

Verbal–Behavioral Dissociations in Development

Jacqueline D. Woolley

The University of Texas at Austin

Verbal and behavioral measures of children's knowledge are frequently dissociated. These situations represent a largely untapped but important resource for furthering an understanding of human cognition. In this paper, verbal–behavioral dissociations in children are discussed and analyzed, drawing from a wide range of domains. The article explores what might lead to different responses in different modalities, and it is proposed that children's goals may be an important factor. It is concluded that a variety of factors are involved in producing these dissociations, and that a richer picture of development will result from attention to these factors.

Developmental psychologists are faced with the never-ending task of devising clever, age-appropriate, and elegant measures of children's understanding. The methods used by developmental researchers fall into two broad classes that are roughly correlated with the ages of the children of interest. Because infants lack the ability to verbalize their responses, researchers who study them measure various aspects of behavior, with the majority of studies using visual fixation time as the dependent measure. However, when participants are children who developed more sophisticated language skills, researchers have the option of probing knowledge and beliefs by asking verbal questions and examining verbal responses. This option is exercised by many, and is often considered to provide more easily interpretable information about children's concepts and beliefs. Thus, for investigations focused on preschool children, a large proportion of research involves a verbal presentation of a problem and requires a verbal response, from a simple yes/no judgment to explanations of a solution. Both verbal and behavioral measures are taken by researchers to reflect the child's understanding of or beliefs about a concept. But are they both always equally good measures of knowledge?

An important place to look to examine this question is a situation in which results from verbal and behavioral measures of knowledge or beliefs differ. Studies revealing such dissociations between verbal and behavioral responding exist, and are diverse in

their content and varied in their findings. Importantly, these dissociations may provide insight into both the nature of conceptual development and the validity of verbal versus behavioral measures of these concepts. In this paper, I will attempt to integrate various developmental literatures to address what verbal–behavioral dissociations can tell us about development and about belief generally. Critical to this enterprise will be addressing whether the verbal–behavioral dissociations found in this diverse set of experiments reflect the same underlying phenomenon or whether they indicate different phenomena. I will also discuss implications of these findings for how developmental psychologists conduct research.

Dissociations between behavioral and verbal measures have been observed in adults as well as in children, and have received much empirical attention in the social psychological (e.g., Greenwald & Banaji, 1995), cognitive (e.g., Nisbett & Wilson, 1977), perceptive (e.g., Bridgeman, Peery, & Anand, 1997), and neuropsychological (e.g., Siegal, Varley, & Want, 2001) literatures. This paper takes dissociations in children as its focus for a number of reasons. One is the tenet that understanding how knowledge develops can provide important information on how knowledge is represented. A fundamental aspect of human cognition is the process by which new knowledge becomes something that can be used more and more flexibly (see, e.g., Karmiloff-Smith, 1992). Because many foundational concepts undergo significant development in childhood, research with children is particularly well suited to capturing different levels of knowledge and thus opportunities to explore potential mechanisms of change. There is also a methodological reason for focusing on children. The majority of research with children employs

I thank Rebecca Bigler, Beth Boerger, Cheryl Browne, and Angeline Lillard for their insightful and helpful comments on earlier drafts of the paper, and also the students in my graduate seminar for their stimulating discussions of this topic.

Correspondence concerning this article should be addressed to Jacqueline D. Woolley, Department of Psychology, University of Texas, 1 University Station, A8000, Austin, TX 78712. Electronic mail may be sent to woolley@psy.utexas.edu.

© 2006 by the Society for Research in Child Development, Inc.
All rights reserved. 0009-3920/2006/7706-0002

primarily verbal measures of conceptual knowledge. This reliance on verbal methods can result in inaccurate or incomplete estimates of children's competence (see, e.g., Bloom & German, 2000). Providing a rich picture of the nature of development may require the use of multiple methodological modalities. To guide this enterprise, developmental researchers must be able to make sense of those findings in which information from different types of measures diverges. Finally, there is a practical reason to focus on research with children. The developmental literature in which dissociations have been observed is large, and is growing. The diversity of findings in this area calls for an in-depth and focused attempt at resolution and synthesis.

Dissociations in Development

Dissociations between verbal and behavioral responses have been obtained in a wide range of domains. Studies on children's ability to make the fantasy–reality distinction reveal mature responding when children are asked questions about fantasy, yet their behavior appears to reveal fantastical beliefs (Bouldin & Pratt, 2001; Harris, Brown, Marriot, Whittall, & Harmer, 1991; Johnson & Harris, 1994; Subbotsky, 1993). Other work similarly reveals more mature responding in verbalizations. For example, children can report a new rule they have been taught for sorting cards (e.g., put the ones of the same color together) but will proceed to sort the cards according to an old rule that they were taught in a previous game (e.g., put the ones of the same shape together; see, e.g., Zelazo & Frye, 1998; Zelazo, Frye, & Rapus, 1996; Zelazo, Müller, Frye, & Marcovitch, 2003). Studies like these suggest that verbal measures may be better than behavioral measures at capturing nascent knowledge.

Yet there are also studies in which more mature responding appears first in behavior. Work by Goldin-Meadow and colleagues (see, e.g., Alibali & Goldin-Meadow, 1993; Goldin-Meadow, Alibali, & Church, 1993; Perry, Church, & Goldin-Meadow, 1988) on children's understanding of mathematical equivalence and conservation shows that, when explaining solutions to a problem, children's gestures reveal more sophisticated knowledge than do their verbal explanations. Similarly, work on children's understanding of false belief shows that, despite verbally erring in reporting where someone with a false belief will look for something, children's eye gaze indicates knowledge of the correct location (Clements & Perner, 1994). These studies suggest that new knowledge may appear first in behavior.

Thus, although all these findings have in common that verbal and behavioral responses are dissociated, they differ in terms of which modality reveals more advanced knowledge. To try to achieve some resolution and to better understand the roles of each modality, I begin by focusing on one content domain in which more advanced knowledge is revealed in the verbal modality and one in which it is revealed in the behavioral modality. I will briefly and uncritically describe these two literatures and then return to them more critically, integrating them with other related findings. I will then attempt to generate a model that can be applied more generally to the broader set of findings, and potentially to other areas within developmental psychology as well.

Fantasy–Reality Distinction and Magical Thinking

A number of studies of children's magical and fantastical beliefs (Bouldin & Pratt, 2001; Harris et al., 1991; Johnson & Harris, 1994; Subbotsky, 1993) have revealed more mature knowledge in verbalizations than in behavior. In Harris et al. (1991, Experiment 4), 4- to 6-year-old children looked into an empty box and pretended that either a monster or a rabbit was inside. Then, in response to a question about the contents of the box, they stated that the box was empty, reflecting, presumably, their knowledge that pretense cannot create reality. However, at that point the experimenter made up an excuse to leave the room. When left alone with the box, these same children engaged in behavior that suggested that they believed that a monster (or rabbit) was really in the box. For example, they left their chairs and engaged in exploratory behavior toward the box. It appears from this work that, although children say that imagined creatures are not real, this knowledge may not fully govern their actions.

Research by Subbotsky (1993, 1994) reveals a similar pattern of results. In one of his studies, an experimenter told 4- to 6-year-old children about a girl who had a magic box that transformed pictures into real things. Children were asked whether they believed that such a box existed and would really be able to accomplish such a transformation. They responded negatively. Then, the experimenter produced a box and claimed that it was the same kind the girl had in the story. As in Harris et al., the experimenter left the room and observed the children's behavior. Subbotsky found that most of the 4- and 5-year-olds, and some of the 6-year-olds, engaged in myriad behaviors indicating belief in the magical

properties of the box. They placed pictures in the box, waved their hands over it, uttered magic words, and looked truly disappointed when it didn't work. Subbotsky's (1993) interpretation of these findings is that children have two ways of thinking about magic that are expressed in the different modalities. The more mature view is expressed in their verbal responses to the experimenter whereas the apparently more primitive view (although Subbotsky would not term it such) is expressed in their solitary behavior.

