Children as cultural explorers: How imitation, pedagogy, and selective trust prepare children for learning in the cultural niche

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Abstract

Human societies have developed over millennia to living in a variety of different social and physical environments, accumulating adaptations too complex and interdependent to be developed independently within the span of a single generation. Thus, every child, as a new member of their culture, must be able to learn from others in order to acquire the knowledge necessary to succeed—and every culture requires its children to be successful social learners for tools, technologies, and beliefs to be transmitted to the next generation. In this chapter, we examine the range of social learning abilities that children are equipped with, and how these capacities facilitate making inferences when faced with ambiguous and complex information. In particular, by combining their capacity for high-fidelity imitation and for understanding others' intentions and goals, children can not only learn about a variety of physical causal relationships but also about a society's norms, traditions, and rituals. Children can also form sophisticated and nuanced beliefs about when to trust others' testimony, and balance the epistemic and normative value of imi-

tating others when their sources disagree on what to believe or how to act. These characteristics, we argue, reflect children's adaptation to learning within a cultural context, and prompt consideration about the unique role that children may play in cultural learning.

Keywords: social learning; cultural learning; pedagogy; imitation; selective trust

1 Introduction

Imagine that you are a passenger on a ship in the Arctic that becomes trapped when the sea ice around you freezes, leaving you unable to navigate away. While your ship is well-stocked, you and the crew of the ship slowly begin to run out of provisions, and soon enough find yourself facing winters averaging a temperature –30°C, requiring protection from the cold as well as sources of food and fresh water. Someone unfamiliar with the environment might be able to generate intuitive solutions to these issues—such as hunting animals for fur coats and food, and melting ice or snow as a source of fresh water—but these descriptions belie the complexity of the problem to be solved.

For example, seals are an essential source of food, both for their meat and for their blubber, which is necessary to create fires in the absence of wood; however, seal hunting requires specialized knowledge about where to find seals and how to travel safely on sea ice, as well as knowledge about crafting and using tools such as harpoons out of caribou antlers. Obtaining potable water requires identifying sea ice old enough to become desalinated, as well as knowledge about how to create fires out of seal blubber, moss, and carved soapstone in order to melt this ice. To protect oneself from the cold, one must not only be able to build shelters resistant to wind and extreme cold by cutting blocks out of snowdrifts with a bone knife, but also know to fashion clothing out of caribou skin from an autumn hunt, at which point it provides superior insulation for extreme temperatures.

This description of the specificity and complexity of the adaptations required to survive in an extreme environment such as the Arctic is posed by Boyd et al. (2011), who describe several cases of groups of European explorers in northern Canada who became stranded due to freezing ice. Critically, even with ample time and resources to acclimatize themselves to their surroundings, these explorers often perished. The notable exceptions to this pattern were explorers who approached the local Inuit inhabitants and learned how to clothe, feed, and shelter themselves using the pre-existing cultural technologies of the Inuit, which were already adapted and optimized for the Arctic environment. These technologies are the product of a multigenerational, iterative process of development and refinement, the existence of which reflects the human ability to transmit prepackaged, conventional knowledge to members of our social groups.

This stark example illustrates a human evolutionary specialization termed by Boyd and colleagues as the cultural niche: that our success as a species rests not solely on

our flexible and powerful cognitive capacities, but our particular attunement, beginning in early infancy, towards learning from others quickly and effectively. The techniques necessary for survival in any unfamiliar environment are not trivial, even as an intelligent adult with prior experiences to draw from.

However, although most adults are not faced with a challenge of this scale, every child is born an "explorer" into a novel culture. Without a deep well of personal experience to draw from, children must be able to rapidly learn the skills, technologies and norms of their culture. With limited knowledge and experience, social models, authorities, and peers become an especially important and informative source of knowledge about the world that can be quickly obtained. By adopting a well-tested strategy from a trusted member of their society, children can obviate the need to engage in the slow, expensive, and possibly dangerous process of trial and error to determine how to interact with the world, and they can then integrate these sources of information with their own direct experience and observation, scaffolding their existing information about a world with highly complicated and ambiguous causal relationships.

While learning from others can be very useful, it can also lead us astray in some situations: people can sometimes be mistaken, unskilled, or untrustworthy, and even trusted or knowledgeable sources of information can sometimes have imperfect knowledge. Further, children often learn from multiple different sources, which may disagree and provide conflicting information. Thus, we require effective strategies for resolving the problems that reliance on others' information introduces.

In this chapter, we will outline the characteristics of human learning across development that facilitate our uniquely effective social learning. First, we discuss the emergence and importance of high-fidelity imitation in children, and how the seemingly less selective strategy of "overimitating" may be more than a naive heuristic, but a strategy necessary for facilitating more complete and effective learning. We tie this tendency to children's sophisticated reasoning about intentionality, ostension and pedagogy, which facilitates rapid induction and generalization not just about what children do see, but about what they do not see as well. Finally, we discuss how children use what they observe to reason about the quality of the information as well as about the sources of information themselves, developing selective trust in more reliable and competent informants, and using signals such as the proportion of people endorsing a claim to bolster these inferences.

2 Learning from doing: imitation and overimitation

What sets children's learning apart from that of other animals? Social learning is observed throughout multiple different species, including bumblebees (Dawson et al., 2013), birds (Holzhaider et al., 2010; Morales Picard et al., 2017; Templeton et al., 1999), fish (Brown & Laland, 2003), and primates (Marshall-Pescini & Whiten, 2008; van de Waal et al.,

2013; Whiten et al., 2007). One characteristic that differs markedly, however, is the faithfulness with which children copy others' behaviour. This facet of social learning has been proposed to underlie our unique success, allowing children to quickly adopt the existing tools, technologies, and rituals of a society (Tomasello, 1994, 1999). When paired with a capacity to innovate new solutions, this allows our cultural learning to operate as a "ratchet", allowing the accumulation and transmission of successful modifications to a behaviour or a belief that might never be reachable by a single individual without the presence of pre-existing cultural adaptations (Dean et al., 2014; Enquist et al., 2010; Legare & Nielsen, 2015; Lewis & Laland, 2012; Tennie et al., 2009; Tomasello, 1994, 1999).

