CHILD DEVELOPMENT PERSPECTIVES

Representational Constraints on Language Development: Thinking and Learning About Absent Things

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ABSTRACT—*In this article, we illustrate the role that representational strength plays in infants' ability to communicate and learn about absent things. When understanding speech about things that are absent, infants retrieve the representation of the referent from long-term memory upon hearing its name, and maintain that representation in working memory to plan an action toward the object or to manipulate the representation on the basis of new information. Strong representations of referents better support retrieval and maintenance operations than weak representations.*

KEYWORDS—*language development; representation*

Communicating about absent things is a core property of human language that enables knowledge to be transmitted across space and time (Deacon, 1997; Hockett, 1960; Werner & Kaplan, 1964). Understanding speech about absent entities is a prerequisite for learning about things that we do not experience directly. In this article, we illustrate the role representational strength plays in infants' ability to communicate and learn about absent things. When understanding speech about absent things, infants retrieve the representation of the referent from long-term memory upon hearing its name, and maintain that representation in working memory to plan an action toward the object or to manipulate the representation on the basis of new information. Strong representations of referents better support retrieval and maintenance operations than weak representations. We discuss properties of strong versus weak representations and predict how representations may constrain communication and learning about absent entities that are consistent with a graded representation account (Munakata, 2001).

Representations of referent objects are stronger when infants have more experience or contact with the objects in question (Shinskey & Munakata, 2005). Because these representations are more established, retrieval and maintenance processes may also be more practiced and thus more efficient. Older infants also form stronger initial representations than younger infants (Munakata, 2001). Strong representations and robust understanding of talk about absent things should thus be associated with older infants and more familiar referent objects. These representations are more easily retrieved and maintained and thus better support actions toward objects and manipulation of representations that are based on new verbal information. Weak representations may be retrieved and maintained less efficiently (Munakata, 2001). As a result, when representations are weak, immediate testing and/or explicit reminders of the referent may be necessary for infants to communicate and learn about absent things.

Research on infants' responses to references to absent objects and toddlers' use of verbal information to update representations of absent objects support these predictions. Across both lines of work, factors that affect the strength of a representation (familiarity with the referent and age) and features of the context that support retrieval (immediate testing, reminders of referents, proximity to the testing context) predict whether children understand references to absent things (see also Ganea, 2005).

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UNDERSTANDING REFERENCES TO ABSENT OBJECTS

Infants begin to mention absent objects and people in the middle to late part of their 2nd year, (e.g., Greenfield, 1982; Huttenlocher, 1974; Lewis, 1951; Lucariello & Nelson, 1987; Sachs, 1983; Snow, Pan, Imbens-Bailey, & Herman, 1996; Veneziano & Sinclair, 1995). Because infants likely understand others' references to absent entities before producing such references (Saylor & Baldwin, 2004), most recent work has focused on infants' *comprehension* of absent references to concrete objects that are nearby.

To comprehend references to absent objects, infants must identify a specific referent that has been shared with the speaker. For example, if someone refers to the *ball*, infants understand the reference only if they identify the ball that is specific to their shared experience, rather than balls in general or balls seen with other people (Saylor & Ganea, 2007; Saylor, Ganea, & Vazquez, 2011). A first step in identification is to use the verbal label to retrieve a representation of the ball from long-term memory. A second step is to maintain the object representation in working memory to instigate a response (e.g., searching or verbal response). Strong representations best support these operations.

Evidence that strong representations support retrieval and maintenance comes from the finding that 13-month-olds are more likely to respond to the name of an absent person who is well known (a sibling) than a new acquaintance (Ganea & Saylor, 2013). However, infants respond to the name of the new person when she is in view, suggesting that they have learned her name. When the new person is absent, infants may not maintain their weak representation to plan a response to her name. In contrast, 16-month-olds respond similarly to new and familiar people. Younger infants, but not older infants, are also less likely to comprehend references to an absent familiar person when the test is delayed after the person's departure (Ganea & Saylor, 2013), suggesting that younger infants have had weaker representations than older infants.

Weak representations may benefit from immediate testing because a weak representation that has recently been activated is more likely to support retrieval of the referent from memory. The more recent activation may act as a reminder of the object and may thus support subsequent retrieval of the representation of the referent. In support of this view, 14-month-olds are more likely to respond to mention of an absent, novel referent (a stuffed animal named Max) when he is mentioned while absent soon after infants are introduced to him (Ganea, 2005). New information that is less strongly represented also decays more rapidly; the decrease in responding after a delay is larger for less familiar referents (Ganea, 2005) than for very familiar referents (Ganea & Saylor, 2013), suggesting that weak representations benefit from the support of recent activation of the representation.

