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The Roots of Verbs in Prelinguistic Action Knowledge

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In this chapter, we consider infants' prelinguistic action knowledge and how this knowledge might be recruited for verb learning. There are at least two ways in which action knowledge could contribute to verb learning. First, understanding the actions of others is critical for discerning their communicative intentions, and thus provides a foundation for all aspects of language learning not just verb learning (see Tomasello, 1999). Second, infants' action knowledge must provide some of the initial elements of meaning that come to be conveyed in verbs. We focus on the second of these issues, since it is unique to verb learning.

Verbs describe events and relations. As many researchers have noted (e.g., Gentner & Boroditsky, 2001; Gleitman, 1990), the same event can be conceptualized in a multitude of ways. A given action, for example, could be described in terms of the observed physical motion through space, or in terms of a more abstract analysis of the causal or intentional structure of the event (see Edwards & Goodwin, 1986; Huttenlocher, Smiley, & Charney, 1983; Tomasello, 1992). At each level of description, more than one analysis is generally possible. To illustrate, imagine a child running toward and entering a school. At the level of motions, we could choose verbs to focus on the manner of motion or the path the child has taken, for example:

She ran into in the school.
She entered the school in a rush.

And other descriptions are possible from several vantage points:

She hurried to school.
She tried to get in before the bell rang.

Adults' verbs convey these different conceptualizations. Children's first verbs may or may not express these same meanings. Which kinds of meanings appear in the

verbs of young learners is, in part, a product of how they conceptualize actions and events.

In early investigations of lexical development, a driving concern was the extent to which infants' first words were grounded in well-organized concepts. This concern was considered in some detail in the case of words than name objects. Some suggested that infants' first object terms did not reflect adult-like conceptual structure, but instead were associated with disorganized clumps of experience or complexive groupings (e.g., Vygotsky, 1962). To illustrate, *cookie* might initially extend to cookies, cookie jars, and kitchens, with more mature word meanings dependent on the putatively late acquisition of the object concept. These proposals were called into question and ultimately ruled out by two lines of evidence. First, investigations of prelinguistic cognition revealed that the conceptual substrate this aspect of the lexicon, namely well-formed object representations, is in place some months before the first words appear (Baillargeon, 1993; Spelke, Breinlinger, Macomber, & Jacobson, 1992). Second, careful observational and experimental work revealed that even 1-year-olds produce and understand words as referring to object categories rather than to undifferentiated clumps of sensory data (Balaban & Waxman, 1997; Huttenlocher & Smiley, 1987; Waxman & Booth, 2003; Waxman & Markow, 1998).

In considering the parallel question of early verb meanings, we first review recent evidence concerning infants' event representations and then the extent to which these aspects of conceptual structure appear in infants' words. We focus on a particular class of events, those involving actions of other people, because verbs describing them are prevalent in children's vocabularies and because recent research has shed light on infants' prelinguistic action representations.

Infants' Action Analysis

Verbs convey varied meanings, but many, especially those used by young children, concern concrete, observable events—in particular, the actions of people. There is rich action information in the infants' milieu. Indeed, infants develop immersed in the actions of social partners. How do infants represent these actions? One possibility is that infants are limited to representing actions as physical motions. Alternatively, infants may, at least in some cases, represent the underlying intentional relations implied by these actions. At the heart of adult action analysis is the understanding that certain actions center on the relation between an agent and the object at which his or her actions are directed (Barresi & Moore, 1996). Many verbs encode these relations. To illustrate, imagine a woman turning to look at and grasp a cup on the table. To adult observers, the relation between the woman and the cup organizes the event. It is in terms of this relation that we would most readily describe it (“She saw the cup,” or “She grasped the cup,” or “She found the cup,” etc.). We can notice other aspects of the event, for example, the path taken

by her arms, the exact motion of her head and body as she turns. We have verbs that describe these patterns of motion, but these aspects of the action seem less central than the agent-object relation.

A number of recent studies have investigated whether and under what conditions infants represent actions in terms of intentional relations. As an example, in one study from our laboratory, we asked whether infants represent a common, concrete action—grasping, as centering on the relation between the agent and the object of her action. We used the habituation-dishabituation technique to investigate infants' representations of events like the cup example described earlier. An experimenter, seated between and behind two objects (a bear and a ball) turned to look at and grasp one of the objects (see figure 1 in Woodward, 2003). Infants viewed the same reaching event repeatedly until their attention to it declined. Then we reversed the positions of the two objects and showed infants test events that either varied the agent-object relation or varied the surface properties of the experimenter's motions while preserving the agent-object relation. That is, on new-object trials, the experimenter turned to the same side as during habituation, this time looking at and grasping a different toy. On new-side test trials, she turned to a different side than during habituation, this time grasping the same toy as during habituation. If infants represented the original event in terms of the agent-object relation, we predicted longer looking on new-object trials, which disrupted this relation, than on new-side trials, which preserved it. This is what we found. We tested 7- and 9-month-old infants, and each group responded by looking longer on new-object than new-side trials.

