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9 Children's Definitions of "Learning" and "Teaching"

Chapter 8 introduced our focus on children's definitions of abstract concepts to provide insight into their development and looked at children's definitions of "science." We found rapid growth in these definitions over the late preschool and early elementary-school period, particularly between the ages of 6 and 8, similar to our investigations of children's diagnostic reasoning abilities (chapter 5) and their understanding of disagreement (see chapter 7). We also found that the younger children we investigated (3- to 6-year-olds) tended to see only certain kinds of questions or activities as scientific and to provide specific topics or actions in response to our open-ended definition question. By contrast, older children (7- to 11-year-olds) and adults accepted a wider range of questions and activities as being scientific, and their definitions included more references to learning and knowledge change.

This chapter focuses on a related set of questions: how children define the concepts of "learning" and "teaching." Analyzing how children talk about these concepts might help us understand how they learn and teach. Moreover, because many children (and most adults) used the concept of learning in their definitions of "science," we can use these investigations to gain greater insight into how they think about the kind of learning activities that might be involved in doing science. Much like our studies on how children conceptualize "science," here we examine the relation between children's appreciation of the intensions of lexical items and their extensions. Specifically, we examine how children define "learning" and "teaching," and we relate those definitions to the inferences that children make about whether someone is learning or teaching.

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"What Is Learning?"

Much research in developmental and educational psychology is devoted to describing not only what children learn, but also, more importantly, *how* children learn. Given the importance of this topic, it is interesting that only a handful of studies have examined children's explicit understanding of learning. Most of this work comes from research in formal learning environments, where it has long been thought that children's understanding of learning might affect their engagement with learning and relate to their academic achievement (Dweck, 2006; Dweck & Leggett, 1988; Eccles et al., 1998; Li, 2004; Skinner, 1995; Stipek & Mac Iver, 1989). But this work has tended to focus on adolescents' developing identities as learners (e.g., Burden, 1998; Randi, 2009; Rubin, 2007), and does not often consider how preschool-age children or even early elementary-school children understand this concept.

To examine this issue, our work (Sobel & Letourneau, 2015) ran a parallel study to the one on children's understanding of science described in chapter 8: We asked 4- to 10-year-olds, "What do you think learning means?" We coded children's responses to this question into three mutually exclusive categories. In Identity responses, children simply defined "learning" as learning. In Content responses, children defined "learning" based on subjects or topics (e.g., "like reading and math"). In Process responses, children defined "learning" as related either to a source (e.g., "when your teacher tells you something") or to a strategy (e.g., "when you practice again and again until you know it") that would result in knowledge change (see figure 9.1).

One of the clearest trends in this study is that children's process-based definitions increased with age. This provides an intriguing parallel with the "what is science" interview described in chapter 8, whereby children became increasingly more likely to define "science" as an active process, specifically a process of learning or knowledge change, between the ages of 6 and 8.

This parallel could be taken to show that the ability to generate process-based definitions of abstract concepts is domain-general. Children's ability to talk about "science" and about "learning" as an active process could reflect a broader aspect of their language development or of their ability to use metacognitive language. However, this is not necessarily the case; as we will see later, children's talk about other abstract concepts like "teaching" and "play" does not follow this same specific developmental trend.

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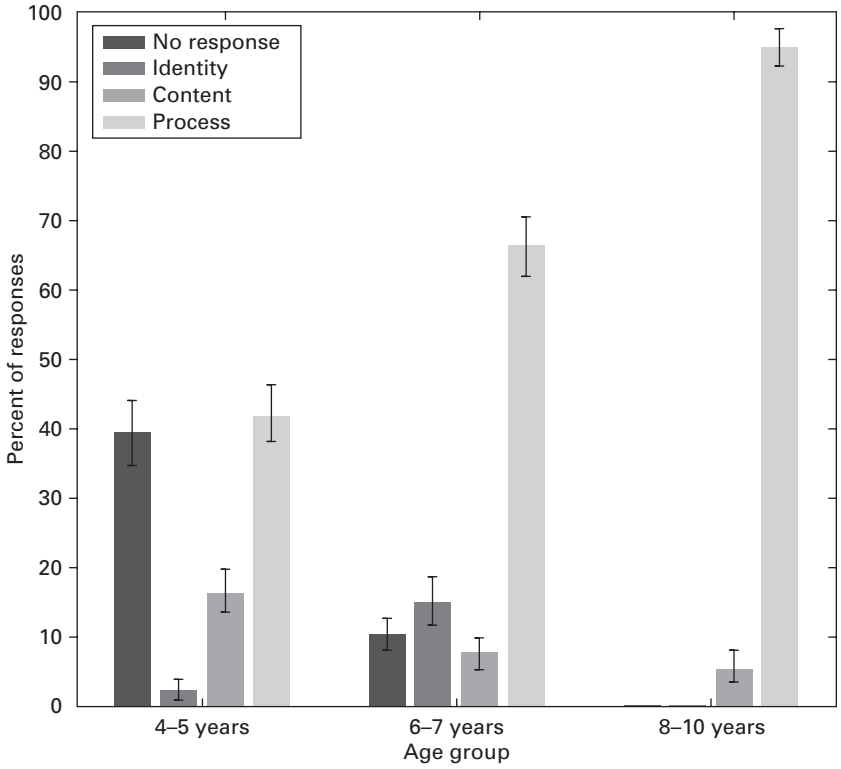

Figure 9.1
How children defined "learning" across age groups.

