CHILD DEVELOPMENT PERSPECTIVES

The Empirical Child? A Framework for Investigating the Development of Scientific Habits of Mind

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ABSTRACT—***We live in the information age. Broad access to vast troves of information can benefit society considerably, providing conduits for inquiry by individuals of all ages, enabling the spread of important information to previously isolated populations, and facilitating social connections across the globe. However, inundated with information from an ever-expanding array of sources, we also live in the* misinformation *age. Thus, it is of paramount importance to raise the next generation to approach the world through an empirical, evaluative lens, and to work to foster the development of habits of mind that will guide how children engage with the world. In this article, I present a new theoretical framework for investigating children's engagement in and understanding of three key steps in the empirical process: (a) asking questions and forming a hypothesis, (b) collecting and analyzing data, and (c) communicating evidence. I discuss young children's capacities for engaging in each step as well as the obstacles they may encounter in doing so, and suggest approaches for researchers working toward this pressing societal goal.***

KEYWORDS—*empirical reasoning; science literacy; social learning; causal learning; selective trust*

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Vaccines cause autism. Human activity does not cause climate change. Men are smarter than women. Each of these claims is empirically testable and demonstrably false. Yet, millions of people believe them. Ensuring that we have a populace that approaches the world with a critical, evaluative lens is a pressing issue facing society. Individuals must be able to assess whether a wide variety of claims are supported by sufficient data, as well as understand when and how to dig deeper to understand a problem. These capacities are foundational not only in science, technology, engineering, and math (STEM) fields but also across all academic disciplines and the lifespan. Society is increasingly inundated with information, with eroding and sometimes insufficient institutional checks on what is authoritatively true. Thus, it is crucial to ensure that the next generation of children develops practices that allow them to use their basic capacities for reasoning about evidence on problems and questions they encounter in their lives. I term these practices scientific or, to emphasize their importance across a broader range of subject areas, *empirical habits of mind*. These include not just the basic cognitive capacities for empirical reasoning, but their use across content domains and contexts, even in the face of obstacles.

How and when do young children develop the basic capacities necessary to navigate an information-rich, complex world? Research in cognitive development suggests that young children can track, produce, and make inferences from probabilistic, statistical evidence (Gopnik, 2012), and that these capacities develop over childhood and adolescence (Kuhn et al., 1988). Thus, children seem to have the prerequisite capacities for several types of empirical reasoning. However, although adults clearly possess these same capacities, and likely in substantially more sophisticated form, we routinely fail to assess evidence critically. What explains this disconnect and how can a developmental lens help rectify it?

Science itself is a set of *practices* by which we assess evidence. These practices are fundamentally shaped by the social contexts in which they occur. From STEM to history to politics to economics, reasoning about evidence is a collective process

in which we ask questions, consider evidence, and draw conclusions with and for each other. This is true in both formal educational contexts and our everyday lives: Teachers, parents, and peers suggest questions to ask, select evidence to consider, and frame the discussion about what to conclude.

Given its fundamentally social nature, understanding the development of empirical reasoning through this lens is critical to combatting misinformation. To support the goal of fostering empirical habits of mind in young children, we must understand the basic cognitive foundations on which these habits are built and identify the obstacles preventing children from using those capacities. Moreover, as the complexity and nuanced nature of the problems and evidence children face increase across development, the fundamentally social nature of the empirical process may play an increasingly central role in how well they use their basic empirical reasoning capacities.

A NEW THEORETICAL FRAMEWORK

To build a foundation for investigating and fostering the development of empirical habits of mind, I propose a new theoretical framework (see Figure 1) that breaks empirical reasoning into distinct components. Empirical reasoning encompasses a broad set of capacities and requires children to coordinate several key steps. Each step involves recruiting the relevant cognitive capacities to engage in and reason about the specifics of the step, as well as navigating obstacles to using those capacities. This framework lays out three steps in the empirical process, the capacities young children have at their disposal, and the obstacles they may face in using those capacities, particularly in a social context.

