



A new experimental paradigm to study children's processing of their parent's unscripted language input



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ABSTRACT

This paper introduces a new experimental paradigm for studying children's real-time language processing of their parents' unscripted speech. Focusing on children's processing of referential expressions, or the phrases that parents used to label particular objects, we engaged dyads in a game in which parents labeled one of several objects displayed on a screen, and the child was to quickly identify it as their eye gaze was tracked. There were two conditions; one included a competitor object (e.g., the target was a striped umbrella and the display also included an umbrella with polka dots), while the other one did not (e.g., only one umbrella was present). The results revealed evidence of children's incremental processing of their parents' referential expressions. They also showed faster processing of postnominally-modified as compared to prenominaly-modified referential expressions. Parents tended to produce postnominally-modified referential expressions in the more difficult experimental condition in which there was a competitor object, suggesting either that these expressions are also easier for them to produce, or that they accommodate their children by producing more easily processed expressions. We discuss the potential of this paradigm for advancing theories of the relationship between child-directed language input and children's language processing.

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Introduction

Children's knowledge about the words, syntactic structures, and discourse-pragmatic properties of their language develops in tandem with their very ability to process and understand these elements. Children are not born with adult-like language processors; rather, their processing abilities increase over development and are shaped by features of the ambient language input. In turn, as they parse the input, they acquire new words and structures and their language competence increases. One domain in which the parallel development of language knowledge and parsing skill is evident is in children's understanding of referential expressions, or the linguistic expressions used to refer to entities in the world. Children's abilities

to identify the referents of these expressions begin early in life and develop rapidly. By 6 months of age, infants asked, for example, to "Look at the apple" from a display depicting an apple and a mouth prefer to look at the apple, indicating that they have processed to some degree the noun "apple" and can shift their gaze to its referent (Bergelson & Swingley, 2012). By 24 months of age, toddlers look to a named image within 500 ms of the noun's onset (Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998), and they process referential expressions incrementally, as indicated by the fact that they launch eye movements to potential referents even before the noun is complete (e.g., Fernald, Swingley, & Pinto, 2001; Swingley, Pinto, & Fernald, 1999). As children get older and processing speed increases, they are able to use prenominal information from determiners and modifiers to narrow down the space of possible referents (e.g.,

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Fernald, Thorpe, & Marchman, 2010; Lew-Williams & Fernald, 2007), and they show recognition of pragmatic and discourse factors that influence their interlocutor's choice of referential expression (e.g., Allen, Skarabela, & Hughes, 2008; Clancy, 1993, 1997; Clark & Amaral, 2010; Graham, Sedivy, & Khu, 2014; Hughes & Allen, 2015; Matthews, Lieven, & Tomasello, 2010).

This developing ability to process even complex referential expressions is of course important in itself, allowing children to identify entities that are the topic of conversation, but it is also important because it allows children to take advantage of opportunities to increase their lexical and grammatical knowledge. Identifying the referent of one expression will in many situations facilitate the assignment of meaning to other linguistic elements later in the utterance. For example, Fernald, Marchman, and Hurtado (2008) found that the faster 3-year-old children are to parse through a modified determiner phrase (e.g., “the red car”), the more likely they are to acquire the meaning of a novel noun downstream in the utterance (as in “The red car is on the *deebo*”). Studies of verb learning, too, suggest that the ability to process referential expressions efficiently is essential. For example, 2- and 3-year-olds more easily acquire novel verb meanings when the verbs are preceded by a short unmodified description (e.g., “The man is *pilking*”) than when preceded by a longer description (e.g., “The nice tall man is *pilking*”) (He, Kon, & Arunachalam, in preparation; Kon, Goksun, Bagci, & Arunachalam, 2016). Given the importance of quick and efficient comprehension of referential expressions for acquisition of new vocabulary, it will be helpful to understand precisely how children's online processing of these expressions develops.