In addition to asking children to define "learning," in this study, we also asked children to generate examples of what they had learned (e.g., "Can you think of something that you have learned?") and how they had learned in each example (e.g., "How did you learn that?"). We also asked children whether they could think of other ways of learning (i.e., "How else could you learn?"). These questions were repeated several times so that children could generate multiple examples. We compared children's answers to these questions to their definitions in order to gain a deeper understanding of how children conceptualized learning.

We found some connections between children's definitions and the examples they provided. If children generated a process-based definition of "learning," they were also more likely to give an example in which they learned a skill (e.g., "how to tie my shoes") or a fact (e.g., "ants have six legs"). In

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contrast, children who did not generate process-based definitions often simply did not respond to this question. Children who generated a process-based definition of "learning" were additionally more likely to describe a source (e.g., "I learned it from my teacher") or a strategy (e.g., "I read it in a book") through which they acquired knowledge. These children were also more likely to generate multiple different strategies for learning. Critically, all of the relations just described held regardless of age. That is, children's definitions of "learning" independently predicted how well children were able to reflect on their own learning abilities. Even some 4-year-olds conceptualized learning as a process, and those children seemed to have better access to process-based details about their own learning than children who defined "learning" as a type of content.

Children's Understanding of When Learning Happens

In general, children develop a concept of learning based on their understanding of other mental states, like knowledge and ignorance. Because learning involves changes to knowledge states (e.g., replacing ignorance with knowledge or updating one belief with another), children's understanding of knowledge, ignorance, and beliefs can all influence their concepts of learning. This claim draws on past literature on the development of theory of mind. Research in theory of mind is rarely described as being about learning, but it can be understood as investigating children's developing abilities to understand knowledge and knowledge change. For example, 3-year-olds use the word "know" in conversations to reflect their own epistemic states (Bartsch & Wellman, 1995; Shatz et al., 1983; Taumoepeau & Ruffman, 2008) and spontaneously use different phrases to distinguish between their own knowledge and ignorance (Harris et al., 2017).

Between the ages of 3 and 5, children come to recognize the distinction between others' knowledge and ignorance (e.g., Hogrefe et al., 1986). They also begin to explicitly understand that beliefs represent one's ideas about the world, which are not necessarily the same as reality (e.g., Gopnik & Astington, 1988; Perner, 1991; Perner et al., 1987; Wellman et al., 2001; Wimmer & Perner, 1983). Children at this age also appreciate some information about the sources of false beliefs, such as that they can arise from different sources of information (Flavell et al., 1992). Although not typically thought of in this way, research on children's theory of mind addresses their understanding

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of learning in its focus on the distinction between having and not having knowledge about particular situations. The preschool years are a time of significant development in the ability to track and reason about others' epistemic states (Wellman & Liu, 2004). The preschool years are also when children's use of words like "learn" and "teach" begins to emerge, as shown by an examination of a corpus of children's natural conversations (Bartsch et al., 2003). In a replication of this analysis, which focused only on utterances that were spontaneously generated by the child, we found that references to learning processes increase between the ages of 3 and 5 (Sobel, Li & Corriveau, 2007).

Although these data suggest that children's understanding of learning in general emerges during the preschool years, this understanding demonstrates an interesting asymmetry: Children seem better able to understand others' learning than their own. That is, preschool-age children have not yet developed the metacognitive capacities to reflect accurately on their own thought processes, and they tend to misunderstand how thinking works (e.g., Flavell et al., 1993, 1995), which might prevent them from fully understanding their own learning (e.g., Klahr & Dunbar, 1988; Kuhn, 1989; Kuhn & Dean, 2004). For instance, preschoolers think that they knew pieces of novel information all along, even when they just learned them (e.g., Esbensen et al., 1997; Taylor et al., 1994). Similarly, 6-year-olds overestimate others' ability to learn (Miller et al., 2003). So while 4-year-olds might understand *that* their knowledge changes, it is not until around age 5 or 6 that they can track and articulate *how* they know their knowledge changes (Gopnik & Graf, 1988; Gopnik & Slaughter, 1991). These results suggest that the metacognitive awareness that is required for understanding one's own learning might develop later in preschool and during the early elementary-school years.

