Rev.Phil.Psych.
DOI 10.1007/s13164-017-0344-5

Children's Decision to Transmit Information is Guided by their Evaluation of the Nature of that Information

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Abstract Recent findings have shown that children's teaching is guided by their evaluation of what a pupil does versus does not know. While children certainly teach to remedy a knowledge gap between themselves and a learner, we argue that children's appraisal of the nature of the knowledge that they are seeking to convey and not just whether a knowledge gap exists plays an important role in children's decision to transmit information. Specifically, we argue that children are more likely to transmit information a pupil does not know in at least three cases: if that information is difficult for the learner to acquire on her own, generic rather than specific, and normative rather than descriptive.

1 Introduction

Humans have the capacity for cumulative culture – the ability to transmit and refine knowledge and skills over time. Teaching is central to that capacity because it allows for the efficient and faithful transmission of information within and across generations (Boyd and Richerson 1985; Tomasello 2009). Indeed, experimental investigations of teaching suggest that relative to other forms of cultural transmission, such as imitation or emulation, teaching allows complex skills to be transmitted with greater fidelity over time (Morgan et al. 2015). For example, in the domain of tool-making, verbal teaching makes it possible to convey aspects of design and production that may not be apparent through observation alone (Zwirner and Thornton 2015). The ability to teach appears to develop naturally in humans (e.g., Strauss et al. 2002) and is complemented by

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Published online: 27 May 2017

children's early sensitivity – as learners - to pedagogical cues (e.g., Csibra and Gergely 2009). Despite its early emergence and important role in human evolution, efforts to understand the development of children's teaching abilities (Strauss and Ziv 2012) and to understand the evolution of teaching are only beginning (Kline 2015).

Research on the developmental origins of teaching has mostly focused on young children's ability to recognize and remedy knowledge gaps between themselves and a naïve interlocutor or pupil. Liszkowski et al. (2006) found that 12- and 18-month-olds who observed an adult search for an object, express puzzlement about its location, and eventually ask about its location often pointed to the missing object. Indeed, they often did so before the adult explicitly asked about its location. Importantly, a follow-up study confirmed that infants were seeking to remedy the adult's ignorance rather than simply responding to the adult's puzzlement. Twelve-month-olds pointed to the missing object's location more often when the experimenter expressed puzzlement and did not know about the object's location (i.e., had not seen the object fall to the floor) than when the experimenter expressed puzzlement but did know about the object's location (i.e., had seen the object fall to the floor) (Liszkowski et al. 2008). Moreover, by 18 months of age, infants spontaneously provide information based not only on an experimenter's ignorance but also on an experimenter's false belief. Eighteen-month-old infants watched an adult attempt to retrieve an object she believed to be inside a container but whose location had been switched to another container in her absence. Infants often pointed to the new and correct location of the object before the adult reached into the original container. Importantly, infants pointed much less frequently in a control condition where the adult had witnessed the switch (Knudsen and Liszkowski 2012). In sum, by 12-months of age, children's provision of information is triggered by the presence of a knowledge gap between themselves and another person.

Between three and seven years of age, children's ability to provide information based on a pupil's knowledge state develops rapidly with developments occurring both in the way that children communicate information and in their ability to adjust in real time the amount and kind of information they teach. These developments parallel changes in children's conceptual understanding of teaching. That is, in contrast to infants, preschoolers begin to transmit more complex information (i.e., information about norms and concepts rather than about location) and to teach in more nuanced ways. We discuss each of these developments in turn.