Yet there is a puzzling consequence to this early social learning capacity: unlike other primates, human children will often imitate actions that are transparently irrelevant to achieving a goal. For example, Horner and Whiten (2005) observed that children and chimpanzees both imitated a demonstrator's actions with high fidelity when learning how to open an opaque puzzle box. However, when the puzzle box was transparent, and it could be seen that one of the actions to open the box had no causal effect, chimpanzees ignored the irrelevant action, and only performed the causally efficacious action to open the box. In contrast, 3–4-year-old children faithfully imitated both the irrelevant and the relevant actions.

This tendency, also known as "overimitation", appears to call into question whether children are more effective social learners than chimpanzees, and even seems to defy the notion that they have an intuitive grasp on the logic of causality. Yet this faithful adherence to an observed behaviour comes with a number of benefits as well: it also facilitates children's learning of substantially more complex tasks, where causality may be unknown or inaccessible (Lyons et al., 2011; Lyons et al., 2007). For example, the reason for following all of the steps in a recipe may not be immediately evident, but copying each step faithfully allows one to represent the entire procedure in the context of the desired goal of preparing the food, rather than having to decompose an action sequence into components whose purpose may not be understood (Buchsbaum et al., 2011; Buchsbaum et al., 2015), facilitating the cultural transmission of complex technologies even when their causal structure is not known by all members of a society.

Children's imitation can often be useful for the purpose of uncovering unknown causal relationships, as they sometimes lack specific causal knowledge that adults might already have. However, their need to learn from causally opaque situations cannot explain the propensity to imitate alone; indeed, despite having greater experience and more thorough causal knowledge, adults show even higher rates of overimitation than children (McGuigan et al., 2011). A parallel line of research has therefore emphasized that high-fidelity imitation offers not just instrumental, but also conventional advantages. Indeed, most children are aware when a causally irrelevant action is not strictly necessary to achieve

a goal (Kenward, 2012); instead, children appear to treat such imitative behaviour as normative. For example, preschoolers will spontaneously protest when they observe a demonstrator fail to imitate a previously observed unnecessary action (Kenward et al., 2011) and overimitate most frequently in normative, rather than instrumental, contexts (Clay et al., 2018; Legare et al., 2015).

This predisposition to imitate facilitates their reasoning not only about the causal utility of a behaviour, but also about when conformity carries social benefits. For example, when a child observes an intentional behaviour that clearly accomplishes no physical outcome, one possible inference is that the actor is incompetent or unreliable. However, an equally valid conclusion is that the action carries normative importance, and functions as a social ritual. Although the purpose behind such actions may be causally opaque, engaging in such rituals cements our relationship with our social groups, and facilitates inferences about the normativity and social nature of the behaviours (Kapitány & Nielsen, 2015; Over, 2020).

Children can reliably understand that instrumental and normative considerations differ from an early age. While infants' imitation of others takes into account instrumental reasons for behaviour (Gergely et al., 2002), by three years of age, children are also able to determine the extent and context-sensitivity of their inferences, endorsing conventional behaviours only when a norm dictates that an actor should do it (Rakoczy et al., 2009; Schmidt et al., 2011), suggesting that they differentiate between actions with conventional justifications and actions with instrumental justifications.

However, while there are often explicit cues to the fact that a behaviour is conventional rather than (or in addition to) being instrumental, such as language, repetition, and synchrony between multiple actors (Herrmann et al., 2013), the distinction between instrumental and normative behaviour is not dichotomous. Rather, the faithfulness of imitation may reflect a continuum of considerations, including not only interpretations of the efficiency and rationality of a behaviour but also the desire to express social affiliation and conform to social pressures (Hoehl et al., 2019). Thus, even in contexts where children gain limited information about behaviours' instrumental purpose, children are deeply sensitive to the intentionality of others' behaviour and use this to develop intuitions about the social world.

3 Learning about teaching

Imitating, and imitating well, is an important component of our learning. Yet on its own, imitating with perfect fidelity is not enough: learning how to act by simply observing and indiscriminately copying a strategy from another does not provide an inherent adaptive advantage over ignoring others and learning through one's own direct experience alone (Boyd & Richerson, 1985; Giraldeau et al., 2002; Rogers, 1988). Thus, critical to the suc-

cess of the strategy of learning from copying another is that it is paired with appropriate strategies or selectivity in learning (Kendal et al., 2018; Laland, 2004).

This can take several forms: for example, one may be selective in deciding *when* to imitate, *whom* to imitate, or *what* to imitate. But one particularly important strategy for social learning seems to straddle these criteria, or to integrate multiple at once: learning from teaching. Though there has been debate on the existence and extent of teaching in nonhuman animals (Caro & Hauser, 1992; Csibra & Gergely, 2011; Hoppitt et al., 2008; Kline, 2015; Strauss & Ziv, 2012), examples of teaching in animals tend to be highly narrow and task-specific (Musgrave et al., 2016; Thornton & McAuliffe, 2006). In contrast, teaching is widespread in humans, present in broad contexts and across societies of all scales and sizes (Kruger & Tomasello, 1998), albeit with considerable cultural variation in the form that it takes (Csibra & Gergely, 2011).

Further, children's sensitivity to others' gaze and spontaneous imitation of others' intentional actions from early in development—within the first few months of life—reflect a deep adaptation to an learning environment with others who are similar to oneself (Meltzoff, 2007) and who provide effective, extensive teaching (Csibra & Gergely, 2006, 2009). In other words, children's social environment is not simply another source of information interchangeable with the information they acquire from their own exploration. Rather, observing others' behaviour allows children to make inferences that rely on others' intentionality and goals, facilitating faster and stronger inductive learning (Bonawitz & Shafto, 2016; Gweon et al., 2010).

These inferences can disambiguate observed information in ways that facilitate rapid acquisition of knowledge. For example, if a child observes someone interact with a toy with two buttons and a light, the other person's behaviour facilitates different inferences. If the person stumbles and presses both buttons accidentally, and then the light turns on, a child may conclude that one button, the other, or both may be necessary to activate the toy, as the physical evidence supports all three interpretations. However, a stronger causal inference—that both buttons are more likely to be needed in order to activate the toy—is facilitated if the child observes the person intentionally pressing both buttons, because the person specifically intended to press both (Shafto et al., 2012; Shafto et al., 2014).

