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ABSTRACT

In many so-called canonical null subject languages, null and overt subject pronouns have contrasting referential preferences: null subjects tend to maintain reference to the preceding subject while overt pronominal subjects do not. We propose that children acquire this contrast by initially restricting their attention to 1st and 2nd person pronouns, whose reference is simpler to infer compared to 3rd person pronouns. We provide supporting evidence from spontaneous production and comprehension in Mexico City Spanish, showing that (i) the null/overt contrast is in principle acquirable from exclusively observing the referential preferences of 1st and 2nd person subject pronouns in caretaker speech; (ii) children themselves condition subject pronoun expression on pronoun reference in the 1st and 2nd persons before doing so in the 3rd person; and (iii) children use the null/overt contrast in comprehension at a similar age when they begin making this distinction in production.

Introduction: revisiting the null subject parameter

Since the seminal work by Hyams (1986), the so-called "null subject parameter" has played a central role in the theory of language acquisition. This research program, situated within the Principles and Parameters approach (Chomsky, 1981, 1986), framed the acquisition of null subjects as a process of deciding between two "settings" of a parameter. If the target language licenses null subjects in tensed clauses, then the child's task is to set the parameter to "on," otherwise the child must set the parameter to "off." Researchers within this program made the surprising discovery that children initially produce null subjects even when acquiring non-null subject languages such as English (Hyams, 1986), Danish (Hamann & Plunkett, 1998), and German (Clahsen, 1990), suggesting that they initially allow the null subject parameter to be set "on."

Subsequent developments in syntax, psycholinguistics, and sociolinguistics have since created a more detailed picture of the phenomenon of *pro*-drop, helping to refine our understanding of those original findings and, more broadly, what it means to "acquire null subjects." First, cross-linguistic syntactic work has revealed that null subjects can be a manifestation of different parameters. In canonical null subject languages like Italian and Spanish, the null subject is arguably licensed by properties of verbal inflection, while in topic-drop languages like Mandarin, null subjects and null objects are both licensed by an operator linked to a topic position (see Barbosa, 2009; Huang, 1984; Roberts, 2010, among others). Second, sociolinguistic and psycholinguistic investigations have revealed that even when languages license the null subject using the same formal mechanisms, the

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precise distribution and preferred interpretation of the null subject can vary substantially (Filiaci et al., 2014; Keating et al., 2011; Carvalho et al., 2015 and references therein).

These findings bring into sharper focus what was perhaps only implicitly assumed in the original framing of the acquisition problem: that the acquisition of null subjects is in fact a multi-step process; one in which the child not only identifies the correct parameters and their settings but also acquires the precise distribution of null and overt subjects in those environments where the two overlap. Since the alternation between null and overt forms in these overlapping environments varies probabilistically depending on a number of linguistic and extra-linguistic factors, further learning is necessary beyond parameter setting. In other words, the parametric approach to language acquisition jump-starts the learning process by reducing the child's initial hypotheses space,[1] but it is not the end of the learning process. After figuring out the proper parameter setting for her language, the child must then go on to acquire additional constraints on subject realization.

L1 researchers have long recognized that the first phase, parameter setting, is accomplished early. Children exposed to *pro*-drop languages produce both null and overt subjects by age 2 (Bel, 2003; Grinstead, 2004). And even though children exposed to non-*pro*-drop languages initially produce and accept null subjects (Wang et al., 1992; Orfitelli & Hyams, 2012 and references therein), their rate of null subject production is significantly lower compared to that of their peers acquiring *pro*-drop languages (Valian, 1990, inter alia) and drops off by two and a half years (Valian, 1989) to three and a half years (Guasti, 2002), depending on the study. However, the second phase has received less attention, and this is where we focus our efforts.

This paper focuses on the division of labor between null and overt personal pronouns in so-called canonical *pro*-drop languages like Italian and Spanish. In these varieties, null and overt personal pronouns may appear in overlapping grammatical environments, but they have different referential preferences: the null variant is probabilistically associated with continued reference to the preceding subject antecedent, while the overt variant is associated with a switch in reference. This alternation is one area where we can examine how using the statistical properties of the input may help the learner to generalize constraints on the use of particular grammatical forms. It is also a good candidate for studying the acquisition of variable patterns more generally, since the alternation between null and overt subject pronouns is geographically widespread, diachronically stable, and well-studied in adults (see Flores-Ferrán, 2007 for a review).

This paper proposes that children acquire the conditions governing subject pronoun expression by tracking the statistical distribution of variants in one subset of their input and then generalizing to a wider subset. Specifically, we hypothesize that children track the referential preferences of 1st and 2nd person pronominal subjects before generalizing to the 3rd person. We argue that this strategy is efficient because 1st and 2nd person pronouns have a much narrower set of potential referents than 3rd person pronouns, making it easier to identify the association between pronoun reference and pronoun realization. We test this hypothesis with two studies on the acquisition of subject pronouns in Mexico City Spanish. Study 1 examines children and caretakers' spontaneous speech in naturalistic interactions. First- and second-person pronouns in caretaker speech are shown to provide the necessary evidence to acquire the target knowledge – that is, children can in principle acquire the null/overt pronoun contrast by relying exclusively on 1st and 2nd person subjects in their input. Children's own speech reveals early, adult-like production of the null/overt contrast in 1st and 2nd person contexts,

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[1]For concreteness we assume the variational model proposed by Yang (2004) for parameter setting. In this model children are endowed with a restricted hypothesis space, in the sense that the parametric options are given from the start. The child's task is to eliminate parametric options that don't fit the input by a Darwinian mechanism that punishes or rewards parametric options against every sentence the child parses. As the child is exposed to a higher number of sentences that fit one particular parametric option and not others, this setting will outweigh alternative settings and become stable. After setting parameters, the grammar is stable, but there is still learning to be done because the child also needs to learn exceptions to a rule (Yang, 2016) and the constraints (linguistic or extralinguistic) that determine the use of a particular grammatical option, and this will also depend to a certain extent on statistical learning. It is important to note that, although the use of statistical learning is common in usage-based/cognitive linguistic proposals, our approach does not assume that everything can be learned directly from the input without a very constrained hypothesis space (which we could call UG).

followed by 3rd person contexts, consistent with our hypothesis. Study 2 examines children's interpretation of grammatically ambiguous 3rd person subject pronouns, both before and after four and a half, the approximate age when children in Study 1 began to reliably differentiate null and overt subject pronouns in production. Before age four and a half, children do not reliably differentiate between null and overt subject pronouns when resolving the antecedent; after this age, however, children do make the distinction, resolving ambiguous null subject pronouns toward the preceding subject antecedent reliably more often relative to overt ones, like adults. This is again consistent with our hypothesis.

The null/overt pronoun distinction in the target grammar

In so-called canonical null subject languages like most varieties of Italian, European Portuguese, and Spanish, tensed clauses can appear without an overtly realized subject (i.e., a null subject) or with an overt subject, such as a noun phrase (1a), an overt pronoun (1b) or even a clause.[2]

(1)a. {*Las llaves/Ø*} *están en la gaveta.*

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"The keys/pro are in the drawer."
    b. {Ellas/Ø} están en casa.
"They-fem/pro are at home."
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The learner's task is to discover not just *that* subjects can be omitted, but *when* they can be omitted. This paper will focus on how children acquiring Mexico City Spanish learn the conditions governing the alternation between null and overt personal pronouns as in (1b). In this section, we describe the factors that probabilistically condition this alternation in canonical null subject languages. In section 3, we illustrate how acquiring these conditions presents a difficult learning challenge and we propose a learning path that could in principle allow learners to efficiently surmount this challenge. In the remaining sections we present evidence consistent with this proposal from the production and comprehension of subject personal pronouns by learners of Mexico City Spanish.

Across varieties of Spanish, adult speakers produce both null and overt personal pronouns in subject position when referring to animate referents, with exact rates depending on multiple grammatical and social factors. In addition to extra-linguistic factors like region and age, the alternation between null and overt variants is probabilistically conditioned by language internal factors like the person and number of the subject, the tense, mood and aspect of the verb, and crucially for this study, what the pronoun's antecedent is (Bayley & Pease-Alvarez, 1997; Carvalho et al., 2015 and references therein; Flores-Ferrán, 2007; Otheguy et al., 2007, 2010; Otheguy & Zentella, 2012; Shin & Otheguy, 2009). Specifically, speakers tend to produce more null subjects when the intended antecedent is the immediately preceding subject, compared to when the intended antecedent is anything else (preceding direct, indirect or oblique object; non-preceding subject, etc.). For example, speakers are more likely to use (2a) to express the message that *Juan called Pedro when Juan was at home*, and to use (2b) to express that *Juan called Pedro when Pedro was at home*.

(2)a. *Juan llamó a Pedro cuando* ☐ *estaba en casa.*[adapted from De La Fuente (2015)]

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[2]See Barbosa (2011a, 2011b) for a discussion of canonical or "full" null subject languages versus partial null subject languages. In this paper we assume that in canonical null subject languages the null subject is a phonologically empty version of the overt subject, which we gloss here as *pro* (following Holmberg, 2005; Roberts, 2010, and others). Other analyses (most notably Alexiadou & Anagnostopoulou, 1998) argue that null subject clauses actually do not have a *pro*, but rather that the agreement marker on the verb itself performs the function of subject – it is an enclitic pronoun on the verb. On this latter analysis, the overt subject (*las llaves* in example (1a), *ella* in example (1b)) is not considered to be a true subject but rather a clitic-left-dislocated phrase adjoined to the clause. Regardless of which analysis turns out to be correct, the learning problem we are considering here remains largely unchanged. Children must still learn when to use which structure/form.

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      "Juan called Pedro when pro was at home."
 b.   Juan llamó a Pedro cuando él estaba en casa.
      "Juan called Pedro when he was at home."
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The subject-antecedent reading, where *Juan* is the one at home, is commonly referred to as the "same-reference" reading because the same referent is referred to in subject position both times; all non-subject readings tend to be grouped under the term "switch-reference" (Otheguy & Zentella, 2012). The contrast between same-reference and switch-reference contexts is consistently found to be one of the strongest factors conditioning subject pronoun expression, and it is the factor that we will focus on in this paper.

On the comprehension side, listeners take advantage of this contrast to help decide what the antecedent of a null or overt subject pronoun is. For example, Spanish speakers presented with grammatically ambiguous examples like (2) above tend to interpret the null subject (2a) as referring to the preceding subject *Juan*, whereas they have no such interpretive bias for the overt subject (2b) (Alonso-Ovalle et al., 2002; De La Fuente, 2015). And in both Spanish and Italian, online reading times and offline acceptability judgments show that the null subject is easier to process and rated as more acceptable when it is pragmatically disambiguated toward a same-reference interpretation, relative to a switch-reference interpretation – and vice-versa for the overt pronoun (Carminati, 2002; Filiaci et al., 2014; Jegerski et al., 2011; Keating et al., 2016, 2011).