Subbotsky (2001) argues that, although much research supports the view that magical thinking declines with age, when behavior is examined in addition to verbal reports, magical beliefs are often revealed. In Study 1, he presented 6- and 9-year-old children with a specially constructed box that appeared to make objects disappear or transform into other objects. In the scientific conditions, the box was connected to what appeared to be a physical device with an on–off switch. In the magical conditions, the experimenter announced that she would put a spell on the box and whispered some magic words. An attractive postage stamp was given to children as a present. On "verbal" trials participants were asked to state whether they thought that the box would actually transform the stamp. On "nonverbal" trials children were asked if they would willingly let the experimenter place the stamp in the box and press the switch. On the verbal trials, 9-year-olds responded similarly in both conditions, with the majority endorsing the efficacy of the event. However on the nonverbal trials, children more often refused to let the experimenter put the stamp in the box in the magical condition than in the scientific condition. In Studies 2 and 3, Subbotsky used a similar procedure with adults and found that skepticism toward magic was more apparent in verbal judgments than in behavior.

According to Subbotsky (1993), verbal judgments start out based on magic, but gradually come to be replaced by more scientific ways of thinking, reflecting the knowledge children acquire from their culture. He proposes that, as children get older, they become aware that, when reporting their beliefs verbally, especially to adults, a more mature worldview is valued. When they are left alone, their fantastical or magical beliefs manifest themselves, because they are free of these societal expectations. Yet magical thinking remains a part of an individual's cognitive repertoire and appears in behavior when an appropriate facilitative stimulus is encountered.

Bouldin and Pratt (2001) also used both verbal and behavioral measures to address children's ability to differentiate fantasy and reality. Four- to

7-year-old children were brought into a room containing a small tent. While in the room children were asked to help the experimenter write a story about "a monster that lives in a cave, a bit like that tent over there" (p. 104). Then, a few minutes later a silhouette of a monster was projected onto the tent. Children's verbal and behavioral responses to the silhouette were recorded. Results revealed that, for a significant number of children, whereas verbal responses indicated skepticism about the monster's existence, behavioral responses suggested that children believed that the monster had materialized in the tent. That is, these children responded physically when the silhouette was projected, and either looked intermittently at the tent during the experimental session or refused to enter it. Bouldin and Pratt interpret their findings as providing support for Subbotsky's theory that different sets of beliefs are reflected in verbal and nonverbal responses.

Conservation and Mathematical Equivalence

Goldin-Meadow and colleagues (see Goldin-Meadow et al., 1993 for a review of this literature) have identified dissociations between children's knowledge as expressed in verbal explanations of their solutions and the gestures that accompany these explanations. Church and Goldin-Meadow (1986) found that children who failed traditional Piagetian conservation tasks often showed awareness of the principles of conservation in their gestures. For example, a child who gives the traditional nonconserving response that one container has more water might indicate verbally that she is unaware of the fact that the two containers differ in width. She might, for example, explain her decision by referring to the height of the containers alone. However, in her gestures, she might indicate, by cupping her hands in different ways, her awareness that one of the containers is wider than the other.

Perry et al. (1988) found similar dissociations in children's understanding of mathematical equivalence. Their research showed that, when asked to solve mathematical equivalence problems, such as $3+5+2 = 8 + \underline{\quad}$, children offered a range of answers, including the incorrect answer of 18. Strikingly, these researchers observed many children who, when asked to explain their solutions, verbalized the incorrect strategy, in this case of adding all the numbers together, and yet displayed evidence of the correct strategy in the gestures that accompanied their explanations. For example, while explaining that they added all the numbers together, children cupped their hands under the $3+5$ and then pointed to the 8.

The authors interpreted this behavior as indicating that children were aware, on some level, that the way to solve the problem was to first note the equivalence between the $3+5$ and the 8. This knowledge was only apparent in the gestural modality. Carlson, Wong, Lemke, and Cosser (2005) also find gesture–speech dissociations in children’s understanding of false belief. Here, children performed better on a task in which they conveyed their answers gesturally than on the standard verbal false belief task.

Goldin-Meadow and colleagues have argued that verbal–behavioral dissociations in mathematical reasoning and the other concepts they have studied are evidence of transitional knowledge. Following from this, they proposed that children who displayed mismatches between verbal and gestural responses would be most receptive to new knowledge. Subsequent work confirmed this prediction (Church & Goldin-Meadow, 1986; Goldin-Meadow et al., 1993; Perry et al., 1988). Their research also shows that children who skip the mismatching state in their apparent mastery of the equivalence concept perform less well on tests of the concept (Alibali & Goldin-Meadow, 1993).

A related way of explaining the dissociation between gestural and verbal responses as observed in this research is that they reflect implicit–explicit knowledge representations—with implicit procedures (first appearing in behavior) eventually being “re-described” into consciously accessible knowledge (accessible to verbalizations). According to Karmiloff-Smith (1992), children learn to perform particular tasks before they can understand and talk about what they are doing. With development, implicit knowledge is gradually re-described and becomes more available to all parts of the cognitive system, including the verbal, at which point the knowledge is considered explicit. Importantly Karmiloff-Smith’s (1992) representational redescription model involves not just an implicit-to-explicit knowledge shift but a series of intermediate steps in which knowledge gradually becomes accessible to conscious awareness (see also Pine & Messer, 2003, for an empirical investigation of these steps). This explains how children can perform successfully without a conscious understanding of how they arrived at the correct answer. Full understanding is proposed to have developed when children are also able to talk about what they know.

Garber, Alibali, and Goldin-Meadow (1998) argue, however, that children’s gestures do not reflect fully implicit knowledge. Rather they view gestures as representing “a middle point along a continuum of knowledge states that ranges from the fully implicit

and embedded in problem-solving procedures, to the fully explicit and accessible to verbal report” (p. 82). They presented children with mathematical equivalence problems and recorded their verbal and gestural explanations. They then presented children with a range of possible solutions to the problems and asked them to rate them. They found that children rated solutions that they had conveyed in their own gestures higher than solutions that they had not generated. Thus, the information reflected in gestures is accessible to children and can be used. Yet it is not fully explicit either, as reflected in the fact that the information in gesture does not seem to be accessible to verbal report. The developmental process involves transforming and reencoding the knowledge into a format that is also accessible to speech.

Summarizing, the studies reviewed on fantastical and magical beliefs reveal mature knowledge in verbal responses and less mature ways of thinking in behavior, whereas work on mathematical equivalence shows more mature responses in behavior than in verbalizations. The theoretical explanations of these two types of verbal–behavioral dissociations suggest very different mechanisms. Work on fantasy–reality differentiation suggests that children possess two contradictory belief systems, each equally available to conscious awareness. Subbotsky (1993) proposes that different modalities pull for expression of different belief systems. Research on mathematical equivalence and conservation suggests that, instead, one of those knowledge sets is implicit and not available to conscious awareness. Nonverbal responses appear to allow the expression of nascent knowledge. The theoretical accounts have in common that they both assign special roles to each modality. But are there really specific roles for these two modalities?

Is Modality Critical?

Although these studies are from very different content domains, verbal–behavioral dissociations are common to them all. In an attempt to explore whether these phenomena also share a common mechanism, in the next two sections I explore the roles played by a variety of factors, including context, task difficulty, uncertainty, and children’s goals. I suggest that these often covary with modality and may be at least partly responsible for the different levels of response in the different tasks.