Such inferences can become even more powerful with the assumptions facilitated by pedagogical learning. Understanding social others not just as behaving intentionally with respect to a physical goal (e.g., activating a toy), but as displaying a communicative intent (e.g., teaching the child how to activate the toy), means that an additional inductive assumption may be made about a teacher's behaviour: the teacher's behaviour is not simply just one effective way of activating the toy among many, but rather a signal that the teacher knows how the toy works, and is giving the child the most informative data to understand how to activate the toy. The constraints on learning obtained from

pedagogical contexts may not emerge until later in childhood (Tecwyn et al., 2020), but children's inductive leaps in these situations are still much larger than those of other primates (Buchsbaum et al., 2011; Buchsbaum et al., under review).

Although such generalizations are frequently useful, they can occasionally limit learning; for example, in Bonawitz et al. (2011), children who were instructed about only one effective action to play with a toy engaged in less spontaneous exploration, and discovered fewer of the total functions of the toy. Nevertheless, despite occasionally backfiring and leading to less overall learning, the assumption that teachers will not choose information that will lead a child to suboptimal learning is critical for rapid learning about when and how to imitate (Buchsbaum et al., 2011), explore (Butler & Markman, 2012; Butler & Tomasello, 2016), or generalize (Butler & Markman, 2014). This information augments children's understanding of a situation beyond observed causal outcomes, to include the role of the demonstrator's intentions or goals as a cause in and of themselves.

4 The development of selective trust

Representing others' goals and intentions also shapes an understanding not only of what demonstrators are attempting to teach, but also about characteristics of the demonstrators themselves; in other words, when we learn *from* others, we also learn *about* others (Bridgers et al., 2016; Buchsbaum, Bridgers, et al., 2012; Buchsbaum, Seiver, et al., 2012). Thus, seeing a demonstrator engage in pedagogy tells a learner not only that the information received from the demonstrator should be assumed to be sampled pedagogically, but also that the demonstrator intends to be perceived as an authority regarding this piece of knowledge.

Children's trust in such authority is not absolute, however, and they are sensitive to the perceived reliability of their sources of information. As children may lack specific knowledge about what they are learning, they can rely on a number of different social cues as effective proxies for such reliability (for reviews, see Harris et al., 2018; Sobel & Kushnir, 2013; Stephens et al., 2015). For example, one strong cue is familiarity: children display a high amount of trust in their own mothers (Corriveau, Harris, et al., 2009) and other familiar sources such as teachers (Corriveau & Harris, 2009) and cartoon characters (Danovitch & Mills, 2014). Further, repeated exposure to a novel character increased epistemic trust in the source before making any kinds of claims or demonstrations (Reyes-Jaquez & Echols, 2013). Closely related to this tendency is a preference for teachers that resemble oneself. Trust is extended to children's own perceived ingroups, including one's own linguistic community (Howard et al., 2015; Kinzler et al., 2011; Kinzler et al., 2007), gender (Taylor, 2013; Terrier et al., 2016), or arbitrary minimal groups (Elashi & Mills, 2014; MacDonald et al., 2013).

But especially as children begin to gain more opportunities to directly observe in-

formation themselves, they can use their own pre-existing partial knowledge to draw conclusions about a demonstrator's competence or reliability (Brink & Wellman, 2020; Corriveau & Harris, 2009; Harris & Corriveau, 2011; Koenig et al., 2004; Koenig & Harris, 2005; Koenig & Jaswal, 2011; Ronfard & Corriveau, 2016; Sobel & Kushnir, 2013). These inferences complement and augment pre-existing social learning strategies that emphasize particular model characteristics for whose behaviour or belief to adopt (Kendal et al., 2018; Laland, 2004; Wood et al., 2012, 2013).

Furthermore, children's inferences are calibrated to the confidence of a demonstrator and the strength of the evidence; for example, in Bridgers et al. (2016), 4-year-old children observed a demonstrator who claimed to be knowledgeable about a machine that could be activated with one of two blocks, or one who simply guessed about which block was superior. Without observing the behaviour of the blocks, children were more likely to endorse the demonstrator that claimed to know about the blocks. After observing a probabilistic pattern of activation that contradicted the claims of the demonstrator, children balanced the statistical evidence with the confidence of the demonstrator, almost never choosing the block endorsed by the naive demonstrator, but choosing the block endorsed by the confident demonstrator about 50% of the time.

Children's choices of which informants they believe or imitate also depend on making inductions about the appropriate scope of their trust (or distrust) in a source, particularly regarding a source's expertise. For example, in Koenig and Jaswal (2011), children observed characters labelling the names of dogs, before making statements about category labels in a novel domain. When children heard the claims of a dog expert as well as a neutral source, children trusted the dog expert's labels of dogs more than the neutral source, but did not extend this preference to the novel domain. In contrast, when children observed an incompetent source as well as a neutral source, the neutral source was preferred for both dogs and the novel domain. This pattern may reflect broader inferences about the untrustworthiness of unreliable informants (Doebel & Koenig, 2013; Koenig & Doebel, 2013).

In contrast, children and adults alike know that different people may be experts in different domains, and do not expect the reliability of an expert on one topic to transfer to unrelated topics (Danovitch & Keil, 2004; Keil et al., 2008; Lutz & Keil, 2002), place greater trust in experts' domain-specific knowledge (Lane & Harris, 2015) and understand that specialist experts tend to have narrower, but deeper, knowledge about a topic than generalists (Landrum & Mills, 2015). This comprehension of the implications of the "division of cognitive labour" present in society underpins our ability to benefit from and rely on others' expertise, granting us a "community of knowledge" spanning many domains, without requiring more than a shallow understanding of the content of this knowledge (Rabb et al., 2019). This distributed knowledge is necessary for the generation of and ongoing transmission of technologies or highly specialized knowledge,

such as powered aviation or microbiology, which have become so complex that no single expert can have exhaustive knowledge of them (Sloman & Fernbach, 2018). Instead, our learning from testimony relies on a chain of epistemic dependence, wherein we do not simply learn about a piece of information from others, but display an ongoing reliance on others' deeper experience or understanding (Rabb et al., 2019).