Different proposals have been made to explain the nature of this contrast (Blackwell & Quesada, 2012; Carminati, 2002; Frascarelli, 2007; Luján, 1985, and many others; see; De La Fuente, 2015 for a review), all of which rely on some notion of prominence: null pronominal subjects tend to pick out the referent previously mentioned in subject position because it is in some sense more prominent than other referents. In some proposals, the preceding subject antecedent is considered prominent because of its syntactic position, appearing higher up in the clause than other arguments (Carminati, 2002). In others, it is considered to be a topic (Frascarelli, 2007) or in the listener's focus of attention (Blackwell & Quesada, 2012).

Some proposals also situate the contrast between null and overt pronominal subjects within a broader, more universal pattern: across languages, speakers tend to refer to more prominent referents using referring expressions with less phonological and semantic content (Almor, 1999; Ariel, 1990; Gundel et al., 1993). Thus, not only do null subject pronouns prefer more prominent referents than overt ones (in languages that have both), but personal pronouns themselves favor more prominent referents than demonstratives (ex. *este* "this one"), which in turn favor more prominent referents than lexical NPs (ex. *este gato* "this cat," *el gato con sombrero* "the cat in the hat"), and so on. As yet, there is no single accepted definition of prominence; rather, it seems that many different linguistic and non-linguistic factors are relevant (see Almor & Nair, 2007; Ariel, 1990; Arnold, 2010 for reviews of adult language; Allen et al., 2015 for a review of child language). For the purposes of this paper, we will be focusing on just one dimension of prominence (reference to the preceding subject antecedent) and its relation to just one morphosyntactic contrast (null versus overt subject pronoun expression), but we recognize that this is only one of many factors that must be considered as the child grows toward adult-like competence.

It is important to underscore that in this case the target knowledge is probabilistic in nature: a pronoun's realization does not categorically determine which antecedent it refers to, nor does the position of the antecedent categorically determine how the pronoun should be realized. Both the null subject in (2a) and the overt subject in (2b) can be grammatically used to refer to the preceding subject antecedent *Juan*; it is simply more *likely* that the speaker will choose the null form when doing so. Likewise, the listener can grammatically resolve the (null or overt) pronoun toward either the preceding subject antecedent, toward the object antecedent, or even an extra-sentential antecedent, depending on the pragmatics of the surrounding discourse. For example, were it made known to the listener that Juan was calling Pedro *in order to find out how bad traffic was on the commute home*, then the object reading would be favored over the subject reading for both the null pronoun in (2a) and the

overt pronoun in (2b). The difference is simply that the object bias would be *even stronger* for (2b). The task for the learner, in other words, is to associate null and overt pronominal subjects, not with categorically distinct interpretations, but with an increase or decrease in the *probability* of a same-reference interpretation, respectively.

This brings up a second important point to underscore. The null/overt contrast is not the only piece of information that listeners consider when interpreting subject pronouns; there are many other pieces of relevant information. Most obviously, speakers may use the pronominal subject's phi-features (i.e. person, number and gender, when available[3]) to identify which antecedent(s) it can potentially refer to. When more than one grammatically compatible antecedent is available, listeners additionally rely on factors like world knowledge, the physical context, the speaker and listener's shared understanding of the question under discussion (Roberts, 1996), and the coherence relations established between clauses (Kehler & Kehler, 2002). Example (3) illustrates this in English. In (3a) both *Bill* and *John* are compatible with the phi-features of the pronoun *he*, but real-world knowledge about rudeness and apologies leads us to choose *John* as the more likely antecedent. However, in (3b), the coherence relation between the rudeness and the apology is reversed, and the preferred antecedent is instead *Bill*. What all of this means for acquisition is that children must learn not only the contrast between null and overt subject pronouns, but also how to coordinate this with other types of information that help narrow down pronoun reference.

(3)a. John apologized to Bill because he had been rude.*P*(he=John) > *P*(he=Bill)

    b. John apologized to Bill even though he had been rude.*P*(he=Bill) > *P*(he=John)

The last point to underscore about the null/overt pronoun contrast is that it varies in strength across different communities. Sociolinguistic studies across varieties of Spanish reveal that the contrast between same-reference and switch-reference contexts can condition overt pronoun production to different degrees depending on the variety spoken, and the strength of this factor can change when dialects come into contact (Otheguy et al., 2007, 2010; Shin & Otheguy, 2009). Cross-linguistic variation is also attested in interpretation. For instance, psycholinguistic experiments show that Italian more strongly associates the overt variant with a non-subject antecedent compared to Spanish (Filiaci et al., 2014). In other words, children must learn not only that there is a contrast between null and overt subject pronouns, they must calibrate the strength of this contrast for the language variety being used around them.

What all of this means for acquisition is that, even if children are aware of the universal correlation between more reduced referring expressions and more prominent referents, there are still a lot of language-particular details to be ironed out. The child must discover which dimensions of prominence are relevant for distinguishing null and overt pronouns specifically, and how strongly they condition pronoun expression in the child's particular speech community.

The learning problem and its solution

Defining the learning problem

How do children acquire the probabilistic association between pronoun realization and pronoun reference? The first step is to determine whether the language allows null subjects and if so, what the licensing conditions are. Assuming the child decides she is dealing with a canonical null-subject language like Spanish, the next phase of learning is to search for the conditions governing when to use each kind of subject. This means tracking the correlation between each form of referring expression

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[3]In canonical *pro*-drop languages, person and number features are in principle recoverable from the verb, so they are available even when the subject itself is null.

(ex. pronoun, demonstrative, lexical NP, name) and the prominence of its eventual referent. For null and overt personal pronouns specifically, this means tracking their use across same- and switch-reference contexts. That is, children must track whether a pronoun refers to the same entity as the referring expression in the preceding subject position (same-reference) or to some other entity (switch-reference) and associate the former interpretaionwith null subject realization. For other forms like demonstratives and definite noun phrases, other dimensions and levels of prominence are relevant, depending on the language (see Gundel et al., 1993 for proposals in English, Japanese, Mandarin, Russian and Spanish). The last step in this phase of the learning process is to fine-tune how strong these different dimensions are, and how they interact with each other.

What could help the learner identify the contrast between same-reference and switch-reference as a crucial factor determining subject pronoun realization? This is not an easy problem to solve because identifying same- and switch-reference environments requires the learner to know in advance what the intended referent of the null or overt pronoun is. If a child is to verify that a null subject in her input indicates reference to the preceding subject, or that an overt subject indicates reference to a non-subject antecedent, she must know what the intended referent of each pronoun is in the first place. However, determining the intended referent is a much more complex task for pronouns than it is for other referring expressions like names and noun phrases, a fact that can be illustrated by any discourse situation that offers more than one potential antecedent for a pronoun.

For example, in the context of a story about Juan and Pedro skipping school, being discovered by the principal, and being disciplined by their fathers, a speaker could utter (4a) or (4b) using either the null or overt pronoun; or as illustrated in (5) the speaker could use any number of more semantically restricted noun phrases, such as a proper name or a noun phrase. Because pronouns are semantically underspecified, they could in principle refer to *any* of the characters in this story, in contrast to the other more semantically restricted expressions, as illustrated in (6).

(4)a. *Después de todo, Juan llamó a Pedro cuando ☐ estaba en casa.*

    "After everything, Juan called Pedro when ***pro*** was at home."
  b. *Después de todo, Juan llamó a Pedro cuando **él** estaba en casa.*
    "After everything, Juan called Pedro when **he** was at home."

(5) Context: A story about Juan and Pedro skipping school, getting caught by the (male) principal, and being disciplined by both of their fathers.

Después de todo, Juan llamó a Pedro cuando {*Juan/el niño/ø/él*} *estaba en casa.*
    "After everything, Juan called Pedro when {Juan/the boy/*pro*/he} was at home."

(6) Potential referents of the subject DP in (5)

Juan: {Juan}
el niño: {Juan, Pedro}
null subject *ø*: {Juan, Pedro, principal, Juan's father, Pedro's father}
él: {Juan, Pedro, principal, Juan's father, Pedro's father}

What this example shows is not that sentences like (4a-b) are impossible for learners to interpret, but that doing so requires an inferential process that should not be taken for granted: the child must consider the set of potential referents and narrow it down to the referent she believes is intended by the speaker. Then – and only then – can she identify the sentence as a same-reference or switch-reference token and associate this interpretation with the pronominal form chosen by the speaker. In contrast,

less ambiguous referring expressions like names and lexical NPs can be more directly associated with their referents, making it easier to track the association between certain forms of referring expression and certain referent properties (givenness, uniqueness, etc.). To put it succinctly, the more complicated it is to locate a referent, the more difficult it will be to track how its salience correlates with the properties of the expression used to refer to it. This makes it a challenge to learn the association between pronoun reference and realization, in particular. In the next section, we propose a solution to this problem grounded in acquiring 1st and 2nd person pronouns, whose referents in the discourse are much less complicated to resolve.

Proposed solution

Charnavel (2019) argues that 1st and 2nd person pronouns have the same formal representation as 3rd person pronouns – all three depend on an assignment function linking their index to the intended referent. The reason for the interpretive differences that researchers have observed between 1st and 2nd person, on the one hand, and 3rd person, on the other, is due to the fact that it is simply a lot easier to infer the intended referent of 1st and 2nd person pronouns. For first person, the intended referent is nearly always the speaker, and for second person it is almost always the addressee.

Charnavel's analysis of pronouns has a couple of implications for acquisition: first, it should be much easier for children to identify same-reference versus switch-reference uses of 1st and 2nd person pronouns; second, there is nothing preventing children from automatically generalizing knowledge they have acquired about 1st and 2nd person subject pronouns to 3rd person subject pronouns. If these implications hold water, this may provide a way around the learning challenge articulated above. That is, if children initially restrict their attention to tracking the realization and reference of 1st and 2nd person subject pronouns, then the association between pronoun realization and pronoun reference can be extended to the more difficult case of 3rd person subject pronouns. We therefore hypothesize that children first form an association between overt 1st and 2nd person pronominal subjects and switch-reference, on the one hand, and null 1st and 2nd person pronouns and same-reference, on the other. Once this association is formed, we hypothesize that they generalize it to all personal pronouns in subject position. This learning path is summarized below.

(7) Proposed learning path:
   (a) Step 1—Association: Track the realization of 1st and 2nd person subjects in same- and switch-reference contexts and associate same-reference readings with a decreased probability of overt pronoun realization.
   (b) Step 2—Generalization: Generalize this association to the production/comprehension of *all* personal pronouns in subject position—1st, 2nd and 3rd person.