Context

As a whole, research on children’s fantastical thinking reveals advanced levels of understanding

when verbal measures are used and less advanced understanding with behavioral measures (Bourchier & Davis, 2002; Harris et al., 1991; Johnson & Harris, 1994; Subbotsky, 1993). The role of context is illuminated by considering a study by Woolley and Phelps (1994), in which the opposite pattern was observed. These researchers observed dissociations between children's verbal and behavioral responses regarding their understanding of the power of imagination. They asked preschool-age children to imagine objects inside empty boxes, and then to report whether they believed the objects to be inside. Then an unfamiliar experimenter entered the room and expressed a need for the object the child had imagined. Children were instructed to give the experimenter any of the boxes that they thought would help her. Although many young children claimed verbally that the objects they had imagined really existed in the boxes, when asked by another person to hand her any boxes that contained the object, very few children complied. Here, children's behavioral responses appeared to reflect the more mature understanding that imagination does not create reality.

Although Woolley and Phelps's (1994) research can be interpreted as evidence for the modality of the response being critical, that the modality findings are opposite to others in this domain suggests that other factors may be more important. The authors propose that children perceived the situation in which the unfamiliar adult asked them for the object as a practical situation that required a mature response. In contrast, when children were simply asked about the object in the context of an "imagination game," they felt free to entertain possibilities for which they may have lacked complete confidence. Woolley and Phelps also discuss how, in the verbal context, children may have perceived little cost to entertaining the belief that imagination could create reality and potential benefit (i.e., finding the object in the box). However, when another adult needed their help, children perceived a cost of acting based on such fantastical thoughts (i.e., doing something that would be unhelpful to an adult). Thus, they argue, although the more mature knowledge is present, certain contexts encourage or discourage its expression.

A closer look at Harris et al.'s (1991) studies suggests a similar conclusion. Although children's initial verbal responses were that the imagined entities were just pretend, when they were later asked to explain their exploration of the boxes, many children reported that they had in fact wondered whether something might be in the boxes. Thus Harris et al. state, "although it is tempting to argue that the paradox turns on the difference between what chil-

dren say and what they do . . . it falls short of a full explanation" (p. 120). Harris et al. instead explain their findings in terms of availability theory. They suggest that when children imagine an object, the mental image is readily available to them. This then increases its subjective likelihood, in other words, how likely the child is to think the object or entity really exists, causing children to consider the possibility that there might really be a creature in the box. This view is also not inconsistent with Subbotsky's (1993, 1994) position, in that the nature of verbal questioning itself could be argued to create a certain context in which more mature knowledge is activated. Thus, at least with regard to this body of work, it may be the context in which the response is requested, and not the modality, that is critical.

Task Difficulty

However, context differences cannot account for dissociations in work on mathematical equivalence and conservation, as both responses are given simultaneously. Here, three aspects of task difficulty may be important in understanding the role of modality. One is cognitive load. Regarding the work on mathematical equivalence and conservation, Goldin-Meadow and colleagues argue that the modality is a critical aspect of the dissociations they observe; they suggest that the spatial nature of the problem lends itself more easily to gestures than the more linear language modality (see also Carlson et al., 2005). According to Goldin-Meadow (1997), because "gestures are mimetic and analog rather than discrete," gesture allows the learner to represent ideas that "lend themselves to these formats and are not yet developed enough to be encoded in speech" (p. 142). Church (1999) similarly argues that whereas the gestural mode uses a "spatial-holistic" system, the verbal modality uses a linguistic system, and that different representations are distributed over the different modalities. Church (1999) suggests that entertaining multiple representations taxes cognitive load, and children may reduce this load by "externalizing" one of their representations, for example, by expressing it gesturally. This is not necessarily incompatible with a modality-neutral position. It is possible that the nature of the problem may affect the need to externalize one or the other representation. One could argue that verbal tasks are more likely to put children under a high load, which causes them to fall back on an earlier level of understanding in their verbalizations. Although it may be the case that verbal tasks do this more often, it is possible to argue that a behavioral task could also place a heavy load

on children, were it constructed in the right way. In that scenario, perhaps the verbal response would index the more sophisticated knowledge.

A second aspect of task difficulty to consider is the amount of planning involved in the response. Clements and Perner (1994) found that, when children's eye movements were observed during a traditional false belief task, they looked to the correct location but verbally responded with the incorrect location. Clements and Perner took these findings to be evidence of the same kind of dissociation as found in the gesture–speech mismatch studies. However, more recently, Garnham and Perner (2001) devised a different behavioral measure to assess the possibility of an implicit understanding of false belief. In this task, a character put a toy in a box that was located at the end of a slide. Then he went up some stairs that led to a platform from which two slides could be accessed. While he was gone, another character surreptitiously moved the toy to a box near the bottom of the other slide. In one condition, children were asked verbally which slide the first character would come down to get his toy, and in the other they were asked to move a mat under one of the slides so the character would have a soft landing. The correct response was the slide that the character thought (falsely) was the right one, not the one that really was the right one. With this task, they found that correct responding appeared earlier in children's spontaneous and immediate mat moving than it normally does in their verbal responses, supporting the idea that there are unique roles of verbal and behavioral responses. However, in a second study, children were first asked where they planned to put the mat. In this study, children's prompted mat-moving responses were similar to their verbal ones. That is, early understanding was apparent in spontaneous mat moving but not in prompted mat moving. This suggests that the important difference might be whether the response is planned or spontaneous, rather than whether it is verbal or behavioral, with early understanding showing up in unplanned or spontaneous behaviors (e.g., eye gaze, spontaneous gestures, spontaneous mat moving) but not in planned behaviors (e.g., planned mat moving, box exploration). One might predict that if children in the mathematical equivalence studies were asked explicitly to show with their gestures what they were thinking, more planning might be involved, which would lead to less evidence of early understanding appearing in the gestures.

A third aspect of task difficulty is the level of conflict in the questions that children are asked. Munakata and Yerys (2001) argue that there is no

special relevance of the verbal–behavioral distinction. This study was in response to work by Zelazo and colleagues (Frye, Zelazo, & Burack, 1998; Zelazo & Frye, 1998; Zelazo et al., 1996, 2003), who show that children will often verbally report a new rule for playing a game (e.g., put the things with the same shape together), but still play the game according to an old rule (e.g., put the things with the same color together). Zelazo and colleagues interpret these patterns as evidence of a dissociation between knowledge, as expressed verbally, and action. Munakata and Yerys (2001) presented 3-year-olds with a card-sorting task similar to that used in Zelazo et al. (1996). They argue that Zelazo et al.'s finding of a verbal–behavioral dissociation reflects the behavioral task being more difficult than the verbal knowledge task. Specifically, the behavioral task (e.g., children must shift from placing a blue truck with blue things to placing the blue truck with trucks) contained inherent conflict whereas the verbal question (e.g., "Where do trucks go?") did not. Thus, they modified the verbal knowledge task so that it was equated for level of conflict with the behavioral task (e.g., "Where do blue trucks go?"). Results showed that children responded similarly on the verbal knowledge and the behavioral tasks. Munakata and colleagues argue that different responses reflect gradations of knowledge—a weaker representation may have allowed children to succeed on tasks in which there was no conflict, whereas a stronger representation was needed to succeed under conflicting, and hence more difficult, conditions. Importantly, the modality is not important; a strong representation of a rule may enable children both to perform the correct behavior in response to a task and to answer a difficult question about the task (see also Munakata, 2001).