5 Selective trust in consensus and majorities

The task of whom to consider competent, reliable, and trustworthy is made all the more imposing by the fact that the information we could use to assess an informant's expertise is not always directly observable, and even when it is, we may not have the knowledge necessary to verify it, especially at young ages, when we are still developing intuitions and knowledge about basic physical processes such as causality and intuitive physics.

Thus, in addition to the characteristics that children use to determine which individuals are more trustworthy, they display an awareness of the degree to which beliefs or behaviours are shared by many members of a community. Given the epistemic value of consensus—it is more likely to emerge when a belief is warranted—it should not come as a surprise that agreement between individuals tends to lead children to weight information coming from large groups more heavily. For example, when lacking perceptual certainty, children more heavily weighted the report of multiple informants than a single informant in their responses (Bernard et al., 2015; Corriveau, Fusaro, et al., 2009; Kim & Spelke, 2020), and tend to copy actions and labels that are used most commonly by members of a group (Whiten & Flynn, 2010).

This tendency to follow a majority in the absence of any other information is common across multiple species (e.g., Chou & Richerson, 1992; Haun et al., 2013; Lachlan et al., 1998; Lefebvre & Giraldeau, 1994), and such tendencies are frequently mathematically favoured (Boyd & Richerson, 1985; Henrich & Boyd, 1998). However, adults do not simply blindly trust majorities, preferring the opinion of a minority with direct information to a majority whose opinion is dependent on a single source (Hu et al., 2015; Otsubo et al., 2017; Whalen et al., 2018), although people may struggle more to appropriately weight the statistical dependency of consensus depending on how subjective or objective a domain is perceived to be (Aboody et al., in press; Yousif et al., 2019).

Preschool-aged children also understand that sources of information need to be verified to be trustworthy and judge unverified claims as less acceptable (Butler et al., 2020; Butler et al., 2018), but they may struggle more in determining the quality of information when source quality conflicts with the size of a majority (Hu et al., 2015) or when majority members share the same source of their information (Otsubo et al., 2017).

Nevertheless, children's reliance on the majority as a source of information is calibrated to the domain of information being received. For example, in Pham and Buchs-

baum (2020), 4- and 5-year-old children observed a 3-person majority that endorsed one object and a 1-person minority that endorsed a different object. When performing a linguistic task (labelling an object), children tended to follow along with the majority's choice as long as children observed the majority endorse an item when another possible item was present and visible. However, when performing a causal task (e.g., pulling a tab to play music), children could see that the causal actions of both the majority and minority were equally efficacious. They showed a weaker preference for the majority relative to the language task, and only when the majority explicitly disendorsed the other potential choice. Thus, while children are sensitive to the presence of a majority alone, a majority may be considered more reliable evidence for imitating in normative contexts, such as the meaning of a word, than in instrumental contexts where children can still integrate their own observation of a causal relationship.

Despite the ability to rely on their own observations, children will sometimes defer to majority testimony that conflicts with their own observations. However, this deference has limits; for example, although children are more highly conformist than adults when facing unanimous groups (Walker & Andrade, 1996), younger children actually underweight social information when they observe disagreement, preferring to rely on their own information, and do not develop an adultlike tendency to conform adaptively to non-total majorities until the age of 7 (Morgan et al., 2015). Furthermore, children's deference does not extend to situations where children had to apply their knowledge to solving a task (Corriveau & Harris, 2010). This behaviour may reflect normative, rather than epistemic, considerations, as children's private assessments of the truth in situations where a majority conflicts with their own observations suggest that children trust their observations, and publicly, but not privately, endorse the majority's opinion (Haun & Tomasello, 2011).

Such patterns extend to imitation of unnecessary behaviours as well; while children will overimitate causally irrelevant actions performed by a majority when observers approve of the majority and disapprove of a minority which only performs causally relevant actions, they perform only the causally relevant actions when observers observe both sets of actions neutrally (Evans et al., 2021). Children may also vary in the degree to which they prefer to endorse a majority in contexts where the majority's behaviour conflicts with that of an expert; while in aggregate children prefer to copy an expert's behaviour rather than that of an incompetent majority, some children preferred to imitate the majority in both instrumental and normative contexts (Burdett et al., 2016). While children are still somewhat selective in their imitation of a group, their willingness to conform at all contrasts sharply with the behaviour of other great apes, who largely do not shift their own behaviour to match a conspecific's, preferring to maintain their own previously effective strategy (Haun et al., 2014).

6 Conclusions

Children are born into a profoundly complex physical and social environment. To resolve the significant challenge to learning this poses, children cannot simply rely on their own advanced intelligence, but must also understand the goals and intentions of the behaviour of people around them. In turn, they must use this information to determine whose information should be trusted and to what extent, while calibrating the information they obtain with their own pre-existing knowledge.

The strategies children deploy reflect a deep adaptation to human cultures in which collective knowledge, both of epistemic truths (Sloman & Fernbach, 2018) and cultural innovations (Migliano & Vinicius, 2022; Pradhan et al., 2012), is distributed among many members of society. Faithfully imitating the process, not simply the outcomes, of others' actions facilitates learning about complex, sequential causal relationships, but also enhances the transmission of cultural traditions or technologies where causality may be opaque to some—or even all—members of a community (Henrich, 2015). Similarly, imitation may help to lay the groundwork of infants' ability to understand others' intentionality (Meltzoff, 2002, 2007), further shaping children's interpretations of their observations by considering them through the lens of what others believe and how they act. In turn, by using these inferences to reason about others' trustworthiness, children can learn from others efficiently even when these sources of information may be unreliable or conflict with each other.