The first step is *asking questions and forming a hypothesis*: recognizing opportunities to learn new information or revise current hypotheses, generating expectations, and forming predictions. The second step is *collecting and analyzing data*: identifying and actively gathering relevant evidence, analyzing it, and making valid inferences. The third step is *communicating evidence*: using evidence and analysis to fulfill various social goals, including teaching, persuading, and deceiving. Next, I discuss research illustrating children's ability to navigate each of these three steps and the reasons children might struggle to *use* these capacities in a social context. I conclude by returning to the question of empirical habits of mind, discussing how we can work toward fostering them in early childhood to give children the tools and practices they need to navigate the complex informational landscape of the modern world.

Step 1: Asking Questions and Forming Hypotheses

The first step in inquiry is recognizing an unresolved problem and generating one or more questions or hypotheses. This step includes identifying patterns, noticing information that conflicts with current beliefs, recognizing ambiguous or confounded evidence, and posing questions or making predictions in ways that support a clear conclusion.

Capacities

Before formulating a question or hypothesis to guide inquiry, children must notice that there is a problem to be solved. One

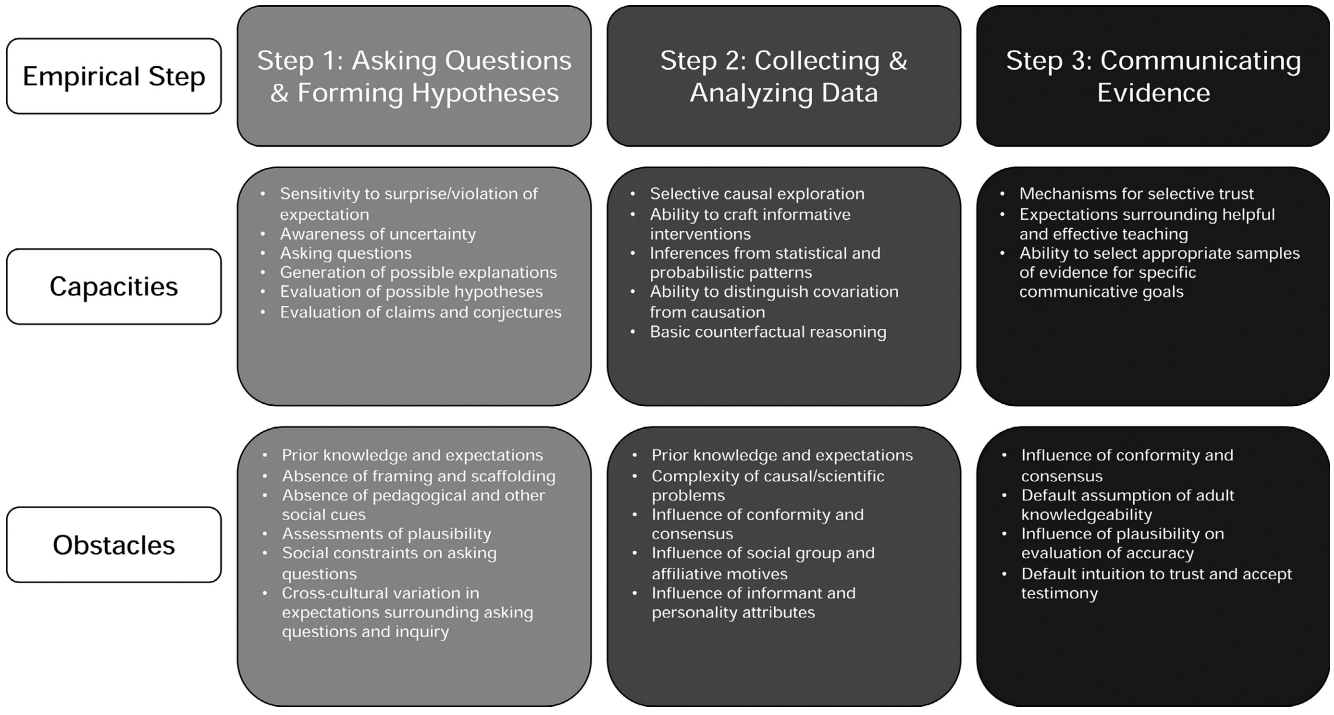

Figure 1. **Proposed theoretical framework for investigating children's empirical reasoning.**