However, children do have some understanding of their own learning at these ages, specifically with respect to *source memory*: the ability to recall from where one learned information. Bemis et al. (2011) asked 4- to 9-year-olds questions they were likely to be able to answer. These children were then asked to describe how they had learned that piece of information. Even the youngest children in their sample could generate some information about how they had learned, although there was significant age-related change (i.e., older children could generate more information).

Bemis et al. (2013) followed up on this finding by teaching 4- and 5-year-olds novel facts and then examining whether those children could

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articulate how they had learned that knowledge. Again, even the youngest children they tested were able to state how they had learned the new facts. Tang and Bartsch (2012; see also Tang et al., 2007) similarly showed 4- to 5-year-olds information either using a visual demonstration or through direct instruction. One week later, these children could accurately report whether they had been shown or told the information, although they could not report that this was done a week prior.

To add to these studies of children's understanding of learning, we investigated the connections among learning and different mental states (Sobel, Li & Corriveau, 2007). We found that preschoolers judge whether learning takes place primarily based on whether an individual wants to learn something, regardless of that individual's other mental states, such as their attention to necessary information. We presented 4- to 6-year-olds with two child characters who were in a similar learning environment (e.g., a teacher was teaching the characters to sing a song at school). The mental states of these two characters were potentially in conflict with their learning goals. One character wanted to learn but did not pay attention to the teacher. The other character did not want to learn but did pay attention to the teacher. When asked whether each character learned, 4-year-olds mostly responded based on the character's desires; they judged that characters who wanted to learn did so while characters who did not want to learn did not. Six-year-olds, in contrast, reported that paying attention or practice was also necessary for learning. Children's understanding of the relations among mental states involved in learning thus continues to develop past the preschool years.

In support of that conclusion, in another study, we asked whether children were sensitive to the type of the knowledge being acquired. Specifically, we wanted to investigate whether children understood the difference between learning a fact and learning a skill, especially with respect to the role of intentional action in the learning process. Facts can have deterministic truth-values and are either known or not known at a given point in time. This means that learning a fact involves changing one's mental state from ignorance to knowledge (or from belief A to belief B). Skills, in contrast, are more scalar. One gets better at a certain skill with practice, but performance may vary and can be subject to chance. This means that learning a skill involves a continual process of improving, and knowledge of a skill is rarely deterministic. Similarly, most facts are insensitive to the agency of

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the learner or teacher; whether you hear a fact on purpose or by accident, you can still learn that fact. In contrast, skill learning is usually intentional; accidental actions that result in a successful demonstration do not show that one has truly learned a skill.

To test whether children understand these contrasts, we (Lai et al., unpublished data, described in Sobel et al., 2016) told a group of sixty-four 4- to 7-year-olds (31 girls, 33 boys; mean age = 71.90 months; age range 50–96 months) stories about a character who wanted to learn either a fact (the location of a teddy bear) or a skill (how to throw a basketball through a hoop). The character then engaged in an action with the intention to either learn (i.e., intentionally looked in a closet or aimed at the basketball hoop) or not (i.e., opened the closet accidentally or accidentally threw the ball in the air). These actions resulted in either a successful or an unsuccessful outcome (i.e., the bear was in the closet or not; the ball landed in the basket or not). After hearing each story, children were asked whether the character had learned the fact (where the bear was) or the skill (how to throw the ball into the basket).

Table 9.1 shows children's responses to the fact and skill questions, depending on the intention of the character and on whether the character's actions resulted in a successful outcome. What is clear from the table is that children made judgments based mostly on the outcome of the action. When the outcome was positive, children tended to say that the character learned, regardless of the other manipulations (91% vs. 18% overall). But there is an

Table 9.1
Children's responses to whether the character had learned a fact or a skill based on whether they intended to learn and they observed the outcome, taken from Lai et al. (unpublished data)

Type of knowledge	Intention	Outcome	Percent of children who said character learned
Fact	Positive	Positive	88 (33)
Fact	Positive	Negative	20 (41)
Fact	Negative	Positive	86 (35)
Fact	Negative	Negative	19 (39)
Skill	Positive	Positive	97 (18)
Skill	Positive	Negative	20 (41)
Skill	Negative	Positive	94 (24)
Skill	Negative	Negative	11 (31)

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additional intuition that we wanted to capture with these data. In the fact condition, reasoning on the basis of the outcome is unsurprising. Characters who find the bear have learned where it is, regardless of how they found it or whether they wanted to find it. In the skill condition, however, the intention is relevant; happy accidents do not necessarily indicate learning. This would predict a significant three-way interaction among the type of question (fact vs. skill), the intention of the character, and the outcome of the action, which is what we found.[1] This can be seen by looking at the last row in table 9.1, where the intention and outcome are both negative for the skill question. Children's rates of saying that the character learned in this condition (11%) are lower than the cases where the outcome is negative for the fact question as well as the case where the intention is positive but the outcome is negative for the skill question (an average of 20%).

