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Cognitive Development



Mapping language to the mind: Toddlers' online processing of language as a reflection of speaker's knowledge and ignorance



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ABSTRACT

The current research examined whether young children react to inconsistencies between a speaker's language and her knowledge or lack of knowledge about reality. Gaze behavior at the speaker was examined during two key frames: prior and post location name. Present findings demonstrate that even before the location name is spoken, the 24-month-olds (N = 122) differentiate between the scenarios in which the speaker is knowledgeable or ignorant about where the object is. Following the location name, infant gaze was largely influenced by the inconsistency of the language. That is, infants looked more at the speaker when she mentioned a location name that was inconsistent with her knowledge or lack of knowledge of the object's transfer. The current results demonstrate that by two years children have begun to take into account other speakers' knowledge or ignorance of an event as they process statements about reality.

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1. Introduction

Successful communication depends, among other things, on the ability to evaluate our communicative partner's intentions and knowledge. One efficient way to make inferences about others' mental states is to observe their interactions with objects in the environment. Another way to assess other person's mental content is through what the person verbally communicates about a current or past situation. While early in development observing others' behavior is necessary to evaluate what others know, as the child develops, the increasing mastery and reliance on language provides an alternative route to this type of information. Language can be used to communicate one's knowledge about reality and thus it provides a means to assess children's understanding of the relation between verbal statements, knowledge, and reality (Astington & Baird, 2005). The primary goal of the present research is to examine the extent to which children evaluate a linguistic statement as a reflection of a speaker's knowledge about reality.

Research has shown that beginning in infancy children track others' interactions with objects in the environment and use information about what others have experienced to interpret references to present (Ganea & Saylor, 2007; Moll, Koring, Carpenter, & Tomasello, 2006; Moll & Tomasello, 2007) or absent things (Saylor & Ganea, 2007). In instances when the reference is ambiguous (e.g. "Can you give it to me?") 14-month-old infants recall the experimenter's previous interaction

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with particular objects to disambiguate the request (Saylor & Ganea, 2007). By 18 months, children are able to make such disambiguation by simply recalling which object an adult attended to visually (Akhtar, Carpenter, & Tomasello, 1996), demonstrating an increasingly robust ability to monitor another person's attention source.

Young children can also judge when others are ignorant about certain objects or events. Starting at around 12 months, children point to inform adults about missed events (Liszkowski, Carpenter, Striano, & Tomasello, 2006; Liszkowski, Albrecht, Carpenter, & Tomasello, 2008) and they begin to seek information from the more knowledgeable (Stenberg, 2012) and reliable social partners (Chow, Poulin-Dubois, & Lewis, 2008). By the time they are 2 years old, they are able to adjust the content of their own communicative attempts based on whether their communicative partner is knowledgeable or ignorant about an event. For instance, in a study by O'Neill (1996), 24-month-olds observed an experimenter hide an object in one of two locations that were out-of-reach for the child. The child's communicative partner, his mother, was either present or absent during the hiding event. Later on, toddlers gestured significantly more for their mothers to get the object when the mother was previously absent, and therefore was ignorant about where the desirable object was, than when she witnessed the hiding and was therefore knowledgeable about the object's location.

To summarize, by their second birthday children interpret others' communicative behavior based on whether or not the person was present during a particular event, attended to it, or interacted with specific objects in the environment. An outstanding question however concerns the extent to which young children understand that others' verbal or physical contact with objects leads to knowing. In other words, do infants attribute causal connections between the objects a person is observing and her knowledge of them, or do they simply associate a person with certain objects because both co-occur together and adjust their communicative attempts accordingly based on a simpler rule? O'Neill (1996) offers such an explanation for 2-year-olds' performance in her studies, by arguing that children may simply want to update the parent about relevant things that happened while the parent was absent. This disengagement + updating explanation would be based on a simple rule of the form "Tell people about significant happenings they did not take part in with me." (O'Neill, 1996; p. 674).

One way to address this question is to test children's reaction during events where the link between a person and an object is no longer a valid cue for accurate inferences about behavior. The unexpected transfer false belief task (Wimmer & Perner, 1983) is one such task, presenting the child with an event in which an actor's behavior is inconsistent with her knowledge of reality. Recent investigations have indicated that infants are sensitive to events in which an actor's behavior violates what she should know (Onishi & Baillargeon 2005; Surian, Caldi, & Sperber, 2007). For example, 15-month-olds look longer when an agent searches, by reaching into one of two locations, for an object where it actually is, rather than where she knows it to be. In other words, they show heightened interest when an agent who has not witnessed the hiding event nevertheless accurately searches for the object (Onishi & Baillargeon, 2005).

One factor that is likely to aid infants with many of the existing tasks measuring child's violation of expectations (VoE) about reality is the presence of behavioral cues that highlight inconsistencies between behavior and knowledge during test events. In a standard, infant-directed false belief task, for instance, children are typically presented with an agent displaying explicit bodily movements that highlight the agent's search for an object in a location she doesn't know the object to be. In some cases the agent attempts to unsuccessfully open one of the two boxes (Buttelmann, Carpenter, & Tomasello, 2009), or reaches into the box in an attempt to retrieve the object (Luo, 2011; Onishi & Baillargeon, 2005; Song, Onishi, Baillargeon, & Fisher, 2008), points to (Southgate, Chevallier, & Csibra, 2010) or moves toward (Surian et al., 2007) one of the locations. Each of these behaviors (reaching, pointing, searching) provides observable and salient evidence that indicates an agent's intent to retrieve an object, highlighting the mismatch between the agent's current behavior and the agent's knowledge about the object's location.

Consistent with the possibility that behavioral cues aid infants in passing many of the existing VoE tasks, studies that have measured anticipatory (looking *prior* to an agent's search event) rather than reactive looking (looking *following* an agent's search) report positive performance later, at around 2 years of age. In a study by Southgate, Senju and Csibra (2007), 25-month-olds, but not younger infants, were able to accurately anticipate an actor's search behavior prior to observing it, suggesting that they understood that the actor would subsequently behave in a manner consistent with her knowledge of reality.

When anticipatory looking was measured following an explicit linguistic cue, positive findings were evident even later. He, Bolz and Baillargeon (2012) found that children at 30-months anticipate an agent to look for the object in the location she believes it to be, following a self-addressed utterance ("Where will she think they [the scissors] are?"). In another study, when the verbal utterance was a direct verbal prompt ("I wonder where she's going to look"), 37-month-olds, but not younger children, looked toward the location where the agent last left the object, revealing their ability to recognize what the person knows and appropriately predict her behavior according to what she knows (Garnham & Ruffman, 2001).

In sum, when behavioral cues have been removed (such as in the anticipation paradigm) or when less salient cues were used (such as language) successful performance on tasks measuring knowledge or ignorance was delayed with positive findings reported with infants at around 2 years. Another way to assess children's understanding of knowledge states is to examine their reaction to situations in which language does not reflect a person's knowledge about reality. By doing so, we can isolate children's reasoning about others' knowledge from simple associations between people and objects, because when a speaker makes a statement about reality no visible link between the person and the objects in the environment is established.

The present study supplements a small body of research examining young children's reactions to language as a reflection of one's knowledge about reality. In one study using the false labeling paradigm (Koenig & Echols, 2003), 16-month-olds

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