A major development in children's teaching is their use of increasingly verbal and precise teaching strategies. Experimental research using paradigms that ask children to teach a naïve learner reveal a steady progression in children's teaching styles (Ashley and Tomasello 1998; Ronfard and Corriveau 2016; Strauss and Ziv 2012; Strauss et al. 2002; Wood et al. 1995). For example, when asked to teach a game to a naïve learner, three-year-old children demonstrate how the game works while five-year-old children explain the rules of the game (Strauss et al. 2002). Moreover, older children not only use more verbal strategies they also more often address their pupils' mistakes directly by offering explanations that contrast what the pupil did with what the pupil should have done (Strauss et al. 2002). This more explicit verbal teaching style suggests that older children are paying closer attention to their pupil's actions and to what these actions mean for their pupil's developing understanding of the task. Indeed, Wood et al. (1995) found that while only 24% of five-year-olds engaged in contingent teaching, adjusting the amount of support they provided based on the learner's performance (i.e.,

providing more support if the learner struggled and less support if the learner was successful), almost 68% of seven-year-old children did so. Ronfard and Corriveau (2016) extended these findings by showing that developments in children's ability to adjust the strategies they use when responding to mistakes were paralleled by developments in children's ability to adjust the specific type of information they provide in response to mistakes. Whereas three- and four-year-olds often retaught all of the rules of a simple two-rule game to pupils who had failed to follow one of the two rules, five-year-olds frequently taught *only* the rule the pupils had failed to follow.

Just as children's actual teaching becomes more explicitly focused on their pupil's understanding and performance between three and five years of age, so do their reflections and conceptions of teaching. When asked how they knew that the peer they had taught had learned how to play a game, three-year-old children referred to their own act of teaching: "I taught him." By contrast, five-year-old children referred to the learner's behavior, "I saw that she played well" (Strauss et al. 2002). Similarly, children's conception of teaching shifts over the same period. Three-year-old children understand that being knowledgeable rather than being older qualifies one to teach (Ziv and Frye 2004) but it is not until 5 years of age that children understand that a teacher's belief about what a pupil knows rather than the pupil's actual knowledge determines whether the teacher will decide to teach (Ziv and Frye 2004) and it is not until 6 years of age that children explicitly define teaching as a communicative act that causes belief change (Sobel and Letourneau 2016).

These developments in children's conception of teaching, engagement in teaching, and reflections about their own teaching are thought to be related to children's developing theory of mind and to their executive function skills. Effectively, teaching requires the coordination of two minds: the learner's mind and the teacher's mind. The teacher needs to consider how the learner will interpret her instructions and the learner needs to think about the teachers' intent in providing information or requesting an explanation (Shafto et al. 2014). Consequently, children's theory of mind should support both children's teaching and their ability to learn from instruction (Tomasello 2009; Wellman and Lagattuta 2004). Children's executive function skills are thought to be implicated in the planning of instruction and in the monitoring of ongoing instruction. Indeed, several studies have found significant and positive relations between children's use of more explicit teaching strategies and their ability to adjust their teaching to a learner's understanding on the one hand and their scores on false-belief tasks and inhibitory control measures on the other (Davis-Unger and Carlson 2008a, 2008b; Strauss et al. 2002; Ziv et al. 2015).

In sum, a review of existing research suggests that children's teaching (and teaching more generally) is guided by what a pupil does versus does not know and is facilitated by children's ability to represent the knowledge states of other people (i.e., their theory of mind). However, the extent to which a learner either possesses or lacks information about a topic may not be the only, or the most important, factor guiding children's decisions to teach. Theoretical models of the evolution of teaching suggest that because teaching requires an investment of time and resources on the part of the teacher, teaching is more likely to be adaptive for the transmission of information that would be difficult rather than easy for a learner to acquire on her own (Fogarty et al. 2011; Thornton and Raihani 2008). That is, given humans' ability to learn from observation, teachers should not waste time teaching information that a learner does not know if the

learner is likely to be able to acquire that information autonomously. Naturalistic observations of children's teaching, interviews with adults about how different domains of knowledge are acquired, as well as experimental research are beginning to lend support to this claim.

