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Title: Personal pronoun usage in maternal input to infants at high vs. low risk for autism spectrum disorder

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Abstract

Children with autism spectrum disorder (ASD) are prone to personal pronoun difficulties. This paper investigates maternal input as a potential contributing factor, focusing on an early developmental stage before ASD diagnosis. Using Quigley and McNally's (2013) corpus of maternal speech to infants (3-19 months; N = 19) who are either at high or low risk for a diagnosis of ASD (Quigley & McNally, 2013), we asked whether mothers used fewer pronouns with high-risk infants. Indeed, high-risk infants heard fewer second-person pronouns relative to their names than low-risk infants. We further investigated the contexts in which mothers were using infants' names. Our results indicated that mothers of high-risk infants often used the infants' names simply to get their attention by calling them. We suggest that high-risk infants may thus hear relatively fewer pronouns because their mothers spend more time trying to get their attention. This may be related to differences in social-communicative behavior between low-risk and high-risk infants.

Difficulty with the personal pronoun system has been noted by researchers for more than a century, and children with autism spectrum disorder (ASD) are more vulnerable than typically developing (TD) children. *Pronoun reversal* errors—using first- in place of second-person pronouns and vice versa (e.g., Cooley, 1908)—are observed in TD children (Charney, 1980b; Chiat, 1982; Clark, 1978; Dale & Crain-Thoreson, 1993; Evans & Demuth, 2012; Oshima-Takane, 1992; Oshima-Takane, Goodz, & Derevensky, 1996) and even precocious talkers (Dale & Crain-Thoreson, 1993; Evans & Demuth, 2012). But these errors are more common in language-matched children with ASD (Dale & Crain-Thoreson, 1993; Evans & Demuth, 2012; Naigles et al., 2016; Seung, 2007; Tager-Flusberg, 1994), although Naigles et al. (2016) recently found that the size of the difference between typically-developing children and children with ASD is quite small. Children with ASD also demonstrate *pronoun avoidance*, or the use of names or kinship terms in place of pronouns (e.g., Jordan, 1989; Lee, Hobson, & Chiat, 1994; Shield & Meier, 2014; Sterponi, de Kirby, & Shankey, 2015). Although many individuals eventually overcome these challenges (Cantwell, Baker, Rutter, & Mawhood, 1989; Kanner, 1943, 1971), a neurological trace of pronoun difficulty persists even in high-functioning adults with autism (Mizuno et al., 2011).

Personal pronouns belong to a distinct lexical category: *deictic* words, which are characterized by shifts of their referents depending on context. The referents of personal pronouns shift depending on discourse role (e.g., speaker, addressee) (Hartmann & Stork, 1972; Levinson, 1983). For example, first-person pronouns (e.g., *I*, *my*) refer to person A when A speaks, but shift to refer to person B when B speaks, and second-person pronouns (e.g., *you*, *your*) refer to different individuals depending on who is being spoken to. This property, called *deictic shift*, means that personal pronoun acquisition may rely on non-linguistic abilities

including perspective-taking, theory of mind, pragmatic sensitivity, and memory and processing abilities required for tracking deictic shifts. It is thus not surprising that personal pronouns pose a unique challenge to language learners.

Despite this challenge, TD children show adult-like comprehension of deictic shifts by 2 years of age (Moyer, Harrigan, Hacquard, & Lidz, 2015). This challenge may be more acute, however, for learners with ASD because of their impairments in social communication. Children with ASD have a tendency to repeat others' speech, called *echolalia* (e.g., Bartak & Rutter, 1974; Charney, 1980a; Kanner, 1943), which may lead to reversal errors if children repeat utterances addressed to them wholesale. They also often have impaired understanding of discourse roles (e.g., Tager-Flusberg, 1994), immature theory of mind (e.g., Boucher, 2003), and limited spatial perspective-taking abilities (e.g., Loveland, 1984; Ricard, Girouard, & Décarie, 1999), each of which may hinder pronoun acquisition. Additionally, in children with ASD, social development is delayed compared to language mastery, and this asynchrony may contribute to difficulty with pronouns because children may begin to acquire pronouns before the social capacities required for pronoun acquisition are fully developed (Naigles et al., 2016).

The Potential Role of Input

In addition to the linguistic properties of the words themselves and the characteristics of the learners, the language input that learners receive from their caregivers may also affect acquisition. In typical development, the quantity and quality of input predict language ability (e.g., Hart & Risley, 1995; Hoff & Naigles, 2002; Hurtado, Marchman, & Fernald, 2008; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Rowe, 2012). Similar input effects have been found in children with ASD. For example, the number of word tokens (Warren et al., 2010) and noun types (Swensen, 2007) in the input positively predict children's later productive

vocabulary. Syntactic complexity (measured by MLU) predicts children's vocabulary size 6 months later (Bang & Nadig, 2015), and the form of wh-questions in maternal input predicts later wh-question comprehension (Goodwin, Fein, & Naigles, 2015).

