reference Production in Young Speakers with and without Autism:
Effects of Discourse Status and Processing Constraints

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ABSTRACT

We examine the referential choices (pronouns/zeros vs. names/descriptions) made by high-functioning children and adolescents with autism and a well-matched typically developing control group as they relate a narrative. The process of choosing appropriate referring expressions has been proposed to require mentalizing abilities. Given reports that autism is associated with mentalizing deficits, individuals with autism may have difficulty producing pragmatically appropriate references. Nevertheless, all participants in our analysis made adult-like referential choices, exhibiting fine-grained sensitivity to the discourse context. Furthermore, referential choices for all participants were modulated by factors related to the cognitive effort of language production. The only difference between diagnostic groups emerged as a tendency for the younger participants with autism to use a higher rate of names and descriptions than their typically developing peers when the referent was neither highly focused nor completely unfocused. We discuss the implications of these findings for the processes of reference production.

Key words: Reference, language production, pronouns, autism, theory of mind, language development
Whenever speakers refer, they must choose between linguistic expressions that are very explicit, like names or descriptions (Sylvester, the cat), or less contentful descriptions like pronouns (he, it) or zeros (…and Ø ran; …while Ø running.). This choice has been claimed to depend on an assessment of the listener’s mental state, where pronouns are specialized for reference to things in the listener’s focus of attention (e.g., Levelt, 1989; Gundel, Hedberg, & Zacharski, 1993). This might mean that reference production requires detailed and explicit models of the listener’s mental state, which could involve sophisticated mentalizing abilities. If so, we might expect different patterns of reference from populations that are known to have difficulty reasoning about mental states, like individuals with autism (e.g., Baron-Cohen, Leslie, & Frith, 1985), or very young children (Wellman, 1990; Wellman & Liu, 2004). On the other hand, speakers may use cognitive shortcuts to approximate the listener’s knowledge. For example, speakers may use their own knowledge of available information, like what has already been said. If so, we would expect individual speakers’ referential choices to be modulated by their own cognitive load (see Arnold & Griffin, 2007; Watson, Arnold, & Tanenhaus, in press), but would expect relatively few differences between distinct populations.

We present here an analysis of referential choices made by children and adolescents with high-functioning autism and their typically developing peers, examining the impacts of both the linguistic context and production-related cognitive load. The language of individuals with autism provides a useful domain for investigating questions about the role of theory of mind in language production, specifically the pragmatically-grounded choice between alternative referring expressions. Autism is a spectrum disorder that frequently involves linguistic impairments (e.g., Baron-Cohen, 1995; Rutherford, Baron-Cohen, & Wheelwright, 2002; Kanner, 1943; Tager-Flusberg, 2001a; Tager-Flusberg, Paul, & Lord, 2005). These
communicative deficits are said to occur principally in the pragmatic areas of language, that is, those processes that control the social and contextual appropriateness of language (Baltaxe, 1977; Rapin & Allen, 1988; Tager-Flusberg, 1999). While some individuals with autism never develop functional language (Tager-Flusberg, 2001a), even high-functioning autism is associated with pragmatic impairment (Bruner & Feldman, 1993; Diehl, Bennetto, & Young, 2006; Landa, Martin, Minshew, & Goldstein, 1995; Losh & Capps, 2003; Young, Diehl, Morris, Hyman, & Bennetto, 2005). As one example, Tager-Flusberg and Anderson (1991) found a lower use of contingent utterances (that is, utterances that relate to the previous one) in their Autism group, compared with a Down syndrome group, although Hale and Tager-Flusberg (2005) later found that contingent discourse use improved over the course of development. Children with autism also often confuse first and second person pronouns (I, you; Lee, Hobson, & Chiat, 1994).

A prominent explanation of linguistic and social deficits of autism suggests that they stem from problems representing the mental state of others, as shown by the tendency for people with autism to perform relatively poorly on theory-of-mind tasks (e.g., Baron-Cohen, et al., 1985; Baron-Cohen, Wheelwright, Hill, Yogini, & Plumb, 2001; Tager-Flusberg, 2001b). The relevance of theory-of-mind, or mentalizing abilities, for linguistic processing is demonstrated by Hale and Tager-Flusberg’s (2005) finding that the use of contingent discourse by individuals with autism correlated with their performance on theory-of-mind tasks.

Mentalizing abilities may be particularly relevant for producing and understanding reference. Typically developing toddlers pay attention to the speaker’s referential intentions to infer what a new word means. For example, they follow the speaker’s gaze to a novel object, instead of assuming the new word refers to an object in their own focus of attention (Baldwin, 1991; 1993; see also Baldwin & Tomasello, 1997; Bloom, 2002). By contrast, children with
autism have difficulty using such inferences to learn new words (Baron-Cohen, et al., 1985; Preissler & Carey, 2005). For example, Preissler and Carey (2005) presented children with a novel object, while the experimenter held a different novel object and uttered a novel word like “peri” while looking at either their own or the child’s object. While typically developing toddlers tended to map the novel word onto the object that the speaker was looking at, the 5-to-9-year-old children with autism were more likely to choose the object they were looking at themselves. By contrast, a second experiment demonstrated that children with autism were equally as proficient as typically developing toddlers at learning new words in situations that did not require taking another’s perspective.

If referential communication depends on the ability to model the focus of attention of one’s interlocutor, we might expect differences between individuals with and without autism in how they refer to entities in a discourse. It has been claimed that speakers only use underspecified expressions, like pronouns, when they assume that the referent is already in the focus of attention of their interlocutor, or at least when the reference is contextually unambiguous (e.g., Bard & Aylett, 2004; Brennan, 1995; Chafe, 1976, 1994; Grosz, Joshi, & Weinstein, 1995; Gundel et al., 1993; Levelt, 1989). As described by van der Meulen, Meyer, & Levelt (2001), “Speakers keep… a more or less veridical account of their addressee’s state of mind, the so-called discourse model,” (p. 513, emphasis in original). If pronoun use does depend on assumptions about the listener’s mental state, we may find that individuals with autism either systematically produce pronouns that are uninterpretable to the listener, or that they systematically overspecify by using explicit expressions even when a pronoun would be sufficient.
Reference processes: Evidence from typical adults

The idea that reference production depends on assumptions about the listener’s focus of attention comes in part from studies of how the linguistic context affects the choice between alternate possible expressions (see Arnold, in press, for a review). For example, recently mentioned entities can be assumed to be in the focus of attention of all discourse participants, leading to a high proportion of pronouns and zeros, for example, Jane worked all day, Ø went to the gym, and I didn’t see her until 9pm. (e.g., Ariel, 1990; Arnold, 1998; Givón, 1983; Gundel, et al., 1993). The structural and thematic properties of the last reference to an entity are also important. Pronouns are more likely for entities previously mentioned in subject, rather than object or oblique, positions; for entities in the parallel grammatical function as the current referring expression; and for entities that previously played particular semantic roles (e.g., Arnold, 1998; 2001; 2003; Arnold & Griffin, 2007; Brennan, 1995; Givón, 1983; Stevenson, Crawley, & Kleinman, 1994). These factors together comprise the discourse status of each entity. When a referent enjoys a prominent discourse status, speakers tend to use underspecified expressions like pronouns.