Howe et al. (2016) recorded naturalistic interactions between Canadian sibling dyads at two time points. At each time point, they recorded siblings' free play interactions 6 times for 90 min each. The younger children in these dyads were 2 years of age whereas the older children were 4 years of age at T1; children were 4 and 6 years of age at T2. The authors report analyses of older sibling's *spontaneous* teaching of mathematical concepts (e.g., mathematical operations – "three plus three equals 6″; geometry – "that's a triangle") to their younger siblings during these two time points. Aside from the development of children's teaching between these two time points, it is noteworthy that older siblings frequently and spontaenously taught mathematical concepts to their younger sibling. Although even pre-verbal infants possess some arithmetic abilties (Wynn 1992) much of what preschoolers know about mathematics is likely to have been learned from other people. The fact that older children spontanouely taught mathematical concepts to their younger siblings suggests that their decisions to teach mathematical concepts were guided not just by their evaluation of what their younger sibling knew or did not know (after all younger siblings are less knowledgeable than their older siblings across a range of domains) but also by their evalution of what their younger sibling would benefit from learning – notably, something that they themselves had most likely learned via teaching.

Kline et al. (2013) report similar findings about what domains of knowledge are more frequently learned through teaching in the Fijian Islands. They interviewed adults in a fishing and horticultural village in the Yasawa region of the Fijian Islands about how various skills are typically acquired in the village. They found that high skill and high value domains of knowledge were significantly more likely to be reported as being learned through teaching rather than through observation and imitation.

Experimental results by Ronfard et al. (2016) confirm that children are sensitive to the difference between information that is easy versus more difficult to acquire and focus their teaching on the latter. They introduced U.S. 4- to 6-year-old children to a novel apparatus from which rewards could be retrieved. Half of the children were allowed to explore the toy and discover their own method before being taught how to retrieve the rewards. The other half of the children were not given this opportunity to explore. Across three experiments, the experimenters varied the opacity of the taught method relative to the method that children could discover on their own. Not surprisingly, children who did not get the opportunity to explore the toy invariably transmitted the method that they were taught to a naïve learner. However, when children had had an opportunity to discover their own method prior to being taught, their propensity to pass on the taught method rather than their own was highest when the taught method was more opaque. By implication, children are prone to evaluate the extent to which a method or skill that they have been taught is esoteric – not easy to discover – and in gauging the degree to which it is esoteric they evaluate it against the backdrop of what they have been able to discover for themselves.

These studies, which were conducted in different parts of the world using different methodologies, all suggest that the decision to teach is not simply guided by what the pupil does versus does not know but also by the teacher's appraisal of what kind of

knowledge would be most valuable for the learner to acquire. This appraisal by the teacher seems to be guided by a number of factors. One major consideration is the ease with which the pupil in question – or indeed any pupil – might figure out the information for themselves, i.e., whether it would be possible for the pupil to figure out the information on her own and whether it would be efficient for the pupil to do so. In the sections that follow, we review additional research suggesting that teachers, including young teachers, base their decisions about what to teach on an appraisal of the body of information that they seek to impart – on its unexpectedness, obscurity, and normative importance. Our focus on these three features should not be taken to imply that children may not consider other features of information to be relevant when making decision about whether and what to teach or that we reject the possibility that these features are part of a broader bias that children (and adults) may have to transmit relevant and reliable information. Nevertheless, we believe that the three features we have identified (i.e., unexpectedness, obscurity, and normative importance) are likely to play a particularly important role in children's considerations about whether and what to teach given what we know about children's sensitivity to these three features of information.

2 Teachers' Knowledge of their Subject: Deciding What Needs to be Taught

We have seen that children are especially prone to teach knowledge that would be difficult for a learner to acquire in the absence of teaching. Granted this bias, it is important to consider more carefully how children identify such knowledge. On what basis do they conclude that a given piece of knowledge would be difficult to acquire in the absence of instruction? In this context, the distinction between knowledge that can be gained from first-hand experience and knowledge that can only be gained via the testimony of other people would seem to be important. More specifically, if children realize that some of their knowledge – for example, that there are birds in the air – is based on their own first-hand observation whereas other knowledge – for example, that there are germs in the air – can only be based on what they have been told, then they would have at their disposal a major criterion for deciding what merits teaching and what does not.