The input provided to children with ASD is broadly speaking comparable to the input provided to TD children when the groups are matched on child language ability (see Nadig & Bang, 2016 for review). Studies have found no significant differences in MLU (Wolchik, 1983), word tokens (Warren et al., 2010), word types (Swensen, 2007), or lexical diversity (Bang & Nadig, 2015); similar findings are reported in French (Bang & Nadig, 2015) and Italian (Venuti, de Falco, Esposito, Zaninelli, & Bornstein, 2012). However, studies looking at specific domains of language do find some differences: Children with ASD hear a smaller percentage of wh-questions than TD children (Goodwin et al., 2015), and fewer clarifying comments about story characters' mental states (Slaughter, Peterson, & MacKintosh, 2007). It is interesting that children with ASD have corresponding deficits in these same areas: with respect to wh-questions, their production is sparser and less complex (Eigsti, Bennetto, & Dadlani, 2007; Tager-Flusberg et al., 1990) and comprehension is much delayed (Jyotishi, Fein, & Naigles, 2017); and they struggle to acquire mental state language (Tager-Flusberg, 1992; but see Bang, Burns, & Nadig, 2013). This does not, of course, suggest a causal relationship such that impoverished input causes poorer language skills—indeed, there is no sense in which parents "cause" autism or autistic symptoms in their children by virtue of their parenting behavior. It could, however, be the case that parents are sensitive to the difficulty their children have with these linguistic elements and use less of them as a result, or that there is a more complex bidirectional relationship between these factors.

Thus, although the input provided to TD children and the input to language-matched children with ASD are commensurate, it may still vary in specific domains where the two groups vary in competence. Personal pronouns may be one such domain. But although we know that pronoun ability differs between groups, we do not know if the input differs with respect to pronouns. This is a reasonable hypothesis to test; for example, Jordan (1989) has speculated that parents of children with ASD may tend not to use pronouns in child-directed speech because they know their children have particular difficulty with these words. If the input directed to children with ASD is indeed systematically impoverished in pronoun use, this would add an important dimension to our understanding of pronoun difficulty in this population.

Studying Early Pronoun Input

ASD is generally diagnosed in the preschool years (Centers for Disease Control and Prevention, 2012), by which time many children are already acquiring language. We are interested in examining linguistic input in infancy, because early input has a cascading influence on development and may offer important insights for early intervention. Many researchers have found it useful to study infants who are either at higher or lower risk for a later diagnosis of ASD. Higher-risk (HR) infants have at least one older sibling with an ASD diagnosis, and lower-risk (LR) infants have an older sibling without ASD. Due to the moderate heritability of ASD (Hallmayer et al., 2011), about 20% of HR infants will receive an ASD diagnosis by 3 years of age (Ozonoff et al., 2011) (in contrast to the prevalence of 1 in 68 in the general population). Further, even of those HR infants who do not go on to have an ASD diagnosis, many exhibit subclinical behavioral characteristics like those in ASD, including language and cognitive delays (e.g., Gamliel, Yirmiya, Jaffe, Manor, & Sigman, 2009), and atypical social interaction (Ibanez, Messinger, Newell, Lambert, & Sheskin, 2008; Nadig et al., 2007; Ozonoff et al., 2010;

Presmanes, Walden, Stone, & Yoder, 2007; Stone, McMahon, Yoder, & Walden, 2007; Zwaigenbaum et al., 2005). Therefore, the current study examines how and how often pronouns occur in the input to HR and LR infants to assess whether there are group differences early on.

Current Study

We examine the pronoun input to English-acquiring HR and LR infants, aged 3 to 19 months, in one-on-one interactions with their mothers. We ask two research questions. Our **first question** is: Do HR infants hear a lower frequency of pronouns than LR infants?

We measure this in two ways: (a) we calculate the *overall frequency* of how often HR and LR infants hear first- and second-person pronouns, and (b) we calculate a more fine-grained measure of *relative frequency* of how often they hear pronouns relative to non-pronoun forms of address. Relative frequency is measured for two reasons. First, overall frequency is likely too coarse of a measure because many utterances include no pronouns; consequently, overall frequency may be too small to identify significant between-group differences. Second, and more importantly, parents often mix non-pronoun forms (such as kinship terms and names) with pronouns when addressing their children (Conti-Ramsden, 1989; Durkin, Rutter, & Tucker, 1982). Non-pronoun forms of address, called "imposter" uses in the syntax literature (Collins & Postal, 2012), though odd in adult-directed speech, are felicitous in child-directed speech, for example, in mothers' use of a kinship term in place of a first-person pronoun (e.g., "Mommy's gonna be right back"). Similarly, given that we study one-on-one mother-infant interactions, the infant's name is never *required* by the discourse, because the infant would be the only plausible referent of a second-person pronoun; nevertheless, name uses are common (e.g., "Where's Maria? There she is!" or, "Does Maria want a bottle?"). Relative frequency thus provides an index of the trade-off between pronouns and non-pronoun forms of address.