There are two additional reasons that make generalizing from 1st and 2nd person pronouns a smart strategy. First, there are fewer forms to track. Demonstratives, lexical NPs and names appear almost exclusively in the 3rd person,[4] so in the 1st and 2nd persons there are only null and overt personal pronouns to worry about. Second, generalizing within the natural class of personal pronouns provides a way to make a constrained generalization. Making generalizations is key to children's ability to learn quickly from limited input, but it also carries an inherent risk of overshooting the target; learners must

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[4]There are certain highly restricted cases such as (i) where 3rd person plural NPs (ex. *las dos* "the two of us") can appear with 1st person plural morphology on the verb. In our sample of over 53,000 utterances we found 19 examples.

   (i) *Vamos a bailar las dos juntas* [JRC 5;11]

   Go-1P to dance the two together
   "Let's dance the two of us together."

make *constrained* generalizations. Using natural classes is a principled way to do this, since belonging to the same natural class already implies that members share a set of formal properties.

Of course, it is not enough to argue that following this learning path is a smart choice, we must show that it is consistent with what children actually do. We make the case that it does by answering three basic questions.

Q1. Is the null/overt contrast acquirable, in principle, from the distribution of 1st and 2nd person pronouns in children's input?

Q2. Do children show sensitivity to this contrast in their own production of 1st and 2nd person subjects?

Q3. Do children generalize this contrast to the production and comprehension of 3rd person pronominal subjects *after* they have acquired it in the domain of 1st and 2nd person?

In the remainder of the paper we present evidence from the acquisition of Spanish in Mexico City that answers each of these questions with a "yes." We report two studies analyzing the spontaneous production of subject pronouns (Study 1) and the comprehension of grammatically ambiguous 3rd person subject pronouns (Study 2). Study 1 uses the Schmitt-Miller corpus (Miller & Schmitt, 2012[5]) of naturalistic parent-child interactions, addressing Q1 using caretaker input and Q2-Q3 using children's own speech. In brief, we show that the referential contrast between null and overt subject pronouns in children's input is significant in the 1st and 2nd persons (and at least as strong as it is in the 3rd person). We also show that children under age 6 reproduce this contrast in their own production of pronominal subjects, and that the contrast emerges earlier within the 1st and 2nd persons as compared to the 3rd person. Study 2 addresses Q3 from the comprehension side. Using a pronoun resolution task, we find that children begin using the null/overt contrast to guide their interpretation of grammatically ambiguous 3rd person pronouns by age four and a half – approximately the same age when adult-like production is revealed in Study 1. Before presenting this data, the next section reviews what is currently known about the developmental path.

Acquisition background

There are two branches of the acquisition literature that are relevant to the learning problem studied here. First are studies on the acquisition of null and overt subject pronouns in canonical *pro*-drop languages. Children learning these languages must associate same-reference contexts with a decreased rate of overt pronoun realization, relative to switch-reference contexts, although the strength of this association may vary across individual varieties (Filiaci et al., 2014; De La Fuente, 2015). Second are studies on children's production and comprehension of referring expressions more generally. Across languages, children must learn to associate more reduced referring expressions (including but not limited to null subject pronouns) with referents that are prominent in some way (including but not limited to having been mentioned in the preceding subject position).

The first branch of literature includes spontaneous production, felicity judgment, and pronoun resolution tasks. Studies of spontaneous production find that children acquiring Spanish, Italian and Catalán begin producing overt subjects before age 2. Initially, they tend to under-produce overt subjects, especially overt pronouns (Bel, 2003; Grinstead, 2004; Paradis & Navarro, 2003; Serratrice, 2005; Serratrice et al., 2004). In Spanish, underproduction of overt subject personal pronouns persists even into middle and late childhood, with first-graders (ages 6–7) overtly realizing them 6–8% of the time and fifth-graders (ages 10–11) 10% of the time (Shin, 2012, 2016) – far less than the 18–22% rate

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found among Mexican adults (Lastra & Butragueño, 2015; Shin & Erker, 2015; Shin & Otheguy, 2013). Despite being infrequent, however, overt subject pronouns are not randomly distributed. In Spanish, Shin (2016) finds that the overt variant is positively associated with switch-reference contexts among even the youngest age group studied (6–7 years). In Italian, Serratrice (2005) finds that children between age 1;7 and 3;3 increase their overall rates of overt subject expression by producing more and more overt 1st and 2nd person pronouns, which they largely use in contrastive contexts. (Overt 3rd person pronouns remain very infrequent, however.)

Felicity judgment tasks show that children are more accepting than adults of overt subjects in same-reference contexts and even more over-accepting of null subjects in switch-reference contexts. In Italian for example, Sorace et al. (2009) asked bilingual children, monolingual children, and adult speakers to choose between descriptions of an event using either a null (8a) or an overt (8b) personal pronoun, alternating between same-reference events (i.e., *Minnie* saying that *Minnie* fell) and switch-reference events (i.e., *Minnie* saying that someone else fell). For switch-reference events, monolingual children ages 6–7 and 8–10 were just as likely as adults to choose the overt variant, but for same-reference events only the 8- to 10-year-olds preferred the null variant quite as strongly as adults. Both English-Italian and Spanish-Italian bilinguals were overall less adult-like than their monolingual peers.

(8)a. *Minnie ha detto che **ø** è caduta.*[Sorace et al. (2009)]

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     "Minnie has said that pro has fallen."
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   b. *Minnie ha detto che **lei** è caduta.*
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     "Minnie has said that she has fallen."
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In Mexican Spanish, Shin and Cairns (2012) report a qualitatively similar and quantitatively even slower developmental trajectory. For switch-reference events, children failed to reliably choose the overt variant until age 8–10, and for same-reference events not even 14–15-year-olds reliably chose the null variant. Studies among L2 learners also show slow acquisition of these preferences, especially when it comes to the null subject pronoun (Belletti et al., 2007; Montrul, 2004, 2011; White, 2011, a.o.).

These results suggest a very protracted developmental path; however, they may underestimate what children actually know about the null/overt pronoun contrast. Felicity judgment tasks are cognitively complex, requiring the listener to hold two utterances in short-term memory while making a metalinguistic judgment about them. Using a less taxing picture-sentence matching paradigm, Papadopoulou et al. (2015) found more adult-like sensitivity to the null/overt distinction among Greek-acquiring children ages 6–11. Participants listened to a sentence like (9a) while simultaneously viewing a picture that corresponded to either a same-reference interpretation (*pro* = the old man), or one of two switch-reference interpretations (object interpretation: *pro* = his grandchild; other interpretation: *pro* = another person) and simply judged whether or not the picture and sentence matched. A second experiment used the same conditions, but with overt pronouns, as in (9b).

(9)a. *O papús millúse δinatá ston egonó tu ótan **ø** δjávaze ena vivlío.*

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"The old man spoke loudly to his grandchild when pro read a book."
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b. *I jajá xerétise tin kipéla ótan **aftí** pernúse to δromo.*
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"The old lady greeted the girl when she crossed the street."
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Like adults, children of all ages accepted the same-reference reading of the null subject nearly all the time; they accepted the object reading less often; and they accepted the "other" reading even less often. For overt subjects, children of all ages were like adults in accepting the object reading most of the time and the "other" reading less often. Children age 6–9 over-accepted the same-reference reading compared to adults but still processed it more slowly than the other readings, as evidenced by longer listening times.

Summing up, in canonical *pro*-drop languages, children as young as 6 detect the association between subject personal pronoun realization and same-/switch-reference, as demonstrated by their production and comprehension, although it may take them much longer to demonstrate adult-like preferences in felicity judgment tasks or to produce overt personal pronouns at quite the same overall rate as adults in free speech contexts. Unfortunately, at this point it is not clear whether children learn this association any earlier than 6. Our study will help address this gap by contributing production and comprehension data for Spanish-acquiring children under 6.

Despite the lack of information on children's early knowledge of the same/switch-reference contrast in canonical *pro*-drop languages, there is plenty of evidence from a variety of languages that children much younger than 6 are aware of the general correlation between a referent's prominence and the types of forms used to talk about that referent. Allen et al. (2015) provide a comprehensive review of the different dimensions of referent prominence (in their terms, "accessibility factors") that have been found to affect young children's production of referring expressions. Some dimensions are extra-linguistic, such as (i) whether the referent is physically present, (ii) whether one or more competing referents are physically present, and (iii) whether or not the child and interlocutor have the same knowledge about the referent or are jointly attending to the referent at the moment when it is mentioned. Other dimensions are linguistic in nature, including (i) whether or not the referent has been explicitly mentioned in the preceding discourse ("prior mention"), (ii) whether it is explicitly contrasted with a competitor ("explicit contrast"), and (iii) whether it is referred to in the 3rd person versus 1st or 2nd persons ("person"). These linguistic dimensions (in their terms, "discourse-based factors") tend to be the earliest determinants of children's referential choices. We will discuss the above three linguistic dimensions in turn and how they relate to the contrast between same- and switch-reference in canonical *pro*-drop languages and then end with a review of children's use of subject prominence in pronoun comprehension.

First, prior mention increases a referent's prominence, making it more likely to be talked about using reduced referring expressions. Children seem to be aware of this factor from very young. In spontaneous speech, children as young as 2;0–2;6 in English (Rozendaal & Baker 2010) and as young as 1;10–2;10 in French (Salazar Orvig et al., 2010) produce pronouns significantly more often when the referent has been mentioned than when it is new to the linguistic discourse. Elicited production reveals slightly later sensitivity (ex. 3;8–4;6 in Catalán-acquiring children; Prat-Sala & Hahn, 2007). Since prior mention is a broad category of prominence that encompasses the more specific case of same- versus switch-reference, these findings set a lower bound on what we would expect for children acquiring canonical *pro*-drop languages like Spanish. Same-reference is a special case of prior mention in which the prior-mentioned antecedent is the subject of the preceding clause. Presumably, children must learn that prior mention increases a referent's prominence before learning the more fine-grained contrast between same- versus switch-reference. This would suggest that the lower bound for acquisition of the same/switch contrast is sometime around age 2.

A second important prominence factor is explicit contrast with another referent. The presence of this other referent means that the target referent competes for prominence; thus, explicit contrast is associated with *less* reduced referring expressions like stressed pronouns and lexical nouns. Children seem to be aware of this factor even earlier than the factor of prior mention. In Italian for example, Serratrice (2005) found that children's first overt pronouns were 1st and 2nd person pronouns used in contrastive contexts. Unfortunately, it is more difficult to say what this result implies about their knowledge of the association between overt pronoun expression and switch-reference, since there is no straightforward mapping between explicit contrast and switch-reference (see Amaral & Schwenter, 2005).

Lastly, reference in the 1st and 2nd persons is associated with reduced referring expressions, since the speaker and addressee are inherently more salient than other referents. Children in Serratrice's 2005 study in Italian were also sensitive to this factor, producing overt pronouns for only 12% of 1st and 2nd person subjects and overt forms like demonstratives and lexical NPs for 23% of 3rd person referents. That is, despite not producing overt *pronouns* in 3rd person contexts, these children still

produced enough *other* overt expressions to outpace the overt subject rate of 1st and 2nd person subjects. Like the dimension of explicit contrast, the dimension of person is also somewhat orthogonal to our research question. All three persons can freely appear in both same- and switch-reference contexts, so early acquisition of one factor does not imply early acquisition of the other. However, it is interesting to note that the greater prominence of speaker and addressee referents may make them easier to track, providing yet another reason for 1st and 2nd person pronouns to potentially be the domain in which children discover the correlation between pronoun realization and pronoun reference.