We have plenty of evidence that young children learn from testimony as well as from first hand observation (Harris 2012). But to what extent do they realize that these forms of learning are different? In a thoughtful exploration of this issue, Lockhart et al. (2016) point out that there are reasons for thinking that this distinction might come easily to young children. A considerable proportion of the world's languages oblige speakers to use a grammatical marker to indicate whether the claim that they are making is based on first-hand observation or on testimony provided by other people. To the extent that young children become quite competent at making this distinction – in both language production and comprehension – in the course of the preschool years (Papafragou et al. 2007), we might reasonably expect them to have some explicit awareness of the way in which knowledge, including their own, has different sources. For example, we might expect them to realize that – to return to the earlier example – people ordinarily come to know about the existence of birds on the basis of first-hand

observation whereas they only come to know about germs on the basis of others' testimony. On the other hand, there is also plenty of evidence that when children acquire a piece of information, they are not very good at monitoring its source. They sometimes mistake what they have been told for what they have observed for themselves (Principe 2014; Principe et al. 2006), and having just learned a piece of information, they are prone to claim that they have always known it (Taylor et al. 1994).

Given these conflicting lines of evidence, Lockhart et al. (2016) devised a test to examine how far children could distinguish the two kinds of knowledge. They invited children and adults to think about someone who had grown up on a deserted island, unable to communicate with anyone else, and to decide what pieces of knowledge the individual could and could not acquire in this isolated state. Children were surprisingly good at realizing that the person could gain various pieces of knowledge directly. For example, they realized that the person would know that it's hard to think about two different things at once, that you can't hold your breath for a whole day, that when a rock is thrown in the air it always comes down and that birds fly. At the same time, children were also quite good at realizing that the person would not acquire other pieces of knowledge given their isolation from others. For example they realized that the person would likely not know that the Earth is round, that germs make people sick, that your body needs vitamins to stay healthy and that there used to be dinosaurs.

Children were not perfect at making this distinction. Across three different experiments, Lockhart and her colleagues found that the differentiation between the two types of knowledge – direct versus indirect – became sharper with age, mainly because there was an improvement in children's ability to recognize the difficulty of acquiring indirect knowledge. Nevertheless, even the youngest children – preschoolers ranging from 5 to 7 years – made a robust differentiation between the two knowledge types – with little overlap between them.

How exactly did children make the distinction? One possibility is that children reflected on how they themselves had acquired each item of knowledge and judged accordingly. For example, remembering that they had seen birds first hand but had never seen any germs, they may have attributed similar opportunities and constraints to the individual on the deserted island. However, this line of interpretation implies that children are good at noticing and remembering how they learned a given piece of information whereas the studies reported by Taylor et al. (1994) suggest that children's source memory is actually quite poor. Accordingly, a somewhat different interpretation is more feasible. Arguably, children do not try to recall how they learned a given piece of information but instead they try to imagine how one could learn it. For example, when asked to decide how someone might learn that birds fly, it seems plausible that they readily imagine a learner who simply sees that birds do indeed fly. Conversely, when asked to decide how someone might know that germs make you sick, it seems plausible that they have difficulty in imagining how anyone could make the relevant observations – granted that germs are ordinarily invisible. Thus, according to this hypothesis, children are quite good at conducting miniature thought experiments in order to gauge the ease with which a piece of information could be learned. They effectively ask: could someone observe this phenomenon for themselves?