Our second research question concerns the function of non-pronoun forms of address, specifically with respect to second-person pronouns and the infants' names. If there is a group difference, such that mothers of HR infants use more names (relative to pronouns) than mothers of LR infants, there are at least two possible reasons they might do so. One possibility is that mothers of HR infants frequently use non-pronoun forms in place of pronouns, as in the impostor uses noted above. Because the infants under study are mostly too young to produce pronouns (TD infants spontaneously produce these around 15 to 18 months, albeit not without errors, (Charney, 1980b; Chiat, 1981; Clark, 1978; Oshima-Takane, 1985, 1988; Shipley & Shipley, 1969), this speech pattern in mothers of HR infants cannot be a response to the infants' own difficulty with pronouns. Instead, mothers might use non-pronoun forms instead of pronouns in response to the difficulties their older child with ASD has with pronouns (Jordan, 1989) and this speech pattern may simply carry over to the younger infants. A second possibility, however, is that mothers of HR infants use names as attempts to get the infants' attention, as in "Maria, come here!" HR infants demonstrate some nonverbal behaviors within the ASD endophenotype, such as reduced social attention, that are different from LR infants (Ozonoff et al., 2010; Zwaigenbaum et al., 2005), and to which parents may respond differently. Critically, HR infants orient to their names less than LR infants (Nadig et al., 2007). In this case, mothers' name uses may be responses to behavioral differences in the HR infants themselves (i.e., a result of more frequent attempts to get the infant's attention) rather than a pronoun-avoidant speech pattern. To assess these two possibilities, we code mothers' uses of the infant's name for its function, which allows us to ask our **second question**: Do mothers of HR infants use proper names to replace second-person pronouns, or to get their infant's attention?

Corpus

We used Quigley & McNally (2013b) corpus in the CHILDES database (MacWhinney, 2006), which comprises 203 transcripts. Each contains transcriptions of 5 continuous minutes of infant-directed maternal speech, selected from up to 15 minutes of one-on-one mother-infant interactions. The infants' speech was not transcribed.

The corpus data were collected from 19 mother-infant dyads. Eight mothers interacted with their 9 infants[1] (5 females, 4 males) who were at relatively higher risk (HR) for ASD because they had at least one older sibling diagnosed with ASD; the other 10 mothers interacted with their 10 infants (4 females, 6 males) who were at lower risk (LR) for ASD because they had at least one older sibling but no family history of ASD. All mothers spoke English (Hiberno or Irish English), and mothers in the two groups were matched (as a group) on age, socio-economic status (low to middle) and level of education (high school to university), all of which are important factors in shaping maternal speech and influencing infant development (e.g., Rowe, 2008). Data were collected once a month for approximately 9 months, but not all dyads had data for every month. Data collection occurred between the ages of approximately 3 to 19 months, and each infant began and ended at slightly different ages.

Our Sample

We coded all transcripts from the 9 HR infants with a total of 8030 maternal utterances[2]; and from 9 out of the 10 LR infants with a total of 8257 maternal utterances. One LR boy was excluded because he was diagnosed with ASD at age 3[3], which made him different from other LR infants (e.g., he might have demonstrated behavioral patterns consistent with ASD

[1]One mother had twin infants.
[2]Each line beginning with "*MOT:" was taken as one utterance.
[3]According to parental report, 5 of the 9 HR infants were diagnosed with ASD at age 3, and only 1 of the 10 LR infants (the one we excluded from analysis) was diagnosed. This is consistent with the higher rate of ASD diagnosis in high-risk infants (Ozonoff et al., 2011).

symptomatology even in infancy). See Table 1 for a summary of the sample. For the age distribution in each group, see Figures 1a and 1b.

TABLE 1 ABOUT HERE

FIGURE 1a ABOUT HERE

FIGURE 1b ABOUT HERE

Coding, Analysis, and Results

Question 1. We first asked whether there were quantitative differences in pronoun input to HR and LR infants.

Coding and Prediction. We coded mothers' speech for the following: (1) first-person pronouns *I*, *me*, *my*, *mine*, and *myself*; (2) second-person pronouns *you*, *your*, *yours,* and *yourself*; (3) names for the mother, including *mam*, *mom*, *mum*, *mama*, *mamma*, *mammy*, *momma*, *mommy*, *mumma*, and *mummy*; and (4) pseudonyms for infants' names as indicated in the corpus documentation and variants on those pseudonyms (e.g., *Callie* for *Cal*).[4] Coding was done by three trained coders. A subset of 1515 utterances in 18 transcripts (one from each infant) was independently coded by a fourth coder. The agreement rate was 99.7%. The discrepancies were 2 missed instances—1 first-person pronoun and 1 infant's name. The errors were fixed prior to analysis.

For each infant at each time point, we calculated the following 4 dependent variables. We first tallied the total numbers of first- and second-person pronouns; because the transcripts varied in the number of utterances across infants and across time points, we divided these numbers by the total number of utterances in each transcript, yielding a measure of (1) *overall frequency of*

[4]We included the pronouns in expressions such as 'give me a kiss' and 'thank you' as well as contracted forms such as 'gimme a kiss.' We also included instances of pronouns or names in singing (e.g., "Row, row, row your boat"), although the pattern of results was the same whether or not these were included.

first-person pronouns and (2) *overall frequency of second-person pronouns*. For (3) *relative frequency of first-person pronouns* versus tokens of kinship terms like *mummy*, and (4) *relative frequency of second-person pronouns* versus tokens of infants' names, we divided the total number of first-/second-person pronouns by the sum of the total number of pronouns and the total number of kinship terms/names[5]. If our hypothesis that the input will differ to HR and LR infants is correct, we should see group differences in overall frequency and/or relative frequency—in particular, higher frequencies to the HR group than the LR group. See Supplementary Table A for the values of the dependent variables for each participant, and Supplementary Table B for counts of the number of utterances containing pronouns and names.

Results and Discussion. We used R (R Core Team, 2014) and the nlme package (Pinheiro, Bates, Roy, & Sarkar, 2017) to perform a mixed-effects linear regression analysis for each of the 4 dependent variables (see above), with risk group (HR coded as 0 and LR as 1) as fixed effect, age (in days) as a continuous predictor (centered around its mean), and participant as a random effect. We adopted a significance level of 0.05 for all statistical analyses[6]. See Table 2 for a summary of the statistical models.