In sum, children's early referential choices demonstrate a reliable association between reduced referring expressions and linguistically prominent referents. Since the same- versus switch-reference contrast is a specifically linguistic distinction, we might expect early awareness of this contrast in *pro*-drop languages like Spanish. The lowest bound suggested by this literature is age 2. On the other hand, the contrast between same- and switch-reference contexts is a more fine-grained distinction than other dimensions of prominence, since it distinguishes between prior mention in the preceding subject position versus other positions.

Results from children's pronoun resolution suggest that the elevated prominence of the preceding subject position takes a little longer to become fully associated with reduced referring expressions. For instance, Hartshorne et al. (2015) found that 5-year-olds resolved a grammatically ambiguous pronoun toward a referent mentioned in the preceding subject position, as opposed to a distractor in a non-subject position, more often than chance (65%) but not as often as adults (90%); moreover, they shifted their looks toward the target referent more slowly than when the pronoun was disambiguated by gender (see also Arnold et al., 2007; Song & Fisher, 2005). This seems to suggest that preschoolers acquiring English are aware that referents mentioned in subject position are more prominent than other prior-mentioned referents; however, they are slow to resolve the competition in real time. For canonical *pro*-drop languages like Spanish, it is therefore possible that the fine-grained distinction between same-reference and switch-reference will also be somewhat difficult for preschoolers. Since this study is the first we know of to look at the same/switch contrast in children under 6, we cast a fairly wide net, examining production and comprehension from just under 3 to just under 6.

Study 1: spontaneous production of 1st, 2nd and 3rd person subject pronouns

The first question we address is whether 1st and 2nd person pronouns in the input actually provide the distributional information necessary to acquire the target knowledge. In this section, we examine a corpus of naturalistic parent-child interactions to determine whether null and overt 1st and 2nd person pronominal subjects in child-directed speech do indeed have different referential tendencies. The next question we address is whether children's own production demonstrates awareness of the contrast, and if so, whether it is acquired first in the domain of 1st and 2nd person subjects before being generalized to the 3rd person.

Hypotheses and predictions

The learning path hypothesized in Section 4 makes three predictions about the realization of pronominal subjects in child and adult speech. First, our proposal assumes that the null/overt distinction is learnable from the distribution of 1st and 2nd person pronouns in the input, meaning that we expect mothers in our sample to produce significantly more overt 1st and 2nd person pronominal subjects in switch-reference contexts than they do in same-reference contexts. Second, if children begin acquiring this statistical pattern at some time before 6 years of age, as suggested by the production and comprehension data available to date, then we predict that at least some of the children in our sample will reproduce this same statistical contrast in their own production of 1st and 2nd person pronominal subjects. Finally, since we hypothesize that children generalize knowledge from 1st and 2nd person to the 3rd person, rather than the other way around, we predict that a slightly

older subgroup of children in our sample will show this statistical pattern in their production of 3rd person pronominal subjects.

Methods

Participants

We use a subset of the Schmitt–Miller corpus (Miller & Schmitt, 2012), collected in Mexico City, Mexico in 2008, which records the spontaneous speech of 25 child-caretaker dyads ages 1;6 to 5;11, with 12 dyads recruited from a public preschool serving predominantly low-SES families and 13 dyads from a private school serving predominantly mid- to high-SES families. Caretakers were recorded playing with their children during 2–4 free-play sessions lasting around 30 minutes each, as well as one approximately 30-minute session chatting with another adult. The entire corpus contains approximately 649,000 words. Due to the time and cost of coding, this study includes data from about half of the corpus.

This study uses the parent-child interactions from 11 mother-child dyads, totaling 225,110 words. Participant word counts and characteristics are summarized in Table 1

Coding

We began analysis of our sample by extracting all tensed clauses – the environment where personal pronouns are grammatically permitted (37,550 clauses). Next, we excluded environments where (i) the overt personal pronoun is ungrammatical or extremely rare, such as when referring to inanimate referents, (ii) the subject of the clause was not clearly identifiable, or (iii) the speaker was not clearly identifiable as the child or caretaker (see section 5.3.1 for details). This left a total of 20,307 animate subjects, including pronouns, demonstratives, noun phrases, names, and other forms. Next, for purposes of coding same-reference and switch-reference we included only those tokens preceded by at least one other clause in the same speaker turn, which we defined as the longest uninterrupted string of speech by the same person, even if the speaker paused or changed the subject. In these environments, we can be confident that children and adults know what the preceding subject antecedent is because they themselves have produced it. These environments also provide a good point of comparison to psycholinguistic studies on the null/overt pronoun distinction reviewed in Sections 2 and 4, all of which test pronouns with locally available antecedents (some within and some across sentence boundaries, but all within a single speaker's turn). This left a total of 6,834 animate subjects. Finally, we coded these subjects for form (null/overt pronoun, demonstrative, definite/indefinite noun phrase, proper name, other; see section 5.3.2 for details) and reference (same, switch) following guidelines in Otheguy and Zentella (2012,

Table 1. Subject characteristics of 11 Mexican Spanish-speaking dyads from the Schmitt-Miller corpus.

School	Child	Age	Mean Length of Utterance (words)	Mother Word Count	Child Word Count
Mid/high-SES	JGAV	2;11	2.90	20,873	7,485
	YGSZ	3;9	3.65	9,608	10,910
	EAMR	4;3	4.71	5,758	8,522
	PLG	4;9	5.59	14,207	11,537
	SLV	4;10	4.74	9,590	11,277f
	KDP	3;4	4.75	8,962	7,007
	KUC	4;5	4.52	11,721	9,393
Low-SES	YBM	4;8	3.99	11,054	8,373
	ACC	4;11	3.34	9,089	3,539
	OMJ	5;2	3.87	11,934	7,314
	JRC	5;11	3.75	14,787	12,170
		Mean: 4;5.3	Mean: 4.16	Total: 127,583	Total: 97,527

appendix; see section 5.3.3 for details). Below, we report results for null and overt personal pronouns produced by children (2,468 tokens) and caretakers (3,632 tokens). Other overt subject expressions produced by children (366 tokens) and caretakers (368 tokens) are reported in Appendix 1, Table I.

Exclusions

We made three major types of exclusions, illustrated in (10)-(12) below. Following Otheguy and Zentella (2012), we excluded subject relative clauses (10a) because overt pronouns never appear in this environment; although the subject is null, the gap is the result of an operator movement, and in Spanish this is not an environment that permits resumptive pronouns. We excluded frozen expressions like (10b) because they always appear in the same form, thus there is no variation between null and overt pronouns. Imperatives (10c) do not grammatically exclude overt personal pronouns; however, Shin (2016) found near categorical subject omission in her sample of Mexican Spanish (167 of 172 imperatives), and we therefore followed her decision to exclude them from analysis. Shin (2016) also found categorical subject omission in the phrase *no sé* ("I don't know") when it was not followed by a complement (47 of 47 cases), and we followed her in analyzing this as a fixed phrase. The last exclusion of this type was generic references to "them" or "people," as in (10e), since these examples rarely appear with an overt personal pronoun.

(10) Exclusion type I: environments with little to no variation

a. subject relative clauses: *El niño que ø/*él toca el piano* ("The boy that (*he) plays the piano")
b. frozen expressions: *¿sabes?* ('ya' know?') *¿ves?* ('see?') *¿viste?* ('see?'), etc.
c. imperatives: *Dime ø ahora* ("Tell me now")
d. fixed phrase *no sé* ("I don't know") not followed by a complement
e. generic references to "them" or "people," such as *ø dicen que el amor es ciego* ("(they) say that love is blind") and *en la escuela ø me dieron de comer* ("at school (they) gave me something to eat")

The second type of exclusion included cases where identifying the subject was not trivial. Dative-experiencer predicates like *gustar* ("to please") have two arguments: a dative-marked experiencer argument in preverbal position (ex. *me* "me" in (11a) below) and a nominative-marked theme argument with which the verb agrees (ex. *tú* "you"). Presentational *haber* ("there is/are") is also not trivial to analyze. Although the verb agrees with the post-verbal nominal (ex. *tres gatos*, "three cats" in (11b) below) the "true" subject may be a null expletive subject (which in English is realized overtly as the dummy subject "there"). Because logical subject and formal subject do not align in both of these cases, we made the conservative decision to exclude these cases.

(11) Exclusion type II: predicates with non-canonical subjects
   (a) Dative-experiencer predicates:

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Me gustas tú
me-DAT please-2S you
"I like you." (literally: "You please me")
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   (b) Presentational *haber*:

```
(ø?) habían tres gatos
have-3P three cats
"(There) were three cats."
```

The third type of exclusion was any subject whose realization was affected by factors external to the speaker him or herself. This included material authored by someone other than the speaker, such as passages from books, song lyrics, etc. It also included verbatim repetitions of another person's speech, as in (12b). When the speaker repeated their own speech verbatim we included only the first instance. Finally, we excluded false starts, as illustrated in (12 c), only coding the realization of the final repetition of the verb.

(12) Exclusion type III: subjects whose realization is affected by external factors
    (a) Pre-authored material: reading from books, song lyrics, nursery rhymes, etc.
    (b) Repetitions: CHI: *Le van a pegar **los niños**.* ("**The boys** are going to hit him.") MOT: ¿*Le van a pegar **los niños?*** ("**The boys** are going to hit him?")
    (c) False starts: *ø van, **ø** nos van a dejar aquí* ("go, (they're) going to leave us here.")

Definition of subject forms

Each animate, turn-internal subject of a tensed clause not excluded by one of the criteria in (10)-(12) was then coded for form, as follows: (i) null pronouns: any subject not overtly expressed; (ii) overt pronouns: *yo, nosotros, tú, usted, ustedes,*[6] *él, ellos, ella, ella*s; (iii) demonstrative pronouns: any demonstrative not accompanied by a noun phrase, including *este/esta* ("this one"), *ese/esa* ("that one"), *aquél/aquella* ("that one"); (iv) definite NP: any noun phrase introduced by a demonstrativee or definite article (ex. *el/este/ese/estos perro(s)* "the/this/that/these dog(s)") (v) indefinite NP: any bare plural or noun phrase introduced by an indefinite determiner (ex. *perros* "dogs," *un/unos perro(s)* "a/ some dog(s)"), (vi) proper name: names of people (ex. *Juan*), story characters (ex. *gato con botas* "puss in boots"), or kin names (ex. *Mamá te quiere* "Mommy loves you."), (v) other: all other forms (ex. wh-phrases).