experience that helps children identify relevant problems is having their expectations violated. Both infants and preschoolers are sensitive to inconsistencies and violations of expectations, and explore selectively to resolve them (Legare, Gelman, & Wellman, 2010; Stahl & Feigenson, 2015). Preschoolers recognize when causal evidence is ambiguous and explore selectively to resolve that ambiguity (Schulz & Bonawitz, 2007). Children are more likely to ask questions when they lack knowledge (Chouinard, 2007) and recognize when someone's response lacks clarity (Pratt & Bates, 1982). Whether they have explicit knowledge of their own uncertainty is less clear, although given appropriate training on a scale representing uncertainty, children as young as 3 years can appropriately gauge their certainty about different events (Lyons & Ghetti, 2011).

Once they have recognized an inconsistency, children must generate a hypothesis or question aimed at resolving it. The earliest form of asking questions is arguably interrogative pointing (Begus & Southgate, 2012). As children begin to acquire the linguistic forms necessary to ask explicit, verbal questions, they learn to do so purposefully, asking appropriate questions aimed at closing a gap in a particular domain of knowledge (Callanan & Oakes, 1992; Chouinard, 2007). They also selectively direct questions to individuals with relevant expertise (Mills, Legare, Grant, & Landrum, 2011) and can identify which questions will likely lead to gaining the most information (Ruggeri, Sim, & Xu, 2017).

Young children's ability to formulate hypotheses is less well explored. Evidence from open-ended exploration tasks suggests that children sometimes generate their own explanations for events spontaneously (e.g., Legare et al., 2010). Perhaps the best evidence that young children generate hypotheses explicitly comes from work in social cognition, which suggests that children seek to explain unexpected behavior in terms of a shift in an individual's goals (Wellman & Woolley, 1990).

Young children also show a developing ability to evaluate possible hypotheses, as seen in work on children's evaluation of others' claims and conjectures. Between ages 3 and 7, children learn to distinguish between claims that are made based on sufficient evidence and those that are made based on insufficient evidence (Butler, Schmidt, Tavassolie, & Gibbs, 2018), and to evaluate whether a conjecture is reasonable given the events related to it (Chu & Schulz, 2018). Furthermore, at least with sufficient scaffolding, 4- to 6-year olds can select which of two proposed causal mechanisms better fits the evidence (Magid, Sheskin, & Schulz, 2015).

Obstacles

Clearly, children can take part in and evaluate asking questions and forming hypotheses. However, several factors may challenge children's use of these capacities. The process of identifying relevant questions is shaped inherently by children's prior knowledge and expectations, as well as by the social context in which they encounter the evidence. Although by preschool age, most children can make basic causal inferences from probabilistic evidence (see Gopnik, 2012), whether they do so may be influenced by social input from adults. For example, framing a causal problem verbally is critical to enabling children to extract relevant causal evidence (Butler & Markman, 2012a). Furthermore, whether adults deliberately demonstrate evidence shapes the extent to which children use that evidence to guide their causal inferences, such as whether that evidence is generalizable (Butler & Markman, 2012b, 2016) and important (Butler & Markman, 2014; Yu & Kushnir, 2016). Just as important as what adults choose to frame or point out is what adults *neglect* to address even when they could have. For example, if a child witnesses an event or action that could elicit surprise or uncertainty, an adult's failure to note or draw attention to that event or action could be seen as an indication that it does not warrant further questioning or investigation.

With respect to asking questions in everyday life, the kinds of questions children ask, as well as to whom and in what contexts questions are considered appropriate, are subject to various social constraints. Also, the ways asking questions and inquiry more broadly are socialized vary across cultures and even across social groups within cultures (see Callanan, Solis, Castañeda, & Jipson, 2020). This may present an additional obstacle because children need to learn how to map their questions onto the inquiry behaviors that are valued and expected in their society.