Despite the fact that the woman's motions were different on new-side trials, infants did not seem to find these changes as salient as a change in the agent-object relation. In fact, although both groups showed reliable recovery from habituation on new-object trials, neither group recovered on new-side trials. Adults would be likely to extend the same verbal description to the habituation and new-side events ("She grasped the bear" in each case) but a different description to the new-object event ("She grasped the ball"). Infants represent these events in similar terms. Findings like these have been obtained for a variety of intentional, object-directed actions in infants ranging in age from 3 to 13 months (see Guajardo & Woodward, 2004; Jovanovic et al., 2003; Kiraly, Jovanovic, Prinz, Aschersleben, & Gergely, 2003; Sommerville & Woodward, 2005; Sommerville, Woodward, & Needham, 2005; Sootsman, Morgante, Wilson Brune, & Woodward, 2003; Woodward, 1998, 1999, 2003, 2005; Woodward & Guajardo, 2002; Woodward & Sommerville, 2000).

The example we outlined earlier concerning the woman and the cup involves several kinds of connections simultaneously. The woman attended to the cup, directing her eyes to it, and shifting her body with respect to it, and she also acted on it concretely by grasping it. The latter action, grasping, appears early in infants' action knowledge. By 5 to 6 months, infants represent grasping events as object-directed, even when they are only able to see the grasping hand (Jovanovic et al.,

2003; Woodward, 1998, 1999). This response seems to be driven by knowledge about meaningful human actions. Infants do not interpret as object-directed matched events in which inanimate objects move toward and touch or grasp other objects (Jovanovic et al., 2003; Woodward, 1998), or purposeless or ambiguous human motions (Sommerville & Woodward, 2005; Woodward, 1999; Woodward & Sommerville, 2000; see also Guajardo & Woodward, 2004). Importantly, the inanimate and ambiguous actions exerted the same kinds of influence on infants' overt attention as did purposeful human actions. To illustrate, in one study (Woodward, 1999), infants in one condition saw an experimenter grasp a toy, and infants in another condition saw the experimenter drop her hand onto the toy, palm up, in an apparently purposeless manner. The events in the two conditions were very similar in terms of the experimenter's range of motion and the degree of contact between her hand and the toy. Moreover, the two events directed infants' attention to the object to the same extent. Nevertheless, infants responded to the two events differently: they treated the grasp, but not the back-of-hand event, as object-directed. Thus, infants' responses seem not to be driven by low-level factors, such as the way the actor's hand moved or the way the events entrained their attention.

Attentional Relations

Concrete actions like grasping create observable evidence concerning their object-directedness. These actions make things move. Acts of attention, for example gazing or pointing, do not exert these same kinds of impact on the world. For this reason, attentional relations seem (to developmental psychologists as well as non-scientists) to be more uniquely psychological. When and how do infants come to understand the invisible connection between a person and the object of his or her attention? Researchers have commonly used infants' tendency to orient in responses to an adult's gaze shift as evidence of understanding the act of looking (e.g., Scaife & Bruner, 1975). However, orienting responses could be driven by factors other than an understanding of the "looking" relation (see Corkum & Moore, 1995; Woodward, 2003).

To get clearer evidence on this issue, we adapted our visual habituation technique to ask this question (Woodward, 2003). Infants viewed events like the ones in figure 8.1, except that the woman only looked at the toy; she did not grasp it. Following habituation to one looking event, the positions of the toys were reversed and infants viewed two kinds of test trials: On new-object trials the woman turned to the same side as during habituation, this time looking at a new toy. On new-side trials, she turned to the other side to look at the same toys as during habituation. If infants represent the invisible link between looker and object, we predict longer looking on new-object trials than new-side trials. We tested 7-, 9-, and 12-month-old infants, and infants at each age robustly followed the woman's gaze shifts—they spent much more time looking at the object at which she gazed than

at the other object. However, this orienting response did not guarantee that infants recovered the looking relation. Only 12-month-olds looked longer on new-object trials than new-side trials. Seven- and 9-month-olds did not even recover attention during test trials. It was as if they identified the objects as being the same (The woman, the bear, and the ball again. How boring!), without considering the relations between them. A similar study, which included pointing as well as looking, yielded nearly identical findings (Woodward & Guajardo, 2002). Infants followed the experimenter's gaze and point robustly, but only the oldest infants tested, 12-month-olds, responded to the object-directed structure of the pointing action.