Definition of same-reference and switch-reference

Following Otheguy and Zentella (2012), subjects were coded as *same-reference* if they referred to the same referent as the subject of the preceding tensed verb within the same turn. In example (13), the null subject of *tienes sueño* ("you're sleepy") refers to the same entity as the subject of *estás bostezando* ("you are yawning") and would therefore be coded as a same-reference token. Subjects were coded as *switch-reference* if they referred to a non-subject argument of the preceding tensed verb, to a new referent not previously mentioned, or to a referent mentioned in a preceding turn. In (13), for example, the null subject of *estás bostezando* ("you are yawning") would be coded as a switch-reference token because it refers to the same referent as the preceding object of *veo* ("see-1Sg"). The subject of *nos vamos* ("we'll leave") would also be coded as switch-reference because it does not match in person and number features with the subject of the preceding verb *tienes sueño* ("you're sleepy"). Since we excluded any subjects that were not preceded by another tensed verb in the same turn, the first subject in (13), *yo* ("I") would be excluded from coding because it has no preceding subject with which to maintain or switch reference. Nevertheless, it still serves as a suitable "trigger" for coding the subject of the following verb, *estás* ("you are").

(13) ***Yo** te veo que □ estás bostezando. Si □ tienes sueño, □ nos vamos.*

"**I** see you that (**you**) are yawning. If (**you**)'re tired, (**we**)'ll leave."

When locating the preceding subject antecedent for the purposes of same-/switch-reference coding, we wanted to only include cases where the preceding subject referred to a specific individual, in order

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[6]The 2nd person singular formal pronoun *usted* and 2nd-person plural pronoun *ustedes* both trigger 3rd-person agreement on the verb but refer to the addressee(s) and are therefore coded as semantically 2nd person pronouns. Children produced a total of 15 (13 null, 2 overt), or 3.4% of 2nd person subject pronouns. Adults produced 49 (46 null, 3 overt) or 3.1% of 2nd person subject pronouns.

to avoid trivially switch-reference contexts.[7] Therefore, we only considered the preceding subject to be an eligible "trigger" for coding a subject pronoun's reference if it met one of the criteria in (14), otherwise it was skipped and the preceding subject before that was considered instead. If no eligible trigger was available within the same turn, that subject pronoun was not coded.

(14) Eligible "triggers" for coding same- and switch-reference on the following subject pronoun
  (a) Animate or inanimate subjects of finite clauses.
  (b) Subjects of an imperative, except for frozen imperative forms: *mira* ("see here"), *oye* ("hey"), *ándale* ("come on"), etc.
  (c) Generic subjects referring to "them" or "people": *ø dicen que . . .* ("(they) say that . . . ")

Subjects that we did not considered eligible "triggers" for reference coding are listed in (15). Subjects described in (15a-e) were excluded because they fail to refer to a specific referent, forcing any subsequent personal pronoun into a trivially switch-reference context by precluding the possibility of a same-reference interpretation. Traces of wh-operators (15f), presentational *haber* (15g), and dative-experiencer predicates (15h) were excluded because locating the subject is not a trivial matter (consistent with the treatment of examples like (11a-b) above).

(15) Subjects not considered "triggers" for coding same- and switch-reference on the following subject
  (a) Subjects denoting events or assertions:

[*Carla tiene sueño*]$_i$ *pero **eso**$_i$ no importa porque ø está fuerte.*
  "[Carla is tired]$_i$ but **that**$_i$ doesn't matter because (she) is strong."

  b. Expletive subjects:

  Ø es que yo no quiero.
  "(It)'s that I don't want to."

  c. Subjects of weather verbs:

  Cuando ø llueve, ¿va a llevar ella su sombrero?
  "When (**it)** rains, is she going to take her hat?"

  d. Subjects of frozen expressions:

  ¡Ándale ø! Ya ø voy.
  "Come on (you)! Now (I'm) going."

  e. Impersonal *se* passives:

  ***Se** dice 'por favor.'*
  "One says please." (i.e., "say please")

  f. Traces of wh-operators:

  *¿**Quién**$_i$ ø   dices   que   **t**$_i$ va   a   llevar   su   sombrero?*
  "**Who**$_i$ do (you) say (**trace**$_i$) is going to take their hat?"

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[7]This is similar in spirit to the approach of Torres Cacoullos and Travis (2018), who argue that "human switch-reference" is the crucial switch-reference context for overt subject pronoun realization.

g. Presentational *haber*:

> *Habían tres gatos*
> "(There) were three cats."

h. Dative-experiencer predicates:

> *Le gustan las manzanas.*
> "(S)he likes apples." (literally: "Apples please him/her.")

Inter-rater reliability

Two different raters coded our sample. To calculate inter-rater reliability, both raters independently coded the form (null, overt) and reference (same-reference, switch-reference) of all subject personal pronouns in 6 transcripts (8% of all speech data) and their ratings for each token were compared. Inter-rater reliability was 96.6% (κ = .84) for pronominal form and 95.7% (κ = .91) for reference.

Examples

Data from our corpus analyses illustrate that both null and overt subjects can occur in both same- and switch-reference contexts in children's naturalistic input. In example (16), produced by the mother of YBM (4;5), we find two same-reference tokens that illustrate this. The speaker's turn begins with a null subject, and the subjects of both the following verbs (*es, tiene*) maintain reference to the same referent (a dancer on a tightrope). In one case, the mother uses an overt subject (*ella*) and in the second she uses a null subject.

(16) *ø estuvo a punto de caerse,*

> "(She) was about to fall,
> *pero no, porque {**ella**} es una experta bailarina*
> but no, because she is an expert dancer
> *y {**ø**} tiene todo el equilibrio para poder bailar en una cuerda floja!*
> and (she) has all the balance to be able to dance on a tightrope!"

The same is true for switch-reference tokens, as illustrated in (17)-(18), from the same mother. The speaker begins her turn with an imperative, whose (null) subject refers to the child, then she switches reference to herself using an overt pronoun (*yo*). Finally, in (18), the mother begins her turn referring to herself (with a null subject) and switches reference to her daughter, this time using a null pronoun.

(17) Context: Mother encourages daughter to sing a lullaby to some lions.

> *Cántasela*
> "(You) sing it to them,
> *Para que {**yo**} me siente un ratito*
> so that I can sit down for a bit."

(18) Context: Mother pretending to be a doctor prescribing "luneta" candies.

> *Okey, entonces ø ya no le doy esta receta*
> "Okay, then (I) won't give you this prescription
> *y ya {**ø**} no va a comer lunetas nunca más en la vida*

```
and now (you-formal) will never eat lunetas ever again in your life."
```

These examples demonstrate that in child-directed speech, as in adult-directed speech, there is not a categorical requirement to use null subjects in same-reference contexts or to use overt subjects in switch-reference contexts. Rather, if these associations are attested in child-directed speech, they will be probabilistic in nature because they are the result of multiple, interacting factors.

Results

Overall rates of overt subject personal pronouns
Table 2 reports the proportion of overt personal pronouns produced by children and mothers in our sample. Children fluctuated between 4.5–26.8% overt pronoun use, with no discernible age-related trends.

The rate of overt pronouns in this sample differs slightly from rates reported elsewhere. On the one hand, mothers in our sample produced overt pronouns at an overall rate of 11.5% (417/3632, mean rate: 11.3%, $SD = 2.2$%), which is considerably lower than the rate of 21.7% (443/2040) reported by Lastra and Butragueño (2015) for adult natives of Mexico City. On the other hand, children in our sample produced overt pronouns at an overall rate of 12.7% (313/2468, mean rate: 12.5%, $SD = 6.7$%), which is quite a bit higher than the rate of 8% (148/1845) reported by Shin (2016) for children aged 6–7 in Querétaro and Oaxaca, Mexico.

Why these differences, and why in different directions? It is unlikely that these differences were driven by our decision to exclude turn-initial pronouns from the analysis – when turn-initial pronouns are included, overall rates remain steady at 11.6% (1105/9541, mean rate: 11.4%, $SD = 2.6$%) for mothers and 12.9% (956/7427, mean rate: 13.3%, $SD = 3.8$%) for children. We think a more likely explanation is the type of speech in our samples. On the one hand, mothers in our sample may have produced fewer overt pronouns because they are using child-directed speech, which tends to reference familiar, physically present items more often than adult-directed speech, potentially increasing the rate of null pronouns. On the other hand, children in our sample may have produced *more* overt pronouns because they were interacting one-on-one with a parent, while those in Shin (2016) were mostly telling stories. Narrative contexts tend to feature a single referent to whom a narrator refers multiple times, in other words, narratives are dominated by same-reference segments, potentially decreasing the rate of overt pronouns (see Travis, 2007 for an example of this genre effect in adult Spanish). In contrast, the one-on-one interactions in the Schmitt-Miller corpus likely have fewer same-reference segments and therefore more overt pronouns. Additionally, one-on-one speech tends to have a higher ratio of 1st and 2nd person pronouns to 3rd person pronouns than narrative speech

Table 2. Rates of overt pronoun realization by parent-child dyads in a subset of the Schmitt-Miller corpus (recorded 2008, Mexico City, Mexico).

Child	Age	Child % overt (total pronouns)	Mother % overt (total pronouns)
JGAV	2;11	4.5% (22)	8.7% (391)
KDP	3;4	17.5% (160)	12.6% (310)
YGSZ	3;9	10.0% (150)	11.6% (190)
EAMR	4;3	11.3% (282)	11.0% (200)
KUC	4;5	5.0% (199)	13.2% (341)
YBM	4;8	12.7% (267)	9. 6% (366)
PLG	4;9	9.1% (427)	11.9% (563)
SLV	4;10	20.3% (453)	7.1% (182)
ACC	4;11	26.8% (56)	14.5% (415)
OMJ	5;2	8.2% (208)	13.2% (302)
JRC	5;11	12.3% (244)	10.8% (372)
Mean		12.5% (*SD = 6.7%*)	11.3% (*SD = 2.2%*)

context type ▨ same-reference ■ switch-reference
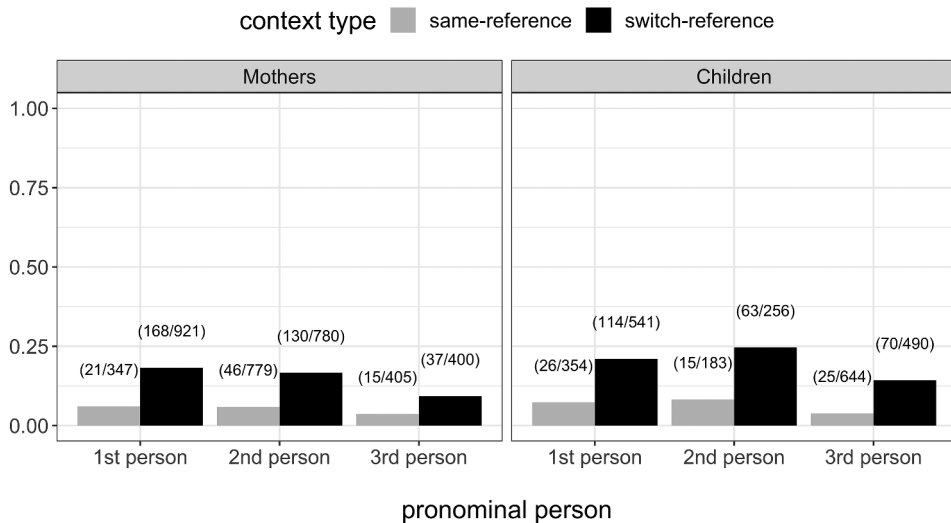
Figure 1. Proportion (frequency) of 1st, 2nd, and 3rd person subject pronouns that are overt, across same- and switch-reference contexts, in the speech of mothers (left) and children (right) in the Schmitt-Miller corpus. (N = 11 dyads; Ages: 2;11–5;11, Children: 2,468 subject pronouns; Adults: 3,632 subject pronouns).

does, and the one-on-one interaction may also have encouraged children to assimilate to their mothers' input – both factors that can lead to more overt subjects overall.