With respect to forming hypotheses, the hypotheses that children consider plausible are likely shaped by what they already believe to be true. Indeed, it is notoriously difficult to overturn prior beliefs, even when they are wrong, so even entertaining a hypothesis that conflicts with already-held beliefs can be challenging. However, few studies have explored how social factors influence children's formation of hypotheses. As with questioning, it may be a key. For example, children are far more likely to consider revising their beliefs when counterevidence is scaffolded in some way by an adult, through prompts for explanation, presentation of a diverse set of counterevidence, or explicit verbal testimony (Macris & Sobel, 2017).

Step 2: Collecting and Analyzing Data

Having identified a question and generated hypotheses, children must reason about and then gather, analyze, and draw conclusions from data.

Capacities

Even young infants can tailor their exploration to help resolve uncertainty (Stahl & Feigenson, 2015), and before their second birthday, toddlers are sensitive to both the evidence and the process by which it was produced in guiding their exploration (Gweon, Tenenbaum, & Schulz, 2010). By preschool age, children are expert explorers, engaging selectively with uncertain causal relations more than with certain causal relations (Legare et al., 2010; Schulz & Bonawitz, 2007), and crafting informative

interventions to test which variables are causally efficacious (Cook, Goodman, & Schulz, 2011).

Whether having gathered evidence themselves or having had evidence presented to them, young children are adept at drawing inferences from minimal data. By preschool age, children use patterns of statistical evidence to distinguish causation from correlation (Schulz & Gopnik, 2004), support some basic counterfactual reasoning (Harris, German, & Mills, 1996), and identify relevant and informative interventions (Kushnir & Gopnik, 2005; Sobel & Sommerville, 2009).

Obstacles

Taken together, this work paints a picture of young children as attending to, actively producing, and drawing conclusions from patterns of evidence in much the way adult scientists do. Indeed, at least provided that children have access to or the ability to generate relevant data, this seems to be the step of the empirical process at which children are most clearly competent. Yet, several factors can undermine children's successful use of these capacities.

First, in aiming to investigate the earliest roots of empirical competency in young children, cognitive developmental researchers have often relied on methodological approaches that arguably oversimplify the problems children face in grappling with probabilistic data. This is necessary to determine what early capacities children possess. But the empirical world children encounter in their lives, let alone that faced by adults, is far more complex, opaque, and challenging to navigate than that presented to children in most laboratory experiments. Thus, this literature may present an overly optimistic view of the child as scientist. Indeed, older children, and in some cases even adolescents, struggle with more complex scientific problems that require them to engage with a larger number of more abstract variables (Chen & Klahr, 1999; Kuhn & Dean, 2004), even though such reasoning relies on basic mechanisms that children as young as preschool age possess.

Second, as mentioned earlier, all evidence has a social history and all scientific reasoning has fundamentally social components. Thus, how children decide what evidence to attend to and what conclusions to draw could be influenced by how evidence is framed and produced (Butler & Markman, 2012a, 2012b, 2014, 2016; Yu & Kushnir, 2016), as well as by broader social factors such as conformity, consensus, and group affiliation (Chen, Corriveau, & Harris, 2013; Haun, Rekers, & Tomasello, 2012).

Step 3: Communicating Evidence

Finally, having asked empirical questions and gathered data to support evidence-based inferences, children must evaluate and, perhaps to a lesser extent, at least early in childhood, engage in the process of conveying knowledge to others. Having taken part in the empirical process, scientists need to communicate their work, adhering to norms of scientific integrity. Thus, it is important to ask how children evaluate communicating evidence and whether they learn norms for communicating evidence that align with principles of scientific integrity. Children rely on adults to frame, present, and convey much of the evidence they encounter. They cannot simply be passive recipients of information, but must selectively evaluate the information others convey.