These findings fit well with long-standing observations that infants become more organized in their triadic interaction patterns at around this age (Carpenter, Nagell, & Tomasello, 1998) and therefore indicate that this change in social responsiveness is accompanied by a change in social cognition. Moreover, other findings shed further light on infants' understanding of attention. Phillips, Wellman, and Spelke (2002) found that 12-month-old infants understand the regular relations between looking and acting, namely that people tend to look at the objects they are about to act on (see also Sodian & Thoermer, 2004). Brooks and Melzoff (2002) report that at around this same age, infants begin to distinguish between obstructed and unobstructed gaze in social partners, suggesting that they know something about the conditions under which people can see things. Moreover, by shortly after their first birthdays, infants employ their newly minted understanding of attention to inform their interpretation of both emotional expressions (Moses, Baldwin, Rosicky, & Tidball, 2001) and language (Woodward, 2003).

Flexible Action Interpretation

The findings summarized so far indicate that infants are not limited to representing actions in terms of their surface structure but instead have begun to understand the relational structure of action. Infants do not seem to begin with the general expectation that all human motions will be object directed. Instead, they seem to discover the relational nature of particular actions, beginning with familiar actions, such as grasping and gazing. These particular actions are so ubiquitous that they have become, for adults, metaphors for more abstract intentional relations (e.g., "The prize was just beyond my grasp" or "I see what you mean"). However, adults are not limited to understanding certain canonical actions as relational. Instead, we can interpret the same scene through different lenses, focusing on the overt motion or the underlying relations, considering descriptions at different levels of analysis, or from different perspectives.

Recent findings show that by the end of the first year of life, infants engage in flexible action analysis in some situations. For one, they can interpret the same motion as being goal-directed or not based on the physical context in which it occurs or based on the other behaviors of the agent. Illustrating the first

of these, Gergely, Csibra, and their colleagues (Csibra, Gergely, Biro, Koos, & Brockbank 1999; Gergely & Csibra, 2003; Gergely, Nasady, Csibra, & Biro, 1995) have found that 12-month-old (and sometimes 9-month-old) infants interpret the same motion, a circuitous motion ending in contact with a goal object, as being goal-directed in some contexts (when the motion circumvents a barrier) but not in others (when no barrier is present) (see also Phillips & Wellman, in press; Sodian, Schoepner, & Metz, 2004). Illustrating the second, Behne, Carpenter, Call, and Tomasello (2005) have found that infants as young as 9 months of age differentiated between two very similar motions, one carried out in a purposeful manner and the other marked as “accidental” with facial and vocal expressions. When an adult purposefully refused to hand infants a toy, they became frustrated. When the adult “accidentally” failed to hand them the toy, they were less frustrated.

Moreover, infants can represent the complementary roles of two entities in the same event. In one study, Golinkoff (1975) habituated infants to standard plausible events (e.g., a man pushed a woman or a man pushed a table). Fourteen- and 18-month-old infants watched anomalous test events (e.g., table pushed the man) longer than the plausible test events (e.g., woman pushed the man), suggesting that they differentiated the agent and recipient roles (see also Golinkoff & Kerr, 1978). Recent evidence shows sensitivity to different roles during the first year of life. Schoepner, Sodian, and Pauen (2004) showed 10-month-old infants give-and-take sequences involving two puppets. Infants were habituated to a sequence in which one puppet was always the giver and the other was always the taker. Then, in the test, these roles were reversed on some trials, whereas on other trials the direction motion of the puppets was reversed but their roles stayed the same. Ten- and 12-month-old infants looked reliably longer on role change trials than motion change trials, but only if the exchange was apparently purposeful. Thus, infants seemed to represent the giver and taker roles embedded in the event, suggesting that they have access to the representations needed to eventually acquire verbs like *give* and *take*, which adopt different perspectives on the same event.

Actions at Varying Levels of Analysis

Actions can be described not only at a local level (“She grasped the pen”) but also in terms of the overarching plans that drive them (“She wrote a letter”). Mature observers perceive actions in terms of what Zacks and Tversky (2001) termed *partnomic hierarchies*, in which subgoals are understood as parts of more abstract plans. Infants begin to represent actions in this way by the end of the first year of life—they attend not only to the local relations between actions and objects, but also to relations between actions and ultimate outcomes (Sommerville & Woodward, 2005; Woodward & Sommerville, 2000). To illustrate, in one study (Sommerville & Woodward, 2005), 12-month-old infants saw an adult reach

toward and grasp a cloth that supported a toy and then pull the cloth toward her in order to grasp the toy. The question of interest was whether infants interpreted the adult's grasp of the cloth as directed at the cloth itself (the proximal goal) or instead at the toy (the ultimate goal). To address this question, infants viewed habituation events featuring two different-colored cloths, each supporting a different toy. During habituation trials, an adult pulled one of the cloths in order to obtain the toy. After habituation, the location of the toys was reversed, and infants saw the adult act toward either a new toy (new toy event) or a new cloth (new cloth event). Twelve-month-old infants looked longer at the new toy than new cloth events, indicating sensitivity to the goal of the sequence. This effect depended on the existence of a causal relation between pulling the cloth and obtaining the toy. When we altered the events by taking the toy off the cloth, 12-month-olds did not interpret the actor's grasp of the cloth as directed at the toy.