A general focus on outcomes in learning might be warranted, because acting on the world is an important mechanism for learning in early childhood. In support of this argument, as reviewed in chapter 4, children are more systematic in their exploration when it has the potential to reveal new information (Cook et al., 2001; Schulz & Bonawitz, 2007; Sobel & Sommerville, 2010). And when we translated research on causal reasoning to informal learning environments, we saw that children who generated more systematic exploratory behaviors during their play at an exhibit were more likely to score higher on measures of causal reasoning about the exhibit (Callanan, Legare, Sobel, et al., 2020, as described in chapter 3).

Because actions are so important for learning in early childhood, children might struggle to understand the nuances of the relation between learning and action. To investigate this issue further, we asked whether 3- to 5-year-olds have an explicit understanding of how actions can lead to subsequent learning (Sobel & Letourneau, 2018). We told preschoolers stories about characters learning about novel toys. In one set of stories, the character learned how the toy worked by acting on it. In the other set, the character learned how the toy worked by being told. Children were asked to recall how the characters had learned through a series of open-ended responses. Before the age of 4, children overemphasized the role of action, stating that the character learned by playing with the toy, regardless of condition. That is, the children in this study overweighted the character's actions as being important for learning, much as they overweight their own actions when they themselves learn.

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We further examined children's understanding of the relation between action and learning by testing how they think about the difference between claims about what others have learned and whether those individuals actually learned (Sobel, 2015; previously described in chapter 1). In this study, we showed preschoolers vignettes about children in a school who were playing with puzzles. Some of the children claimed they knew how to solve the puzzles, while others did not make this claim. A teacher then asked the children to solve the puzzles. Some of these children succeeded and some failed. Children were then asked whether each character had learned to solve the puzzle. When the character's claims were in accord, as when a character who claimed to know how to solve the puzzle actually did so, children had no trouble stating that the character had learned (or had not learned) how to solve the puzzles. But when the claim and the demonstrative ability were in conflict, children struggled with answering the questions; they said that the character had learned about half of the time. Critically, what seemed to predict children's understanding was their performance on a standard false belief task. If children passed the false belief task, they were more likely to use the character's demonstrative actions as the basis for their response. These children seemed to understand that claims about knowledge could be false, and that the judgment of whether someone had learned something was based on whether they could demonstrate that they had the knowledge.

These results, however, are more about the development of children's understanding of the role of belief in learning; children's understanding of the interrelation between learning and other mental states continues to develop past the preschool years. As noted above, 6-year-old children judge that characters who are paying attention or who have the intention to learn will be more likely to learn than characters who are not or who do not, while 4-year-olds misunderstand these relations. This holds true in children's own learning as well: When the results of an action are identical, understanding that another person generated the action for the purpose of getting others to learn leads to better learning than not having such a rationale (Sobel & Sommerville, 2009). Nevertheless, it appears that children come to this more mature understanding of what learning is and how it works in early elementary school, not in preschool.

Taken together, the results described in this section begin to suggest a developmental trajectory regarding children's understanding of learning. Early on,

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learning is embedded in action and intention. If you want to learn something, you learn it; if you do it, you learn it. Learning as a mental state might be conflated with action (perhaps specifically goal-directed action). However, over the course of the preschool years, children begin to appreciate the difference between learning and other mental states. This developmental trajectory has strong parallels to children's understanding of science, described in chapter 8. For both concepts, there seems to be a marked shift around age 6 where children move past an outcomes-focused or actions-focused conception and toward a more sophisticated understanding of the role of mental states and knowledge change for both learning and science.

As an example, consider the difference between knowledge and beliefs about one's knowledge. One either knows something or not (particularly for factual knowledge), but one's belief about one's knowledge is not the same as possessing the knowledge itself. One can know something and know that one knows it, or similarly, not know something and know that one is ignorant. These concordant cases seem trivial; the more interesting ones are when knowledge and belief about that knowledge are in conflict. One can believe one knows something (particularly about how to do something or about how something works), but be revealed to be ignorant or to have overestimated one's knowledge (such as in the case of the "illusion of explanatory depth"; see Rozenblit & Keil, 2002). But one can also believe oneself ignorant, but actually possess the knowledge all along, such as in the plot of many mystery stories. More relevant to children's lives, there are many situations where young children might initially think themselves incapable of performing an action that adults know they can actually do, and encouragement and guidance ("scaffolding"; see Mermelshtine, 2017) can lead them to realize their abilities.

Children's Understanding of the Relations between Learning and Play

So far, our discussion has centered on children's understanding of learning generally construed. In this section, we want to expand this discussion to one aspect of learning that we have not considered yet: learning through play.