Capacities

Evidence from many studies suggests that children do not receive information passively. Children selectively judge others' trustworthiness based on past accuracy (Koenig & Harris, 2005), logical consistency (Doebel, Rowell, & Koenig, 2016), and access to knowledge (Brosseau-Liard & Birch, 2011), among other factors (see Harris, Koenig, Corriveau, & Jaswal, 2018, for further review). Children also rate the helpfulness and informativeness of teachers based on the thoroughness of their transmission of information (Gweon, Pelton, Konopka, & Schulz, 2014), suggesting that they have expectations for how information should be communicated.

Furthermore, when asked to teach a concept to a naïve learner, preschoolers select a diverse and representative sample of evidence (Rhodes, Gelman, & Brickman, 2010). They can flexibly select different patterns of evidence to lead others to draw a specific true or false conclusion (Rhodes, Bonawitz, Shafto, Chen, & Caglar, 2015). These findings suggest that young children recognize that the evidence they choose to communicate has consequences for what others learn, and that they tailor their actions to the pedagogical benefit of learners. Although more work is needed, especially on whether children have explicitly normative expectations for how to communicate evidence, children clearly have some basic capacities for reasoning about transmitting evidence.

Obstacles

As communication is intrinsically social, social factors can play an important role in undermining children's reasoning about communicating evidence. First, as mentioned earlier, children are very sensitive to conformity and consensus. Second, even absent a consensus, a confident claim from one individual may be difficult to reject outright, especially if children assume that individual to be knowledgeable because they have relevant expertise or are an adult. Indeed, communication works because we assume that communicators provide accurate, clear, relevant statements (Grice, 1975). Adults are unlikely to reject statements, even false ones, unless they are paying close attention, the claim is implausible or incoherent, or the source is untrustworthy (Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012). Children are sensitive to similar constraints (Harris et al., 2018), but may accept plausible claims from relatively trustworthy sources unless the claim is clearly invalid (e.g., because it conflicts with a claim from someone with more knowledge; Butler et al., 2018). Third, as with data collection and analysis, both

the influence of consensus and a default tendency to accept claims as true may be especially strong in cases in which factors like group membership and authority come into play.

FOSTERING EMPIRICAL HABITS OF MIND

Children possess basic building blocks for empirical reasoning by the time they enter formal schooling. They can recognize gaps in their knowledge or inconsistencies that need explaining, and they can formulate ideas about how to resolve them. They can generate evidence and base conclusions on minimal data, and show some ability to evaluate others' engagement in this process. They also know that some ways of transmitting information and evidence are preferable over others. Yet at each step of the empirical process, children face obstacles that could make using these capacities to draw accurate conclusions challenging. Today, raising children who are motivated and prepared to engage with the world through an evaluative, empirical lens is of the utmost importance. How can developmental scientists studying basic processes of learning and reasoning generate important, useful knowledge to help support this goal?

Simply investigating the roots and development of children's understanding of and engagement in the empirical process is a necessary but insufficient step. Beyond mapping the development of key critical thinking capacities in childhood, developmental researchers must directly address when those capacities fail to lead children to draw the correct evidence-based conclusions, and they should develop and test strategies to help children overcome the obstacles to using their empirical reasoning capacities. Many (though not all) of these barriers are social. They include relying on others to point out discrepancies and frame causal problems and treating social cues as an indication of importance and relevance (and their absence as indication of a lack of importance). They are also affected by broader social factors such as conformity, consensus, group pressures, and prestige or authority. The fundamentally social nature of the empirical process is a double-edged sword, and engaging with the promises and pitfalls that come with any sociocultural practice could help children learn how to participate in the process successfully.

Central to this endeavor may be recognizing that science is more than a set of capacities—it is a set of habitual practices. Indeed, the notion of science as a set of practices to be fostered by parents and teachers is a key component of recent frameworks for guiding science education, such as the Next Generation Science Standards (GSS Lead States, 2013). These practices are inherently grounded in the social world. One of children's principal jobs is to learn how they are expected to engage with and behave in society, and much of this involves learning the social norms of their culture (Tomasello, 2019). If science is a cultural practice, then establishing social norms around empirical practices could be key to fostering empirical habits of mind, especially as children face more complex problems and evidence as they develop. For example, adults can build on children's tendency to explore to resolve uncertainty by establishing norms of looking for, being curious about, and focusing on such instances. As inconsistencies can often be subtle or easily overlooked, encouraging children to regularly seek inconsistencies could be particularly effective.