Weak representations may also require additional supports to retrieve the referent from memory. Memory cues and a referent's physical proximity to the test context support retrieval: In naturalistic contexts, memory cuing occurs when absent references are supported by joint attention to a present object (e.g., talking about *daddy* when pointing and looking at his shoes; Eisenberg, 1985; Huttenlocher, 1974; Sachs, 1983). Anchored references may support retrieval because present reminders of absent entities serve as signposts to retrieve the item from memory. Infants first understand talk about absent entities when reminders of those entities are present. In particular, 12- and 16-month-olds comprehend absent reference by looking at reminders of absent entities (Saylor, 2004). Older infants reveal more robust abilities by gesturing and coordinating their looks and gestures with looks to the speaker, suggesting that 16-month-olds use their stronger representation of the referent to coordinate their communicative behaviors.

The retrieval of weak representations can also be supported by a referent's physical proximity to the test context. Items that have been physically proximal may be more easily brought to mind if they have become associated with the test context (the test context may then serve as a retrieval cue). For example, 1-year-olds respond to absent references made about a highly familiar individual (parent or sibling) if the person came with them to a lab visit (Gallerani, Saylor, & Adwar, 2009; Ganea & Saylor, 2013), but do not respond if the person did not accompany them (Miller, Chapman, Branston, & Reichle, 1980; Saylor & Baldwin, 2004).

Another way to support associations between referents and test contexts is to provide cues to the identity of the object as it is moved across contexts. In one study, 12-month-olds were more likely to locate a mentioned absent object if it had been introduced in the same room in which it was subsequently hidden. If the object had been introduced in a nearby room or if it was an object brought from home, they failed to respond to talk about the absent object (Osina, Saylor, & Ganea, 2013). The effect of changing contexts on object identification is ameliorated when the speaker points to distinctive object features that help infants keep track of object identity across dislocations (Osina, Saylor, & Ganea, in press). Infants' difficulty identifying the object as the same item they saw previously may have interfered with their ability to maintain the object in working memory so they could plan and execute appropriate search responses. Thus, absent reference understanding emerges best in 1-year-olds with contextual supports that may be necessary for retrieving weak representations.

In summary, whether representations are weak or strong affects infants' ability to respond to references to an object when not in view. If an object's representation is weak, infants respond to the mention of an absent object only in contexts that provide support for retrieval of the referent from memory and maintenance of its representation in working memory to plan a response. With age, infants' representations tends to be stronger, making them less likely to be affected by factors that make it difficult to retrieve or maintain representations and more likely to comprehend absent reference across a range of contexts.

LEARNING ABOUT ABSENT THINGS THROUGH LANGUAGE

With age, children not only engage in a wider range of discussions about absent things, they also learn about the world through language alone. Bringing to mind a referent upon hearing its name is a critical step that sets the stage for using language to update representations with new verbal input (Ganea & Harris, 2013). Manipulating representations based on new verbal input is a defining feature of human cognition that is critical for learning about things not directly experienced through conversations (e.g., testimony; Harris, 2012). For example, knowledge about how the brain works or the shape of earth cannot be gathered by direct observation. However, despite the wealth of information on visual updating of representations in infancy (e.g., Koechlin & Dahaene, 1998; Uller, Carey, Huntley-Fenner, & Klatt, 1999; Wynn, 1992), we have only started to learn about young children's ability to update their knowledge of an object through language.

As experience with language grows, representational changes are based increasingly on verbal input rather than direct observation. The transition from responding to names of absent objects to using language to revise mental representations may be supported by increases in working memory capacity and more efficient integration of information acquired across modalities into a unified representation. Infants who respond to absent references earlier and more reliably may benefit from more opportunities to learn about unobservables during conversations. These infants may show earlier understanding of unobservable entities across domains; for example, their understanding of mental states may be more advanced (Baldwin & Saylor, 2005).

When processing new verbal information about an absent thing, infants understand and encode the new verbal input, retrieve the representation of the referent from long-term memory upon hearing its name, and maintain that representation in working memory to manipulate it on the basis of new information (Ganea & Harris, 2013). Recent studies have investigated when infants can update their representation of a hidden object and how their object representations enable (or constrain) such updating.