Uncertainty

The third issue to consider is the role of cognitive uncertainty. It is conceivable that if one is uncertain about something, different answers will appear in different modalities (Acredolo & O'Connor, 1991). Yet there is no clear reason to suppose that greater certainty is tied to a particular modality. Acredolo and O'Connor predict that uncertainties will manifest themselves in behavior in specific ways, for example, by attuning our perceptual systems to information that could potentially resolve those inconsistencies. This might explain the pattern obtained by Clements and Perner (1994). Children's eye movements to particular locations might reflect uncertain hypotheses about where the character would

go or look, whereas the verbal responses might reflect certain judgments. Yet Clements and Perner deny that uncertainty explains their data. They argue that if this were the case, children would have also looked toward the incorrect location at least half of the time, which they did not. This explanation works for the hypothetical case in which a child is perhaps equally uncertain about both alternatives. However, it seems possible that a child who is just beginning to entertain the correct hypothesis might glance quickly at the correct location before responding incorrectly to the experimenter's question.

Research by Ruffman, Garnham, Import, and Connolly (2001) indicates that eye movements in Clements and Perner's (1994) tasks may not reflect uncertain hypotheses. Using a similar false belief task to that used by Clements and Perner, children had to predict which slide a character would go down. Eye movements were monitored. In addition, along with their verbal response, children "bet" counters next to what they thought was the correct slide, and were told that they would receive a prize for the highest number of counters. The expectation was that if children's eye movements reflected uncertain hypotheses then they would at least bet some counters on the location at which they looked. If, alternatively, children lacked awareness of the correct location, no counters would be bet. Results were that younger children who failed the verbal task did not bet on the location that was indicated by their eye movements, suggesting a lack of awareness of this knowledge. They also conclude, however, that "the transition to explicit knowledge is marked by striking lack of confidence" (p. 213) and that "children's awareness of false belief seems to coexist with lingering uncertainty" (p. 218). Often children who answered verbally with the correct location still bet a significant number of counters on the incorrect location. One caveat to bear in mind, however, is that these interpretations rest upon the effectiveness of the betting measure for indexing certainty. It will be important to assess its validity and reliability in future research.

In summary, a close examination of studies in which verbal–behavioral dissociations are found suggests that the following three factors may contribute to verbal–behavioral dissociations: (1) *Context*. Certain contexts activate certain types of representations. A verbal (or behavioral) task that encourages fantastical thinking will facilitate a fantastical response whereas a verbal (or behavioral) task that calls for practical reasoning will encourage a more mature response. (2) *Task difficulty*. Three facets of task difficulty were discussed. Verbal tasks

that have been used in most of the studies reviewed may place higher loads on children, resulting in dissociations in which greater knowledge is revealed in behavior. Additionally, responses that involve planning may reveal less mature knowledge. Finally, the difficulty of the questions used in the tasks may be a critically important factor to consider in interpreting apparent dissociations. (3) *Level of uncertainty* may also generate modality differences. It is hoped that attention to the factors identified here can help address whether there indeed is a unique role for each of these modalities in cognitive development and learning.

Role of Goals in Dissociations

The final factor I will consider is the role of children's goals. A focus on the goals children use to formulate their responses may also help explain why behavioral and verbal responses function differently in these studies. Sophian (1997) discusses how potential mismatches between a child's goals and those of the experimenter have been used to explain differences between children's supposed competence on a task and their actual performance. She develops this idea further by proposing that children's goals with regard to certain concepts change with age, and that changing goals foster different kinds of learning at different ages. Thus, children's eventual mastery of a difficult concept can be attributed, at least in part, to forming new goals about the concept. Extending this to the present topic, there are important differences across the studies reviewed in what can be considered the goal of the two types of response. In what follows, I suggest that, in certain studies, the verbal response is goal driven whereas the behavioral response may not be. I also propose that in other studies, although both the verbal and behavioral responses appear to be goal driven, they may be driven by different goals. In both of these situations, the possibility of two different responses (i.e., a verbal–behavioral dissociation) is high, even if there appears to be only one experimental question.

In work on mathematical equivalence and conservation, the verbal response is an explanation of a solution to a problem. The goal of children's verbal response is to convey knowledge about their thought processes to the experimenter. The behavioral response is an involuntary accompaniment to the verbal explanation. In Clements and Perner's (1994) false belief studies, the goal of the verbal response is also to convey knowledge. As with the mathematical equivalence studies, the behavioral response is automatic and unintentional. In both sets of studies,

verbalizations lag behind behavior, presumably because making the underlying concept or thought process accessible to conscious awareness requires an additional step. This view predicts that, were one to change the goal of the verbal response, a higher level of knowledge might be revealed. For example, if children were asked to talk aloud to themselves while they solved mathematical equivalence problems, the goal of the verbal response would no longer be to convey knowledge to another person. This way, the requirement of making knowledge accessible to someone else, which presumably requires some attention, would be eliminated. This freeing up of attention might result in the child's verbalizations revealing a more sophisticated level of knowledge.

In the two sets of studies just discussed, it appears that behavioral responses primarily capture knowledge that is inaccessible to awareness, and thus not consciously motivated by a particular goal. Yet more mature knowledge also appears in behavior when both the behavioral and the verbal responses are goal directed. In both Woolley and Phelps's (1994) study of children's understanding of imagination, and Garnham and Perner's (2001) study of false belief understanding, more mature knowledge was similarly expressed in behavior. Yet although the goal of the verbal response was to convey knowledge, the behavioral response in these studies was intentional. Despite the very different content domains and methods of these two sets of studies, it seems plausible to conclude that, in both cases, children's behavioral goal was to help someone. Focusing on this goal may have activated a more sophisticated level of knowledge than was apparent in children's verbal reports. As with the first set of studies, conveying knowledge to an experimenter may require resources that may not be necessary in performing an action like moving a mat or handing someone a box. Alternatively, perhaps there is an emotional component to helping someone that facilitates access to this knowledge.

Additional insight into the role of children's goals comes from studies in which the more sophisticated answer appears in verbalizations. In Harris et al.'s (1991) imagination tasks, children are clear in their initial verbal response that imagination does not create reality. The same is true in Subbotsky's (1993) studies of beliefs in magical processes. Here, as with the false belief studies and the gesture–speech mismatch studies, the goal of the verbal response is to convey knowledge to the experimenter. But what is the goal of children's behavior, which appears to indicate that they believe that imagination does in-

deed create reality or that magic boxes really work? Unlike in mathematical equivalence studies, their behavior is not an involuntary accompaniment to the verbal response. Like in Woolley and Phelps's (1994) research, it is an intentional planned action. Because of this, one must also consider what other goals, aside from conveying knowledge, might guide children's responses. Children's goals might be to gather new knowledge or to test a tentative hypothesis. Either of these could result in behavior that reveals different levels of knowledge and/or beliefs than that revealed through verbal questioning.

One must also consider why the goal of conveying knowledge to another would interfere with accessing knowledge in one situation (e.g., as in the mathematical equivalence studies) but produce more mature responses in another (e.g., as in studies of magical beliefs). This is likely to be a function of the domain of study, and the type of knowledge being probed. For example, Alibali and Goldin-Meadow discuss gesture–speech mismatches found in work by Goodman, Church, and Shonert (1991, cited in Alibali & Goldin-Meadow, 1993) on children's moral reasoning. They suggest that because moral reasoning is more socially and culturally bound than is mathematical equivalence, advanced reasoning may appear in speech before it appears in gesture. Subbotsky (1993) makes a similar argument in explaining verbal–behavioral dissociations in magical beliefs. He suggests that children are aware of the scientific worldview possessed by most adults, and recognize that, when discussing such matters, this worldview is valued over a magical one. Yet when left to their own devices, children feel freed of these expectations and behave in accord with a more magical view of the world.