The idea that referential expressions are designed for interpretability is also supported by evidence that speakers use pronouns more often when the discourse context contains only one referent that matches the features of the pronoun. For example, pronouns are more frequent in a context with one female and one male character than in an identical context with two female characters (e.g., Arnold, Wasow, Losongco, & Ginstrom, 2000; Francik, 1985). This “gender effect” is often explained as an ambiguity avoidance strategy (but see Arnold & Griffin, 2007).

At the same time, the constraining role of the discourse context raises an alternate possibility. Since everything in the discourse is usually public to all interlocutors, speakers could
simply represent the discourse status of entities in their own mind, and ignore their addressee. If so, we would not expect differences in referential choices by individuals who have difficulty performing mentalizing tasks, like children with autism.

At the very least, there is evidence that choices in reference production are not purely driven by the needs of the addressee, in that speakers’ choices are modulated by factors that affect their ability to represent the characters and actions in a discourse situation. Arnold and Griffin (2007) found that speakers were less likely to use pronouns in a story-telling experiment when a second character was present, drawing the speaker’s attention away from the other character. This occurred even though the target character was the most salient in the discourse context, and the second character always had a different gender from the target, so even a pronoun would be unambiguous. Thus, the speaker’s ability to focus attention on even the main character can influence the use of pronouns and zeros. Further support for the role of production-internal processes comes from preliminary results from another experiment, where pronoun use declined when working memory capacity was compromised (Griffin & Arnold, in preparation).

Methodological approach and predictions

The current study builds on the above findings, seeking evidence of the effects of both discourse context and current cognitive load. We report an analysis of the referential choices made in narratives told by children and adolescents with high-functioning autism and a well-matched control group of typically developing adolescents. Each participant viewed a Sylvester and Tweety cartoon (Canary Row, see also McNeill, 1992), in three installments, and told the narrative to an experimenter who feigned ignorance of the story. We analyzed each reference to the three main characters: Sylvester the cat, Tweety the bird, and Granny, the bird’s owner.
Because the story was provided by the cartoon, we could infer in most cases who the intended referent was, based on what happened in the video. We calculated the frequency with which each participant used underspecified expressions (pronouns or zeros) out of all singular references to that character.

The approach used here offers several advantages. First, we investigate reference within the context of a fine-grained analysis of the linguistic context. This is important because it allows us to ask whether participants with and without autism respond in the same way to each discourse context. Moreover, it makes it possible to observe differences that occur only in certain contexts, which would be missed by a simple count of pronouns. We predicted that both groups would be sensitive to the discourse context. Weber (2003) reports that the references made by two boys with autism adhere to the predictions of Preferred Argument Structure (Du Bois, 1987), showing similar patterns to those of typical adults (e.g., Kumpf, 1992; Thompson, 1997). For example, the highest incidence of pronouns/zeros occurred in intransitive subject position, slightly fewer for transitive subjects, and the least for objects. Likewise, the rate of reference to previously mentioned information declined from intransitive subjects to transitive subjects to objects, and so did the incidence of reference to animate entities. However, Weber did not specifically analyze the relationship between pronouns/zeros and the discourse status, nor did she provide any direct comparison with a typical control group in the same situation.

Second, we examine how referential choices correlate with a set of discourse features that index the processing load experienced during the production of individual utterances: disfluency and utterance length. This tests the proposal that reference production is influenced by more than just designing expressions to be interpretable in context. As Arnold and Griffin (2007; see also Griffin & Arnold, in preparation) have argued, reduced cognitive resources during utterance
planning can lead to a reduction in the activation of the referent in working memory, leading to a higher rate of explicit referential expressions.

Third, our study compares reference production between matched autism and control groups. This comparison is critical because all people (adults and children) occasionally produce references that seem somewhat odd upon closer inspection, so the presence of unpredicted tokens is not evidence of atypicality. The same is true of our sample; Tables 1 and 2 show examples of two kinds of pragmatically odd references. Table 1 demonstrates cases where a pronoun or zero is used when the intended referent is not currently the most salient entity that matches the expression. These would probably cause confusion for the comprehender. Table 2 shows cases where the speaker used an expression that is too explicit, repeating a name or description when it is the most salient entity in the current segment. Although these references do not pose the same kind of communication problems as the unclear pronouns, this kind of over-explicit reference can slow comprehension (Hudson-D’Zmura & Tanenhaus, 1998; Gordon, Grosz, & Gilliom, 1993).

Instead, the question to be examined here is whether referential patterns are systematically different. If speakers with autism have difficulty modeling the comprehension needs of their addressee, we might assume that they would overuse pronouns and zeros, perhaps in situations where the referent is accessible in their own mind but not their addressee’s. On the other hand, there is some evidence that individuals with autism have impairments in working memory compared with their peers (Bennetto, Pennington, & Rogers, 1996; Joseph, Steele, Meyer, & Tager-Flusberg, 2005). This could predict an overuse of explicit expressions by the Autism group, after discourse status of the referent has been controlled (for observations supporting this prediction, see Baltaxe, 1977).
Table 1. Examples of unclear referential choices. The right column specifies the intended referent for underlined pronouns and zeros, as well as points of confusion.