We also found a developmental change in infants' interpretation of these sequences. Ten-month-old infants, as a group, did not recover the overarching goal of this sequence. However, at this age, infants' goal sensitivity was related to their own ability to implement goal-directed strategies in a similar action task: Infants who produced a high frequency of apparently goal-directed strategies in the action task represented the toy as the actor's goal, whereas those that produced few goal-directed strategies apparently misrepresented the goal of the cloth-pulling sequence as the cloth itself. Thus, under more supportive conditions, perhaps given a simpler relation between the two actions, even 10-month-olds might have recovered the overarching goal.

Conclusions From the Research

The findings of the last several years yield strong evidence that infants have begun to analyze the relational structure of human actions during the first year of life. These findings are consistent with those of studies of nonsocial event analysis. Infants represent causal roles in launching sequences (Leslie & Keeble, 1987), causal chains (Cohen, Rundell, Spellman, & Cashon, 1999), and other physical relations that are encoded by verbs in some languages (Casasola & Cohen, 2002; Choi, McDonough, Bowerman, & Mandler, 1999). We focus on actions because they are pervasive in infants' experience and in their early talk. But we note that they are but one aspect of the infants' emerging ability to represent the relational structure of events.

Taken together, these findings indicate that by the end of the first year of life, infants have the conceptual material relevant for a range of verb meanings, including not only verbs that encode the observable trajectories of moving objects (e.g., *fall*) but also verbs that encode the outcomes of causal sequences (e.g., *open*), intentional actions (e.g., *get*), transactions (e.g., *give*), and psychological states (e.g., *see*). Moreover, there is evidence that in some circumstances infants can interpret an event through more than one lens, considering it for example, as goal-directed

or not based on the context, in terms of the complementary roles of two interactive agents, or in terms of proximal versus ultimate goals. Given that the conceptual material exists, when do infants begin to put it into words? We next turn to the question of whether these kinds of meanings are, in fact, expressed in children's earliest verbs or event words.

The First Action Words

Which aspects of events are first expressed in children's language? Given that researchers have been investigating early word learning for more than a century, one might think this question is easily answered. It is not. There is debate about which word forms should be considered relevant to the question. A strict definition would include only words that are members of the syntactic category verb. However, we could also include a variety of words from other grammatical categories that children use to convey information about actions and events. In fact, many of the first words that English-speaking children produce relate to events such as the appearance of a person (e.g., *hi*) or function as a request for an action (e.g., *up*), but they are not verbs. This issue also arises when considering development across languages. Different languages can use different word classes to refer to the same event (see, e.g., Choi & Bowerman, 1991), a fact that complicates cross-linguistic comparisons. Across studies, researchers have adopted different focal sets—driven very often by somewhat different questions. We seek to address two issues: (1) which aspects of action do children first describe? and (2) how does action knowledge contribute to their learning of verbs in particular? Given this dual focus, we consider evidence about verbs as well as other classes of words that children use to describe actions. Beyond deciding which words to consider, it is also necessary to determine what children mean when they use them. This issue is not unique to the study of verb acquisition. The indeterminacy problem describes the infinite number of potential meanings that could be associated with any word. How are researchers to know which of these meanings the child means to convey?

In confronting these problems, researchers have adopted three general methods for investigating the meanings children glean from and convey with verbs and other action terms: analyses of spontaneous speech, laboratory measures of verb comprehension, and laboratory procedures in which novel verbs are trained. We next review the evidence from each of these approaches with a focus on the earliest event terms and verbs.

Event Words in Natural Discourse

Researchers have long noted that action words appear very early, among the first 50 words in English-speaking children (Benedict, 1979; Bloom, Tinker, & Margulis, 1993; Gopnik & Meltzoff, 1997; Nelson, 1973; Tomasello, 1992). Benedict

(1979) found that 19% and Nelson (1973) found that 13% of the first words seemed to be about actions. Moreover, several of these words could be interpreted as comments on goals (*uh-oh*), perception (*all-gone, look, see*), and other aspects of agents' relations to each other and the world (e.g., *give, bye-bye*). Indeed, Gopnik and Meltzoff (1984) found that infants began to use words such as *uh-oh* and *did it* during periods in which they were honing their problem-solving abilities. This suggests that these terms express newfound insight into the purposes behind babies' own actions.