6.1 Open Questions

Although children quickly learn the beliefs, norms, and traditions of the society that they are born into, there is a possible paradox to children's rapid acculturation and acquisition of knowledge within the context of our cultural learning. On the one hand, children are highly curious, and are often more willing than adults to engage in greater exploration (Blanco & Sloutsky, 2020; Liquin & Gopnik, 2022) and entertain more unusual or imaginative hypotheses when faced with uncertain evidence (Gelpi et al., 2020; Lucas et al., 2014), which can sometimes make them better or more flexible learners than adults. These characteristics of creativity and lateral thinking would appear to be essential ingredients to the most impressive technological and scientific advancements of human cumulative culture, and they been argued to reflect a solution to the explore-exploit dilemma through a lifelong tuning in the propensity to explore (Gopnik, 2020).

On the other hand, children show very low rates of innovation relative to adults until later in childhood (Carr et al., 2015) and struggle to develop novel tools. For example, children introduced to a task where they had to bend a pipecleaner to develop a tool to retrieve stickers from a bucket struggled to independently turn the pipecleaner into a hook by bending it, even when they had a full understanding that they could bend

the pipecleaners to change their shape (Cutting et al., 2014). Children can also be hindered in their ability to successfully innovate by modifying a pre-existing tool rather than developing their own (Cutting et al., 2019), suggesting that under some conditions they can be vulnerable to "learning traps" that are more frequently observed in adults (e.g., Gelpi et al., 2020; Liquin & Gopnik, 2022; Rich & Gureckis, 2018).

How is it that children can on the one hand be prolific imitators with low rates of innovation, and on the other hand be highly exploratory and creative, sometimes coming up with solutions that adults do not? Developing an effective balance between conformity and divergence may itself be a culturally learned process. Indeed, children as young as 2 years old show greater evidence of divergent thinking when presented with a model that plays with toys in multiple different ways (Hoicka et al., 2018). Being presented with candidate solutions to a problem also leads children to generate more novel solutions, while it tends to constrain adults' ability to propose them (Cassotti et al., 2016). And while children do tend to rely more on consensus than adults, they are less likely to conform to majorities than adults when there is variation or disagreement within a population (Morgan et al., 2015; Walker & Andrade, 1996).

We suggest that future work should consider whether this puzzling combination may reflect children's unique role in driving cultural learning. Children are not simply consumers of information, but play an active role in their own learning throughout development (Gopnik & Wellman, 2012; Xu & Kushnir, 2013). One possibility, then, is that even if children may struggle to develop the new technologies that build cumulative culture, due to the high demands on prior knowledge and specialization that developing these innovations requires in a highly complex society, children's creativity and open-mindedness may nonetheless predispose them to being early adopters of new innovations and ideas. For a culture to change and evolve, new tools, technologies, and traditions must not only be invented or developed, but they must then be adopted by others, and ultimately replace pre-existing solutions in order to become established in a society. By better understanding what makes children's exploration different from that of adults, we can establish the unique role that children might play in the cultural niche; not necessarily in blazing trails that have never been tried before, but in exploring the variation inherent to every culture.

References

Aboody, R., Yousif, S. R., Sheskin, M., & Keil, F. (in press). Says who? Children consider informants' sources when deciding whom to believe. *Journal of Experimental Psychology: General*.

Bernard, S., Harris, P., Terrier, N., & Clément, F. (2015). Children weigh the number of informants and perceptual uncertainty when identifying objects. *Journal of*

Experimental Child Psychology, *136*, 70–81. https://doi.org/10.1016/j.jecp.2015.03.009

Blanco, N. J., & Sloutsky, V. M. (2020). Attentional mechanisms drive systematic exploration in young children. *Cognition*, *202*, 104327. https://doi.org/10.1016/j.cognition.2020.104327

Bonawitz, E., & Shafto, P. (2016). Computational models of development, social influences. *Current Opinion in Behavioral Sciences*, *7*, 95–100. https://doi.org/10.1016/j.cobeha.2015.12.008

Bonawitz, E., Shafto, P., Gweon, H., Goodman, N. D., Spelke, E., & Schulz, L. (2011). The double-edged sword of pedagogy: Instruction limits spontaneous exploration and discovery. *Cognition*, *120*(3), 322–330. https://doi.org/10.1016/j.cognition.2010.10.001

Boyd, R., Richerson, P. J., & Henrich, J. (2011). The cultural niche: Why social learning is essential for human adaptation. *Proceedings of the National Academy of Sciences*, *108*(Supplement_2), 10918–10925. https://doi.org/10.1073/pnas.1100290108

Boyd, R., & Richerson, P. J. (1985). *Culture and the evolutionary process*. University of Chicago press.

Bridgers, S., Buchsbaum, D., Seiver, E., Griffiths, T. L., & Gopnik, A. (2016). Children's causal inferences from conflicting testimony and observations. *Developmental Psychology*, *52*(1), 9–18. https://doi.org/10.1037/a0039830

Brink, K. A., & Wellman, H. M. (2020). Robot teachers for children? Young children trust robots depending on their perceived accuracy and agency. *Developmental Psychology*, *56*(7), 1268–1277. https://doi.org/http://dx.doi.org/10.1037/dev0000884

Brown, C., & Laland, K. N. (2003). Social learning in fishes: A review. *Fish and Fisheries*, *4*(3), 280–288. https://doi.org/10.1046/j.1467-2979.2003.00122.x

Buchsbaum, D., Bridgers, S., Whalen, A., Seiver, E., Griffiths, T. L., & Gopnik, A. (2012). Do I know that you know what you know? Modeling testimony in causal inference. *Proceedings of the 34th Annual Meeting of the Cognitive Science Society*, 156–151.

Buchsbaum, D., Gopnik, A., Griffiths, T. L., & Shafto, P. (2011). Children's imitation of causal action sequences is influenced by statistical and pedagogical evidence. *Cognition*, *120*(3), 331–340. https://doi.org/10.1016/j.cognition.2010.12.001

Buchsbaum, D., Griffiths, T. L., Plunkett, D., Gopnik, A., & Baldwin, D. (2015). Inferring action structure and causal relationships in continuous sequences of human action. *Cognitive Psychology*, *76*, 30–77.