Adults can also communicate norms about asking what we do and do not know about a particular problem and how and from whom we know what we know, and encourage children to actively question what we believe to be true. Also, adults can reinforce norms around communicating evidence, such as stating claims only when one has sufficient knowledge, being fully transparent about what conclusions are licensed by a pattern of evidence, and presenting evidence honestly. Such norms, and an awareness of what might indicate their violation, can help insulate children from deliberate misuse of evidence. In fostering these norms, scaffolding how parents and children talk about evidence could be key. Indeed, parents' epistemological orientation toward evidence and knowledge influences how they and their children discuss evidence (Luce, Callanan, & Smilovic, 2013), suggesting that conversations between parents and their children might be a promising way to convey norms and practices around engaging with and communicating evidence.

Researchers should seek to identify the habits of mind adults should focus on and the approaches that are most effective. Leveraging children's attention to social norms could be a powerful way to instill a habit of approaching the world empirically. By investigating children's understanding of and engagement in the empirical process before and as they enter formal education, researchers who use the theoretical framework I have presented can help inform approaches parents and teachers can use to foster empirical habits of mind in early childhood. In so doing, they can also help prepare the next generation to harness the power of information while avoiding the pitfalls of *mis*information.

REFERENCES

Begus, K., & Southgate, V. (2012). Infant pointing serves an interrogative function. *Developmental Science*, *15*, 611–617. https://doi.org/10.1111/j.1467-7687.2012.01160.x

Brosseau-Liard, P. E., & Birch, S. A. (2011). Epistemic states and traits: Preschoolers appreciate the differential informativeness of situation-specific and person-specific cues to knowledge. *Child Development*, *82*, 1788–1796. https://doi.org/10.1111/j.1467-8624.2011.01662.x

Butler, L. P., & Markman, E. M. (2012a). Finding the cause: Verbal framing helps children extract causal evidence embedded in a complex scene. *Journal of Cognition and Development*, *13*, 38–66. https://doi.org/10.1080/15248372.2011.567201

Butler, L. P., & Markman, E. M. (2012b). Preschoolers use intentional and pedagogical cues to guide inductive inferences and exploration. *Child Development*, *83*, 1416–1428. https://doi.org/10.1111/j.1467-8624.2012.01775.x

Butler, L. P., & Markman, E. M. (2014). Preschoolers use pedagogical cues to guide radical reorganization of category knowledge.

Cognition, *130*, 116–127. https://doi.org/10.1016/j.cognition.2013.10.002

Butler, L. P., & Markman, E. M. (2016). Navigating pedagogy: Children's developing capacities for learning from pedagogical interactions. *Cognitive Development*, *38*, 27–35. https://doi.org/10.1016/j.cogdev.2016.01.001

Butler, L. P., Schmidt, M. F., Tavassolie, N. S., & Gibbs, H. M. (2018). Children's evaluation of verified and unverified claims. *Journal of Experimental Child Psychology*, *176*, 73–83. https://doi.org/10.1016/j.jecp.2018.07.007

Callanan, M. A., & Oakes, L. M. (1992). Preschoolers' questions and parents' explanations: Causal thinking in everyday activity. *Cognitive Development*, *7*, 213–233. https://doi.org/10.1016/0885-2014(92)90012-G

Callanan, M. A., Solis, G., Castañeda, C., & Jipson, J.(2020). Children's question-asking across cultural communities. In L. P. Butler, S. Ronfard, & K. H. Corriveau (Eds.), *The questioning child: Insights from psychology and education* (pp. 73–88). New York, NY: Cambridge University Press.