However, it is often difficult to tell whether these early words name actions or simply accompany them. Many of children's early event words seem to function as performatives, that is, as part of the action rather than the name for it. Children's understanding of these words is idiosyncratic and context specific. For example, Tomasello (1992) reported that in his diary study of his daughter Travis's action words, including verbs, there were several months in which terms were limited to particular performative contexts. At 17 months, Travis used the word *play-play* in the context of banging the piano keys and the word *phone* in response to hearing the telephone ring. Careful cross-context analyses revealed Travis also produced verbs that seemed to name actions. As reviewed next, this finding is consistent with others. By the second half of the second year, many children produce names for actions.

When children produce verbs (or other terms that seem to refer to actions), do they at first name only the physical properties of actions, or can they also name the logical and intentional relations that structure action? In a foundational paper, Huttenlocher, Smiley, and Charney (1983) framed this question and collected initial evidence to address it. Their goal was to use verb production and comprehension as evidence about young children's conceptual representations of actions. They reasoned that if children are able to represent actions not only in terms of physical motions but also in terms of underlying relations and goals, then this should be evident in their use and understanding of verbs that encode these different aspects of action. Given this focus, Huttenlocher and colleagues were particularly interested in verbs such as *dance, run, and wiggle*, which name observable patterns of motion, and verbs such as *bring, find, and give*, which rely on an understanding of the relational structure of an event and, perhaps, on the agent's goals in acting.

The 22- to 30-month-old children they tested produced and comprehended both kinds of verbs, thus providing initial evidence that they have access to both kinds of action analysis in at least some cases. However, it turned out that these two kinds of verbs were not equally distributed across the child's own actions and those of others. Children produced both kinds of verbs when talking about their own actions (though they used intentional action verbs more often), and they were able to comprehend both kinds of verbs, as evidenced by their ability to respond to commands such as "sit down" and "get X" (see also Goldin-Meadow, Seligman, & Gelman, 1976). In the case of the observed actions of other people, in contrast, children much more readily identified movement verbs than intentional

action verbs. Huttenlocher and colleagues suggested that this difference was due to the fact that children only know their own intentional states, not those of others, and that very young children are therefore limited to representing others' actions in terms of movement.

There are two ways in which this conclusion might be true. Children might not know that others have intentions at all. This framing is at odds with the findings, summarized earlier, that infants analyze others' actions not only as physical movements but also, in some cases, as intentional actions. Alternatively, children might understand that others have intentions but be less able to infer a person's particular intention based on observational evidence, particularly for complex events. Determining which particular intention a person has in mind can be a difficult enterprise even for adults. One's own goals may be more salient, or more directly knowable in some cases.

Furthermore, later diary studies (Edwards & Goodwin, 1986; Tomasello, 1992) call the strong form of the conclusion into question because they report that 16- to 18-month-olds sometimes use action words for others' as well as their own actions. For example, Tomasello (1992) reports that at around 16 months of age, Travis used verbs to talk about the movements of other people (e.g., *crying*, *fall-down*) and to request and comment on both her own and others' relational actions (e.g., *move* [*an object*], *get-it*) (see also Edwards & Goodwin, 1986).

Intentional action verbs such as *give* or *find* are about relations. In order to extend them appropriately, children must at least encode the relevant relations (e.g., the relations between giver, object, and recipient). For adults, these actions are also bound up with our understanding of others' psychological states (intentions, perceptions, etc.). It is difficult to know whether babies also represent these aspects of events such as giving or finding. However, more explicit evidence for babies' understanding psychological relations comes from their use of psychological verbs, such as *want* and *see*. We turn next to these verbs.

Many studies have investigated children's use of verbs that, in adult usage, directly encode the psychological nature of intentional relations. In these analyses, a central focus has been the attempt to determine whether children mean to convey information about a psychological relation, or instead use the term as part of an idiomatic expression ("You know what?" versus "I didn't know my shoes were in the basement"). Verbs like *gonna*, *try*, and *mean to* seem express children's intentions from relatively early on. Between 24 and 30 months of age, multiple studies report production of *gonna* (Bartsch & Wellman, 1995; Dunn, 1999; Dunn, Bretherton, & Munn, 1987; Dunn, Brown, & Beardsall, 1991; Fenson et al., 1994). Using the context surrounding children's speech, Bartsch and Wellman (1995) found that 2-year-olds said *gonna* to express goal-directed actions in the immediate future. Six of the 10 children in the sample used these terms first to refer to only their own actions. For three of the children, mental verbs for their own actions and those of others emerged during the same observation. Only one child described others' actions before describing his own actions.