Another key difference between the studies on imagination and magic and the mathematical equivalence studies concerns the effects of emotion on children's goals. In Harris et al.'s (1991) studies, children may have been motivated by curiosity to explore the boxes. Children may have been excited about the possibility of finding a cute rabbit that they could play with. In Subbotsky's studies, children may have been excited about the possibilities that the magic box potentially offered. In both of these sets of studies, a simple desire to continue a fun experience may have motivated actions. One must give serious consideration thus to the possibility that the behavioral responses in these tasks may have been motivated by an emotional reaction rather than, or possibility in addition to, the child's belief. As Harris (2000) discusses, when children are in a fictional situation, their standard response will be to engage

with the material as if it were real. Because of this, various emotions will be generated, such as curiosity and fear. These emotions lead to certain behaviors, such as exploration and avoidance. That children engage in such behaviors, Harris argues, does not indicate that they cannot tell that the situation is fictional. They can tell, but this information is not necessarily fed back into the appraisal system. The ability to integrate knowledge of reality status into the appraisal system develops with age, but can be disrupted even in adults, such as when one has an emotional reaction to a scary movie. Thus, when behavioral responses appear to reflect less mature ways of thinking, one must consider the potential role played by emotion. Fear may redirect a child's attention away from conveying knowledge and toward self-protection; excitement may redirect attention from conveying knowledge to continuing a fun pretend game. Thus, in these situations, behavior may be driven by emotion, whereas knowledge or belief may motivate the verbal response.

Tasks requiring verbal versus behavioral responses may also differ in terms of how they direct children to the experimenter's intended goal. Research by Byrd, van der Veen, McNamara, and Berg (2004) on children's planning indicates that differences in social context may result in dissociations between verbal and behavioral responses. Researchers administered a computerized version of the Tower of Hanoi task to 3- to 5-year-old children. In the "manual" condition, to make their moves, children touched a ball on the computer screen and dragged it, with their finger, to the desired location. In the "spoken" condition children simply told the experimenter what move they wanted to make. Children performed better on the verbal task. The authors suggest that asking the children to tell the experimenter how they wanted to move may have changed the "social-instructional context of the task," making it more like an educational interaction and thus encouraging children to focus on the goal (p. 444). In contrast, they speculate, when children made the move themselves, it may have seemed more to them like a solitary play situation, freeing them to explore the task rather than to focus on the goal. This pattern seems quite similar to that observed in the Harris et al. (2001) and Subotsky (1993, 1994) studies.

Thus a critical factor in making sense of these findings may be whether the verbal and behavioral responses are being produced with the same goal. In some cases, behavioral responses may not be motivated by wanting to arrive at or convey the correct answer. Performance on these tasks may instead tell us more about what children want or what they feel.

If the goal is other than to convey knowledge, it is less certain that the two measures reflect different levels of knowledge of a concept. Instead, these dissociations may reflect two different processes. As Harris (2000) proposes, one might reflect children's conceptual knowledge and the other an appraisal of emotional implications. In other cases, though, a child's focus on a different goal (e.g., helping someone) may actually facilitate access to knowledge. Identifying how children's goals are related to their responses is an important task for future research.

In summary, although it appears at initial inspection that modality is critical, patterns are inconsistent. Sometimes more mature knowledge appears in speech and at other times in behavior. Thus, other factors may be important to take into consideration in explaining and understanding verbal–behavioral dissociations. The goals children form in an experimental session may play a role in the types of answers they generate. A number of factors, including context and emotion, appear to affect the goals children formulate in response to various tasks. Even after children have formulated goals and interpreted the problem accordingly, other factors may affect how their knowledge or beliefs are expressed and, specifically, whether different measures reveal different types or levels of understanding. Certainty and task difficulty may contribute to dissociations. When the behavioral response is generated as an unconscious accompaniment to a verbal response, as in the mathematical equivalence, conservation, and eye fixation false belief studies, it may be more likely that the modality is indeed critical, with implicit knowledge appearing in behavior. However, there are also alternative explanations for these dissociations. Dienes and Perner (1999) suggest that the looking time results in Clements and Perner (1994), for example, may not really index an implicit understanding of belief, but rather expectations children have based on behavioral regularities. Children may have looked to the correct location not because they possessed implicit knowledge about belief, but because they knew that people usually go where they left things. When both responses are conscious and planned, verbal and behavioral responses may differ, but these differences may not be tied to modality but rather to children's goals and to factors that affect children's goals.

The Nature of Knowledge: Transitional Knowledge Versus Contradictory Beliefs

This review raises the issue of whether it makes sense to try to determine the precise age at which a

child knows something. Although many developmental researchers do focus on issues of process and mechanism in cognitive change (e.g., Alibali & Goldin-Meadow, 1993; Church & Goldin-Meadow, 1986; Siegler, 1996; Thelen & Smith, 1994), as Karmiloff-Smith (1992) states, "one only has to glance at the developmental literature to notice that a sizable number of researchers are absorbed in the ages at which children reach cognitive milestones" (p. 27). The research reviewed in this paper underscores the fact that there are often multiple levels of knowledge or multiple (and sometimes conflicting) beliefs within a given child about a particular concept, and that different measures may access different levels of knowledge or different beliefs. But the concepts of transitional knowledge and multiple belief systems are themselves perplexing. Can a child really, at the same time, both possess knowledge that the equal sign indicates equivalence and think that it means to add all the numbers? Can a child both understand that beliefs can be false and think that all beliefs are true? Can a child both believe in magic and disavow it? One way to begin answering these questions is to consider the similarities and differences between being in a transitional knowledge state and holding contradictory beliefs.

Transitional knowledge can be thought of in (at least) two distinct ways (see also Siegler, 2000, for an expanded discussion of the ways in which learning takes place). In one view, transitional knowledge is incomplete knowledge or partial knowledge; some component of the full knowledge is missing. With this view, the receptivity to instruction shown by children in transitional knowledge states is due to the teacher supplying a missing piece of knowledge. Alternatively, transitional knowledge can be conceived of as full knowledge, but knowledge that is inflexible and of limited generalizability. Thus children can use this knowledge in some situations but not in others. With this view, the receptivity to instruction would reflect the teacher creating a context in which this knowledge is activated and its use facilitated. The latter model of transitional knowledge may have much in common with a model of contradictory belief systems, similar to that proposed by Subbotsky (1993). Here, context would set up particular goals, which would then motivate a particular response.

Cotrell, Winer, and Smith (1996) offer some insight into how it may be possible for individuals to hold contradictory beliefs. They studied the phenomenon of people sensing that other people are staring at them. Both adults and children reported that they were able to feel other peoples' stares, even when

they were unable to see them. These reports were most common in the oldest participants tested, and were evident despite participants' claims that they do not believe anything emanates from the eye during vision. The authors suggest that peoples' beliefs that it is not possible to feel stares are grounded in logic, whereas their intuitions that they can sense this when it happens to them are grounded in emotion. The implication is that being "grounded" in different systems allows these contrasting beliefs to coexist. It may also simply be that contradictory belief systems are both "grounded" in logic but logics of different sorts. For example, with regard to children's understanding of illness, researchers have found that folk-theory explanations of illness (e.g., one catches a cold from going outside without a coat) and biological theories (e.g., germs cause colds) often coexist in children and adults (Nguyen & Rosengren, 2004). Likewise, some researchers suggest that children may hold contradictory beliefs about gender; they may display both gender-stereotyped and gender-egalitarian beliefs at the same time (Gelman, Taylor, & Nguyen, 2004). According to Acredolo and O'Connor (1991), people "often entertain contradictory notions" . . . and the resultant "uncertainties are prevalent and prolonged" (p. 219).