For many years, play has been thought to be critical to children's healthy social and cognitive development (e.g., Pellegrini & Boyd, 1993; Rubin et al., 1983; Saracho & Spodek, 1998; Smith & Vollstedt, 1985). Play provides children with the opportunity to develop social skills, emotional regulation

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abilities, prosocial behavior, and empathy (e.g., Coplan & Arbeau, 2009; Ginsburg et al., 2007; Lester & Russell, 2010). Play also supports learning, particularly collaborative or guided play with adults (Hirsh-Pasek et al., 2009; Mayer, 2004; Weisberg et al., 2016). Play is a way that children learn, and this has been a focus for early childhood education.

Yet learning and play are often conceptualized as mutually exclusive by young children (see e.g., Shirilla et al., 2019). Children think that play reflects their autonomy, because they can choose to do what they want. Learning, in contrast, involves mandatory activities. Similarly, children think play is fun and enjoyable while learning is serious and dull. Play is also inherently social, even if one sometimes plays alone. Learning, however, is a mostly solitary endeavor (see Beisser et al., 2013; Howard et al., 2006; Karrby, 1990; Keating et al., 2000; King & Howard, 2014; Robson, 1993; Rothlein & Brett, 1987). Indeed, in the study where we asked to children to report on ways that they learned (Sobel & Letourneau, 2015), no child ever mentioned that they learned through play. The closest we ever saw children refer to this idea was in a corpus analysis of children's natural speech, which we used as the title for one of our papers: "They danced around in my head and I learned them" (Sobel, Li & Corriveau, 2007).

But these studies might not capture the extent to which children conceptualize learning through play, or play in general. In particular, many of the studies on the relation between play and learning present children with stimuli (photos or vignettes) and ask children to categorize whether the individuals under discussion are playing or learning (or whether they are playing or working). That forced-choice question does not allow for a third response, which is that individuals may be both learning and playing.

To look at whether children conceptualize play and learning in similar ways, we first wanted to have children define and reflect on "playing," much in the same way that they defined and reflected on "science" and "learning" in our previous interviews. We[2] asked 70 children between the ages of 4 and 10 (33 girls, 37 boys; mean age=83.04 months; age range 48–131 months) to define "playing."

We coded how children responded to this question into five categories (see figure 9.2). Similar to when children were asked to define "learning," they also sometimes generated Identity responses to the question of what playing is (e.g., "Playing is when you play"). Children also sometimes generated Content responses that focused on the kinds of things that happen in

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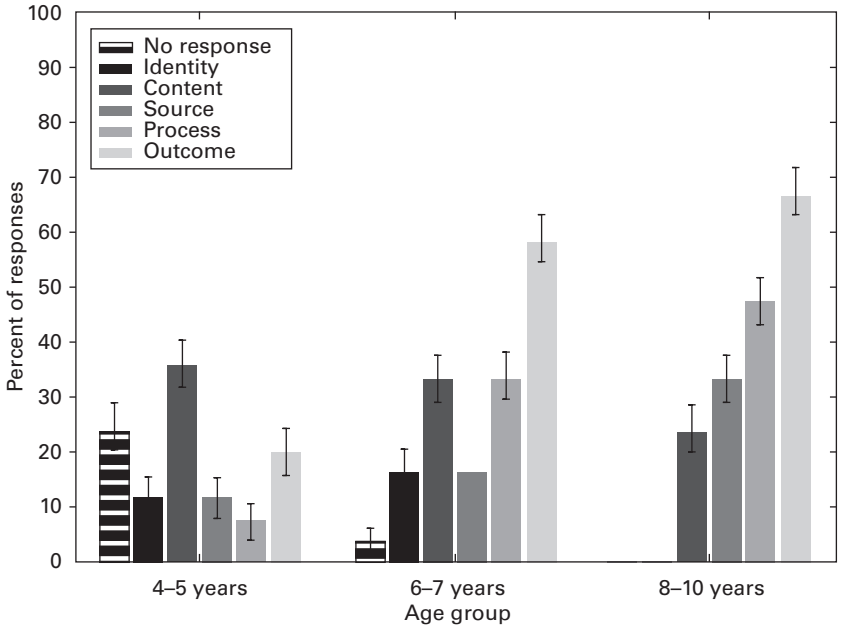

Figure 9.2
Percentage of children who generated definitions of "playing" in each category.

play (e.g., "Using your toys and playing games"). They also talked about who they played with (e.g., "Hanging out with your friends," coded as Source), how they played (e.g., "chasing each other," "building things," "pretending," coded as Process), and the result of playing ("having fun" or "being happy," coded as Outcome). Much like in the learning interviews, we combined these last three responses together, because they all indicated a more process-based understanding of what play is and how it works. As children got older, they were more likely to generate these kinds of definitions, even when controlling for the length of their responses.