<table>
<thead>
<tr>
<th>1. Control participant, age 15</th>
<th>Ø = Tweety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ø = Tweety</td>
</tr>
<tr>
<td>(him used for Sylvester when Tweety has been more recently mentioned)</td>
<td>him = Sylvester</td>
</tr>
<tr>
<td>• and uh tweety started flipping out</td>
<td>him = Sylvester</td>
</tr>
<tr>
<td>• and Ø ran</td>
<td>(last two uses of “him” would initially be interpreted as coreferential with Tweety)</td>
</tr>
<tr>
<td>• and Ø got the old lady</td>
<td>(he = Sylvester)</td>
</tr>
<tr>
<td>• and the old lady whacked him</td>
<td>(he = Tweety)</td>
</tr>
<tr>
<td>• and threw him down to the ground</td>
<td>(him = ?)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2 Participant with autism, age 15</th>
<th>(he = Sylvester)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(he = Tweety)</td>
</tr>
<tr>
<td>• and there's a guy named um sylvester</td>
<td>(him = ?)</td>
</tr>
<tr>
<td>• and he's this black like cat a er yeah he’s a cat yeah</td>
<td>(he = ?)</td>
</tr>
<tr>
<td>• and um there's a yellow tweety bird</td>
<td>(he = Sylvester)</td>
</tr>
<tr>
<td>• and he's in the cage</td>
<td>(he = Sylvester)</td>
</tr>
<tr>
<td>• and um first you see him looking through at um like outside to see what he sees</td>
<td>(he = ?)</td>
</tr>
<tr>
<td>• and um then he's trying to find ways to um get the bird</td>
<td>(he = Sylvester)</td>
</tr>
</tbody>
</table>
Table 2. Examples of overspecified referential choices, where a repeated name or description is used even though the referent is currently in discourse focus. Overspecified references are underlined.

1. Control participant, age 12
   - and then he starts looking for the bird
   - and then the granny gives him a shiny penny
   - and then he lifts his hat
   - and then the granny whacks him in the head again
   - and then the **granny** calls the desk clerk

2 Participant with autism, age 10
   - but it like hits the wall next to the window where the bird is
   - and um then the cat's like thinking some more
   - and the **cat** climbs up a like electric wire

Methods

The narratives analyzed here were collected as part of a larger study of communication in autism at the University of Rochester.

Participants

Participants were 23 children and adolescents with autism between the ages of 9 and 17 years, and 23 children and adolescents with typical development (see Table 2). Diagnoses of autism were confirmed in the autism group and ruled out in the control group with a combination of the Autism Diagnostic Interview-Revised with the parent (Rutter, LeCouteur, & Lord, 2003) and the Autism Diagnostic Observation Schedule with the participant (Lord, Rutter, DiLavore, & Risi, 1999). For the control participants, there was also no evidence of learning disabilities,
language delays, or other behavioral or psychiatric disorders, and no concerns about autism spectrum disorders in their first- or second-degree relatives.

Depending on participant’s age, we administered the Wechsler Intelligence Scale for Children-3rd Edition (Wechsler, 1991) or Wechsler Adult Intelligence Scale-3rd Edition (Wechsler, 1997). Receptive language level was further evaluated with the Peabody Picture Vocabulary Test, 3rd Edition (PPVT-III, Dunn & Dunn, 1997).

Participants were matched by group means on age, Full Scale IQ (FSIQ), Verbal IQ (VIQ), PPVT-III Standard Score, and gender composition. For the purposes of evaluating developmental trends, participants were grouped by age into younger (n=10 in each group; ages 9.8 – 12.9) and older (n=13 in each group; ages 13.1-17.8) age groups, using the same chronological age criterion for both diagnostic groups (Autism and Control).

*Table 3. Participant characteristics.*

<table>
<thead>
<tr>
<th></th>
<th>Autism Younger (n = 10)</th>
<th>Autism Older (n = 13)</th>
<th>Control Younger (n = 10)</th>
<th>Control Older (n = 13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronological Age</td>
<td>11.1 (0.3)</td>
<td>15.1 (0.2)</td>
<td>11.6 (0.3)</td>
<td>14.6 (0.4)</td>
</tr>
<tr>
<td>Verbal IQ</td>
<td>114 (3.9)</td>
<td>117 (4.0)</td>
<td>117 (3.6)</td>
<td>120 (4.3)</td>
</tr>
<tr>
<td>Performance IQ</td>
<td>110 (8.4)</td>
<td>113 (6.5)</td>
<td>110 (3.8)</td>
<td>115 (4.5)</td>
</tr>
<tr>
<td>Full-scale IQ</td>
<td>114 (5.5)</td>
<td>117 (4.8)</td>
<td>116 (3.0)</td>
<td>120 (4.5)</td>
</tr>
<tr>
<td>Receptive Language</td>
<td>112 (3.6)</td>
<td>119 (3.0)</td>
<td>115 (4.3)</td>
<td>119 (3.5)</td>
</tr>
<tr>
<td>Gender (M:F)</td>
<td>9:1</td>
<td>11:2</td>
<td>9:1</td>
<td>12:1</td>
</tr>
<tr>
<td>Handedness (R;L)</td>
<td>7:3</td>
<td>11:2</td>
<td>7:3</td>
<td>11:2</td>
</tr>
</tbody>
</table>
Note: Numbers presented are group means, with standard error of the mean in parentheses. Verbal, Performance, and Full Scale IQ scores were measured with the Wechsler Intelligence Scale for Children-3rd Ed. or the Wechsler Adult Intelligence Scale-3rd Ed. Receptive Language was measured with the PPVT-III Standard Score.

This research was approved by the University’s Research Subjects Review Board. Prior to testing, written informed consent was obtained from parents and written assent was obtained from the participants.

Narrative elicitation

Participants watched “Canary Row,” a Sylvester and Tweety Bird cartoon that has previously been used to elicit narratives and gestures (McNeill, 1992). The cartoon involves a clear story line in which Sylvester the cat attempts (unsuccessfully) to catch Tweety the bird, who is protected by its owner, Granny. The 7.5-minute cartoon was divided into three segments to decrease memory load; after each segment the participants retold the story to a confederate who pretended not to have seen the cartoon.

Transcription and Coding

Two coders at the University of Rochester, who were blind to the participants’ diagnoses, transcribed the videotaped narratives. All verbal aspects of the narratives were transcribed, including disfluencies, and coders achieved 95% reliability. Each narrative was then divided into clauses, which comprised each main or subordinate clause, all its arguments and adjuncts, and any dependent subordinate clauses (see Table 3). Coders achieved 96% reliability for
determining clause breaks. For each clause, coders recorded the number of words in the clause (not including disfluent or repaired words). A separate analysis of the presence and types of disfluencies is reported elsewhere for a subset of this sample (Bennetto, Diehl, & Arnold, 2007).