TABLE 2 ABOUT HERE

With respect to *overall frequencies*, the data revealed that, on average, HR infants heard first-person pronouns at a rate of 6% (i.e. in 6 out of 100 utterances) and second-person pronouns at a rate of 21%; LR infants heard these pronouns at a rate of 8% and 29% respectively. Our statistical models indicated no main effect of risk group. However, the numerical differences trended in the predicted direction: LR infants heard first-person pronouns (M = 0.08, SD = 0.03)

[5]When there was no production of pronouns or kinship terms/names, the denominator was 0, rendering this dependent variable not available. In such cases, 'N/A' was entered, and 'N/A's were removed when calculating the means and standard deviations.

[6]We also reported those effects with a *p*-value between 0.05 and 0.1 but did not use them as bases for interpretation.

at a higher frequency than HR infants (M = 0.06, SD = 0.03) (p = 0.091); and they also heard second-person pronouns (M = 0.29, SD = 0.08) more often than HR infants (M = 0.21, SD = 0.08) (p = 0.067). Our models also indicated no main effect of age for either the overall frequency of first-person pronouns or that of second-person pronouns. But there was a trend for mothers to use more first-person pronouns as infants grew older (p = 0.058), as indicated by the positive coefficient estimate (0.000089)—that is, for each day infants aged, first-person pronoun usage increased by this amount. There was no interaction between risk group and age.

In terms of *relative frequencies*, HR infants heard first-person pronouns relative to kinship terms like *mummy* at a rate of 66% (i.e., out of 100 occurrences of first-person pronouns and kinship terms, 66 are first-person pronouns), and heard second-person pronouns relative to their names at a rate of 75%; these rates for LR infants were 74% and 88% respectively. Our statistical models indicated no group difference with respect to the relative frequency of first-person pronouns. But there was a significant group effect for the relative frequency of second-person pronouns (p = 0.0070, coefficient estimate = 0.13)—that is, out of 100 occurrences of second-person pronouns and infants' names, infants from the HR group heard 13 fewer second-person pronouns relative to their names as compared to infants from the LR group. Neither model showed a main effect of age.

These results largely showed similarities between the two groups with respect to mothers' use of first-person pronouns. However, with respect to second-person pronouns, we observed an important group difference: Mothers of HR infants used second-person pronouns less often relative to the infant's name than mothers of LR infants. We next asked what might underlie this difference.

Question 2. Given that our above analyses showed that the overall frequency of second-person pronouns was similar across groups, the difference in relative frequency must have been driven primarily by name usage. That is, mothers of HR infants used their infant's name more often than mothers of LR infants, leading to a lower relative frequency of second-person pronouns. But what did mothers of HR infants use their names for—to replace pronouns or to get the infant's attention? To address this, we revisited mothers' uses of their infant's names for their function.

Coding and Prediction. All 856 instances of the infant names were independently coded, by two trained coders with 100% agreement, for the following two functions. *Pronoun-substitution* functions were instances of the name used (a) as the subject of a predicate, (b) as the object of a predicate, or (c) in its possessive form. In these uses, the mother could have used a second-person pronoun instead (e.g., "Maria loves hats" and "You love hats" are, given the context, meaning-equivalent and both felicitous). *Vocative* functions were instances in which the mother seemed to use the infant's name to call his/her attention. This function is not one that is typically served with a pronoun. This distinction is difficult to infer when the name is part of an utterance. For example, "hello Maria" could be used to call the infant's attention or to greet her; utterances beginning with the infant's name seem likely to be vocative (e.g., "Maria, come on!"), but those ending in the name may not be (e.g., "Come on, Maria!"). Therefore, to avoid subjectivity in our coding, we used the infant's name in isolation as a proxy for the vocative function: e.g., "Maria?" "Maria!" See Table 3 for representative examples, and Supplementary Table A for the frequencies of each function by participant.

TABLE 3 ABOUT HERE

The two possibilities discussed earlier make different predictions with respect to these variables. If the difference in the relative frequency of second-person pronouns is due to mothers' larger pronoun-avoidant pattern carried over from older siblings to HR infants, then we would expect HR infants to hear more pronoun-substitution uses of names than LR infants; if, on the other hand, the difference is due to mothers' responses to HR infants' social-communicative profile and attempts to get their attention, then we would expect HR infants to hear more vocative uses of names than LR infants.

Results and Discussion. We calculated the percentage of *pronoun-substitution* and *vocative* uses of the infant's name (out of all name uses). Data were entered into a mixed-effects linear regression model, with risk group as fixed effect (HR coded as 0, LR as 1), age (in days) as continuous predictor, and participant as random effect. With respect to pronoun-substitution uses, our results indicated no group difference and no age difference. With respect to vocative uses, however, there was a significant group difference ($p = 0.0012$, coefficient estimate = -0.28), a main effect of age ($p = 0.0041$, coefficient estimate = -0.00084), and a significant interaction between group and age ($p = 0.0070$, coefficient estimate = 0.0011). A closer examination of the interaction revealed the following: a) infants from the HR group heard more vocative uses of their names (M = 0.45, SD = 0.18) than infants from the LR group (M = 0.20, SD = 0.13), and b) the age effect obtained in the HR group ($p = 0.010$), but not in the LR group ($p = 0.24$). Specifically, in the HR group, vocative uses of names decreased as infants grew older, as indicated by the negative coefficient (-0.00084). See Table 4 and Table 5.