Children also express their intentions using desire terms such as *want* and *need*. For example, Travis, at 23 months of age, replaced her use of *have* and *hold* with *want* (to obtain an object; Tomasello, 1992). By 28 months, nearly all of the children in Bretherton and Beeghly's (1982) sample produced it; of these children, 77% used *want* to talk about themselves and other people. When Bartsch and Wellman (1995) analyzed the context surrounding children's early mental verbs, they found that *want* comprised 97% of 21- to 24-month-olds' desire terms. In their analysis, children's use of *want* was not limited to making requests. Children also used *want* in reference to forming goal-directed action plans, wanting to misbehave, and wanting to act like another person. As Bartsch and Wellman (1995) noted, children's desire terms are intimately linked to actions, "From its earliest appearance, talk about desires seems to rationalize, to explain, and at time to argue for certain actions by appeal to the actors wants" (p. 116).

In addition to goals, children use verbs to comment on perceptual experience by their second birthdays if not before. By 28 months, Bretherton and Beeghly (1982) found that *see* was used by 97% of their sample of 30 children, *look* by 90%, and *watch* by 80%. In all cases, over half of the children used these words to refer to themselves as well as to refer to other people. Children used these words to talk about their own behavior (e.g., "I don't want to see it"), or to request action from another person (e.g., "Don't watch me"). Travis used *look* and *see* at 19 months of age to make a request and to direct another's attention (Tomasello, 1992). By 23 months she used *see* to refer to herself as perceiving something, rather than as a request to direct attention or to comment on what she was doing. This fits with Gopnik and Meltzoff's (1997) review of the CHILDES database, which found that children first produced *see* between 18 and 30 months of age to replace the word *gone* when making a request for something that was no longer in view. Shortly after this, *see* was extended to include situations describing others' ability to see.

Experimental Studies

Naturalistic observations, though rich and ecologically informative, provide a limited window through which to view children's verb knowledge. Children's utterances are driven by pragmatic forces that may lead them to produce some verbs only in limited contexts, for example, to announce their own intentions (Edwards & Goodwin, 1986). As Goldfield (2000) has suggested, the pragmatics of American children's interactions with their mothers often involve requests for noun production (e.g., "What's this called?") and few requests for verb production (e.g., "What's it doing?"). Rather than elicit verb production, parents are more likely to elicit action production (e.g., "What can you make it do?"). Naturalistic evidence concerning children's comprehension may be similarly constrained.

Parents report that their infants understand event words in everyday speech (Fenson et al., 1994). Evidence from parental reports suggests that 50% of

8-month-old infants understand words that are embedded in games and routines (e.g., *peek-a-boo*) and 50% of 12-month-olds understand words associated with actions (e.g., *eat*, *drink*). These reports are difficult to evaluate because, concerns about parents as informants aside, infants may understand these terms as parts of actions rather than names for actions.

To circumvent these problems, researchers developed more controlled paradigms. In one of the first of these, Goldin-Meadow et al. (1976) assessed 14- to 27-month-old babies' comprehension and production of familiar nouns and verbs in the course of a structured test session in their homes. To distinguish familiar routines from true verb comprehension, they asked babies to produce familiar actions with unusual objects, for example, "Eat the bear." All babies responded correctly at least some of the time, and babies 22 months of age and older responded correctly most of the time. Their items included both verbs that name motions (e.g., *jump* and *run*) and verbs that name relations (e.g., *pick up* and *open*). Babies were less able to produce familiar verbs when asked, "What am I doing?" although some were able to respond some of the time (4 to 16 times out of 30 opportunities).

Goldin-Meadow and colleagues' findings were among the first to show that young 2-year-olds comprehend familiar verbs, even in somewhat unusual contexts (e.g., eating the bear). Forbes and Poulin-Dubois (1997) tested the extent to which 20- and 26-month-olds could extend familiar verbs in comprehension. Using a visual preference paradigm, they showed babies films of a person kicking an object and of a person picking up an object, associating each with the familiar labels *kick* and *pick up*. Then they tested babies' comprehension using films that varied the agent, the manner of the action, or the outcome of the action. For example, in the manner change event, the agent picked up the object with her foot, and in the outcome change she grasped the object with her hand, but then put it down rather than picking it up. Twenty-six-month-olds responded correctly when either the agent or manner changed. That is, they seemed to be able to recognize picking up even when a new person did it or when it was done with the foot. However, they did not respond systematically when the outcome changed. These findings suggest that babies regarded the particular patterns of motion less central to the meaning than the outcome.