Less clear at the moment is the extent to which children distinguish between direct and indirect knowledge, not just when explicitly asked to do so, as in the study by

Lockhart et al. (2016) but also when they engage in teaching. But it would not be difficult to gather such evidence. Suppose that we invite children to listen to 'lessons' on topics with which they have some familiarity – such as rainbows or stars – and for each topic we provide two pieces of information, one that could be acquired directly and one that could only be acquired indirectly. For example, we tell them that every rainbow has several colors and also that rainbows are made up of tiny drops of water and light, or we tell them that stars cannot be seen during the day and also that they are very hot. We then invite children to become the teacher – to tell a puppet or younger child what we have taught them. When assigned this role, children might be tempted to regurgitate everything they have been taught, irrespective of how anyone could learn about it. On the other hand, it is feasible that they will be selective – that they will favor the teaching of indirect knowledge, passing over information that their pupil could gather for him- or herself.

Consider again two of the pieces of information that Lockhart et al. (2016) invited children to consider, namely that birds fly and that stars are very hot. As noted, one can learn that birds fly via direct experience but not that stars are very hot. Despite this important difference, the two pieces of information do have an important similarity. Each of them can be conveyed by a generic assertion, one implying that all birds or all stars – and not just one or two – have the property in question. Thus, as Gelman (2000) has pointed out, generic knowledge is often expressed via generic noun phrases, such as *birds* in the sentence "Birds fly" or *a star* in the sentence "A star is very hot". These assertions attribute a characteristic that applies across all members of the category. By contrast, assertions such as "That bird is nesting" or "Those stars are part of the Milky Way" pick out particular instances rather than the entire category of birds or stars.

Granted the power of such generic statements, we might expect such statements to figure prominently in pedagogic texts, including those aimed at children – and indeed that is the case. Gelman et al. (2013) surveyed a representative set of books aimed at young children and divided them into three categories: informational, narrative and mixed (i.e., a combination of narrative and informational). They found that mixed and especially informational books included a greater proportion of generic statements than did the narrative books. In two follow-up studies, they asked if young children showed a similar bias toward generic assertions when they were cast in the role of teacher. Six-year-olds – and to a lesser extent 5-year-olds – produced more generic statement when they were asked to imagine being a teacher than when asked to imagine being engaged in a conversation with a peer. More specifically, when they were given a book with pictures of familiar items (e.g., a penguin, a banana) and asked to talk about them, they produced more generics (e.g., "penguins are great swimmers" and "A banana is white on the inside and yellow on the outside") in the teacher role than in the peer conversation role. Conversely, the proportion of personal statements (e.g., "I watched a penguin show in school" and "I want to eat it") was greater in the peer conversation role than in the teacher role.

How did these young children – especially the 6-year-olds – come to adopt a more generic stance when they were cast in the role of teacher? Gelman et al. (2013) focus on two plausible interpretations. On the one hand, children might have a broad and potentially early-emerging assumption that teaching calls for the provision of generic information – information that goes beyond any specific instance of a given category. Alternatively, children might come to connect pedagogy and genericity through

exposure to their linkage in the context of formal education. For example, at school, they might notice that teachers – as compared to other caregivers – are prone to generic statements and eschew more anecdotal information and that bias might be especially pronounced when teachers are engaged in straightforwardly pedagogic communication – about germs, stars, and penguins – as opposed to more personal or narrative-oriented communication. Research with children who have had different amounts of exposure to formal schooling should help to choose between these two alternative interpretations.

Finally, it is worth pondering the relation between the two themes that we have explored. Young children realize that some knowledge cannot be gained first-hand but must be learned though the testimony of others. They also realize that teaching calls for the communication of generic information about categories rather than more local information about specific instances. Do they coordinate these two insights in any way? Consider a child who says of a banana: "A banana is white on the inside and yellow on the inside". Clearly, such generic information about bananas is something that a learner could discover first-hand. Indeed, a teacher who conveys that information is not likely to be adding anything to the stock of a pupil's knowledge. Consider, by way of contrast, a generic statement about less easily observed phenomena: "Penguins are great swimmers" or about phenomena that are ordinarily impossible to observe in any direct fashion: "Stars are very hot." Arguably, children conceive of pedagogy as involving a bias not simply toward generics but rather toward hard-to-observe generics. Again, this speculation is testable.