Wilson, Lindsey, and Schooler (2000) suggest that people often have two different attitudes about the same object. As they explain, one attitude may be implicit and activated automatically, whereas the other may be an explicit attitude that is apparent in certain contexts. For example, someone might acquire an implicit racial stereotype by growing up in a racist family, but also hold a new explicit nonracist attitude formed later in adulthood. According to Wilson et al., the new attitude does not necessarily replace the old one; the two may coexist. Harris (2000) also addresses how people might hold dual attitudes or beliefs about magic and fantasy. According to Harris, people "construct a semi-permeable boundary" between conflicting beliefs (p. 173). Harris suggests that children might be more open-minded than adults and thus construct what he refers to as half-beliefs: they "adopt a more open-minded attitude, half wondering whether—or even hoping that—magic might be on offer" (p. 73). In considering how holding contradictory beliefs might differ from being in a transitional knowledge state, one obvious focal point is the simple fact that the term "transitional" implies that one is going somewhere, presumably from the incorrect representation to the correct one. One could also, of course, be transitional from one belief system to another, but in many cases these belief systems coexist for long

periods of time (Nguyen & Rosengren, 2004; Subbotsky, 1993).

It is possible thus that there are similarities in terms of how transitional knowledge and contradictory beliefs are represented, but differences in the mechanisms that operate on them. With transitional knowledge, the primary mechanisms may be one of attending to and resolving inconsistencies. For example, a child who is made aware of the content in her gestures may recognize that they convey something different from her speech. This alone may promote change, or it may make the child more receptive to instruction (see Church, 1999, for a discussion of mechanisms promoting cognitive change). In contrast, with coexisting belief systems, the mechanisms may serve to isolate the belief systems in order to preserve harmony. With regard to children's magical beliefs, many of these beliefs appear to violate a basic understanding of how the world works. For example, in Subbotsky's studies, children seem to think that one physical object can turn into another. In work by Bloom and DeLoache (2005) children seem to think that a machine can turn a picture of an object into a real object. What does it mean for children's naïve theories that they so willingly appear to disregard foundational knowledge? Perhaps it means that these theories are more fragile than researchers have thought. Alternatively, perhaps rather than disregarding them, children simply set them aside temporarily. A suggestion proposed by Woolley, Phelps, Davis, and Mandell (1999), with regard to children's beliefs in wishing, is that magical beliefs are quarantined from beliefs about the real world. According to Woolley et al., children never think of wishing as an ordinary act of the mind; if they did it would threaten their basic beliefs about mind–world relations. Instead, children know from the beginning that wishing is a magical process and mark it as so, hence understanding that it obeys a different set of rules. This allows children to believe in magical phenomena without disruption to their developing theories about how the world works.

In summary, an examination of the similarities and differences between transitional knowledge and contradictory beliefs may inform understanding of knowledge representation. If one conceives of transitional knowledge as knowledge that is limited in its use, then there are potential similarities with contradictory beliefs. Development may consist in the ability to recognize when a situation calls for application of particular knowledge or beliefs. Two potential explanations for the existence of conflicting beliefs are as follows: (1) one belief may be grounded in emotion and the other in cognition, and (2) the beliefs may be

components of different theoretical systems. Finally, transitional knowledge and contradictory beliefs may differ in terms of the types of mechanisms that operate on them, with the former involving attention to inconsistency and the latter potentially involving suppression of such information.

Capitalizing on Dissociations in Research

How should development psychologists proceed on this issue? I will offer three suggestions. The first is that developmental researchers should use multiple measures of children's beliefs and knowledge. This will facilitate obtaining a complete picture of how knowledge develops. In employing both verbal and behavioral measures, developmental researchers must also be cognizant of the context in which the response is solicited, the types of emotions that might be generated by the task, and the possibility that the child's goal may differ from that of the experimenter. Ideally researchers should more often also include measures of certainty in their studies.

This sort of multimethod approach should not be confined to areas in which verbal–behavioral dissociations have already been found. According to Siegler (1996, 2000), dissociation is the norm rather than the exception. If this is true then dissociations should be revealed in numerous content domains, not just in the limited set reviewed here. In many areas of development, research is often inspired by an observation of behavior. For example, Harris et al.'s (1991) research was inspired in part by the question of why children often act afraid of monsters. A likely answer was that they believe that they are real. Yet, although children in their studies did indeed act as if imagined monsters were real, their verbal responses revealed a clear understanding that they were not. This then enabled Harris (2000) to probe other explanations for why children often act afraid of monsters, such as the possibility that there are separate cognitive and emotional appraisal systems. Similar explorations may prove fruitful regarding questions of social development as well. For example, a sensible answer to the question of why young children engage in sex-typed toy play is that their gender stereotypes about the toys are guiding their engagement with the toys. Yet verbal tasks have indicated a lack of awareness of these stereotypes (e.g., Campbell, Shirley, & Candy, 2004; Levy, 1999; Weinraub et al., 1984). It would seem sensible to conclude that stereotype knowledge is not guiding such engagements. Alternatively, however, researchers would benefit from designing nonverbal

measures of these stereotypes, which could potentially reveal different levels of knowledge. Researchers should also consider what children's goals might be in these verbal tasks, and whether they are the same goals held by the experimenter.

Related to the issue of stereotype knowledge, it also seems very likely that children, like adults, hold both implicit and explicit gender and racial attitudes, which may appear as verbal-behavioral dissociations. One study by Skowronski and Lawrence (2001) probed both explicit and implicit gender attitudes in fifth graders and college students. The results for the children are somewhat ambiguous, in that the two implicit attitude measures (latency and error rate) produced different patterns in the data and were not correlated. However, there is a suggestion of a dissociation in that children showed a pro-female preference on explicit measures, whereas the latency measures on the implicit attitude tests indicated no preference. A recent study on children's racial attitudes also indicates that such dissociations are present in children. Rutland, Cameron, Milne, and McGeorge (2005) found that 6- to 16-year-old children who showed in-group bias on implicit measures suppressed that bias on explicit measures of racial and national attitudes.

The second suggestion concerns the role of uncertainty in conceptual development. Beginning with Piaget's (1985) concept of disequilibrium, many researchers have endorsed the idea that development results from the existence of conflicts or contradictions in children's thought processes. Presumably, the existence of such conflicts motivates children to reconcile them (Chapman & McBride, 1992). According to Acredolo and O'Connor (1991), children experience uncertainty about conflicting ideas. This uncertainty motivates children to seek information that will help them evaluate which idea is better. Importantly, children should be expected to exist in such uncertain states much of the time. However, researchers' focus on only one sort of task, behavioral or verbal, contributes to the false impression that such uncertain states are rare or transitory. Ideally, researchers would focus more on identifying these states of uncertainty. However this is difficult, as uncertainty is often hard to detect, especially in young children. Acredolo and O'Connor argue that neither consistency across trials, resistance to counter-suggestion, nor claims to certainty are reliable indices of certainty (p. 207). Thus a clear task for developmental researchers is to develop better measures for assessing the existence of multiple beliefs or knowledge sets in children and the associated certainty that children attach to these beliefs. Work

by Ruffman et al. (2001) represents one promising approach to assessing certainty.