TABLE 4 ABOUT HERE

TABLE 5 ABOUT HERE

These results indicated that mothers' increased use of names relative to pronouns in speech to HR infants was due to attention-calling rather than a substitution of names for pronouns. Interestingly, this pattern decreased with age, suggesting that mother-infant communication became more successful as the infant developed, and the mother did not spend as much time trying to get the infant's attention. Further, it is unlikely that the group effect was merely an extension of the age effect because the HR group had fewer transcripts from young ages than the LR group (see Figure 1); if more vocative names were used when infants were younger (as the age effect in HR group suggested), then the many transcripts from younger ages in the LR group should have led to more vocative names uses.

General Discussion

Personal pronouns pose a challenge for young learners, particularly so for children with ASD (Dale & Crain-Thoreson, 1993; Evans & Demuth, 2012; Jordan, 1989; Lee et al., 1994; Naigles et al., 2016; Seung, 2007; Sterponi et al., 2015; Tager-Flusberg, 1994). A range of factors may contribute to this challenge, including properties of the words themselves (i.e., complexity of deictic shift) and the specific skills that children with ASD struggle with (e.g., perspective-taking, discourse-pragmatics). In the current paper, we consider another factor that may play a role: maternal linguistic input. In particular, we focus on the very beginning of language acquisition and ask whether young infants at high risk (HR) for ASD (because they have an older sibling with an ASD diagnosis) receive different personal pronoun input than infants at low risk (LR) (who have an older sibling without an ASD diagnosis).

Our corpus analysis reveals both similarities and differences in the input directed to HR and LR infants. The similarities include commensurate overall frequencies of first- and second-person pronouns; thus, it is *not* the case that pronouns make up a smaller proportion of the input

to HR than LR infants. Even when we consider non-pronoun forms of address, we also observe similarities—similar relative frequencies of first-person pronouns versus kinship terms like *mommy*, and comparable frequencies of pronoun-substitution uses of names. Another similarity is that in both groups, mothers prefer using pronouns—when referring to themselves, they use a higher proportion of first-person pronouns than kinship terms; and when referring to the infant, they use a higher proportion of second-person pronouns than the infant's name. This is likely because in mother-infant dyadic interactions, the referents of first- and second-person pronouns are usually highly transparent. Second, mothers sometimes still use kinship terms and the infant's name rather than pronouns, as is prevalent in child-directed speech (see examples in Collins & Postal, 2012; Siewierska, 2004). In this respect, mothers are not different across risk groups. These similarities in the input to HR and LR infants are consistent with many previous reports that older children with ASD receive similar input to TD children (e.g., Bang & Nadig, 2015; Swensen, 2007; Wolchik, 1983; see Nadig & Bang, 2016 for a review).

Nevertheless, our analysis also reveals two note-worthy group differences. First, HR infants hear fewer second-person pronouns relative to their names than LR infants. Second, this difference seems to be driven by a significantly higher vocative use of infants' names in the input directed to HR infants—usages that are *not* pronoun substitution. Why might mothers of HR infants call their infants' names more than mothers of LR infants? We suspect that mothers are responding to a difference in the infants' social behavior, as HR infants are less responsive to their names than LR infants (Nadig et al., 2007). In fact, there are many instances in the transcripts in which it seems that mothers work hard to get their infant's attention. (There are such instances in the LR transcripts too, but they are fewer.) Below is an example from one of the HR infants, nicknamed "Cal."

**MOT:* *hello.*

**MOT:* *Cal?*

**MOT:* *xxx.*

**MOT:* *Cal?*

**MOT:* *Cal?*

%com: *voices can be heard outside the room and child is distracted and looking around. mother is trying to attract her attention.*

**MOT:* *Cal?*

**MOT:* *Cal?*

**MOT:* *Cal?*

This interpretation—that more vocative name uses with HR infants is a response to HR infants' social behavior—is consistent with Quigley and McNally's (2013a) findings from the same corpus. Quigley and McNally (2013a) focused on social-communicative aspects of the input (e.g., attention-soliciting utterances, interrogatives, responsive utterances contingent on the infant's behavior), and reported important differences between HR and LR dyads. Pertinent to the current discussion, they found more prominent use of "attention-soliciting utterances designed to elicit and to regulate the infants' attention" (57) in mothers of HR infants than mothers of LR infants, which they take as a result of lower responsiveness and liveliness in HR infants. Our finding from one particular type of attention-soliciting devices—name calling—corroborates Quigley and McNally's (2013a) discovery; and importantly, we establish a connection between this social-communicative aspect of the input and the linguistic input that infants receive with respect to pronouns.

Linguistic and social factors are often interlocked in language development. Naigles et al. (2016) demonstrated that both linguistic and social factors contribute to pronoun reversal in

children with ASD—higher vocabulary and joint attention scores independently predicted fewer pronoun errors. Furthermore, they showed that social development in children with ASD was even more delayed than linguistic development; and this asynchrony (linguistic-ahead-of-social) might have contributed to their production errors (see (Evans & Demuth, 2012) and (Dale & Crain-Thoreson, 1993) for similar findings with precocious TD children). Our finding adds to this picture of social-linguistic interplay: Although aspects of the input that reflect linguistic choices (i.e., substitution of name for a pronoun) are similar across groups, the social-communicative aspects are not, reflected in the group difference in vocative uses of the infant's name.