The previous sections suggest that when transmitting information children consider two factors: the ease with which information can be acquired and its generalizability. We now turn to a third consideration – whether the information to be taught contains a normative component, specifically information about social conventions. Moral norms and social conventions are both prescriptions of behavior that are culturally relevant and mostly acquired through teaching or other forms of social learning. However, social conventions are more likely to be group-specific relative to moral norms and thus especially pertinent for a novice learner. Information about social conventions is valuable not only because it is generalizable and difficult to acquire on one's own but also because knowledge of social conventions, particularly knowledge of group rituals, signals group membership (e.g., Legare and Watson-Jones 2015). Being perceived to be a member of a group is important for at least two reasons: it increases one's credibility with other members of the group (Henrich 2009; Rossano 2012) and it provides privileged access to the group's knowledge and skills (Misch et al. 2016). Given these considerations, we can expect child learners to be receptive to information about social conventions. Similar considerations are likely to apply to children as teachers. Thus, if children consider various qualities of the information rather than simply the knowledge state of the learner when deciding whether to transmit information, then we would expect that children's teaching decisions to be influenced by the presence of a social convention or ritualized component.

Young children are sensitive to norms and conventions and they spontaneously correct and teach individuals who break them whether those individuals are breaking social conventions about objects labels (Pea 1982), game rules (e.g., Rakoczy et al. 2008), or object functions (Casler et al. 2009). For example, Rakoczy et al. (2008) found that children as young as 2-years of age will spontaneously correct and teach a puppet whose actions violate the rules of a game but only when the puppet stated that

she wanted to play the game (i.e., "I'm gonna dax now" vs. "I'm gonna show you something"). Importantly, children were more likely to spontaneously correct and teach a puppet that failed to conform to a previously taught social convention when it was part of their in-group rather than their outgroup (Schmidt et al. 2012). This selective transmission of social conventions suggests that children's *interventions* are not based solely on the pupil's knowledge state but rather on whether the puppet lacks relevant knowledge (i.e., knowledge of the social convention of their group). If children were only paying attention to the puppet's lack of knowledge about the rules of the game, then we would expect that they would spontaneously correct the puppet's mistake whether or not it is part of the child's in-group.

In addition to selectively teaching and enforcing norms, young children's transmission of causally opaque behaviors depends on their perception of these behaviors as normative (i.e., as part of a social convention). Clegg and Legare (2016) taught children how to construct a beaded necklace. These instructions included causally irrelevant actions such as stretching the string, placing it above the tray, and touching three beads on one's forehead before placing them on the string. Three- to six-year-old children were randomly allocated to two groups. For one group, the activity was framed using instrumental language: "I am going to make a necklace. Let's watch what I am doing." For the other, the activity was framed using conventional language: "I always do it this way. Everyone always does it this way." Clegg and Legare (2016) found that not only were children at all ages more likely to imitate the causally irrelevant actions (e.g., touching three beads on one's forehead) when the activity had been framed using conventional rather than instrumental language but that children were also subsequently more likely to *transmit* these causally irrelevant behaviors to a naïve puppet.

In sum, children's decision to transmit information is not solely driven by the knowledge state of the learner. Rather, our review of existing research suggests that children pay attention to three qualities of the information that a learner lacks: whether that information is difficult to acquire, whether that information is generalizable rather than restricted to a particular instance, and whether that information includes a normative component. A positive reply to each of these qualities appears to increase the likelihood that children will transmit the information in question. An important issue for future research is how these three components interact. Is difficult-to-acquire generic information more likely to be taught than generic information that is easy to acquire? Are complex rituals more likely to be taught than less complex ones? In other words, can information be ranked from least to most likely to be transmitted based on these three features? A second set of questions concerns how children learn that certain kinds of information are particularly valuable for naïve learners. For example, do children teach difficult-to-acquire information more because they engage in thought experiments prior to teaching to assess the difficulty of learning a concept or skill, or do they teach difficult-to-acquire information more because they are more likely to be taught such knowledge from others as learners and are more likely to request such information from others (Was and Warneken 2017)?