Three coders at the University of North Carolina at Chapel Hill, also blind to the participants’ diagnoses, then examined each clause for any singular references to Sylvester, Tweety, or Granny. Seven participants were coded by two or more coders to check for cross-coder reliability. They achieved 95% reliability for identifying the form of reference (pro, zero, or name/NP); nearly all mismatches occurred because one coder failed to provide a coding. The independent variables were also checked for cross-coder reliability for all references that had not been omitted altogether by one or more coders. Coders achieved a 98% accuracy on grammatical function of the referent, 94% accuracy on the number of clauses since last mention of the entity, and 94% accuracy on the grammatical function of the last mention of the referent. The first author checked all codings for consistency and corrected if necessary. In most cases, it was obvious who the speaker was referring to, given the events in the cartoon. The few truly ambiguous references were excluded from analysis. If there was more than one reference in a clause, only the first one was analyzed. If a referential form was repaired to another form in the same clause, the first form chosen was used in the analysis (e.g., *alright, Sylvester was he went he climbed up the gutter pipe inside*)

The referring expression type was coded as one of the following categories: zeros (*and Ø ran*), pronominal (*he, she*), name (*Sylvester, Tweety, Granny*), definite NP (*the cat*), indefinite NP (*a cat*), or bare NP (*cat*). Examples are provided in Table 4. These codings were collapsed into a binary contrast between the underspecified zeros and pronouns, and the more explicit names and NPs (cf. Givón, 1983; Gundel et al., 1993). This constituted the dependent variable,
which is reported here as the proportion of pronouns/zeros out of all singular references (i.e., all pronouns/zeros and names/descriptions). Possessive references (his head) and compound references (e.g., they, Tweety and Granny) were not included in the analysis, but they counted as prior mentions.

The grammatical function of each reference in its utterance was coded (e.g. subject, or object/object-of-preposition). Each reference was also coded for the number of clauses since the most recent reference to the same character: 1 clause back (i.e., previous clause), 2 clauses back, 3 or more clauses back, or no prior mention. For references to something that had been mentioned in the previous clause, the grammatical function of its prior mention was coded as subject or nonsubject (i.e., object/object-of-preposition). At the start of each episode, all characters were considered to have no prior mentions.

Table 4. Examples of coding categories

<table>
<thead>
<tr>
<th>A. Examples of clauses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple main clause: he went up</td>
</tr>
<tr>
<td>Coordinated main clause: and Ø ran</td>
</tr>
<tr>
<td>Subordinate finite clause: while he ran</td>
</tr>
<tr>
<td>Main clause with complement clause: and then he tries to swing over into the other building</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Referential form (example reference is underlined)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero: he grabbed it; Ø ran out the back alley; Ø opened it up (Autism, age 15.3)</td>
</tr>
<tr>
<td>Pronoun: after that he got kicked out (Autism, age 10.3)</td>
</tr>
<tr>
<td>Definite NP: while um the bird was singing (Control, age 12.3)</td>
</tr>
<tr>
<td>Name: Tweety flew out yelling help me help me (Autism, age 15.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Not included in the analyses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possessive: and um I think maybe she saw his ears (Control, age 12.0)</td>
</tr>
<tr>
<td>Plural: and it's being driven by Tweety and Granny (Control, age 14.5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Recency of mention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 clause back: while Sylvester was in a different one</td>
</tr>
<tr>
<td>and he he just ran into the building (Autism, age 10.3)</td>
</tr>
</tbody>
</table>
D. Grammatical function of current expression and mention in previous clause:

<table>
<thead>
<tr>
<th>Current expression:Previous mention</th>
<th>Subject:Subject</th>
<th>Subject:Nonsubject</th>
<th>Nonsubject:Subject</th>
<th>Nonsubject:Nonsubject</th>
</tr>
</thead>
<tbody>
<tr>
<td>and he runs</td>
<td>and Ø gets zapped again. (Autism, age 11.8)</td>
<td>and Ø got the old lady (Control, age 15.1)</td>
<td>and then he climbs through the water pipe. and then tweety sees him (Control, age 12.4)</td>
<td>Ø trying to find the bird (Control, age 13.3)</td>
</tr>
<tr>
<td>And he had binoculars</td>
<td>And he was looking at it (Control, age 10.3)</td>
<td>And the old lady whacked him (Control, age 15.1)</td>
<td>and Ø chases tweety. and the granny mistakes him for a monkey. (Autism, Age 14.5)</td>
<td>And the cat is trying to chase the bird But he never catches her. (Autism, age 10.0)</td>
</tr>
</tbody>
</table>

Results

All results are reported here as the average of participant means for the Autism and Control groups, divided by age group. The reliability of each pattern was assessed by submitting
the participant means to analysis of variance (ANOVA). All ANOVAs included the between-participant independent variables of Group (Autism vs. Control) and Age (younger vs. older). The critical analyses of discourse and cognitive effort effects also included within-participant variables, as described below. For proportion data, each ANOVA was conducted with both the raw data, and with an arcsine transformation of each participant mean (Winer, Brown, & Michels, 1991). For transparency we report the raw means and analyses; the arcsine analysis always produced the same significance patterns unless otherwise noted.

**General Narrative Characteristics**

As background to understanding the analysis on choices between more- and less- explicit expressions, it is important to assess the distribution and frequency of references overall, and within each discourse context. Perhaps the most notable difference between groups was the tendency for participants with autism to produce fewer references overall than typically developing controls, as shown in Table 5. The total number of references were submitted to a 2x2 ANOVA with Group and Age as independent variables, which revealed a main effect of Group, $F(1,42) = 6.68, p = .013$, but no effects or interactions with age. This finding stems directly from Bennetto et al.’s (2007) finding (with a subset of this sample) that participants with autism tended to produce shorter narratives. The means for our sample (Table 5) show the same difference. A 2x2 ANOVA again revealed a main effect of Group, $F(1,42) = 7.09, p = .011$, and no effects or interactions with Age. Nonetheless, as reported by Bennetto et al. (2007), the average length of each clause was the same for Autism and Control groups, and for both age groups. In sum, the linguistic complexity of each utterance was the same across groups, but the
participants with autism provided less detail about each narrative. For more detail about the complexity of these narratives, see Bennetto et al. (2007).