Children were then asked to provide examples of things that they had played before and of how they engaged in that play. Children provided between 1 and 8 examples of play ($M = 3.47$, $SD = 1.59$). Each example was categorized using one of six mutually exclusive codes: (1) Physical Activity, including sports, playground activities, outdoor games (like tag), and unstructured activities (like climbing or running); (2) Structured Indoor Activities, including board games, card games, video games, educational games, puzzles,

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and mazes; (3) Creative Activities, including construction activities, drawing, arts and crafts, and building with blocks or LEGO; (4) Pretense, including role play and other pretense activities that specifically involved object representation; (5) Functional Object Play, including playing with toys, dolls, or pretense that involved giving toy objects specific functions, like pretending to cook with toy pots and pans; and (6) No Content, such as simply mentioning play with another person (e.g. "I play with grandma"). Finally, we also coded all of the examples as being either *solitary*, in which children do not mention other people in their example or specifically state they were alone, or *social*, in which the example involves other people.

Overall, we found that children generated examples of physical activities and of structured indoor activities most frequently. Children generated examples of solitary play and social play with the same frequency: 73% of the children generated at least one example of solitary play and 83% of the children generated at least one example of social play, not a significant difference.[3] There were relatively few reliable effects of age or gender. In terms of age, as children got older, they talked less about functional object play (such as playing with dolls or other toys).[4] Additionally, older children were more likely to generate examples of social play.[5] But generating an example of solitary play did not correlate with age.[6] In terms of gender, girls talked more about pretend play than boys.[7] But there were no other differences between boys and girls. Finally, we considered the relation between the ways in which children defined "play" and the examples of play they generated. Unlike the relation between children's definitions of "learning" and their reflections of how they learned, there were no relations between children's definitions of "playing" and what they did during play or how they played.[8]

There is one other interesting null result here. Before we started interviewing children about play, we thought about how we would code the data. One of the codes that we thought about, a priori, was academic or proto-academic activities (like counting). We thought children might generate some examples of playing that happened at school or that involved learning. But they didn't, so we did not even consider this variable.

This study—much like the studies where children are asked to categorize events as either learning or play—showed that young children can reflect on their own play. But children in these studies did not seem to relate play with learning (or vice versa), despite the great importance placed on this relation from educational and psychological researchers. However, it is

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possible that we discouraged children from talking about learning through play because we did not mention anything about learning in these interviews. Much like the forced-choice method, then, we might have underestimated the extent to which children recognize that playing can lead to learning or that learning can occur while playing.

To address this possibility, in more recent work, we asked 5- to 8-year-olds to define both "learning" and "play," using these same interview methods (Letourneau & Sobel, 2020). We chose this narrower age range because children's definitions of both "learning" and "play" tended to change during this time, moving from describing particular topics or activities to more process-based definitions, which we took to reflect the emergence of a more metacognitive ability to reflect on the nature of these activities. Asking children about both learning and playing allowed us to directly compare how children talked about each and whether the developmental trajectory of children's definitions of these concepts was similar or different.

In this study, children's process-based definitions of "play" emerged earlier than their process-based definitions of "learning" (see figure 9.3). This provides evidence that children's ability to reflect on different activities (like play and learning) does not emerge in a domain-general way. That is, children describe the process of how play works for them differently from how they do so for learning—and also differently from how they do so for teaching, as we will see in the next section.

We did two other things in this interview. First, we asked children whether they could give examples of cases where they were playing and learning at the same time, and why those activities were both playing and learning. Second, we asked half the children to provide instances of playing that had features that were congruent with play, for example, times when playing was fun, chosen by the child who was playing, or not done with adults. These children were also asked to provide instances of learning that had features that were congruent with learning, for example, times when learning was done in a serious manner, or when learning was guided by an adult or not freely chosen. The other half of the children were asked to provide instances of playing that had features congruent with learning and instances of learning that had features congruent with playing.

We found that children were able to generate at least some instances of playing and learning at the same time in response to the first prompt. Some of the examples were based in physical activities, such as, "When I was doing ice