Implications for Acquisition

One limitation of the current study is that we do not know whether or how the differences we find in the input affect pronoun acquisition, because we lack information about the infants' subsequent pronoun development trajectories. We nevertheless raise some ideas that must be considered when evaluating the relation between input and pronoun acquisition.

In word learning, it is robustly documented that the frequency of a word is negatively associated with its age of acquisition (e.g., Goodman, Dale, & Li, 2008; Naigles & Hoff-Ginsberg, 1998; Roy, Frank, & Roy, 2009). Although this association is comparatively weaker for closed-class words (than, for example, for nouns) (e.g., Goodman et al., 2008; Roy et al., 2009), low frequency may still have a negative influence, especially at early stages of acquisition. From the perspective of a young learner, who may not distinguish vocative and referential uses of names but may recognize that both names and pronouns can be used to refer to people, more frequent name uses may diminish the density and salience of pronoun uses. Therefore, HR infants' second-person pronoun input may result in pronouns being less salient

than in LR infants' input, which may in turn exacerbate the already difficult task of acquiring the pronominal system. This could result in pronoun reversal errors if the difficulty of pronoun acquisition is affected across the board, but pronoun reversal errors are not overly common in children with ASD (Naigles et al., 2016). It could also, however, result in pronoun avoidance, if the salience of pronouns in the input is reduced.

It is also worth pointing out that a higher proportion of pronouns (relative to names) may not necessarily be more supportive of learning. In fact, mixed use of personal pronouns and names/kinship terms may support pronoun acquisition because names/kinship terms have stable referents and can serve as an anchor for referents that are otherwise shifting (Macnamara, 1982; Oshima-Takane, 1999; Oshima-Takane et al., 1996; Smiley, Chang, & Allhoff, 2011; but see Durkin, Rutter, Room, & Grounds, 1982). It may also be that mothers find calling their infant's name to be a valuable adaptive strategy that improves the infant's attention and, in turn, the dyad's communication. Given that joint attention is a predictor of pronoun acquisition (Naigles et al., 2016), calling the infant's name may ultimately *support* pronoun acquisition by helping mothers to establish joint attention.

Lastly, the current study only focuses on mother-infant one-on-one interactions, but to fully grasp the deictic shift nature of pronouns, learners must observe how the referents of pronouns change depending on the speaker and addressee. This is best modeled in interactions with more than two individuals (Oshima-Takane, 1992; Oshima-Takane & Benaroya, 1989; Shipley & Shipley, 1969). In fact, second-born children, who have ample opportunities to overhear conversations between parents and other siblings, are more skilled with personal pronouns than firstborn children, whose primary source of input is parent-child dyadic conversation in which first-person pronouns often only label the mother, and second-person

pronouns often only label the child (e.g., Oshima-Takane et al., 1996; Oshima-Takane, Takane, & Shultz, 1999). Our own work in progress suggests the same is true for preschool-aged children with ASD (Georgeson, Netburn, Arunachalam, & Luyster, in prep). Therefore, future work examining whether there are effects of early input on later outcomes should also examine exposure to overheard speech that is not directed to the child.

Summary

Our analyses of early pronoun input indicated that mother of infants at high risk for ASD differ from mothers of infants at low risk primarily in increased vocative uses of the infant's name, which is likely a response to the infant's social-communicative behavior. This difference may have benefits (e.g., promoting joint attention) and drawbacks (e.g., reducing the salience of pronouns) for the at-risk population. Whether it contributes to later pronoun difficulties in children with ASD is a question for future research.

Table 1. *Corpus summary*

Child alias	Risk group	*No.* of transcripts	*No.* of maternal utterances across transcripts	
			Mean	*SD*
Ard	HR	13	81.77	20.46
Cal	HR	11	105.09	22.41
Car	HR	11	99.18	29.16
Eoi	HR	11	86.64	20.64
Gav	HR	8	70.38	9.04
Ois	HR	9	87.33	20.99
Reb	HR	12	97.00	18.73
Rut	HR	8	72.50	10.68
Sai	HR	11	61.27	12.85
Bre	LR	11	114.36	15.82
Cya	LR	11	95.55	20.37
Eri	LR	11	82.55	18.36
Haz	LR	10	52.60	23.42
Lar	LR	11	89.64	14.04
Nia	LR	11	92.64	10.89
Rhi	LR	11	61.91	12.28
Rub	LR	11	93.45	8.43
Tho	LR	11	72.73	19.60

Table 2. *Summary of results from mixed-effects linear regression models for overall and relative frequency of first- and second-person pronouns.*

	Coefficient	*Std. Error*	*DF*	*t-value*	*p-value*
Overall frequency of first-person pronouns					
(Intercept)	0.060	0.010	172	5.80	0.0000
risk group (HR vs. LR)	0.026	0.014	16	1.80	0.091
age (days)	0.000089	0.000047	172	1.91	0.058
risk group x age interaction	-0.000068	0.000061	172	-1.11	0.27
Overall frequency of second-person pronouns					
(Intercept)	0.21	0.027	172	7.89	0.0000
risk group (HR vs. LR)	0.074	0.038	16	1.96	0.067
age (days)	0.000085	0.00011	172	0.81	0.42
risk group x age interaction	-0.00015	0.00014	172	-1.09	0.28
Relative frequency of first-person pronouns					
(Intercept)	0.69	0.058	166	11.92	0.0000
risk group (HR vs. LR)	0.038	0.080	16	0.48	0.64
age (days)	-0.00033	0.00026	166	-1.25	0.21
risk group x age interaction	-0.0000158	0.00034	166	-0.047	0.96
Relative frequency of second-person pronouns					
(Intercept)	0.74	0.030	172	24.45	0.0000
risk group (HR vs. LR)	0.13	0.043	16	3.09	0.0070*
age (days)	0.00010	0.00013	172	0.78	0.44
risk group x age interaction	-0.00024	0.00018	172	-1.38	0.17