Table 5. Overall narrative length and number of words and references

<table>
<thead>
<tr>
<th></th>
<th>Autism</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Younger</td>
<td>Older</td>
</tr>
<tr>
<td>Average # clauses per narrative</td>
<td>59</td>
<td>79</td>
</tr>
<tr>
<td>Average # words per clause</td>
<td>7.2</td>
<td>7.0</td>
</tr>
<tr>
<td>Sylvester: % pro (avg. N)</td>
<td>.77 (41)</td>
<td>.90 (55)</td>
</tr>
<tr>
<td>Tweety: % pro (avg. N)</td>
<td>.23 (11)</td>
<td>.27 (14)</td>
</tr>
<tr>
<td>Granny: % pro (avg. N)</td>
<td>.27 (7)</td>
<td>.58 (10)</td>
</tr>
</tbody>
</table>

Note: The percentage of pronouns are reported out of all singular references, averaged by participant within each participant group. The average number of references to each character is in parentheses.

Of particular relevance to the process of choosing referential expressions is the distribution of different discourse contexts within each participant’s narrative. Pronouns and zeros are most likely to occur when the referent was prominently mentioned (e.g. recently or in a prominent syntactic position), and especially when the referring expression was in a parallel position. Figure 1 presents the proportion of reference types, categorized by the syntactic position of the current referring expression (subject vs. nonsubject) and the syntactic position of the last mention of the referent (subject, nonsubject, not in previous clause). Despite the differences in narrative lengths, all participant groups were remarkably similar in their distribution of reference types. The most frequent type of reference is subject-to-subject
references (i.e., the subject co-refers with the grammatical subject of the previous clause). Overall, there were also many more references in subject position than nonsubject position (80% of the dataset).

![Figure 1](image)

Figure 1. Percentage of references by discourse context, averaged by participant within each diagnostic / age group.

**Reference Form Choices**

We examined how the production of pronouns and zeros by participants of different ages and from each diagnostic group were influenced by two categories of constraint: 1) The discourse status of the referent, as assessed by the linguistic characteristics of how it had last been mentioned (e.g., how recently, and in what syntactic position), and 2) Phenomena that are
expected to influence the cognitive load that the speaker is currently experiencing: disfluency and clause length. As described above, both discourse status and cognitive load have been shown to correlate with the reference form choices of typical adults.

**Discourse Status Effects.** Two measures of discourse status were examined: recency of mention of the character, and for those things that had been mentioned in the previous clause, the syntactic position of the current expression and that of its last mention. Recency of mention was calculated as the number of clauses since the character was last mentioned, grouped into four categories: previous clause, 2 clauses back, 3 or more clauses back, never mentioned within the episode. The analyses presented below show that both age groups and both diagnostic groups exhibited sensitivity to both of these measures, as predicted by adult reference production in other studies (Arnold, 1998, 2001, 2003; Arnold & Griffin, 2007; Brennan, 1995; Givón, 1983; Stevenson et al., 1994). At the same time, the Autism group differed from the Control group by showing a developmental trend: the younger participants produced fewer pronouns than the older ones.

As shown in Figure 2, all participants used the most pronouns/zeros when the referent was last mentioned in the previous clause. As the number of clauses since the last mention of the referent declined, the use of full forms (names and descriptions) increased. However, the youngest Autism group used fewer pronouns per category than the older Autism and both Control age groups. This interaction was especially pronounced in the two categories of discourse context where the choice of referring expression is not as strongly constrained (i.e., when the referent was previously mentioned, but not in the immediately preceding clause). That is, all groups converged on a high rate of pronouns/zeros when the referent was just mentioned;
and all used nearly 100% explicit expressions when it had not been mentioned at all, but the
younger Autism group tended to use more explicit expressions in the middle two categories.

These data were submitted to a 2x2x4 ANOVA with two between-participant variables
(Group and Age) and one within-participant variable, Recency of mention (previous clause vs. 2
clauses back vs. 3 clauses back vs. no previous mention). There was a significant three-way
interaction between Diagnostic Group (Autism vs. Control), Age, and Recency, $F(3,126) = 4.93,$
$p = .003.$ There was also a main effect of Age $F(1,42) = 4.78,$ $p = .034,$ a Group x Age
interaction, $F(1,42) = 12.58,$ $p = .001,$ and a main effect of Recency, $F(3,126) = 308.79,$ $p <
.001$. Separate ANOVAs with data from the Autism and Control groups revealed that the three-
way interaction was carried by a developmental trend in the participants with autism, who
exhibited main effects of both Age, $F(1,21) = 11.86,$ $p = .002,$ and Recency, $F(3,63) = 152.46,$ $p
< .001,$ and an interaction between the two, $F(3,63) = 6.03,$ $p = .001.$ The use of pronouns/zeros
in the Control group was only influenced by Recency, $F(3,63) = 157.28,$ $p < .001.$

---

1 One participant in the younger Autism group had one missing cell, which was replaced by the
participant mean.
Figure 2. Percentage of pronouns/zeros chosen as a function of the recency of the last mention of the referent character. Error bars represent standard error of the mean.

It may seem surprising that there are any pronouns/zeros at all when the character had not been previously mentioned. There were 19 such references in the database (11 from the Autism group, and 8 from the Control group). All occurred in the second or third episodes on the first mention of the character within that episode. Seventeen of these were references to Sylvester, who could have been considered so salient to the story that he did not require naming. One reference was to Tweety (well first uh the cat tries to get uh him again), and another to Granny (… she threw him out the window again), both of which were understandable in context. These
tokens underscore the fact that while discourse status is highly constraining, it does not fully determine speakers’ choices.

As a second measure of discourse status, we examined all references to something that had also been mentioned in the previous clause (66% of all references), analyzing the effect of the syntactic position in which the character had last been mentioned. It is widely established that speakers tend to use pronouns and zeros more often for entities that were just mentioned in subject position, compared with those just mentioned in nonsubject positions (Arnold, 1998; Brennan, Friedman, & Pollard, 1987; Brennan, 1995; see Arnold, in press, for a review). It has been suggested that subject position confers salience on the entities referred to, such that the speaker can assume that the listener is more likely to focus attention on things in subject than nonsubject positions. An independent factor is the parallelism between the syntactic position of the referring expression itself and the last mention of the referent, where pronouns and zeros are more common for parallel than nonparallel reference (Arnold, 1998; for related evidence from comprehension see Grober, Beardsley, & Caramazza, 1978).