Chen, E. E., Corriveau, K. H., & Harris, P. L. (2013). Children trust a consensus composed of outgroup members—But do not retain that trust. *Child Development*, *84*, 269–282. https://doi.org/10.1111/j.1467-8624.2012.01850.x

Chen, Z., & Klahr, D. (1999). All other things being equal: Acquisition and transfer of the control of variables strategy. *Child Development*, *70*, 1098–1120. https://doi.org/10.1111/1467-8624.00081

Chouinard, M. (2007). Children's questions: A mechanism for cognitive development. *Monographs of the Society for Research in Child Development*, *72*, i–129, 286. Retrieved from https://www.jstor.org/stable/30163594

Chu, J., & Schulz, L. (2018). Cognitive pragmatism: Children flexibly endorse facts and conjectures. In T. T. Rogers, M. Rau, X. Zhu, & C. W. Kalish (Eds.), *Proceedings of the 40th annual conference of the cognitive science society* (pp. 226–231). Austin, TX: Cognitive Science Society.

Cook, C., Goodman, N. D., & Schulz, L. E. (2011). Where science starts: Spontaneous experiments in preschoolers' exploratory play. *Cognition*, *120*, 341–349. https://doi.org/10.1016/j.cognition.2011.03.003

Doebel, S., Rowell, S. F., & Koenig, M. A. (2016). Young children detect and avoid logically inconsistent sources: The importance of communicative context and executive function. *Child Development*, *87*, 1956–1970. https://doi.org/10.1111/cdev.12563

Gopnik, A. (2012). Scientific thinking in young children: Theoretical advances, empirical research, and policy implications. *Science*, *337*, 1623–1627. https://doi.org/10.1126/science.1223416

Grice, H. P. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Syntax and semantics* (Vol. *3*, pp. 41–58). New York, NY: Academic Press.

GSS Lead States. (2013). *Next generation science standards: For states, by states*. Washington, DC: The National Academies Press.

Gweon, H., Pelton, H., Konopka, J. A., & Schulz, L. E. (2014). Sins of omission: Children selectively explore when teachers are under-informative. *Cognition*, *132*, 335–341. https://doi.org/10.1016/j.cognition.2014.04.013

Gweon, H., Tenenbaum, J. B., & Schulz, L. E. (2010). Infants consider both the sample and the sampling process in inductive generalization. *Proceedings of the National Academy of Sciences of the United States of America*, *107*, 9066–9071. https://doi.org/10.1073/pnas.1003095107

Harris, P. L., German, T., & Mills, P. (1996). Children's use of counterfactual thinking in causal reasoning. *Cognition*, *61*, 233–259. https://doi.org/10.1016/S0010-0277(96)00715-9

Harris, P. L., Koenig, M. A., Corriveau, K. H., & Jaswal, V. K. (2018). Cognitive foundations of learning from testimony. *Annual Review of Psychology*, *69*, 251–273. https://doi.org/10.1146/annurev-psych-122216-011710

Haun, D. B., Rekers, Y., & Tomasello, M. (2012). Majority-biased transmission in chimpanzees and human children, but not orangutans. *Current Biology*, *22*, 727–731. https://doi.org/10.1016/j.cub.2012.03.006

Koenig, M. A., & Harris, P. L. (2005). Preschoolers mistrust ignorant and inaccurate speakers. *Child Development*, *76*, 1261–1277. https://doi.org/10.1111/j.1467-8624.2005.00849.x

Kuhn, D., Amsel, E., O'Loughlin, M., Schauble, L., Leadbeater, B., & Yotive, W. (1988). *The development of scientific thinking skills*. Cambridge, MA: Academic Press.

Kuhn, D., & Dean, D. (2004). Connecting scientific reasoning and causal inference. *Journal of Cognition and Development*, *5*, 261–288. https://doi.org/10.1207/s15327647jcd0502_5

Kushnir, T., & Gopnik, A. (2005). Young children infer causal strength from probabilities and interventions. *Psychological Science*, *16*, 678–683. https://doi.org/10.1111/j.1467-9280.2005.01595.x

Legare, C. H., Gelman, S. A., & Wellman, H. M. (2010). Inconsistency with prior knowledge triggers children's causal explanatory reasoning. *Child Development*, *81*, 929–944. https://doi.org/10.1111/j.1467-8624.2010.01443

