



## How do children learn to avoid referential ambiguity? Insights from eye-tracking <sup>☆</sup>



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### ABSTRACT

Children have considerable difficulty producing informative and unambiguous referring expressions, a fact that still lacks a full explanation. Potential insight can come from psycholinguistic models of ambiguity avoidance in adults, which suggest that, before describing any scene, speakers pro-actively monitor for some – but not all – types of potential ambiguity, and then subsequently monitor whether their just-produced expression provides an ambiguous description. Our experiments used eye tracking to assess the developing roles of these skills in children's referential communication. Experiment 1 shows that adults' eye movements can index the processes of both pro-active and self-monitoring. Experiments 2 and 3 show that children ( $n = 110$ ) typically do not pro-actively monitor for potential ambiguity, although they do show evidence of pro-active monitoring on the occasions when they produce informative expressions. However, we do find evidence that children consistently monitor their own descriptions for ambiguity, even though they rarely correct their utterances. We propose that the process of self-monitoring might act as a learning signal, that guides children as they acquire the ability to monitor pro-actively.

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### Introduction

Children learning a language are not only required to master its structural features, such as phonology and syntax, but must also learn to communicate their messages in effective ways. In particular, children must learn to produce utterances that are appropriately informative and unambiguous. If Wee Jim owns both a red hat and a blue hat and wants to wear the red one, then it is uninformative for him to demand “I want my hat” (not to mention a little domineering). A more informative request would, instead, specify which of the two hats he desires. It is well

established that learning to generate these appropriately informative utterances is a difficult task for young children: Preschoolers, and even young school-age children, who take part in referential communication tasks (an experimental analogue of the situation described above) frequently produce descriptions that are decidedly ambiguous and uninformative (e.g., Glucksberg & Krauss, 1967; Glucksberg, Krauss, & Weisberg, 1966; Matthews, Lieven, & Tomasello, 2007; Nilsen & Graham, 2009; Sonnenschein & Whitehurst, 1984, amongst others). But while children's difficulty with reference is well-established, exactly why this difficulty exists – and why it persists so late in development – remains something of a mystery.

The most historically prominent explanation for children's difficulties with referential communication has focused on egocentricity: Children are assumed to be somewhat blind to the mental states of other people, and so they fail to take these states into account when communicating

<sup>☆</sup> Note that data and analysis scripts can be found at: <https://github.com/hughrabagliati/ETRef>

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(Glucksberg et al., 1966; Krauss & Glucksberg, 1969; Piaget, 1926). But this idea has fallen out of favor, as study after study has demonstrated that children who are too young to successfully complete a referential communication task are nevertheless surprisingly adept at reasoning about the mental states of others, including in communicative situations (Glucksberg, Krauss, & Higgins, 1975; Liebal, Behne, Carpenter, & Tomasello, 2009; Liebal, Carpenter, & Tomasello, 2010; Moll, Richter, Carpenter, & Tomasello, 2008; Nayer & Graham, 2006; Onishi & Baillargeon, 2005; O'Neill, 1996; Wimmer & Perner, 1983). Consistent with this, recent work has shown that children with ASD, who have difficulty taking the perspective of others, still show age-appropriate success in completing referential communication tasks (Fukumura, 2015; see also Nadig, Vivanti, & Ozonoff, 2009).

An alternative approach has been to ask whether children's more general cognitive limitations, such as their still-developing working memory or executive function capacities, might play a role in their referential communication abilities (de Cat, 2015; Epley, Keysar, Van Boven, & Gilovich, 2004; Nilsen & Graham, 2009; Varghese & Nilsen, 2013). Under these theories, children and adults are assumed to have similar ego-centric biases, but are strikingly different in their ability to over-ride that egocentrism and act in a communicatively appropriate fashion. For example, Nilsen (e.g., Nilsen & Graham, 2009) has suggested that adults can override these biases because they have stronger executive functions (see also Brown-Schmidt, 2009; Epley et al., 2004). Consistent with this, she has found an increased use of egocentric biases in children who have relatively weak executive function skills (Nilsen, Buist, Gillis, & Fugelsang, 2013; Nilsen & Graham, 2009; Nilsen, Varghese, Xu, & Fecica, 2015), independent of their age or linguistic ability. But while it seems plausible that skills like inhibition, monitoring, or working memory may play important roles in facilitating children's referential communication, exactly what those roles might be is unclear.