Subject pronoun realization in same- and switch-reference contexts

Figure 1 shows the proportion and raw frequency of overt 1st, 2nd and 3rd person pronominal subjects produced by mothers and children across same- and switch-reference contexts. Figure 2 further breaks these rates down by individual dyad, in order of the child's age. In line with studies of other Mexican Spanish varieties (Bayley & Pease-Alvarez, 1997; Lastra & Butragueño, 2015; Michnowicz, 2015), we find that null pronouns account for the majority of subjects in both same- and switch-reference contexts (even when overt forms like demonstratives and lexical NPs are included, see Appendix 1, Table I). This reflects the fact that appearing in a switch-reference context does not necessarily decrease a referent's prominence to the point where it cannot be referred to with a null subject pronoun – this simply makes it *relatively* less prominent than if it had appeared in a same-reference context.

The learning path proposed in Section 3 depends upon the assumption that children's input provides the statistical information necessary to establish the null/overt pronoun distinction from 1st and 2nd person subjects alone. Hence, the first prediction to test is whether 1st and 2nd person subject pronouns in child-directed speech are indeed overtly realized more often in switch-reference compared to same-reference contexts. To test this prediction, we employed a chi-square test of proportion within each of the three persons. Across all three persons, mothers produced significantly more overt pronominal subjects in switch-reference contexts relative to same-reference contexts (1st person: χ(1) = 28.57, p < .001; 2nd person: χ(1) = 44.00, p < .001; 3rd person: χ(1) = 9.35, p < .01). The size of this effect as estimated by Cramer's V was even slightly larger for 1st person (φ$_C$ = 0.15) and 2nd person (φ$_C$ = 0.17) pronouns compared to 3rd person pronouns (φ$_C$ = 0.11). Thus, the null/overt pronoun distinction is not only attested in the 1st and 2nd persons, it appears to be at least as strong as it is in the 3rd person. If children limited themselves to tracking 1st and 2nd person subject realization, they would still be able to acquire the target knowledge.

Given that 1st and 2nd person pronominal subjects in the input provide the necessary statistical signal, the second prediction to test is whether children detect this signal at some point before age 6. Chi-square tests of children's own speech revealed significantly more overt pronouns in switch-
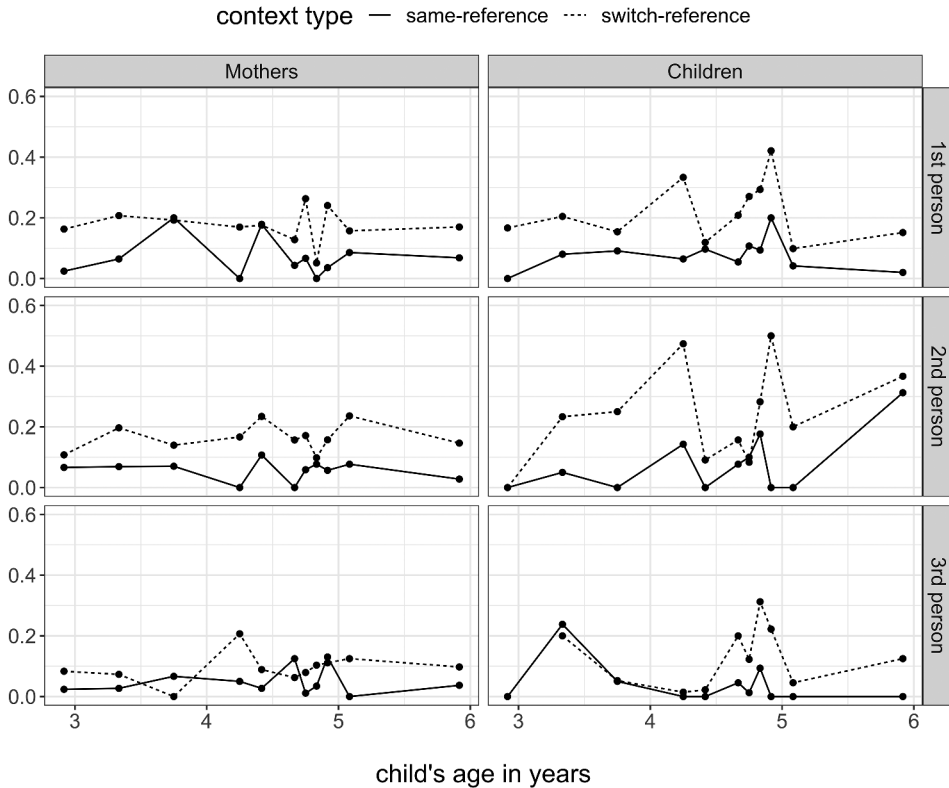
Figure 2. Proportion of overt 1st, 2nd, and 3rd person pronominal subjects across same- and switch-reference environments, by individual dyad. Mothers (left) and children (right) are plotted in order of the child's age.

reference relative to same-reference contexts, within the 1st person ($\chi(1) = 29.53$, $p < .001$, $\varphi_C = 0.18$), the 2nd person ($\chi(1) = 18.57$, $p < .001$, $\varphi_C = 0.21$), and the 3rd person ($\chi(1) = 37.90$, $p < .001$, $\varphi_C = 0.18$), indicating that, as a group, they have indeed detected the null/overt distinction and applied it to their own referential choices.

Given that children do indeed acquire the target knowledge by age 6, the final prediction to test is whether they extract this knowledge from the 1st and 2nd persons and generalize it to 3rd person, as opposed to the other way around. In other words, we must verify whether the null/overt distinction is acquired *earlier* in the 1st and 2nd persons compared to the 3rd person. Figure 2 certainly seems to suggest that this is the case: most children produce more overt 1st and 2nd person pronouns in switch-reference conditions (dotted line) compared to same-reference conditions (solid line), but in the 3rd person, this differentiation only appears to hold for children over four and a half. To test whether this impression is statistically significant, we fit a logistic regression model predicting pronoun realization (null = 0, overt = 1) as a function of the pronoun's reference (same = 0, switch = 1), the pronoun's person feature (3rd = 0, 1st/2nd = 1), and children's age in years (2.9–5.9, centered around the mean). We included random intercepts for dyad but no random slopes, since this prevented the model from converging.[8] If children as a group distinguish between same- and switch-reference more reliably in the 1st and 2nd persons than in the 3rd person, this should produce a positive interaction between switch-reference and 1st/2nd person. If, however, children show this asymmetry *only at younger ages*,

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[8]We also tested models including SES as an interaction with these main effects as well as a simple main effect. The interaction model failed to converge. The model including SES as a simple main effect failed to fit the data significantly better than the model without SES, as determined using R's *anova()* function ($\chi^2(1) = 0.60$, $p = 0.44$). SES was therefore excluded.

Table 3. Fixed effects of reference and person on adult pronoun realization (null = 0, overt = 1). Mixed-effects logistic regression model fit using *glmer()* function of the *lme4* package in R (Team, R Core et al., 2013) as follows: nullovert ~ reference * person + (1 | participant).

	β-estimate	Std. Error	z-value	p-value
Intercept	−3.2759	0.2665	−12.291	p < .001 ***
Reference (switch)	0.9784	0.3147	3.109	p < .01 **
Person (1st/2nd)	0.5079	0.2925	1.737	p = .08
Reference x person	0.2336	0.3449	0.677	p = .499

Table 4. Fixed effects of reference, person, and age in years (2.9–5.9, mean centered) on children's pronoun realization. Mixed-effects logistic regression model fit using *glmer()* function of the *lme4* package in R (R Core Team 2013) as follows: nullovert ~ age * reference * person + (1 | participant).

	β-estimate	Std. Error	z-value	p-value
Intercept	−3.4038	0.2601	−13.085	p < .001 ***
Age	−0.8981	0.4256	2.110	p = .035 *
Reference (switch)	1.3507	0.2502	5.399	p < .001 ***
Person (1st/2nd)	0.8353	0.2702	3.091	p = .002 **
Age x reference	1.3904	0.4810	−2.891	p = .004 **
Age x person	1.1633	0.4483	−2.595	p = .009 **
Reference x person	−0.1190	0.3139	−0.379	p = .705
Age x reference x person	−1.5415	0.5495	2.805	p = .005 **

before they have generalized the same-switch contrast to all persons, this should produce a negative correlation between child age and the reference x person interaction. In other words, we expect a negative, 3-way age x reference x person interaction. We also fit the same model, minus the effect of age, to adult subject pronoun realization.

Model results are shown in Table 3 for adults and Table 4 for children. For adults there was a simple main effect of reference and no other effects or interactions. For children, there was a negative 3-way interaction between age, reference, and person, just as predicted. To further explore this interaction, we divided children into groups by age year (3 and under: $N = 3$; 4: $N = 6$; 5: $N = 2$) and compared the proportion of overt 1st, 2nd, and 3rd person pronominal subjects across same- and switch-reference contexts using one-sided chi-square tests of proportion. For the youngest children, the rate of overt pronouns in same-reference relative to switch-reference environments was marginally significant within the 1st person (same: 7.7%, switch: 17.6%, $\chi(1) = 2.5$, $p = .056$, $\varphi_C = 0.12$), significant within the 2nd person (same: 2.4%, switch: 22.0%, $\chi(1) = 5.6$, $p < .01$, $\varphi_C = 0.26$), and not significant within the 3rd person (same: 13.6%, switch: 12.8%, $\chi(1) = 0.0$, $p = .5$). For the other two age groups, all differences were significant (all $\chi > 2.9$, all $p < .05$). This confirms the impression from Figure 2 that children differentiate between same- and switch-reference within the 1st and 2nd persons at younger ages than within the 3rd person.