Buchsbaum, D., Seiver, E., Bridgers, S., & Gopnik, A. (2012). Learning about Causes from People and about People as Causes. *Advances in Child Development and Behavior* (pp. 125–160). Elsevier. https://doi.org/10.1016/B978-0-12-397919-3.00005-8

Buchsbaum, D., Tecwyn, E. C., Whalen, A., Messer, E. J. E., Bryant, E. L. F., Gopnik, A., Griffiths, T. L., & Seed, A. M. (under review). Children, but not capuchins, rationally integrate social and physical information when deciding which actions to copy.

Burdett, E. R. R., Lucas, A. J., Buchsbaum, D., McGuigan, N., Wood, L. A., & Whiten, A. (2016). Do Children Copy an Expert or a Majority? Examining Selective Learning in Instrumental and Normative Contexts (R. L. Kendal, Ed.). *PLOS ONE*, *11*(10), e0164698. https://doi.org/10.1371/journal.pone.0164698

Butler, L. P., & Markman, E. M. (2012). Preschoolers Use Intentional and Pedagogical Cues to Guide Inductive Inferences and Exploration. *Child Development*, *83*(4), 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*(1), 116–127. https://doi.org/10.1016/j.cognition.2013.10.002

Butler, L. P., & Tomasello, M. (2016). Two- and 3-year-olds integrate linguistic and pedagogical cues in guiding inductive generalization and exploration. *Journal of Experimental Child Psychology*, *145*, 64–78. https://doi.org/10.1016/j.jecp.2015.12.001

Butler, L. P., Gibbs, H. M., & Tavassolie, N. S. (2020). Children's developing understanding that even reliable sources need to verify their claims. *Cognitive Development*, *54*, 100871. https://doi.org/10.1016/j.cogdev.2020.100871

Butler, L. P., Schmidt, M. F. H., 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

Caro, T. M., & Hauser, M. D. (1992). Is There Teaching in Nonhuman Animals? *The Quarterly Review of Biology*, *67*(2), 151–174. https://doi.org/10.1086/417553

Carr, K., Kendal, R. L., & Flynn, E. G. (2015). Imitate or innovate? Children's innovation is influenced by the efficacy of observed behaviour. *Cognition*, *142*, 322–332. https://doi.org/10.1016/j.cognition.2015.05.005

Cassotti, M., Camarda, A., Poirel, N., Houdé, O., & Agogué, M. (2016). Fixation effect in creative ideas generation: Opposite impacts of example in children and adults. *Thinking Skills and Creativity*, *19*, 146–152. https://doi.org/10.1016/j.tsc.2015.10.008

Chou, L.-S., & Richerson, P. J. (1992). Multiple models in social transmission of food selection by Norway rats, Rattus norvegicus. *Animal Behaviour*, *44*, 337–343. https://doi.org/10.1016/0003-3472(92)90039-C

Clay, Z., Over, H., & Tennie, C. (2018). What drives young children to over-imitate? Investigating the effects of age, context, action type, and transitivity. *Journal of*

Experimental Child Psychology, *166*, 520–534. https://doi.org/10.1016/j.jecp.2017.09.008

Corriveau, K. H., Fusaro, M., & Harris, P. L. (2009). Going With the Flow: Preschoolers Prefer Nondissenters as Informants. *Psychological Science*, *20*(3), 372–377. https://doi.org/10.1111/j.1467-9280.2009.02291.x

Corriveau, K. H., & Harris, P. L. (2009). Choosing your informant: Weighing familiarity and recent accuracy. *Developmental Science*, *12*(3), 426–437. https://doi.org/10.1111/j.1467-7687.2008.00792.x

Corriveau, K. H., & Harris, P. L. (2010). Preschoolers (sometimes) defer to the majority in making simple perceptual judgments. *Developmental Psychology*, *46*(2), 437–445. https://doi.org/10.1037/a0017553

Corriveau, K. H., Harris, P. L., Meins, E., Fernyhough, C., Arnott, B., Elliott, L., Liddle, B., Hearn, A., Vittorini, L., & de Rosnay, M. (2009). Young Children's Trust in Their Mother's Claims: Longitudinal Links With Attachment Security in Infancy. *Child Development*, *80*(3), 750–761. https://doi.org/10.1111/j.1467-8624.2009.01295.x

Csibra, G., & Gergely, G. (2006). Social learning and social cognition: The case for pedagogy. In Y. Munekata & M. H. Johnson (Eds.), *Processes of Change in Brain and Cognitive Development, Attention and Performance* (pp. 249–274). Oxford University Press.

Csibra, G., & Gergely, G. (2009). Natural pedagogy. *Trends in Cognitive Sciences*, *13*(4), 148–153. https://doi.org/10.1016/j.tics.2009.01.005

Csibra, G., & Gergely, G. (2011). Natural pedagogy as evolutionary adaptation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1567), 1149–1157.

Cutting, N., Apperly, I. A., Chappell, J., & Beck, S. R. (2014). The puzzling difficulty of tool innovation: Why can't children piece their knowledge together? *Journal of Experimental Child Psychology*, *125*, 110–117.

Cutting, N., Apperly, I. A., Chappell, J., & Beck, S. R. (2019). Is tool modification more difficult than innovation? *Cognitive Development*, *52*, 100811. https://doi.org/10.1016/j.cogdev.2019.100811

Danovitch, J. H., & Keil, F. C. (2004). Should You Ask a Fisherman or a Biologist?: Developmental Shifts in Ways of Clustering Knowledge. *Child Development*, *75*(3), 918–931. https://doi.org/10.1111/j.1467-8624.2004.00714.x

Danovitch, J. H., & Mills, C. M. (2014). How familiar characters influence children's judgments about information and products. *Journal of Experimental Child Psychology*, *128*, 1–20. https://doi.org/10.1016/j.jecp.2014.06.001

Dawson, E. H., Avarguès-Weber, A., Chittka, L., & Leadbeater, E. (2013). Learning by Observation Emerges from Simple Associations in an Insect Model. *Current Biology*, *23*(8), 727–730. https://doi.org/10.1016/j.cub.2013.03.035

Dean, L. G., Vale, G. L., Laland, K. N., Flynn, E., & Kendal, R. L. (2014). Human cumulative culture: A comparative perspective. *Biological Reviews*, *89*(2), 284–301. https://doi.org/10.1111/brv.12053