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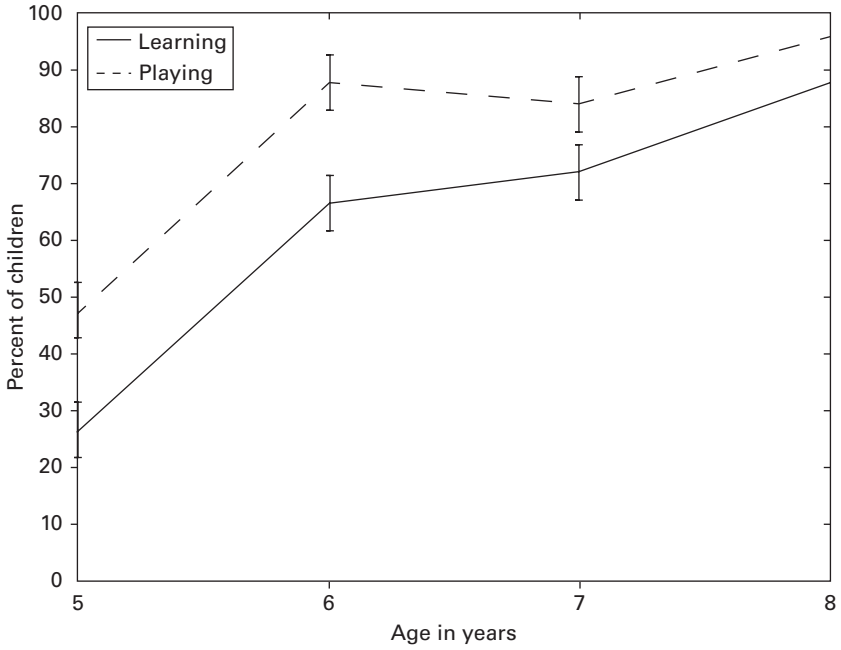

Figure 9.3
Percentage of children who generated process-based definitions of "learning" and "play" across the four age groups in Letourneau and Sobel (2020).

skating I was playing on the ice and I was learning how to skate" (age 7 years, 4 months). Other examples involved children realizing only later that they were engaged in both activities: "When I was in my classroom. I was playing school with my friend and we were actually doing real math" (age 6 years, 10 months). Finally, some of them were based in learning about what one was playing (or what one was playing with): "Well once I was playing with my new American Girl doll and I was reading the tag and it told me to not brush her hair and it taught me how to make her hair curly and keep it curly" (age 8 years, 11 months). Similarly, "Maybe when I first learned how to solve a Rubik's cube, I went on a computer, and I was playing around with it, and I wasn't able to solve a color, and then I went on the internet and I got interested in it and then I solved . . . I tried solving it and I looked it up on the internet and I learned how to solve it" (age 8 years, 2 months).

The number of examples children generated of learning and playing at the same time increased with age. This frequency also significantly correlated

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with whether children generated a process-oriented definition of "learning" or "playing." Critically, in an analysis designed to isolate the independent contribution of these factors, we found that whether children generated a process-oriented definition of "learning" was the only factor that uniquely explained how frequently they generated examples of playing and learning at the same time. This seems to indicate that children's understanding of how learning happens allows them to connect play with learning, not their understanding of play itself (see Letourneau & Sobel, 2020, for statistical details).

Similarly, and perhaps unsurprisingly, children were able to generate more examples of learning and playing with congruent features than with incongruent features in response to the second prompt. The number of examples that children generated correlated with whether they had generated a process-oriented definition of "learning" and "play," as well as with their age. Again, when we ran a model to isolate the unique contribution of these factors, only whether children generated a process-based definition of "learning" mattered to their ability to answer these questions (beyond the differences explained by the questions we had asked them). In both cases, age did not predict children's ability to understand that learning and playing can happen at the same time. Again, these results indicate that children must have a process-oriented understanding of learning to appreciate that learning can happen through play. In turn, this suggests that children's development of an understanding of learning as a process involving knowledge change might be a bottleneck in their ability to see that learning and play are related.

"What Is Teaching?"

Teaching is often conceptualized as "causing to learn" (Kastovsky, 1973). This suggests that teaching has a cognitive relation to learning. Children might be aware of this as soon as they use words like "learn" and "teach" in their everyday conversation, which is fairly early in development (as reviewed by Bartsch et al., 2003). Teaching has also been described as a "natural cognitive ability" (Strauss, 2005, p. 368; see also Strauss & Ziv, 2012), in that teaching is a universal and basic form of communication that children learn through everyday social interactions rather than through explicit instruction. Children engage in actions designed to teach at early ages (Ashley & Tomasello,

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1998; Frye & Ziv, 2005; Kruger & Tomasello, 1998), and school-age children often teach others without prompting (e.g., Brown & Palincsar, 1989; Flynn, 2010; Rogoff, 1990).

However, while children can engage in teaching activities, they might not understand that those activities are teaching. Such a metacognitive understanding of how teaching works and of how to make choices about whom to teach seems reliant on an understanding of other mental states. Specifically, a concept of teaching may need to emerge from a concept of learning, much like the concept of learning seems to emerge from a concept of knowledge (e.g., Astington & Pelletier, 1998; Knutsen et al., 2014; Strauss et al., 2002; Wellman & Lagattuta, 2004; Ziv & Frye, 2004; Ziv et al., 2008; although see Davis-Unger & Carlson, 2008, for an alternative view). This would imply that children's understanding of teaching develops after their understanding of learning, because it relies on children's abilities to think about learning and other related mental states, like knowledge or intention.