The child model in Table 4 additionally reveals the following effects: (i) a positive main effect of reference, indicating that children as a group produce more overt pronouns in switch-reference contexts than in same-reference contexts; (ii) a positive interaction between age and reference, suggesting that children's sensitivity to reference increases with age; (iii) a negative main effect of age, indicating that older children produce fewer overt pronouns overall; (iv) a positive main effect of person, indicating that children produce more overt pronouns in the 1st and 2nd persons compared to 3rd and (v) a positive interaction between age and person, suggesting that this person effect increases with age. The negative main effect of age (iii) is somewhat mysterious but may be related to longer and more coherent turns. The effect of person (iv), on the other hand, is consistent with findings in Italian (Serratrice, 2005) and may also have something to do with the input, since mothers also produced overt 1st and 2nd person pronouns at a higher overall rate than 3rd person pronouns (1st person: 14.9%, 2nd person: 11.3%, 3rd person: 6.5%), although the difference fails to reach significance ($p = .082$).

Table 5. Individual children's overt pronoun rates in same- and switch-reference contexts.

| School | Child | Age | Proportion overt | | Chi-square comparison |
			Same-reference	Switch-reference	
Mid/high-SES	JGAV	2;11	0%	11.1%	$\chi(1) = 0.04, p = .85$ NS
	YGSZ	3;9	5.6%	13.9%	$\chi(1) = 2.01, p = .16$ NS
	EAMR	4;3	2.2%	20%	$\chi(1) = 20.48, p < .001$***
	PLG	4;9	4%	14.7%	$\chi(1) = 13.36, p < .001$***
	SLV	4;10	10%	30%	$\chi(1) = 26.86, p < .001$***
Low-SES	KDP	3;4	12.1%	21.3%	$\chi(1) = 1.66, p = .2$ NS
	KUC	4;5	3%	7.1%	$\chi(1) = 1.05, p = .31$ NS
	YBM	4;8	6.2%	18.8%	$\chi(1) = 8.48, p < .001$**
	ACC	4;11	9.1%	38.2%	$\chi(1) = 4.39, p = .04$*
	OMJ	5;1	1.3%	12%	$\chi(1) = 5.96, p = .01$*
	JRC	5;11	4.8%	20%	$\chi(1) = 11.63, p < .001$***

When is the same- vs. switch-reference distinction fully acquired?

Having found that children's pronoun realization is conditioned by same- and switch-reference contexts, and that the distinction arises earlier in the 1st and 2nd persons compared to 3rd person, we are now in the position to ask when, exactly, this distinction is fully acquired. That is, at what age does the rate of overt pronoun realization in switch-reference contexts become reliably higher than the rate in same-reference contexts, across all persons? We compared these rates using chi-square tests of proportion for each individual child, reported in Table 5. In the high-SES group, all children produced more overt subject pronouns in switch- versus same-reference contexts, but the difference reached significance for those age 4;3 and up. In the low-SES group, all children produced more overt subject pronouns in switch- versus same-reference contexts, but the difference reached significance for those age 4;8 and up. If these patterns can be generalized to a larger population, then this suggests that typically developing children acquire the null/overt contrast at around 4 and a half years old.[9]

Discussion and study limitations

This sample of naturalistic speech from the Schmitt-Miller corpus (Miller & Schmitt, 2012) has provided three pieces of evidence consistent with the learning path hypothesized in Section 3. First, analysis of the input reveals that the null/overt pronoun distinction is in principle acquirable, even if children only learn it from 1st and 2nd person subjects, as we propose. Caretakers produce significantly more overt 1st and 2nd person pronominal subjects in switch-reference contexts relative to same-reference contexts, and the difference is at least as large as it is in the 3rd person. Second, analysis of children's production reveals that they extract the target information from the input before age 6, producing overt pronouns more often in switch-reference contexts compared to same-reference contexts. Third and most importantly, this difference becomes significant in the 1st and 2nd persons earlier than it does in the 3rd person, consistent with our proposal that children acquire the null/overt distinction within the 1st and 2nd persons and subsequently generalize it to the 3rd person.

This sample also provides the first evidence we are aware of that children acquiring a canonical *pro*-drop language like Spanish acquire the specific association between null/overt pronominal subjects and same/switch-reference, respectively, before age 6. For children in our sample the age of acquisition appears to fall approximately around age four and a half. This may seem a little late when compared to other spontaneous production studies, which reveal that children's referential choices are conditioned by various other dimensions of referent prominence by age 2 or even younger (see review in Allen

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[9]A reviewer asks whether it is possible that this result is driven by children over 4 ½ simply using more 1st and 2nd person pronouns, for which the same/switch contrast is stronger. However, the frequency of 1st and 2nd person pronouns, as opposed to 3rd person pronouns, does not correlate with age ($\beta = 0.299$, SE = 0.353, $z = 0.299$, $p = .40$). Moreover, three children (EAMR, PLG, and SLV) produce more 3rd person pronouns than 1st and 2nd person *combined*, yet they still significantly distinguish between same- and switch-reference (see Appendix 1, Table II).

et al., 2015). On the other hand, it requires a fairly fine-grained distinction between prior-mentioned referents in the preceding subject position versus other positions, which children appear to process slowly until at least age 5 (Arnold et al., 2007; Hartshorne et al., 2015).

This study has two main limitations relating to how the data were sampled. First, due to the time and cost of hand coding, we were able to include only 11 dyads, which means that conclusions about acquisition generally speaking should be made with caution. The number of dyads is comparable to other spontaneous L1 production studies reviewed here (ex. Serratrice, 2005, *N* = 6) and the total number of tokens that we analyzed (2,468 child tokens, 3,632 adult tokens) is comparable to other variationist studies (ex. Bayley & Pease-Alvarez, 1997, p. 1,549 for children age 8–12; Shin, 2016, pp. 1,845 for children age 6–7). Still, the results we found for our sample of 11 children should be confirmed with further data. Longitudinal data in particular would allow for a stronger conclusion about the order of acquisition, as would an experimental study eliciting production in a larger sample of children. Second, the way we sampled null and overt subject pronouns was different from most variationist studies on the topic. Breaking with the standard of Otheguy and Zentella (2012), we made the decision to limit our analysis to pronoun reference within a single speaker turn in order to focus our attention on pronouns with locally available antecedents. On the one hand, this provides a good point of comparison to psycholinguistic studies on the topic, all of which test the comprehension of pronouns with locally available antecedents (some within the same sentence and others across sentence boundaries, but all within a single speaker's turn). On the other hand, this decision makes the comparison to sociolinguistic studies less direct.

Study 2: comprehension of ambiguous 3rd person subject pronouns

The learning path proposed in Section 3 makes predictions not only for production, but also for comprehension. If, as we hypothesize, children generalize the knowledge they have internalized about the realization of 1st and 2nd person subjects to the realization of 3rd person subjects, then they should be able to leverage this same knowledge when interpreting 3rd person subjects, not just when producing them. Since the children in our sample seem to have acquired the null/overt contrast at around age four and a half, we would expect other children acquiring Mexico City Spanish to begin using this contrast in their interpretation of 3rd person pronouns at approximately the same age.

Previous research with L1 learners of Mexican Spanish suggests that children do not distinguish between null and overt 3rd person pronouns in felicity judgment tasks until late childhood or even adolescence (Shin & Cairns, 2012). However, our interest is not in children's ability to distinguish felicitous from infelicitous uses of these pronouns, but rather to identify the most likely *interpretation* of each one. Evidence from pronoun interpretation tasks in Greek reveals that 6-year-olds have adult-like antecedent preferences (Papadopoulou et al., 2015), but younger children were not tested. Here, we test pronoun interpretations from children age 3 to 6, using a forced-choice picture selection task, as in (19)-(20). This kind of task places lower demands on working memory compared to a felicity judgment task: rather than requiring children to choose between two alternative sentences, which must be held simultaneously in working memory, this task simply asks children to choose between two different interpretations of a single sentence, both of which are presented simultaneously (Pictures A and B).

(19) Juan le pega a Pedro y después {ø/él} se va.

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"Juan hits Pedro and then pro/he leaves."
Picture A: Juan leaving
Picture B: Pedro leaving
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(19) Juan le pega a Pedro y por eso {ø/él} se va.

> "Juan hits Pedro and so *pro/*he leaves."
> Picture A: Juan leaving
> Picture B: Pedro leaving

If children internalize the differing referential preferences of null and overt subject pronouns by age four and a half, as suggested by Study 1, then we would expect them to pick Picture A, depicting the subject antecedent *Juan*, significantly more often when a null pronoun is used compared to an overt pronoun. Moreover, this difference should persist across different pragmatic contexts, such as (19) where the temporal connective *y después* ("and then") triggers an overall bias toward the subject, as well as (20), where the casual connective *y por eso* ("and so") triggers a slight object bias.

For children under age four and a half, we do not expect the contrast between null and overt subjects to influence picture selection. However, their choices might be influenced by the contrast between temporal (19) and causal (20) contexts. Evidence from pronoun resolution tasks suggests that children can at least use causal information to choose antecedents. For example, Pyykkönen et al. (2010) report that 3-year-olds interpret ambiguous pronouns differently, depending on whether or not the preceding clause uses a highly transitive verb (ex. *The panda hit the parrot . . . he . . .*), which among other things presupposes that the subject is a causal agent. And Wykes (1981) reports that 5-year-olds tend to resolve pronouns in a manner consistent with a cause-effect relationship between clauses (ex. *Jane needed Susan's pencil. She* (=Susan) *gave it to her* (Jane).). While neither of these studies manipulate discourse connectives *per se*, they do at least demonstrate awareness of how causality influences pronoun interpretation.

Methods

Participants

A total of 41 adults (35 women) and 76 children (41 girls) ages 2;11 to 6;4 (*M* = 4;5) completed the task. After exclusions (see 6.1.3 below), children were divided into two age groups: those under four and a half (*N* = 40, Range = 2;11–4;5, *M* = 3;9, SD = 5.8 months), and those at least four and a half (*N* = 33, Range = 4;6–6;4, *M* = 5;5, SD = 5.1 months). Participants were recruited from a private daycare in Mexico City, Mexico. Parents were invited via a school announcement, with in-person follow-ups by the first author to answer any questions and obtain signed consent. Adult participants were recruited from among school staff, who provided their own signed consent at the time of testing. Children and adults received a small present (sticker, candy, colorful pen) as thanks for their participation.

Design and procedure

Each participant was presented with 16 trials divided evenly into four within-participant conditions: (i) null subject, temporal connective, (ii) null subject, causal connective, (iii) overt subject, temporal connective, (iv) overt subject, causal connective. Items were created by crossing each condition with eight unique verb-phrase pairs (*alegrar–aplaudir*: "cheer up–applaud," *cantar para–bailar*: "sing for–dance," *perseguir–cansarse*: "chase–get tired," *asustar–gritar*: "scare–yell," *pegarle–irse*: "hit–leave," *pelearse con–llorar*: "quarrel with–cry," *tocar–reírse*: "poke–laugh," and *hablar con–sonreír*: "speak to–smile"). Characters mentioned in these items were four school-aged children with common Mexican names, two male and two female (*María, Sara, Juan, Pedro*). Since there were 16 trials but only 8 unique verb pairs, each participant saw the same verb pair twice, in two different conditions. Items were presented in blocks, by condition, with the order of blocks counterbalanced across participants. Within each block, items were presented in random order. Between blocks, participants saw items from a separate study using some of the same illustrated characters, as in (21).