Doebel, S., & Koenig, M. A. (2013). Children's Use of Moral Behavior in Selective Trust: Discrimination versus Learning. *Developmental Psychology*, *49*(3), 462–469. https://doi.org/10.1037/a0031595

Elashi, F. B., & Mills, C. M. (2014). Do children trust based on group membership or prior accuracy? The role of novel group membership in children's trust decisions. *Journal of Experimental Child Psychology*, *128*, 88–104. https://doi.org/10.1016/j.jecp.2014.07.003

Enquist, M., Strimling, P., Eriksson, K., Laland, K., & Sjostrand, J. (2010). One cultural parent makes no culture. *Animal Behaviour*, *79*(6), 1353–1362. https://doi.org/10.1016/j.anbehav.2010.03.009

Evans, C. L., Burdett, E. R. R., Murray, K., & Carpenter, M. (2021). When does it pay to follow the crowd? Children optimize imitation of causally irrelevant actions performed by a majority. *Journal of Experimental Child Psychology*, *212*, 105229. https://doi.org/10.1016/j.jecp.2021.105229

Gelpi, R., Prystawski, B., Lucas, C. G., & Buchsbaum, D. (2020). Incremental hypothesis revision in causal reasoning across development. *Proceedings of the 42nd Annual Meeting of the Cognitive Science Society*, 974–980.

Gergely, G., Bekkering, H., & Király, I. (2002). Rational imitation in preverbal infants. *Nature*, *415*(6873), 755–755. https://doi.org/10.1038/415755a

Giraldeau, L.-.-A., Valone, T. J., & Templeton, J. J. (2002). Potential disadvantages of using socially acquired information. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *357*(1427), 1559–1566.

Gopnik, A. (2020). Childhood as a solution to explore–exploit tensions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1803), 20190502. https://doi.org/10.1098/rstb.2019.0502

Gopnik, A., & Wellman, H. M. (2012). Reconstructing constructivism: Causal models, bayesian learning mechanisms, and the theory theory. *Psychological Bulletin*, *138*(6), 1085.

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*, *107*(20), 9066–9071. https://doi.org/10.1073/pnas.1003095107

Harris, P. L., & Corriveau, K. H. (2011). Young children's selective trust in informants. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1567), 1179–1187. https://doi.org/10.1098/rstb.2010.0321

Harris, P. L., Koenig, M. A., Corriveau, K. H., & Jaswal, V. K. (2018). Cognitive Foundations of Learning from Testimony. *Annual Review of Psychology*, *69*(1), 251–273. https://doi.org/10.1146/annurev-psych-122216-011710

Haun, D. B. M., Rekers, Y., & Tomasello, M. (2014). Children Conform to the Behavior of Peers; Other Great Apes Stick With What They Know. *Psychological Science*, *25*(12), 2160–2167. https://doi.org/10.1177/0956797614553235

Haun, D. B. M., & Tomasello, M. (2011). Conformity to Peer Pressure in Preschool Children. *Child Development*, *82*(6), 1759–1767. https://doi.org/10.1111/j.1467-8624.2011.01666.x

Haun, D. B. M., van Leeuwen, E. J. C., & Edelson, M. G. (2013). Majority influence in children and other animals. *Developmental Cognitive Neuroscience*, *3*, 61–71. https://doi.org/10.1016/j.dcn.2012.09.003

Henrich, J., & Boyd, R. (1998). The evolution of conformist transmission and the emergence of between-group differences. *Evolution and Human Behavior*, *19*(4), 215–241.

Henrich, J. (2015). *The Secret of Our Success*. Princeton University Press.

Herrmann, P. A., Legare, C. H., Harris, P. L., & Whitehouse, H. (2013). Stick to the script: The effect of witnessing multiple actors on children's imitation. *Cognition*, *129*(3), 536–543. https://doi.org/10.1016/j.cognition.2013.08.010

Hoehl, S., Keupp, S., Schleihauf, H., McGuigan, N., Buttelmann, D., & Whiten, A. (2019). 'Over-imitation': A review and appraisal of a decade of research. *Developmental Review*, *51*, 90–108. https://doi.org/10.1016/j.dr.2018.12.002

Hoicka, E., Powell, S., Knight, J., & Norwood, M. (2018). Two-year-olds can socially learn to think divergently. *British Journal of Developmental Psychology*, *36*(1), 22–36. https://doi.org/10.1111/bjdp.12199

Holzhaider, J. C., Hunt, G. R., & Gray, R. D. (2010). Social learning in new Caledonian crows. *Learning & Behavior*, *38*(3), 206–219. https://doi.org/10.3758/LB.38.3.206

Hoppitt, W. J. E., Brown, G. R., Kendal, R., Rendell, L., Thornton, A., Webster, M. M., & Laland, K. N. (2008). Lessons from animal teaching. *Trends in Ecology & Evolution*, *23*(9), 486–493. https://doi.org/10.1016/j.tree.2008.05.008

Horner, V., & Whiten, A. (2005). Causal knowledge and imitation/emulation switching in chimpanzees (pan troglodytes) and children (homo sapiens). *Animal Cognition*, *8*(3), 164–181.

Howard, L. H., Henderson, A. M. E., Carrazza, C., & Woodward, A. L. (2015). Infants' and Young Children's Imitation of Linguistic In-Group and Out-Group Informants. *Child Development*, *86*(1), 259–275. https://doi.org/10.1111/cdev.12299

Hu, J. C., Whalen, A., Buchsbaum, D., Griffiths, T. L., & Xu, F. (2015). Can children balance the size of a majority with the quality of their information? *Proceedings of the 37th Annual Meeting of the Cognitive Science Society*, 956–961.