Lewandowsky, S., Ecker, U. K., Seifert, C. M., Schwarz, N., & Cook, J. (2012). Misinformation and its correction: Continued influence and successful debiasing. *Psychological Science in the Public Interest*, *13*, 106–131. https://doi.org/10.1177/1529100612451018

Luce, M. R., Callanan, M. A., & Smilovic, S. (2013). Links between parents' epistemological stance and children's evidence talk. *Developmental Psychology*, *49*, 454–461. https://doi.org/10.1037/a0031249

Lyons, K. E., & Ghetti, S. (2011). The development of uncertainty monitoring in early childhood. *Child Development*, *82*, 1778–1787. https://doi.org/10.1111/j.1467-8624.2011.01649.x

Macris, D. M., & Sobel, D. M. (2017). The role of evidence diversity and explanation in 4- and 5-year-olds' resolution of counterevidence. *Journal of Cognition and Development*, *18*, 358–374. https://doi.org/10.1080/15248372.2017.1323755

Magid, R. W., Sheskin, M., & Schulz, L. E. (2015). Imagination and the generation of new ideas. *Cognitive Development*, *34*, 99–110. https://doi.org/10.1016/j.cogdev.2014.12.008

Mills, C. M., Legare, C. H., Grant, M. G., & Landrum, A. R. (2011). Determining who to question, what to ask, and how much information to ask for: The development of inquiry in young children. *Journal of Experimental Child Psychology*, *110*, 539–560. https://doi.org/10.1016/j.jecp.2011.06.003

Pratt, M. W., & Bates, K. R. (1982). Young editors: Preschoolers' evaluation and production of ambiguous messages. *Developmental Psychology*, *18*, 30–42. https://doi.org/10.1037/0012-1649.18.1.30

Rhodes, M., Bonawitz, E., Shafto, P., Chen, A., & Caglar, L. (2015). Controlling the message: Preschoolers' use of information to teach and deceive others. *Frontiers in Psychology*, *6*, 867. https://doi.org/10.3389/fpsyg.2015.00867

Rhodes, M., Gelman, S. A., & Brickman, D. (2010). Children's attention to sample composition in learning, teaching and discovery. *Developmental Science*, *13*, 421–429. https://doi.org/10.1111/j.1467-7687.2009.00896.x

Ruggeri, A., Sim, Z. L., & Xu, F. (2017). "Why is Toma late to school again?" Preschoolers identify the most informative questions. *Developmental Psychology*, *53*, 1620–1632. https://doi.org/10.1037/dev0000340

Schulz, L. E., & Bonawitz, E. B. (2007). Serious fun: Preschoolers engage in more exploratory play when evidence is confounded. *Developmental Psychology*, *43*, 1045–1050. https://doi.org/10.1037/0012-1649.43.4.1045

Schulz, L. E., & Gopnik, A. (2004). Causal learning across domains. *Developmental Psychology*, *40*, 162–176. https://doi.org/10.1037/0012-1649.40.2.162

Sobel, D. M., & Sommerville, J. A. (2009). Rationales in children's causal learning from others' actions. *Cognitive Development*, *24*, 70–79. https://doi.org/10.1016/j.cogdev.2008.08.003

Stahl, A. E., & Feigenson, L. (2015). Observing the unexpected enhances infants' learning and exploration. *Science*, *348*, 91–94. https://doi.org/10.1126/science.aaa3799

Tomasello, M. (2019). *Becoming human: A theory of ontogeny*. Cambridge, MA: Harvard University Press. https://doi.org/10.4159/9780674988651

Wellman, H. M., & Woolley, J. D. (1990). From simple desires to ordinary beliefs: The early development of everyday psychology. *Cognition*, *35*, 245–275. https://doi.org/10.1016/0010-0277(90)90024-E

Yu, Y., & Kushnir, T. (2016). When what's inside counts: Sequence of demonstrated actions affects preschooler's categorization by nonobvious properties. *Developmental Psychology*, *52*, 400–410. https://doi.org/10.1037/dev0000088