An alternative vantage point is to teach babies new verbs in the laboratory. This method, developed by Golinkoff, Hirsh-Pasek, Cauley, and Gordon (1987), asks how babies can learn and extend new verbs and what meanings they attach to them. These studies involve a training session whereby the babies associate a verb label for a novel action. In the subsequent testing session, two actions that differ in one key element appear side by side and the child is asked to look at the named action. This manipulation enables the researcher to ask which elements the child attended to and used to define the novel verb. Researchers have used this method to ask whether babies would more readily attach a novel name to motion patterns versus causative actions in an event.

In one of the first uses of this logic, Naigles (1990) found that 25-month-old children could interpret a novel verb as the name for either a pattern of motion or a causal relation. Children watched films of characters engaging these two kinds of action simultaneously while they heard a novel verb either in a transitive sentence (e.g., “The duck is glorping the bunny”) or an intransitive sentence (e.g., “The duck and the bunny are glorping”). Children responded appropriately in both cases, looking at the appropriate video that matched the syntax of the accompanying audio track. These data show not only that 25-month-old children can use syntax to determine the meaning of a novel verb but also that they are flexible in their representation of the event in that they are able to interpret it as a distinctive pattern of motion or as a causative relation. Children could endorse either meaning (see also Fisher, 2002; Naigles, 1996).

The results from these syntactic bootstrapping studies suggest that children can flexibly learn verbs that refer either to patterns of motion through space or to intentional relations. In a more explicit manipulation of the intentional structure of the event, Poulin-Dubois and Forbes (2002) tested whether 21- and 27-month-olds could use an agent’s behavioral cues to intentions to learn a novel verb. Children viewed videotapes of paired actions that differed in the extent to which the actor conveyed a goal (e.g., *knocking over* [the actor watches his arm move an object on purpose] versus *toppling* [the actor looks away when his arm accidentally moves an object]). Children in the older group used these intentional behaviors to discriminate the actions where the agent’s intention differed and consequently were able to learn distinct verbs for the actions. This suggests that by 27 months of age, children interpret events in terms of intentional structure indicated by overt behavioral cues, and use this information to learn new verbs.

Mind the Gap

Throughout this chapter, we have considered the issue of the level at which children represent actions and level at which they name actions. Recent findings from our laboratory and others indicate that infants understand several kinds of intentional relations by the end of the first year. Interestingly, when children begin to use verbs, they name these intentional relations as readily as patterns of motion. There does not seem to be a period during which infants only talk about observable motions. From the start, they also talk about their own (and perhaps others’) intentional relations. However, most of the evidence for production and comprehension of these verbs (like others) comes from studies of 2-year-olds, with robust patterns evident around the second birthday but not earlier. The evidence suggests a notable gap between the beginnings of organized thinking about actions and the emergence of words to describe these actions. In the final section of this chapter, we will consider two possible explanations for this gap.

Tracking Actions Versus Extracting Exemplars

In observing an action, one could consider it as an example of a kind of action (e.g., an instance of seeing). Alternatively, one could consider this action within the ongoing stream of action to make inferences about the agents' likely next actions and responses. Adults can freely adopt either stance and may well do both simultaneously. In fact, in mature reasoning, these two stances inform one another. By attending to a person's prior actions, we can identify exemplars of more abstract actions (e.g., buying, hiding), and this categorization in turn aids online action interpretation.

Here we raise the possibility that infants' initial interpretations of actions may be focused on extracting the meanings of event sequences and making sense of an individual's behavior over time rather than on extracting exemplars of particular kinds of actions. Because the latter is required for verb learning, we speculate that infants may not readily pull out the kinds of units that verbs name. Acquiring a label for an action requires pulling out the exemplar. An accurate representation of a verb, for example, *see*, *want*, or *get*, requires an understanding of the event devoid of the context, that is, without reference to the individual person performing the action and without reference to the specific goal object, or the actions which precede and follow it. Conversely, understanding action in context is at the heart of understanding others' behavior ("She saw it, wanted it, and then got it"). The individual who performs the action, the goal object of the action, and the other actions performed by the agent are critical to making sense of the behaviors of social partners.

The habituation studies we reviewed earlier could be accounted for by infants' adopting either stance. For example, consider the studies in which infants see a person grasp one of two objects. Infants may view each habituation trial as an instance of grasping the ball. Thus, they encode the grasping relation as well as the particular object to which it is directed. Then, in the test, infants may respond to the relative novelty of an action exemplar directed at a new object rather than the old object. Alternatively, infants might seek to link the individual habituation trials together as parts of an extended event in order to predict the agent's next actions. ("She still wants that ball. She's going to want the ball this time too.") In this case, longer looking on new goal trials could indicate a violation of expectation ("Oh, now she wants the bear").