Importantly, which referential expressions a child will hear depends on properties of the referential world, such as how many potential referents are co-present, as well as properties of the dyad, such as the goals of the communication (e.g., parents may seek to educate or entertain in addition to achieving successful reference) and the parent's perceptions of the child's developmental level. Parents are known to tailor their speech according to their child's level (e.g., Bellinger, 1980; Bornstein, Hendricks, Haynes, & Painter, 2007; Hoff-Ginsberg, 1994; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Newport, Gleitman, & Gleitman, 1977; Pan, Rowe, Singer, & Snow, 2005; Snow, 1972, 1977) as evident, for example, in the higher pitch and slower tempo characteristic of infant-directed speech (Fernald & Simon, 1984; McRoberts & Best, 1997), as well its redundancy and shorter and simpler grammatical structures (e.g., Snow, 1972).

Because of these individual and situational differences, it is important to study parents' speech in naturalistic situations. But studying what parents produce offers only an incomplete picture of what children will understand from that input. After all, child-directed speech is unlikely to be taken up veridically by the child's developing language processing system (e.g., Harris, 1992; Lidz & Gagliardi, 2015; Omaki & Lidz, 2015). (Most obviously, syntactic structures that the child parses incorrectly will be represented differently in the child's mind than in the speaker's.) Understanding how children processes the input in real-time will offer insight into what linguistic

representations they are likely to form. New approaches are thus needed to reveal not only the linguistic input that children are exposed to, but how they comprehend this input, and in turn, whether parents, too, are aware of the limitations of children's intake and tailor their child-directed speech accordingly.

To study these issues, we developed a paradigm to integrate the study of unscripted productions from parents and the study of children's language processing. We took advantage of recent advances in portable eye-tracking by using a small eye-tracker with a tablet; the tablet setup allowed parents and children to sit together relatively naturally and to feel like they were playing a game, while yielding eye-tracking evidence about the children's online language processing. We presented the dyads with a finding game in which parents labeled one of six pictures on the screen for their child, and the child had to guess which picture was intended. On each trial the dyads viewed an array of six clipart images of animals, objects, and people. We first numbered the six locations for the parent and subsequently referred to the images by their numbered location. We indicated a specific image to the parent on each trial by whispering a number to them. Parents were not told what to say; they were only told that they could talk, but not point, to help their child find the correct picture as quickly as possible. From the recordings of these interactions and the child's gaze coordinates as recorded by the eye-tracker's software, we asked what kinds of referential expressions parents used to label the pictures, and how quickly these expressions were understood by the children as they sought to identify the target on each trial.

We designed two trial types. On trials in the Same condition, the target images were ones that had to be described with a modifier in order to disambiguate them from one of the distractors, such as a striped umbrella in an array that also included an umbrella with polka dots. In the other trial type, the Different condition, only one umbrella was present in the array, and so no modifier was necessary; it would thus be *overinformative* for parents to produce, “a striped umbrella” or “an umbrella with stripes” on that trial. We analyzed children's eye gaze to determine whether their latency to look to the target image differed by type of referential expression.

One might expect parents to produce “good” referential expressions that support their children's comprehension. After all, adult speakers engage in *audience design* (Clark & Murphy, 1982), and generally speaking, their referential expressions are adapted to the knowledge state of their interlocutor, both in adult- and child-directed speech (e.g., Ariel, 1990; Chafe, 1987; Clancy, 1993, 1997; Du Bois, 1987; Gundel, Hedberg, & Zacharski, 1993; Hughes & Allen, 2015; Prince, 1985; Rohde & Frank, 2014; Skarabela, 2006).¹ The fact that parents' child-directed

¹ At least in some cases, what appears to be audience design may be minimization of the speaker's own processing load (e.g., Ferreira & Dell, 2000; Horton & Gerrig, 2005; Horton & Keysar, 1996; Wardlow Lane & Ferreira, 2008; Wardlow Lane & Liersch, 2012). We return to this possibility in the General Discussion; our question here is simply to what degree parents' choice of referential expression converges with what children find easy to process.

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