Participants in both age groups were sensitive to both the syntactic position in which a referent had previously been mentioned, and parallelism with the current referring expression. We analyzed these two factors as independent variables in an analysis of all references to something that had been mentioned in the previous clause in the singular (i.e., not as part of a compound). However, the relatively low occurrence of references in object position meant that 12 participants (8 Autism, 4 Control) were missing one of the cells for nonsubject referring expressions. These 12 cells (out of a total of 184) were replaced by the participant mean, which is a conservative strategy because it reduced the chance of finding the critical differences. Nonetheless, as shown in Table 6, participants in all Age / Diagnostic groups showed the
predicted tendency to use pronouns more for something that was previously mentioned in subject position than something previously mentioned in object position. At the same time, there were relatively more pronouns/zeros when the current referring expression and last mention of the referent were in parallel syntactic positions. These data were submitted to an ANOVA including Group, Age, Syntactic Role of Previous Mention (subjects vs. nonsubject) and Parallelism of reference (Parallel vs. Nonparallel). The results showed a main effect of previous syntactic position, $F(1,42) = 34.25, p < .001$, and a main effect of parallelism $F(1,42) = 6.19, p = .017$. There were no effects or interactions with Group or Age.

Table 6. Rate of pronouns/zeros out of all singular references, depending on the syntactic position in which the referent was last mentioned (subject vs. nonsubject), and whether the current syntactic position is the same (parallel) or not (nonparallel). Standard Error in parenthesis.

<table>
<thead>
<tr>
<th></th>
<th>Autism younger</th>
<th>Autism older</th>
<th>Control younger</th>
<th>Control older</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel, previous Subject (Subject-to-Subject)</td>
<td>0.96 (.02)</td>
<td>0.97 (.01)</td>
<td>0.95 (.03)</td>
<td>0.96 (.01)</td>
</tr>
<tr>
<td>Nonparallel, prev. Subject (Nonsubject-to-Subject)</td>
<td>0.81 (.08)</td>
<td>0.94 (.03)</td>
<td>0.80 (.08)</td>
<td>0.88 (.04)</td>
</tr>
<tr>
<td>Parallel, previous Nonsubject (Nonsubject-to-Nonsubject)</td>
<td>0.72 (.08)</td>
<td>0.77 (.07)</td>
<td>0.80 (.08)</td>
<td>0.76 (.06)</td>
</tr>
<tr>
<td>Nonparallel, previous Nonsubject (Subject-to-Nonsubject)</td>
<td>0.70 (.12)</td>
<td>0.81 (.04)</td>
<td>0.74 (.06)</td>
<td>0.62 (.06)</td>
</tr>
</tbody>
</table>

Because of the large number of missing cells, we also assessed the effect of the syntactic position of previous mention by further restricting the analysis to references in subject position (87% of all of the references to something in the previous clause). Figure 3 shows that all participants exhibit the predicted effects of syntactic position: nearly exclusive use of pronouns
or zeros for parallel reference to something that was previously mentioned in subject position, and fewer pronouns/zeros for nonparallel reference to something previously mentioned in a nonsubject position. A 2 (Group) x 2 (Age) x 2 (Syntactic role of previous mention) ANOVA revealed a main effect of Previous Mention $F(1,42) = 47.81, p < .001$, and no effects or interactions with Group or Age. The lack of Group or Age effects suggests that the developmental trend in the Autism group is restricted to references when the last mention of the referent occurred prior to the preceding clause.

![Figure 3](image)

**Figure 3.** Percentage of pronouns/zeros chosen as a function of the grammatical function of the last mention of the referent, including all referents last mentioned in the previous clause. Error bars represent standard error of the mean.

**Effects of Cognitive Load.** To assess the effects of processing effort on reference production choices, we analyzed the rate of pronouns/zeros under two conditions where the
speaker was likely to be experiencing cognitive load: 1) the presence of disfluency, and 2) the number of words in the clause being currently being produced.

Disfluency occurs naturally in spoken language, as speakers utter disfluent filler words like *uh* or *um*, repeat or repair words, or even use disfluent pronunciations like “thiy” (rhyming with “tree”) instead of “thuh” for *the* (Clark & Fox Tree; 2002; Clark & Wasow, 1998; Fox Tree and Clark, 1997). It is generally agreed that disfluent elements like these occur under conditions where the speaker is having some difficulty planning and/or producing their utterance (Bortfield, Leon, Bloom, Schober, & Brennan, 2000; Goldman-Eisler, 1968; Siegman, 1979; Beattie, 1979; Clark & Fox Tree, 2002; Clark & Wasow, 1998). Even though such difficulty can occur for many reasons, the presence of disfluency can be used as a metric that the speaker is currently experiencing cognitive difficulty. If such load adversely affects the speaker’s ability to represent the discourse context, we might expect a lower rate of pronouns and null references under conditions of disfluency. This is what Arnold & Griffin (2007) observed for adult speakers without autism.

As predicted, participants in both the Autism and Control groups in the current sample were more likely to use a pronoun or zero in fluent utterances than disfluent ones (see Table 7). To control for variations in clause complexity, this analysis was limited to only references in subject position, although disfluency also predicts reference choice in the full dataset. The ANOVA (including Disfluency, Age, and Group as independent variables) revealed a main effect of Disfluency, $F(1,42) = 35.48, p < .001$. As in the analyses above, there was also an interaction between Group and Age, $F(1,42) = 5.85, p = .020$, reflecting the same overall lower use of pronouns by the younger Autism group. There were no other main effects or interactions.

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2 Nonsubject references tend to occur in longer clauses than subject references do, on average.
Although disfluency is a good indicator of cognitive load, participants can also expend cognitive effort in the planning and production of fluent utterances. In particular, planning and production processes are expected to increase as the length of the clause being produced increases. Even though a certain amount of incremental planning takes place as the utterance unfolds (e.g., Fereirra, 1993; Griffin, 2003), there is evidence that listeners plan at least some aspects of an utterance at its onset: longer clauses have a greater incidence of disfluency (Clark & Wasow, 1998), and a higher likelihood of nondisfluent pauses immediately before the clause (Watson & Gibson, 2004). In Bennetto et al.’s (2007) analysis of a subset of these narratives, participants also tended to produce disfluency at the onset of long clauses more often than at the onset of short clauses, at the same rate for participants with and without autism.