Understanding how various features of information influence its transmission over time through explicit teaching would clarify the role of teaching in the evolution of cumulative culture. Cumulative culture requires both high fidelity transmission and innovation (Legare and Nielsen 2015). Yet, high fidelity transmission and innovation may sometimes be at odds with each other. Bonawitz et al. (2011) found that children

who were taught about a novel toy subsequently focused on the aspects of the toy that were demonstrated to them rather than on exploring other functions. As a result, relative to children who were not taught about the toy, children who received instruction discovered fewer of its functions. This suggests that instruction may limit innovation by restricting exploration and thus discovery. However, it is also possible that teaching and innovation are not necessarily at odds with one another. This is because children (and by implication adults) make inferences about the reliability of their teachers as well as inferences about the reliability of the information they are given and these inferences influence subsequent exploration (i.e., constrain the influence of instruction on exploration) and thus the potential to innovate. For example, children give lower ratings to under-informative teachers (e.g., a teacher who did not teach every function a toy could perform) than to teachers who are fully informative (e.g., a teacher who taught every function of a toy) and subsequently engage in more exploration of a novel toy when they have been taught by the under-informative teacher than by the informative teacher (Gweon et al. 2014). Thus, children's inferences about a teacher's knowledge and reliability underlie the effect of instruction on exploration. Children's evaluations of the knowledge they are given also determines whether instruction influences their exploration of novel objects. In Bonawitz et al. (2011), children learned about a *novel* toy and thus did not have any prior intuitions about the toy's functions. However, the nature of the taught information may play an important role in children's decision to either restrict or not restrict their actions based on that instruction. Indeed, when children are provided with a claim that contradicts their intuitions (e.g. if they are told that a small object is heavier than a large object) some children subsequently test that claim through empirical investigation (i.e., lifting the dolls and comparing their weights) (Harris et al. 2017). These results suggest that the effect of instruction on children's exploration and discovery may depend on children's evaluation of the information they are taught – whether or not it conflicts with their intuitions and prior experiences. In sum, when learners have doubts about a teacher's competence or are surprised by a given piece of information they turn to exploration. This suggests intriguing parallels between children's transmission of information and their receipt of information. In both cases, children's ability to evaluate information and people (i.e., teachers or pupils) along various dimensions play an important role in subsequent decisions (i.e., whether to teach or whether to explore).

3 Conclusions and Implications

We began by discussing the importance of teaching for cumulative culture. We then discussed recent developments in our understanding of children's development as teachers. This research, which has mostly focused on how children adjust their teaching based on what others know and do not know, shows a steady development in these abilities. As children get older, their teaching becomes increasingly precise and flexible. However, the ability to track what others know and do now know cannot be the only consideration guiding children and adults' teaching. The differences in knowledge between any two people are vast and teaching to reduce or eliminate all of those differences would be time-consuming and not necessarily adaptive. As a result, teaching efforts are best spent on skills and information that can only be acquired through

teaching or that are especially valuable (e.g., hard to acquire information, generalizable knowledge, information about social norms). This implies that children need to be able to identify what types of knowledge are valuable. The research that we have reviewed suggests that young children are indeed able to make these assessments and make decisions about what to teach in accordance with them. In the introduction, we mentioned that humans not only seem to be predisposed to teaching others but that they are also predisposed to learning from such instruction (e.g., Csibra and Gergely 2009; Strauss et al. 2002). Perhaps our capacity for cumulative culture is due not just to our ability to teach and to attend to what others know and do not know but rather, and more importantly, to our ability to decide what not to teach and to focus instead on teaching those concepts and skills that we believe are most valuable for someone else – especially those that we have acquired through teaching rather than autonomous learning.

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