Perhaps the major limiting factor for developing a cognitive theory of children's referential communication is that our current understanding of the moment-by-moment mechanisms involved in children's language production is too sparse to offer much guidance. While we know an increasing amount about how children comprehend language online (Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998; Huang & Snedeker, 2009; Rabagliati, Pyllkkänen, & Marcus, 2013; Snedeker & Trueswell, 2004; and see Snedeker and Huang (2015) for review), we know much less about how they plan and structure their own utterances (although for recent examples of investigations using eye tracking, see Bunker, Trueswell, & Papafragou, 2012; Davies & Kreysa, 2016; Norbury, 2014). Previous work on children's referential communication has suggested some production strategies that children might use to decide what to say (Glucksberg et al., 1975; Sonnenschein & Whitehurst, 1984; Whitehurst & Sonnenschein, 1981), but has not tied these strategies into a specific processing model of children's language production.

The adult psycholinguistics literature can provide some suggestions about what that processing model might look

like. Recent work has suggested particular situations in which adults – like children – consistently generate expressions that are ambiguous and uninformative. An examination of the differences between the situations in which adults tend to be informative and the situations in which they do not, can therefore shed light on precisely which skills children must master in order to communicate in an adult-like way.

In particular, Ferreira and his colleagues (Ferreira, 2008; Ferreira, Slevc, & Rogers, 2005) have shown that adults frequently produce uninformative referring expressions when describing scenes that contain “linguistic” ambiguities. This difficulty was found in a simple referential communication task, in which participants had to name a target picture from an array that also contained a foil picture and two distractor pictures. In the critical manipulation, the target picture and the foil picture shared a lexically ambiguous label. For instance, if the target was a baseball bat then the foil would be an animal bat. Adults were strikingly bad at noticing and avoiding ambiguity in this task: they frequently labeled the baseball bat as *bat* even though this also described its foil (Ferreira et al., 2005; Rabagliati & Snedeker, 2013), a behavior that is strikingly similar to children's performance in more standard referential communication tasks.

By contrast, adults have little difficulty avoiding what Ferreira et al. term “non-linguistic” ambiguities. The same adults who do not notice the ambiguity caused by a baseball and an animal bat will naturally notice and account for the ambiguity caused by two different baseball bats. That is to say, adults do not notice ambiguity caused by overlap in linguistic representation alone (i.e., two different concepts with one label) but they do notice ambiguity caused by overlap in both non-linguistic and linguistic representations (i.e., two different instances of the same thing).

The findings discussed so far suggest that, when speaking, adults monitor for non-linguistic ambiguity both proactively and automatically (i.e., without regard to the needs of their partner), while failing to proactively monitor for linguistic ambiguity. But this cannot be the entire story as, oftentimes, we do notice that the expression we have just produced is ambiguous. This suggests that monitoring not only occurs while we prepare an utterance, but also afterwards: speakers can re-comprehend their utterances and check for ambiguity or speech errors (cf. Levelt, 1983). This monitoring can also help speakers to avoid ambiguity in their subsequent productions: Ferreira et al. (2005) found that when asked to name a baseball bat followed by an animal bat (or vice versa), speakers may say *bat* for the first picture, but often correct themselves and produce an unambiguous expression (*baseball bat*) for the second picture.

Ferreira's findings with adults suggest a more precise description of how referential skills develop, one in which children do not just move from being generally underinformative to being informative *tout court*, but in which they gradually learn a very particular set of skills for avoiding certain types of ambiguity. One of these skills is an automatic tendency to monitor for potential non-linguistic ambiguity before speaking. Another is a set of processes that can be deployed to evaluate whether their

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