If the referential choices are influenced by the cognitive load incurred by normal planning and production, we would expect a greater rate of pronouns for shorter (1-6 words) than longer utterances (7+ words). The data support this prediction, as shown in Table 8. In order to isolate the effect of clause length, this analysis was restricted to references in subject position, within fluent utterances. The ANOVA with independent variables Group, Age, and Clause Length (short vs. long) revealed a main effect of Clause length, $F(1,42) = 9.05, p = .004$. As before, there was an interaction between Group and Age $F(1,42) = 5.29, p = .027$, although it was marginal in the arcsine-transformed analysis, $F = 3.87, p = .056$. There was no effect of Group nor interactions with it. When the entire dataset was included, Clause length still predicted pronoun/zero use, but this analysis did not distinguish between the effects of Clause length and disfluency, since fluent utterances tend to be shorter (average = 6.5 words) than disfluent utterances (average = 8.8 words), even though the disfluent words themselves do not contribute toward our measurement utterance length.
Table 7. Average percentage pronouns/zeros used in each participant group for clauses with and without disfluent elements, calculated out of all singular references in subject position. Standard Error of the Mean is in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>Autism</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>younger</td>
<td>older</td>
</tr>
<tr>
<td>no disfluency</td>
<td>75 (4.0)</td>
<td>85 (2.3)</td>
</tr>
<tr>
<td>disfluency</td>
<td>64 (5.4)</td>
<td>75 (3.0)</td>
</tr>
</tbody>
</table>

Table 8. Average percentage pronouns/zeros used in each participant group for short (1-6 words) and long (7+ words) clauses, calculated out of all singular and fluent references in subject position. Standard Error of the Mean is in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>Autism</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>younger</td>
<td>older</td>
</tr>
<tr>
<td>Short clause (1-6 words)</td>
<td>81 (3.8)</td>
<td>89 (2.8)</td>
</tr>
<tr>
<td>Long clause (7+ words)</td>
<td>68 (8.5)</td>
<td>79 (3.6)</td>
</tr>
</tbody>
</table>

In sum, participants in both the Control and Autism groups in our sample chose referential expressions on the basis of the same discourse criteria that have been shown to influence adults in other studies (e.g., Arnold, 1998; 2001; Arnold & Griffin, 2007; Brennan, 1995). All participants used pronouns and zeros more often for entities that had been recently or prominently mentioned, especially when referring in a parallel syntactic position. All participants were also influenced by cognitive effort, as indicated by disfluency and clause length.
effects. These effects were observable in both younger and older participants, both with and without autism. In addition there was a tendency in the Autism group for younger participants to use fewer pronouns/zeros than older ones. This effect was restricted to references to things that had been mentioned, but not in the previous clause. By contrast, the use of pronouns/zeros was consistently high for both ages and both groups when the referent was in the previous clause, and consistently low when it had not been mentioned previously at all.

Discussion

There are two primary conclusions to be drawn from the above findings. First, the reference form choices of both participants with autism and typically developing controls were sensitive to the same discourse and processing conditions as has been shown to influence adults, and in the same ways. Second, despite this overall similarity, the younger participants with autism were more likely to use explicit expressions, after controlling for discourse context, than the other participants. This relative over-specification did not occur for all references, but rather was restricted to references to something that had been previously mentioned, but not for two or more clauses. This difference did not stem from any systematic differences in the types of discourse contexts produced by each group, which were very similar. This overuse of explicit forms contrasts with Tager-Flusberg’s (1995). In her narrative data, children with autism failed to introduce new characters with full lexical NPs, instead using pronouns. However, Tager-Flusberg’s narratives were told in the context of an illustration, making it possible to use pronouns deictically (a strategy that is also attested for young children, Karmiloff-Smith, 1985). By contrast, in our data, where participants could not refer deictically, the younger autism group used relatively fewer pronouns and zeros. This finding is consistent with Baltaxe’s (1977)
observation that adults with autism often used referential expressions that were more specific than needed.

To understand these reference production patterns, we need to consider the processes that underlie referential choices. It is generally agreed that one major determinant of referential choices is the referent’s conceptual status: if it is central to the discourse, and likely to be important to the upcoming discourse, discourse participants focus their attention on it, and speakers can use underspecified expressions for referring to it (for a review see Arnold, in press). The speaker must represent this conceptual status, whether it involves explicitly modeling the listener or not. One way to model this calculation is in terms of the activation, where the activation of each entity in the speaker’s mental representation indicates the degree to which the referent is focused, in a graded way. Thus, recently and prominently mentioned entities are highly activated, but this activation decays as other referents become more central. This representation guides the choice between alternate referring expressions. Other things being equal, pronouns and zeros tend to be chosen if the referent has a sufficiently high enough activation (Arnold & Griffin, 2007).

Under this model, there are two possible calculations that could explain the observed tendency for younger participants with autism to use fewer pronouns/zeros than the other participants. One possibility is that they have difficulty maintaining activation on referents that have not been mentioned recently. If activation decays more rapidly for these participants, then it will fall below the threshold for choosing an underspecified expression more quickly, for example as soon as one or two other references intervene. This explanation is consistent with evidence that decreases in memory capacity via memory load and/or low memory span can lead to a reduction in the use of pronouns and zeros (Griffin & Arnold, in preparation). It is also
broadly consistent with the correlation between autism and low performance on memory span tasks (Bennetto et al., 1996). This was true in our sample too: performance on a forward- and backward-digit span task\(^3\) was lower for participants with autism, both the younger group \((M = 9.2, S.E. = 0.9)\) and older group \((M = 9.0, S.E. = 0.9)\), compared with both the younger control group \((M = 10.4, S.E. = 0.9)\) and older control group \((M = 12.14, S.E. = 0.6)\). Digit span was analyzed with an ANOVA including Group and Age as independent variables, which demonstrated a main effect of Group, \(F(1,42) = 7.38, p = .01\), and no effects or interactions with Age. But working memory cannot be the only explanation, since the older autism participants produced just as many pronouns/zeros as the control participants, even though they had lower average span scores as well.