(21) María saluda a los niños y después los niños saludan a la maestra.

"Maria waves to the boys and then the boys wave to the teacher."

Pictures were presented on a 13" Macbook Air using Psychopy version 1.82.01 (Peirce, 2007), and the position of the first-mentioned character (left or right side) was counterbalanced across verb-phrase pairs. Children were read the prompts by a native speaker who recorded their responses on the computer by pressing either the "4" key (left-hand picture) or "9" key (right-hand picture). Adults listened to prerecorded prompts and pressed the keys for themselves. Before beginning, the experimenter explained the task and either asked for adults' signed consent or obtained children's verbal assent using the following script.

(22) *Te voy a contar unas historias acerca de mis amigos. Al final de cada historia, vas a ver dos fotos, y tú me tienes que decir cuál es la foto que corresponde, ¿sale?*

"I'm going to tell you some stories about my friends. After each story, you're gonna see two pictures, and you have to tell me which is the one that matches, sound good?"

Next, participants were introduced to the characters used in the pictures. Learning the characters' names was not technically necessary to complete the task, since the first clause of each experimental prompt always identified the characters by name and by an accompanying illustration. However, we reasoned that familiarity with character names facilitates processing, and we therefore administered a 4-item name-recognition task to weed out any participants with especially poor name recall. Finally, the experimenter elicited the child's assent a second time and began the experiment.

Exclusions

Subjects providing fewer than two correct answers in the pre-experimental name-recognition task were excluded from analysis (1 adult, 3 children). The remaining adults gave an average of 3.63 correct responses out of 4 and children averaged 3.37 correct out of 4. A small number of individual responses were eliminated for reasons including inattention, failure to select only one picture, or experimenter error in presenting items (1.16% of total data).

Results

We estimated participants' sensitivity to pronominal form by measuring the rate at which they chose the picture compatible with a same-reference reading; i.e., the picture depicting the character mentioned in subject position performing the action. Figure 3 shows the rate of same-reference choices made by adults, older children, and younger children, for null and overt pronouns in each version of the experiment.

To test the prediction that listeners use the null/overt distinction to help interpret ambiguous subject pronouns, we modeled the likelihood of a same-reference response using multilevel logistic regression models fit to adults, older children, and younger children's data, with pronominal form (null = 1, overt = 0) and connective (temporal *después* =1, causal *por eso* = 0) as level-1 fixed effects and items and participants as level-2 random intercepts (see Appendix 2 Table I for full details).

For adults, the null pronoun was associated with a significant increase in the likelihood of a same-reference response (β = 0.95, SE = 0.25, $p \leq 0.001$), and so was the temporal connective (β = 1.17, SE = 0.26, $p < .001$). There was no interaction, indicating that the contrast between null and overt pronoun preferences remained constant even as the baseline preference changed across different versions of the experimental items.

For older children, the null pronoun was associated with a significant increase in the likelihood of a same-reference response (β = 0.60, SE = 0.28, p = .035), but there was no effect of connective and no interaction, indicating that their use of the null/overt distinction was stable across different versions of
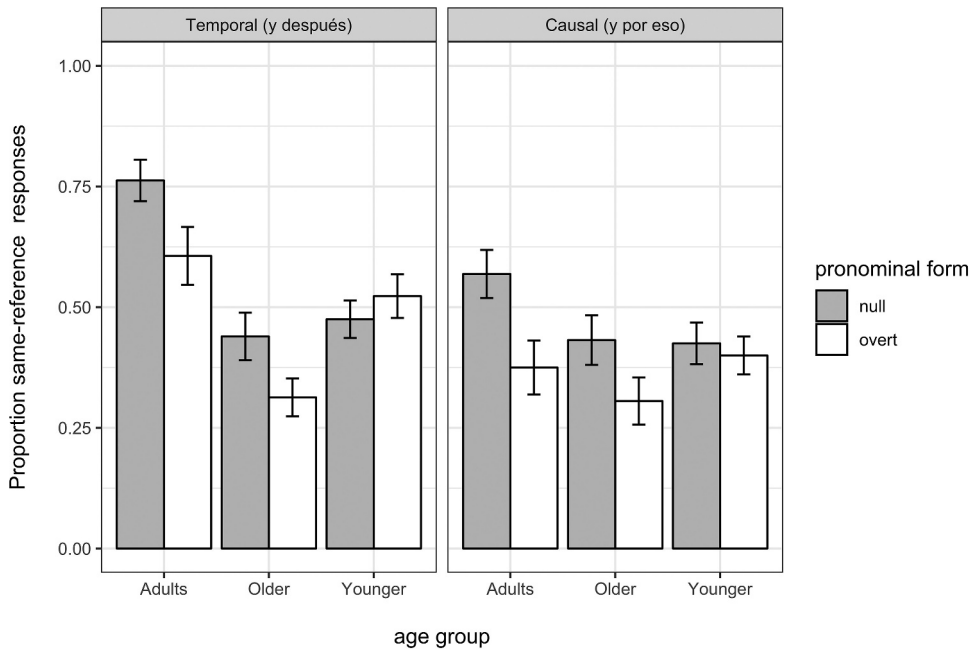
Figure 3. Proportion of responses resolving the subject pronoun toward the preceding subject antecedent ("same-reference" interpretation). Pronouns appear in clauses with either temporal (left) or causal (right) connectives. Adults ($N = 40$), older children (4;6–6;4, $N = 33$), and younger children (2;11–4;5, $N = 40$). Error bars represent standard error of participant means.

the experimental items. For younger children, the temporal connective was associated with a significant increase in the likelihood of a same-reference response ($\beta = 0.53$, SE $= 0.24$, $p = .026$), but there was no effect of pronominal form and no interaction. Neither group showed any evidence of using both pieces of information simultaneously, as adults do.

This result suggests that children initially rely on the content of lexical connectives to interpret ambiguous pronouns, until approximately age four and a half, when they switch to relying exclusively on the null/overt distinction. To explicitly test this hypothesis, we designed a regression model for all children's data combined, which included an interaction between age group and pronominal form and an interaction between age group and connective (see Appendix 2 Table II). This analysis revealed a significant main effect of pronominal form ($\beta = 0.57$, SE $= 0.20$, $p < .01$) and an interaction between pronominal form and age such that being in the younger age group was associated with a reduced effect of pronominal form ($\beta = -0.56$, SE $= 0.26$, $p = .032$). There was no main effect of connective and no interaction between connective and age. In sum, children's use of pronominal form appears to change with age, but there is not solid evidence that their use of connectives changes.

Discussion and study limitations

This study provides robust evidence that children learn to use pronominal form as a cue to pronoun interpretation beginning sometime around age four and a half, and that children younger than this rely instead on the lexical information provided by temporal and causal connectives. This result is consistent with our hypothesis that children generalize their knowledge of 1st and 2nd person subject realization to not just production but also comprehension of 3rd person pronominal subjects. It also shows that sensitivity to the null/overt contrast begins earlier than has been previously revealed by felicity judgment tasks (Shin & Cairns, 2012; Sorace et al., 2009) and other pronoun interpretation tasks (Papadopoulou et al., 2015).

Importantly however, this study does not show that children's comprehension of null and overt pronominal subjects is fully adult-like. First of all, while children in both age groups were able to incorporate at least one relevant piece of information into their interpretation – lexical connectives for younger children, pronominal form for older children – neither group appears to use both types of information simultaneously. While it is unlikely that children over four and a half have "forgotten" how to use connectives to interpret pronouns, we take this as an indication that they fail to deploy this knowledge reliably. These children may know that connectives are relevant to pronoun interpretation yet consider that information less important than newly acquired information like pronominal form, or they may simply be unable to integrate the two types of information together. A second deviation from adult-like behavior is that neither group of children displays the same absolute preferences as adults. Both groups appear more strongly biased overall toward the switch-reference reading, as compared to adults. This could be due to processing constraints that render the more recently mentioned non-subject antecedent easier to access, or it could be that children fail to fully incorporate all the relevant pieces of information that adults may be drawing on in this task, such as background knowledge of the world, prior biases and/or heuristic strategies favoring the preceding subject, and so on. Whatever the reason, it is clear that children of this age are still in the midst of sorting out the complex process of pronoun resolution.

The fact that children this age are still learning how to resolve ambiguous 3rd person pronouns should come as no surprise, given our arguments in section 3 about how challenging pronoun resolution can be for learners. What is truly impressive is that despite their lack of full competence resolving 3rd person pronouns, these children have *still* managed to discover the link between pronoun resolution and pronoun realization. This state of affairs is consistent with our proposal that children generalize this link from the 1st and 2nd persons and argues against the idea that children could have acquired it directly from 3rd person input. If children do not yet have adult-like command of 3rd person pronoun reference, it will be difficult for them to observe the correlation between pronoun reference and pronoun realization in the 3rd person.

Conclusion

In this paper we set out to identify the learning path that children follow after they have discovered the target setting of the null subject parameter. Specifically, we sought to understand how children acquiring so-called canonical null subject languages like Spanish and Italian learn to probabilistically associate null subjects with reference to the preceding subject antecedent, in contrast to overt pronominal subjects. We identified the challenge that this task presents to children, namely, that acquiring this contrast requires the child to identify pronoun referents in the first place – a non-trivial task. We proposed that children overcome this problem by first tracking the realization of 1st and 2nd person pronominal subjects in their input, whose intended referents are much less complicated to identify than 3rd person pronoun referents.

Our proposal is based on the independently motivated claim by Charnavel (2019) that 1st, 2nd and 3rd person pronouns all share the same underlying formal representation and that the intended referent of 1st and 2nd person pronouns is easier to identify. To show that our proposal is consistent with actual child learning, we first demonstrated that 1st and 2nd person subjects in the input provide the statistical signal necessary to associate null pronominal subjects with same-reference interpretations (Study 1). Next, we showed that children apply this contrast to their own production of 1st and 2nd person subject pronouns before generalizing this association to the realization of 3rd person subject pronouns, and that they reliably deploy this knowledge across 1st, 2nd and 3rd person subject pronouns by around four and a half years of age (Study 1). Finally, we showed that they also use this knowledge to resolve ambiguous 3rd person subject pronouns at the same age (Study 2).

This study contributes to the wider theory of language acquisition by showing how a combination of statistical learning and generalization within natural classes can speed up the acquisition process. By generalizing from the distribution of 1st and 2nd person pronominal subjects, children can begin to

produce and interpret 3rd person pronominal subjects in adult-like ways, without having to work out the finer details of 3rd person pronoun resolution first.

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