With respect to the role of intention, in order to understand teaching as "causing to learn," one must recognize that there is usually an agent doing the causing. That is, teaching might not be "causing to learn" as much as it is "*intentionally* causing to learn." Various studies suggest that children come to an understanding of teaching as requiring some kind of intentionality around the age of 5. For example, Strauss et al. (2002) presented children with stories about a character (A) who learned something from watching another person (B), although person B was unaware that A was watching. Three-and-a-half-year-olds judged that B was teaching, while 5.5-year-olds recognized that B was not teaching. The older children understood the intentional nature of teaching, while the younger children simply conceptualized teaching as demonstrating information.

Similarly, teachers teach individuals whom they believe lack knowledge, regardless of whether that is actually true. But for children to appreciate this relation, they must have at least a rudimentary capacity for reasoning about others' false beliefs. To examine this facet of teaching, Ziv et al. (2008) presented 3.5- and 5.5-year-olds with stories in which teachers either had true or false beliefs about students' knowledge states. For example, the teacher might believe that the student did not know something that the student actually did know, or the teacher might believe that the student knew something that the student actually did not know. Five-and-a-half-year-olds predicted whom the teacher would teach based on the teacher's

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belief states, while 3.5-year-olds predicted whom the teacher would teach based on the *learner's* belief. More importantly, age was not the crucial factor here—rather, it was performance on a standard false belief task. That is, children's developing understanding of how knowledge works strongly influenced their developing understanding of how teaching works.

Children's understanding of teaching thus relies on their understanding of belief and knowledge, suggesting that this understanding would show a prolonged developmental trajectory. To investigate this, we (Sobel & Letourneau, 2016) asked 4- to 7-year-olds what "teaching" means, and then asked them to reflect on times they were taught and times when others taught them, using a semi-structured interview similar to the investigations of children's understanding of "learning," "play," and "science" that we have already described.

Much like in those other investigations, children's definitions of "teaching" mostly referred to either Content ("To show kids math and science") or to Process ("Showing somebody how to do something so they know how to do it if somebody else asks them to"), although a small number of children simply said that teaching was learning. We found that process-based definitions increased with age: 4- and 5-year-olds generated them only about 17% of the time, while 6- and 7-year-olds did so about 46% of the time. Critically, the frequency with which children generated process-based definitions of "teaching" lagged well behind children's process-based definitions of "learning." Additionally, children who generated process-based definitions of "teaching" were better able to generate examples of when they were taught and when they taught others, controlling for age and for a measure of language production.

Moreover, after children were asked for examples of times they taught others, they were asked to reflect on how they did so. Children who generated process-based definitions were much more detailed in answering these questions. For example, one child who generated a process-based definition (age 7 years, 6 months) responded: "I teached my brother history." When the experimenter prompted this child to explain, "How do you teach them about history?" they said, "Well, I told them about the world and Abraham Lincoln and George Washington and World War II." Critically, these kinds of answers were typical only of children who generated a process-based definition of "teaching," regardless of their age; children who did not generate such definitions simply failed to respond to this question about 75% of the

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time. These results suggest that, although young children show an intuitive grasp of teaching during their social interactions, they do not really have an explicit understanding of teaching as an intentional action until after the preschool years.

Consistent with this conclusion is the fact that children tended to produce the same kinds of examples of what they had been taught and what they taught others, regardless of whether they had generated a process-based definition of "teaching." Generating a process-based definition of "teaching" thus did not impact whether they understood how to engage in the act of teaching; this only affected children's metacognitive reflections about what teaching is. This result further suggests that there are communicative and situational cues that help children recognize teaching in everyday life, which may also be used when children are thinking of examples of teaching events in response to our interview. The ability to define "teaching" itself as a process that results in knowledge change, however, relies on a different set of cues and cognitive precursors. The act of teaching thus might be a natural form of social interaction, but reflecting on how teaching occurs seems to have a more prolonged developmental trajectory.

More generally, looking at how children's definitions of concepts like "learning," "play," and "teaching" relate to their reflection on these actions provides an interesting parallel to the conclusions we drew about children's understanding of science in chapter 8. Children learn, play, and teach at early ages. Learning, playing, and teaching might all be "natural" and early-emerging aspects of their cognitive development, just as the causal reasoning capacities that they have early in development allow them to engage in rudimentary aspects of scientific thinking. But the ability to explicitly reason about science, learning, playing, and teaching comes later and may involve the kind of metacognitive understanding that we think of as being part of what distinguishes scientific thinking from causal reasoning. While understanding science, learning, playing, and teaching might all have different developmental trajectories, there is a clear distinction between children's ability to perform these actions and to reflect on what these actions mean or how these processes work.

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Constructing Science

Connecting Causal Reasoning to Scientific Thinking in Young Children

By: Deena Skolnick Weisberg, David M. Sobel

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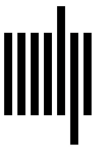

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