Table 3. *Representative examples for pronoun-substitution uses and vocative uses of the child's name*

Type of Uses		Examples
Pronoun-Substitution Uses	Subject of a predicate	"Cal loves hats"; "Carr is a baby"; "Ron is good"
	Object of a predicate	"make the film of Cya"; "now I see Ron"; "tickle tickle Eoi"
	Possessive form	"Eoi's turn"; "put it in Ard's mouth"; "what about little Carr's talking song"
Vocative Uses		"Cal!"; "Ruth?"; "Ron."

Table 4. *Summary of results from mixed-effects linear regression models for vocative name uses and pronoun-substitution name uses.*

	Coefficient	*Std. Error*	*DF*	*t-value*	*p-value*
Percentage of vocative name uses					
(Intercept)	0.49	0.051	132	9.61	0.0000
risk group (HR vs. LR)	-0.28	0.072	16	-3.92	0.0012*
age (days)	-0.00084	0.00029	132	-2.92	0.0041*
risk group x age interaction	0.0011	0.00040	132	2.74	0.0070*
Percentage of pronoun-substitution name uses					
(Intercept)	0.29	0.062	132	4.65	0.0000
risk group (HR vs. LR)	0.11	0.089	16	1.27	0.22
age (days)	0.00012	0.00034	132	0.35	0.73
risk group x age interaction	-0.00053	0.00047	132	-1.12	0.27

Table 5. *Summary of results from mixed-effects linear regression models for the HR and LR group with respect to vocative name uses.*

	Coefficient	*Std. Error*	*DF*	*t-value*	*p-value*
HR group					
(Intercept)	0.46	0.058	73	7.80	0.0000
age (days)	-0.00084	0.00032	73	-2.63	0.010*
LR group					
(Intercept)	0.19	0.037	59	5.09	0.0000
age (days)	0.00029	0.00024	59	1.19	0.24

Figure 1a. Age Distribution for the HR group

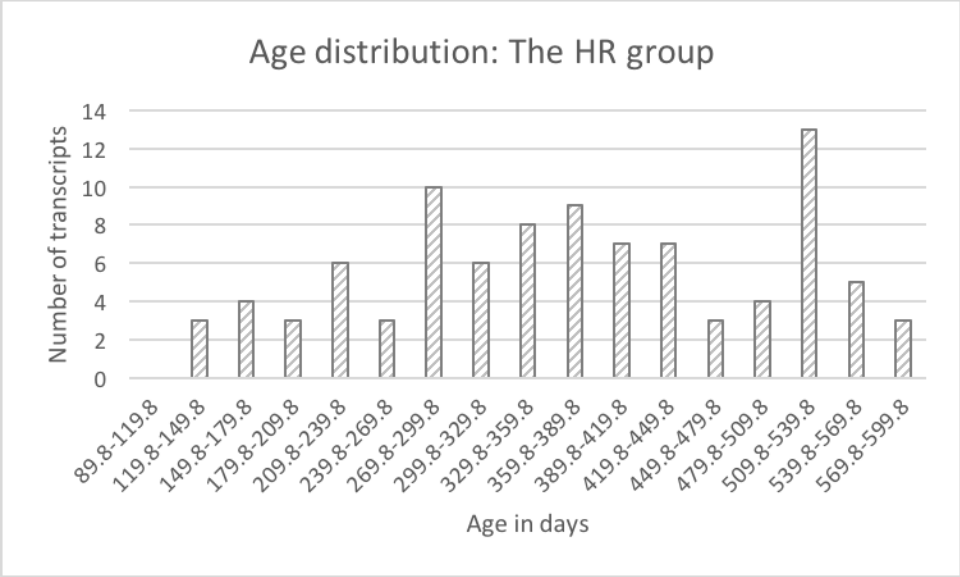
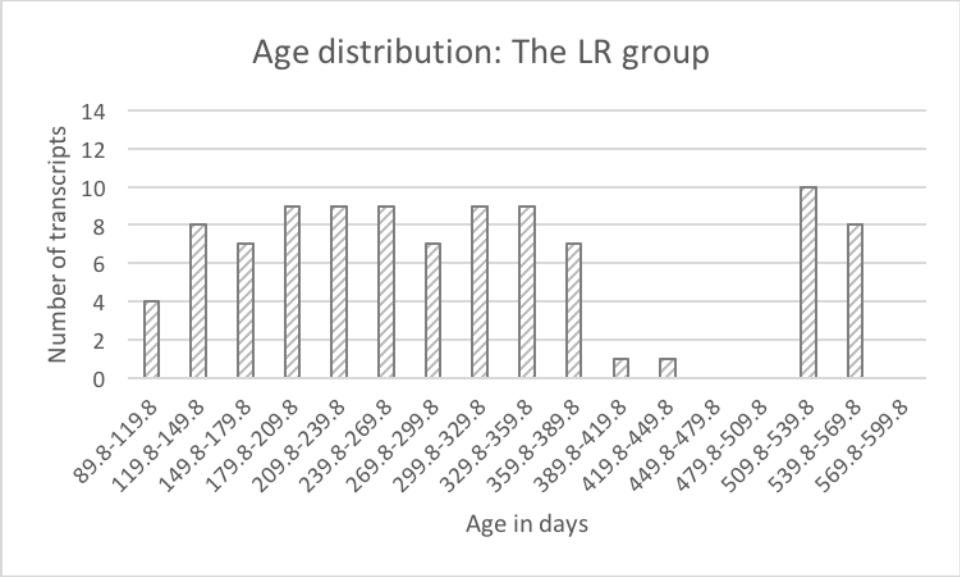