A recent series of studies from our laboratory indicates that by 9 months of age, infants seem to treat the habituation events as part of an ongoing stream of the agent's behavior rather than as isolated exemplars (Sootsman & Woodward, 2004). We used a modified version of the paradigm originally designed to assess infants' understanding of goal-directed actions. Infants in one group saw the typical event from our laboratory. In the habituation event, a person grasped one of two objects on a stage, then in the test the locations of the objects were switched and infants looked longer at the new-goal event than the new-side event. Infants in a second group saw the modified condition. They saw one actor perform the habituation event and a different actor perform the test event. Our reasoning was that if infants do not

consider the identity of the agent to be an important part of the event, the results of this condition should be identical to those in the original single-actor condition. If however, infants do know that the identity of the agent is an important part of the event and the behavior of one actor does not necessarily relate to the behavior of a second actor, then the results of this condition should differ. The second response pattern is what we found. Infants did not respond systematically in the test trials, indicating that by 9 months of age, infants' interpretation of an event is tied to the individual who performs it. This is noteworthy because it suggests that infants view the event not just as a series of action exemplars devoid of context (e.g., picking up 1, picking up 2, etc.), but instead view actions as connected to the agent (i.e., *she* is picking up the ball, and now *she* is picking up the ball again). Thus, in the context of this experiment, 9- and 13-month-olds tended to view actions as part of an ongoing behavioral stream and not necessarily as distinct exemplars. To the extent that many real-world interactions require babies to follow the actions of particular social partners, this may make action exemplars difficult to extract.

However, these findings do not mean that there are no conditions under which infants would isolate action exemplars. In the real world, infants see multiple agents acting, and perhaps comparison across agents provides a basis for extracting action categories. We did not test whether infants noted that both agents were grasping rather than hitting or poking. Further research is needed to investigate this issue.

Determining Which Relation Is Being Named

Prelinguistic action knowledge sets the conditions for learning words because it enables the child to represent the relational structure of events. However, as we reviewed earlier, infants can represent a given action from more than one vantage point, for example, considering an action as "grasping the lid," or as part of "opening the box." In fact, understanding events at multiple levels can nominate several possible word meanings, making the task of interpreting what a novel verb means more complex. Interpreting a verb requires that the learner determine which of many possible perspectives the speaker means to take on the event in question (Gentner & Boroditsky, 2001; Gleitman, 1990; Tomasello, 1992). Infants may know that seeing, grasping, and getting, are occurring, but still be uncertain which of these is being named. Furthermore, research described earlier (Naigles, 1990; Fisher, 2002) suggests that children are flexible their interpretations of events—they are able to learn verbs referring to either distinctive patterns of motion or causative relations. Thus, in this case conceptual structure may provide such a rich an array of possible meanings that constraints on learning are necessary to achieve robust verb learning.

One critical source of constraint for verb learning is argument structure. Many researchers (Gleitman, 1990; Gentner & Boroditsky, 2001; Fisher, 2002; Naigles, 1990, 1996) have proposed that the use of syntactic frames is key to learning new verbs. These frames seem to provide information about the packaging of linguistic

units required for the establishment of connections between linguistic and conceptual units. As described earlier, by 28 months, children can use different sentence frames to narrow down the possibilities for what a new verb means (Naigles, 1996). We presume that syntax is one of several sources of information on which children can draw (see Hollich et al., 2000; Woodward & Markman, 1998). Its particular importance for verb learning may explain, in part, why the first verbs emerge when they do (Gleitman, 1990).

Conclusion

We began with the question of whether infants possess well-organized action representations that could be recruited for verb learning. Recent findings indicate that they do. Before their first birthdays, infants understand human actions not only as physical motions through space but also as embodying intentional relations of several kinds and at several levels of analysis. Moreover, the evidence from studies of verb acquisition indicates that these representations are expressed in children's earliest verbs. However, by our estimate, perhaps as much as a year elapses between the emergence of well-organized action representations and the first strong evidence for verbs that express them. This gap, we think, points out the fact that having an organized idea does not automatically provide a word meaning. Determining how concepts are expressed in language requires pulling out taxonomic exemplars from the ongoing stream of experience and then determining which of the many possible exemplars are being named. Each of these may present a special challenge in the case of verbs. Infants may focus their action analysis not on extracting exemplars, but instead on predicting what happens next. These processes are not independent. Deciding that this event is an instance of *opening* or *wanting*, for example, requires analyzing the ongoing stream of action. Moreover, having extracted an exemplar, young children face the well-established problem of determining which construal is relevant for the meaning of a verb. In a given scene, grasping, opening, and wanting may all be occurring simultaneously, and learners need more evidence to determine which of these is being named.

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