The third suggestion concerns a proposal put forth by Schwitzgebel (1999, 2001). According to Schwitzgebel, developmental psychologists need to pay more attention to the idea of in-between belief. He proposes a dispositional model of belief, based on Ryle (1949, cited in Schwitzgebel), in which all beliefs or states of knowledge have a set of dispositions that we normally associate with the belief. For example, as he states, borrowing from Ryle, a person with a belief that "the ice is dangerously thin" would have the following dispositions, among others: to tell others that the ice is thin, to skate warily, and to imagine falling through the ice, etc. (Schwitzgebel, p. 81). Schwitzgebel argues that in-between belief, which may be another way of referring to transitional knowledge, consists in a person having some but not all of the dispositions that we would normally associate with a particular belief.

Schwitzgebel's (1999, 2001) view is in opposition to a competence explanation of dissociations, in which the knowledge is said to be present but not expressed due to task demands or even inaccessibility to consciousness. His view would also seem to be in contrast to a view in which the knowledge is there but it is "selected" to be used sometimes and not always. With Schwitzgebel's model, one doesn't ask the question of whether knowledge is there or not there. One would not conclude, for example, that a child does or does not understand mathematical equivalence or that imagination cannot create reality. Rather, one would try to document the conditions in which children are disposed to indicate verbally that one adds the numbers on both sides of the equal sign, and the conditions in which children have the disposition to gesture accordingly. Researchers might differentiate children who both show the disposition to say that imagination does not create reality and show the disposition to not hand the experimenter any boxes from children who show just one of these dispositions, or none. Importantly, the primary goal would not be to say which children "know" that imagination does not create reality and which children don't, but rather to document the (many) steps to belief formation or understanding.

The main argument, in line with that put forth by Siegler (1996, 2000), is that developmental researchers should focus less on identifying the precise age at which children have a particular concept. The question of whether children have this or that concept should not be thought of as a yes or no question. Instead researchers need to focus on the types of situations or contexts that promote children to

display various “dispositions” or that interfere with their expression. Siegler has used microgenetic methods to identify the various strategies children may hold at any given time, primarily with regard to mathematical concepts (e.g., Siegler, 1995; Siegler & Stern, 1998). From this review, it should be apparent that this way of thinking about development should be extended far beyond strategy change, as some have begun to do (see, e.g., Adolf, 1997; Amsterlaw & Wellman, in press; Chen & Klahr, 1999). Just as a child learns when it is appropriate to activate one strategy and when to activate another, children may learn, for example, when to act upon and when to verbalize their beliefs in magic.

In addition, researchers should refrain from considering one type of response, verbal or behavioral, as more revealing, more precise, or more “true.” Often other aspects of the situation may be responsible for different responses, and researchers should attempt to chart these. Such aspects that should receive more attention include (1) the different goals children formulate in a given task, and that they bring to concept learning more generally, (2) the role of emotion in experimental settings and in concept formation, and (3) the effects of various contexts or social settings on children’s responses. Similarly, rather than attempting to determine whether implicit or explicit measures of attitudes or beliefs reveal a participant’s “true” attitude, researchers need to assess both types of attitudes and chart the factors that affect their expression.

Conclusion

The studies reviewed herein, although diverse in content, share a common phenomenon—conflict between what is revealed verbally and behaviorally. Despite this, it does not appear that these modality differences are tied to one mechanism that underlies all these patterns. Instead a variety of factors, including context, task difficulty, uncertainty, and children’s goals and emotions, can all lead to different answers being produced in different modalities.

The analyses presented in this paper suggest that dissociations in the developmental literature may fall into (at least) two classes: (1) those that reflect a transition from implicit to explicit knowledge (e.g., as in research on mathematical equivalence), and (2) those that reflect coexisting beliefs or levels of knowledge (e.g., as in research on magical beliefs). With the first type of dissociation, in the studies reviewed, knowledge often appears first in behavior; however task difficulty, the amount of planning in-

involved in the response, and children’s goals can affect this. With the second type, mature knowledge should not be expected to appear first in one modality or the other; this should depend on context, certainty, emotion, and goals. Both sorts of dissociation may be present in certain domains (e.g., as shown in Ruffman et al.’s, 2001, work on false belief). As suggested earlier, mechanisms operating on these two types of representational systems may be very different. Identifying a diverse set of domains in which dissociations occur, and exploring their similarities and differences, has the potential to illuminate how knowledge is represented and used. There may, for example, be important similarities between how children’s fantasy beliefs and their racial attitudes are represented. In both cases, children appear to hold conflicting beliefs, with one set more often accessed in contexts that encourage awareness of societal proscriptions.

In concluding I echo the positions of others (Acredolo & O’Connor, 1991; Karmiloff-Smith, 1992; Schwitzgebel, 1999; Siegler, 1996, 2000) that the goal of developmental psychology should not be to answer the “Does a child know this or doesn’t s/he?” question, but to understand the nature of children’s representations and the mechanisms by which these change. To do this, researchers need to document the contexts or situations in which children display various behaviors or verbally respond in ways that are characteristic of conceptual knowledge. Yet neither verbal measures nor behavioral measures consistently offer a “direct line” to children’s knowledge. Verbal measures can often be subject to biases and expectations about what constitutes an appropriate answer. Behavioral measures can reflect emotional responses or other goals rather than cognitions. Researchers need to pay more attention to why children respond incorrectly when they do. Instead of concluding that a child “lacks knowledge” of a concept, we may need to say that she “was less certain of this idea and more certain of that one,” that she “found it easier to apply that strategy in this context,” or discuss how the child’s goals may have been directing her attention differently. In doing so, although we will often fail to provide the precise age estimates that many demand of us, we will produce a much richer picture of development.

References

- Acredolo, C., & O’Connor, J. (1991). On the difficulty of detecting cognitive uncertainty. *Human Development, 34*, 204–223.