A second possibility is that the younger participants with autism tend to represent activation in the same way as other participants, but they have a higher threshold for deciding that a pronoun or zero is sufficient. For the most recently mentioned and syntactically prominent referents, they are confident that a pronoun or zero is warranted. But for a referent with slightly decayed activation, they are more likely to assume that the pronoun would no longer be acceptable. We speculate that the setting of a threshold for using an underspecified expression may be impacted by judgments about what an addressee might need to successfully understand the reference. It has been proposed that autism is characterized by a developmental delay in theory-of-mind abilities, rather than a categorical absence of these abilities (Tager-Flusberg, 2001b). If these abilities are needed to set an appropriate threshold, deficits in theory of mind might explain the developmental delay in using pronouns and zeros for entities with middle-level activation.

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\(^3\) Digit span is the scaled score \((M=10, SD=3)\) from the Wechsler IQ test.
But it is important to keep in mind that the observed difference between the Autism and Control groups was a matter of degree, and not a qualitative difference in reference production strategies. Neither was it a static difference: since the older Autism group produced just as many pronouns and zeros as the Control group, we can infer that children with autism develop the same production strategies as typically developing children, but slightly more slowly.

At the same time, our results demonstrated an equally important finding, that all participant groups were sensitive to the same discourse context and cognitive constraints. All participants tended to choose pronouns or zeros more often when referring to something recently mentioned, especially if it was in subject position or a parallel position to the referring expression. There was also evidence that all participants produced fewer pronouns and zeros when experiencing an increase in the cognitive load, as indicated by the presence of disfluency or the production of a longer utterance.

These findings stand in contrast to the prediction that speakers with autism, who tend to have difficulty with theory-of-mind processes, might be unable to assess the focus of attention of their addressee, which has been proposed to be integral to the choice between alternate referring expressions. Although there are many possible interpretations of this finding, at the very least it suggests that the mentalizing abilities required for reference production are not beyond those that are available to an autistic population. While a theory-of-mind deficit may have contributed to the tendency for overspecification in the younger Autism group, it did not result in a wholesale failure to choose pragmatically appropriate expressions.

There are several possible explanations for the lack of a fundamental difference between groups. Since we do not have laboratory measures of theory-of-mind abilities of the participants in our sample, we do not know the extent, if any, of mentalizing deficits in this particular set of
individuals with autism. Although there is clear evidence for autism-specific theory-of-mind difficulties in younger and lower-functioning samples (Baron-Cohen, et. al 1985; Rutherford, et al., 2002), it is quite possible that the older participants with autism in our sample had essentially “caught up” with the control group in those areas of mentalizing that are relevant for reference production. This interpretation is consistent with evidence that theory-of-mind deficits affect autism by matter of degree, not as a categorical difference, and can attenuate over the course of development (Tager-Flusberg, 2001b).

Another (and not inconsistent) interpretation of the similarity between our participant groups is that the mentalizing required for choosing pragmatically appropriate referring expressions is minimal. This is consistent with reports that very young children also tend to use pronouns appropriately, even though they have not fully developed their theory-of-mind abilities at this age. For example, Hickmann and Hendriks (1999) reported that English-speaking children ages 4-5 years produced the highest rate of pronouns for Subject-to-Subject reference (83%), less for Nonsubject-to-Subject (64%) or Subject-to-Nonsubject (54%), and least for Nonsubject-to-Nonsubject (37%). Similar patterns occurred for other languages (French, German, and Chinese) and older agegroups. This pattern echoes the sensitivity of our participants to syntactic position, although their data did not show evidence of parallelism. Likewise, Gundel, Ntelitheos, & Kowalsky (2007) describe a number of examples of reference from very young children, which attest appropriate usage of a variety of referential forms (pronouns, definite NPs, etc.) by age 3. They propose that this correct usage indicates that “children… are sensitive to the memory and attention state of their interlocutors (p. 16).” While this conclusion seems to be at odds with the tendency for children of this age to fail false-belief tasks, Gundel et al. (2007) suggest that the
kind of information needed for reasoning about the addressee’s current focus of attention may be different, and easier, than what is needed to pass a false-belief task.

A more extreme version of their proposal, which is consistent with their results and ours, is that reference production does not always, or even typically, require explicit representations of the addressee’s mental state. This is particularly possible in a discourse situation like the narratives examined here, where most of the relevant information is available in the prior linguistic discourse. Therefore, the speaker’s own representation of the situation suffices as a stand-in for the focus of attention of the addressee. On the other hand, other studies have shown that speakers monitor for cues to their addressee’s focus of attention, like eye gaze (Clark & Krych, 2004). Thus, while addressee design is likely to play some role in reference production, it is not a prerequisite for making appropriate assumptions about referent activation and choosing pragmatically appropriate referential expressions (see Arnold, in press, for related discussion).

Regardless of whether reference production involves some degree of mentalizing or not, our data also supported the claim that reference production is modulated by speaker-internal constraints. Participants in all groups produced fewer pronouns when they were experiencing cognitive load, as illustrated by the correlation of reference form choices with disfluency and the length of the clause being uttered. This supports other findings that speakers produce more pronouns when there are fewer characters in the discourse to compete with each other (Arnold & Griffin, 2007), and fewer pronouns are used when available working memory resources are reduced (Griffin & Arnold, in preparation). Likewise, speakers’ prosodic choices are influenced by both communicative goals and speaker-internal processing load (Watson, et al., in press). Thus, while our findings do not preclude the possibility that speakers choose expressions on the basis of the addressee’s needs, they area also consistent with a growing body of evidence that
production choices are not always made with the addressee’s needs in mind (Arnold, Wasow, Asudeh, & Alrenga, 2004; Ferreira & Dell, 2000; Ferreira, 2003; Ferreira, Sleve, & Rogers, 2005; Horton & Keysar, 1996).

In sum, children and adolescents with high-functioning autism choose referential expressions in nearly the same way as their typically-developing peers. What differences exist are a subtle matter of degree, and result in a slight over-specification of references to entities that fall in the ambiguous category of being activated somewhat, but not too much. Moreover, both groups of participants reacted in adult-like ways to the constraints of the discourse context and the cognitive load associated with normal utterance production. These findings, along with reports of how very young children produce references, suggest that reference production does not require sophisticated mentalizing abilities.
Author Note

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