In one study, infants were taught a proper name (Lucy) for a stuffed frog (Ganea, Shutts, Spelke, & DeLoache, 2007). While Lucy was left to sleep, children were taken into another room. When the toy was out of sight, children were told that the toy had undergone a change ("Lucy got wet. She is all covered in water!"). Children were asked to choose Lucy from three items: a wet frog, a dry frog, and a wet pig. Twenty-two-month-olds selected the wet frog; 19-month-olds did not. However, 19-month-olds did update their representation when the verbal information was offered in the presence of the toy. Because the only information that children could use about the toy's new state was verbal, by 22 months, children use verbal information about changes that they do not directly observe.

To update an object representation based on new information, children must understand and encode the verbal input about the object and use the information to adjust the content of their representation. If the initial representation of the referent is weak, children may fail to maintain and manipulate it on the basis of the new information. Consistent with this possibility, when the 19-month-olds in the study had a weak representation as a result of low exposure to an object, they did not use information received in the absence of the object to update its representation (Galazka & Ganea, 2013). In contrast, 19-month-old-olds updated their representation when they were more familiar with the object and its representation was strong. Activating an object's weak representation (by showing a picture of the object) also improved performance. Therefore, difficulty with updating may be due to poor activation and maintenance of a representation and not to difficulty using new information about the object.

Stronger representations are also required to solve tasks in which old and new information conflict (Munakata, Morton, & Yerys, 2003; Munakata & Yerys, 2001). For instance, children have problems remembering a new rule when its representation is not strong enough. If the task does not involve conflict between an old and a new rule, infants can succeed even with weak representations of the new rule.

The effect of conflict on infants' ability to manipulate mental representations has also been demonstrated with verbal updating (Ganea & Harris, 2010). When children are told that a toy that they had originally hidden in one location was moved to a new location, 23-month-olds search for the object at the first location. When children watch the object being moved to a new location, they disregard information about the previous location and use the visual information to search for the object. By 30 months, children can verbally update their representation of an object's location and search at the new location.

Developmental differences in verbal updating occur only when children need to resolve a conflict between their knowledge of a specific prior location and the new information. For example, 23- and 19-month-olds use information about a new location to find the object when a prior representation of the object's location does not interfere (e.g., when told that the toy they left in the middle of the room had been moved to a new location; Ganea & Harris, 2010). The developmental change in updating may be due to increases in working memory capacity (Ganea & Harris, 2013). Children may fail to actively maintain in working memory new information about the change in location because they have to disregard conflicting prior information.

Toddlers' difficulties updating representations of the location of an absent object on the basis of language occur irrespective of the modality in which the initial knowledge is represented. In one study, 23-month-olds continued to search the initial location of a toy when they had to revise a prior visual or verbal

representation of an object's initial location (Ganea & Harris, 2013). Researchers should test whether the perseverative effect is unique to spatial tasks. Changes in state may also be difficult for toddlers, as when children first are told about a property of a toy (*wet*) and then are told about a change in state (the toy became *dry*). Also, manipulations that may strengthen children's representations of the new verbal input, such as asking children to repeat what they have been told, should improve accuracy in updating.

In summary, updating representations on the basis of new verbal input is determined by the strength of the initial representation and the degree of conflict between new and old information. The degree of conflict can be mediated by how the new information is represented. The ability to update representations may also differ as a function of the type of revision involved—that is, whether the updating requires *enrichment* (e.g., learning about new properties of an entity) or *revision* (e.g., replacing old information with the more accurate information). For instance, if children think the earth is flat (as it appears to them), when told by an adult that the earth is round (something that children cannot perceive directly), they have to revise their previous representation with the new information. Presumably, the different ways of updating knowledge involve different processing demands and so the existing representations may need to be of different strengths. Because strong representations are more connected, it may be harder to replace them but easier to enrich them. More research into how children gather information from others and how this information interacts with their existing knowledge would be valuable for learning how to best communicate information that cannot be acquired through first-hand experience.

SUMMARY

The research we review in this article clarifies that basic cognitive mechanisms constrain the emergence of a core area of language understanding that is critical to the acquisition of knowledge of unobservable entities. In particular, strong representations support retrieval and maintenance processes to enable infants to respond to requests for absent things and to update their representation of an absent referent through language. Identification of the contexts that best support understanding of absent reference offers insight into the emergence of a broad sampling of early competencies, because absent reference understanding paves the way for children's ability to acquire abstract concepts, to pretend and to acquire new information by language alone.

In the future, it will be important to clarify how strong versus weak representations continue to constrain understanding of language as children develop, and whether these basic mechanisms by themselves can offer a sufficient explanation of how children become expert consumers of language-based information. Detailing what other perceptual and social-cognitive mechanisms are involved in processing words referring to absent entities is a key issue for research. This research will offer critical insight into the origins of the human language capacity.

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