- Adolf, K. E. (1997). Learning in the development of infant location. *Monographs of the Society for Research in Child Development*, 62, 1–139.
- Alibali, M. W., & Goldin-Meadow, S. (1993). Gesture–speech mismatch and mechanisms of learning: What the hands reveal about the child’s state of mind. *Psychological Review*, 100, 279–297.
- Bloom, M., & DeLoache, J. (October, 2005). Children’s acceptance of impossible physical transformations. In M. Bloom & J. DeLoache (Co-Chairs), “Hey kid, wanna buy the Brooklyn Bridge? Children’s acceptance and rejection of information offered by adults.” Symposium held at the 4th Biennial Meeting of the *Cognitive Development Society*, San Diego, CA.
- Bloom, P., & German, T. (2000). Two reasons to abandon the false belief task as a test of theory of mind. *Cognition*, 77, 25–31.
- Bouldin, P., & Pratt, C. (2001). The ability of children with imaginary companions to differentiate between fantasy and reality. *British Journal of Developmental Psychology*, 19, 99–114.
- Bourchier, A., & Davis, A. (2002). Children’s understanding of the pretense–reality distinction: A review of current theory and evidence. *Developmental Science*, 5, 397–426.
- Bridgeman, B., Peery, S., & Anand, S. (1997). Interaction of cognitive and sensorimotor maps of visual space. *Perception and Psychophysics*, 59, 456–469.
- Byrd, D. L., van der Veen, T. K., McNamara, J. P. H., & Berg, K. (2004). Preschoolers don’t practice what they preach: Preschoolers’ planning performances with manual and spoken response requirements. *Journal of Cognition and Development*, 5, 427–449.
- Campbell, A., Shirley, L., & Candy, J. (2004). A longitudinal study of gender-related cognition and behavior. *Developmental Science*, 7, 1–9.
- Carlson, S. M., Wong, A., Lemke, M., & Cosser, C. (2005). Gesture as a window on children’s beginning understanding of false belief. *Child Development*, 76, 73–86.
- Chapman, M., & McBride, M. (1992). The education of reason: Cognitive conflict and its role in intellectual development. In C. U. Shantz & W. W. Hartup (Eds.), *Conflict in child and adolescent development* (pp. 36–39). Cambridge, UK: Cambridge University Press.
- Chen, Z., & Klahr, D. (1999). All other things being equal: Children’s acquisition of the Control of Variables Strategy. *Child Development*, 70, 1098–1122.
- Church, R. B. (1999). Using gesture and speech to capture transitions in learning. *Cognitive Development*, 14, 313–342.
- Church, R. B., & Goldin-Meadow, S. (1986). The mismatch between gesture and speech as an index of transitional knowledge. *Cognition*, 23, 43–71.
- Clements, W. A., & Perner, J. (1994). Implicit understanding of belief. *Cognitive Development*, 9, 377–397.
- Cotrell, J. E., Winer, G. A., & Smith, M. C. (1996). Beliefs of children and adults about feeling stares of unseen others. *Developmental Psychology*, 32, 50–61.
- Dienes, Z., & Perner, J. (1999). A theory of implicit and explicit knowledge. *Behavioral and Brain Sciences*, 22, 735–808.
- Frye, D., Zelazo, P. D., & Burack, J. A. (1998). Cognitive complexity and control: Theory of mind in typical and atypical development. *Current Directions in Psychological Science*, 7, 116–122.
- Garber, P., Alibali, M. W., & Goldin-Meadow, S. (1998). Knowledge conveyed in gesture is not tied to the hands. *Child Development*, 69, 75–84.
- Garnham, W. A., & Perner, J. (2001). Actions really do speak louder than words—but only implicitly: Young children’s understanding of false belief in action. *British Journal of Developmental Psychology*, 19, 413–432.
- Gelman, S., Taylor, M. G., & Nguyen, S. P. (2004). Mother–child conversations about gender. *Monographs of the Society for Research in Child Development*, 69, 1–126.
- Goldin-Meadow, S. (1997). When gestures and words speak differently. *Current Directions in Psychological Science*, 6, 138–143.
- Goldin-Meadow, S., Alibali, M. W., & Church, R. B. (1993). Transitions in concept acquisition: Using the hand to read the mind. *Psychological Review*, 100, 279–297.
- Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: Attitudes, self-esteem, and stereotypes. *Psychological Review*, 102, 4–27.
- Harris, P. L. (2000). *The work of the imagination*. Oxford, UK: Blackwell.
- Harris, P. L., Brown, E., Marriot, C., Whittall, S., & Harmer, S. (1991). Monsters, ghosts, and witches: Testing the limits of the fantasy–reality distinction in young children. *British Journal of Developmental Psychology*, 9, 105–123.
- Johnson, C., & Harris, P. L. (1994). Magic: Special but not excluded. *British Journal of Developmental Psychology*, 12, 35–51.
- Karmiloff-Smith, A. (1992). *Beyond modularity*. Cambridge, MA: MIT Press.
- Levy, G. D. (1999). Gender-typed and non-gender-typed category awareness in toddlers. *Sex Roles*, 41, 851–873.
- Munakata, Y. (2001). Graded representations in behavioral dissociations. *Trends in Cognitive Sciences*, 5, 309–315.
- Munakata, Y., & Yerys, B. E. (2001). All together now: When dissociations between knowledge and action disappear. *Psychological Science*, 12, 335–337.
- Nguyen, S. P., & Rosengren, K. S. (2004). Causal reasoning about illness: A comparison between European- and Vietnamese-American children. *Journal of Cognition and Culture*, 4, 51–78.
- Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, 84, 231–359.
- Perry, M., Church, R. B., & Goldin-Meadow, S. (1988). Transitional knowledge in the acquisition of concepts. *Cognitive Development*, 3, 359–400.
- Piaget, J. (1985). *The equilibration of cognitive structures: The central problem of intellectual development*. Chicago: University of Chicago Press.

- Pine, K., & Messer, D. (2003). The development of representations as children learn about balancing. *British Journal of Developmental Psychology, 21*, 285–301.
- Ruffman, T., Garnham, W., Import, A., & Connolly, D. (2001). Does eye gaze indicate implicit knowledge of false belief? Charting transitions in knowledge. *Journal of Experimental Psychology, 80*, 201–224.
- Rutland, A., Cameron, L., Milne, A., & McGeorge, P. (2005). Social norms and self-presentation: Children's implicit and explicit intergroup attitudes. *Child Development, 75*, 451–466.
- Schwitzgebel, E. (1999). Gradual belief change in children. *Human Development, 42*, 283–296.
- Schwitzgebel, E. (2001). In-between believing. *The Philosophical Quarterly, 51*, 76–82.
- Siegal, M., Varley, R., & Want, S. C. (2001). Mind over grammar: Reasoning in aphasia and development. *Trends in Cognitive Sciences, 5*, 296–301.
- Siegler, R. S. (1995). How does change occur: A microgenetic study of number conservation. *Cognitive Psychology, 29*, 225–273.
- Siegler, R. S. (1996). *Emerging minds: The process of change in children's thinking*. Oxford, UK: Oxford University Press.
- Siegler, R. S. (2000). The rebirth of children's learning. *Child Development, 71*, 26–35.
- Siegler, R. S., & Stern, E. (1998). A microgenetic analysis of conscious and unconscious strategy discoveries. *Journal of Experimental Psychology: General, 127*, 377–397.
- Skowronski, J. J., & Lawrence, M. A. (2001). A comparative study of the implicit and explicit gender attitudes of children and college students. *Psychology of Women Quarterly, 25*, 155–165.
- Sophian, C. (1997). Competence models of numerical development. *Cognitive Development, 12*, 281–303.
- Subbotsky, E. V. (1993). *Foundations of the mind: Children's understanding of reality*. Cambridge, MA: Harvard University Press.
- Subbotsky, E. V. (1994). Early rationality and magical thinking in preschoolers: Space and time. *British Journal of Developmental Psychology, 12*, 97–108.
- Subbotsky, E. V. (2001). Causal explanations of events by children and adults: Can alternative causal models co-exist in one mind? *British Journal of Developmental Psychology, 19*, 23–46.
- Thelen, E., & Smith, L. B. (1994). *A dynamic systems approach to the development of cognition and action*. Cambridge, MA: MIT Press.
- Weinraub, M., Clements, L. P., Sockloff, A., Ethridge, T. E., Gracely, D., & Myers, B. (1984). The development of sex role stereotypes in the third year: Relationships to gender labeling, gender identity, sex-typed toy preference and family characteristics. *Child Development, 55*, 1493–1503.
- Wellman, H. M., & Amsterlaw, J. (2006). Theories of mind in transition: A microgenetic study of the development of false belief understanding. *Journal of Cognition and Development, 7*(2), 139–172.
- Wilson, T. D., Lindsey, S., & Schooler, T. Y. (2000). A model of dual attitudes. *Psychological Review, 107*, 101–126.
- Woolley, J. D., & Phelps, K. E. (1994). Young children's practical reasoning about imagination. *British Journal of Developmental Psychology, 12*, 53–67.
- Woolley, J. D., Phelps, K. E., Davis, D. L., & Mandell, D. J. (1999). Where theories of mind meet magic: The development of children's beliefs about wishing. *Child Development, 70*, 571–587.
- Zelazo, P. D., & Frye, D. (1998). Cognitive complexity and control: The development of executive function. *Current Directions in Psychological Science, 7*, 121–126.
- Zelazo, P. D., Frye, D., & Rapus, T. (1996). An age-related dissociation between knowing rules and using them. *Cognitive Development, 11*, 37–63.
- Zelazo, P. D., Müller, U., Frye, D., & Marcovitch, S. (2003). The development of executive function. *Monographs of the Society for Research in Child Development, 68*, 1–138.