Figure 1b. Age Distribution for the LR group



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Supplementary Materials.

Supplementary Table A. *Dependent variables by infant*

Child alias	Risk group	Frequency of first person pronouns		Frequency of second person pronouns		Relative frequency of first person pronouns		Relative frequency of second person pronouns		Frequency of vocative uses of names		Frequency of pronoun substitution uses of names	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Ard	HR	3%	3%	25%	13%	51%	32%	85%	13%	30%	28%	61%	39%
Cal	HR	10%	9%	24%	9%	100%	1%	73%	13%	63%	37%	18%	31%
Car	HR	11%	5%	29%	13%	84%	19%	85%	9%	55%	43%	28%	35%
Eoi	HR	3%	3%	15%	10%	68%	32%	62%	19%	35%	34%	41%	29%
Gav	HR	6%	6%	20%	7%	57%	29%	78%	16%	60%	29%	11%	19%
Ois	HR	6%	5%	23%	7%	43%	31%	69%	15%	13%	17%	56%	32%
Reb	HR	11%	7%	35%	14%	93%	14%	91%	11%	71%	38%	0%	0%
Rut	HR	3%	4%	10%	8%	42%	39%	64%	24%	42%	39%	22%	33%
Sai	HR	3%	4%	13%	5%	59%	51%	63%	30%	36%	34%	21%	31%
Bre	LR	8%	5%	39%	15%	71%	28%	92%	12%	26%	24%	44%	30%
Cya	LR	10%	5%	26%	15%	68%	33%	93%	12%	6%	14%	69%	42%
Eri	LR	6%	4%	22%	11%	77%	24%	91%	10%	38%	32%	28%	44%
Haz	LR	12%	6%	38%	17%	98%	4%	94%	11%	38%	48%	25%	50%
Lar	LR	7%	5%	20%	6%	74%	31%	88%	12%	10%	23%	71%	39%
Nia	LR	11%	5%	26%	7%	79%	15%	89%	11%	21%	26%	34%	39%
Rhi	LR	8%	6%	28%	13%	63%	36%	87%	13%	18%	33%	33%	47%
Rub	LR	5%	4%	22%	12%	79%	24%	73%	17%	26%	26%	38%	38%
Tho	LR	8%	5%	40%	16%	55%	21%	85%	14%	3%	6%	29%	34%

Supplementary Table B. *Number of utterances that contain a pronoun and/or a kin-term/name*

Child alias	Risk group	*No.* of transcripts	*No.* of utterances containing first person pronoun		*No.* of utterances containing names for mother		*No.* of utterances containing second person pronoun		*No.* of utterances containing names for child	
			Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Ard	HR	13	2.69	2.36	3.92	5.36	16.00	8.75	3.54	3.62
Bre	HR	11	8.55	7.33	0.09	0.30	21.27	9.81	7.73	4.20
Cal	HR	11	8.45	2.30	1.91	2.95	24.27	9.62	4.09	2.39
Car	HR	11	3.09	3.27	2.00	2.37	12.09	8.96	6.45	4.03
Cya	HR	8	3.88	3.27	2.00	0.93	12.00	4.50	4.00	3.63
Eoi	HR	9	5.11	4.46	5.56	3.47	16.22	4.92	8.33	4.69
Eri	HR	12	8.58	4.44	1.17	2.62	24.83	7.35	3.17	3.33
Gav	HR	11	2.13	2.90	1.38	1.41	7.50	6.48	4.50	4.96
Haz	HR	8	1.82	2.27	1.18	1.66	6.73	2.72	6.55	7.22
Lar	HR	11	2.69	2.36	3.92	5.36	16.00	8.75	3.54	3.62
NIa	LR	11	8.27	4.71	5.18	7.15	38.00	15.11	3.27	3.90
Ois	LR	11	8.73	4.80	5.55	6.25	21.18	11.63	2.27	3.69
Reb	LR	11	4.55	2.66	2.09	2.59	14.18	6.13	1.91	2.43
Rhi	LR	10	5.90	4.95	0.30	0.67	18.40	11.72	1.00	1.49
Rub	LR	11	5.82	4.09	1.45	1.75	15.55	4.80	2.27	2.37
Rut	LR	11	9.55	4.97	2.27	1.56	22.00	6.91	3.00	2.45
Sai	LR	11	4.36	3.14	2.64	3.20	14.18	6.40	1.82	1.66
Tho	LR	11	4.55	2.98	6.82	5.86	18.18	7.32	3.00	2.86