Kapitány, R., & Nielsen, M. (2015). Adopting the ritual stance: The role of opacity and context in ritual and everyday actions. *Cognition*, *145*, 13–29. https://doi.org/10.1016/j.cognition.2015.08.002

Keil, F. C., Stein, C., Webb, L., Billings, V. D., & Rozenblit, L. (2008). Discerning the Division of Cognitive Labor: An Emerging Understanding of How Knowledge Is Clustered in Other Minds. *Cognitive Science*, *32*(2), 259–300. https://doi.org/10.1080/03640210701863339

Kendal, R. L., Boogert, N. J., Rendell, L., Laland, K. N., Webster, M., & Jones, P. L. (2018). Social Learning Strategies: Bridge-Building between Fields. *Trends in Cognitive Sciences*, *22*(7), 651–665. https://doi.org/10.1016/j.tics.2018.04.003

Kenward, B. (2012). Over-imitating preschoolers believe unnecessary actions are normative and enforce their performance by a third party. *Journal of Experimental Child Psychology*, *112*(2), 195–207. https://doi.org/10.1016/j.jecp.2012.02.006

Kenward, B., Karlsson, M., & Persson, J. (2011). Over-imitation is better explained by norm learning than by distorted causal learning. *Proceedings of the Royal Society B: Biological Sciences*, *278*(1709), 1239–1246. https://doi.org/10.1098/rspb.2010.1399

Kim, S., & Spelke, E. S. (2020). Learning from multiple informants: Children's response to epistemic bases for consensus judgments. *Journal of Experimental Child Psychology*, *192*, 104759. https://doi.org/10.1016/j.jecp.2019.104759

Kinzler, K. D., Corriveau, K. H., & Harris, P. L. (2011). Children's selective trust in native-accented speakers. *Developmental science*, *14*(1), 106–111.

Kinzler, K. D., Dupoux, E., & Spelke, E. S. (2007). The native language of social cognition. *Proceedings of the National Academy of Sciences*, *104*(30), 12577–12580.

Kline, M. A. (2015). How to learn about teaching: An evolutionary framework for the study of teaching behavior in humans and other animals. *Behavioral and Brain Sciences*, *38*, e31. https://doi.org/10.1017/S0140525X14000090

Koenig, M. A., Clément, F., & Harris, P. L. (2004). Trust in testimony: Children's use of true and false statements. *Psychological Science*, *15*(10), 694–698.

Koenig, M. A., & Doebel, S. (2013). Children's Understanding of Unreliability. In M. R. Banaji & S. A. Gelman (Eds.), *Navigating the Social World* (pp. 235–240). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199890712.003.0043

Koenig, M. A., & Harris, P. L. (2005). The role of social cognition in early trust. *Trends in Cognitive Sciences*, *9*(10), 457–459.

Koenig, M. A., & Jaswal, V. K. (2011). Characterizing Children's Expectations About Expertise and Incompetence: Halo or Pitchfork Effects? *Child Development*, *82*(5), 1634–1647. https://doi.org/10.1111/j.1467-8624.2011.01618.x

Kruger, A. C., & Tomasello, M. (1998). Cultural learning and learning culture. *The Handbook of Education and Human Development: New Models of Learning, Teaching and Schooling*, 353–372.

Lachlan, R. F., Crooks, L., & Laland, K. N. (1998). Who follows whom? Shoaling preferences and social learning of foraging information in guppies. *Animal Behaviour*, *56*(1), 181–190. https://doi.org/10.1006/anbe.1998.0760

Laland, K. N. (2004). Social learning strategies. *Learning & Behavior*, *32*(1), 4–14.

Landrum, A. R., & Mills, C. M. (2015). Developing expectations regarding the boundaries of expertise. *Cognition*, *134*, 215–231. https://doi.org/10.1016/j.cognition.2014.10.013

Lane, J. D., & Harris, P. L. (2015). The Roles of Intuition and Informants' Expertise in Children's Epistemic Trust. *Child Development*, *86*(3), 919–926. https://doi.org/10.1111/cdev.12324

Lefebvre, L., & Giraldeau, L.-A. (1994). Cultural transmission in pigeons is affected by the number of tutors and bystanders present. *Animal Behaviour*, *47*(2), 331–337. https://doi.org/10.1006/anbe.1994.1046

Legare, C. H., & Nielsen, M. (2015). Imitation and Innovation: The Dual Engines of Cultural Learning. *Trends in Cognitive Sciences*, *19*(11), 688–699. https://doi.org/10.1016/j.tics.2015.08.005

Legare, C. H., Wen, N. J., Herrmann, P. A., & Whitehouse, H. (2015). Imitative flexibility and the development of cultural learning. *Cognition*, *142*, 351–361. https://doi.org/10.1016/j.cognition.2015.05.020

Lewis, H. M., & Laland, K. N. (2012). Transmission fidelity is the key to the build-up of cumulative culture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2171–2180. https://doi.org/10.1098/rstb.2012.0119

Liquin, E. G., & Gopnik, A. (2022). Children are more exploratory and learn more than adults in an approach-avoid task. *Cognition*, *218*, 104940. https://doi.org/10.1016/j.cognition.2021.104940

Lucas, C. G., Bridgers, S., Griffiths, T. L., & Gopnik, A. (2014). When children are better (or at least more open-minded) learners than adults: Developmental differences in learning the forms of causal relationships. *Cognition*, *131*(2), 284–299. https://doi.org/10.1016/j.cognition.2013.12.010

Lutz, D. J., & Keil, F. C. (2002). Early Understanding of the Division of Cognitive Labor. *Child Development*, *73*(4), 1073–1084. https://doi.org/10.1111/1467-8624.00458

Lyons, D. E., Damrosch, D. H., Lin, J. K., Macris, D. M., & Keil, F. C. (2011). The scope and limits of overimitation in the transmission of artefact culture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1567), 1158–1167.

Lyons, D. E., Young, A. G., & Keil, F. C. (2007). The hidden structure of overimitation. *Proceedings of the National Academy of Sciences*, *104*(50), 19751–19756.

MacDonald, K., Schug, M., Chase, E., & Barth, H. (2013). My people, right or wrong? Minimal group membership disrupts preschoolers' selective trust. *Cognitive Development*, *28*(3), 247–259. https://doi.org/10.1016/j.cogdev.2012.11.001

Marshall-Pescini, S., & Whiten, A. (2008). Social learning of nut-cracking behavior in east african sanctuary-living chimpanzees (pan troglodytes schweinfurthii). *Journal of Comparative Psychology*, *122*(2), 186.

McGuigan, N., Makinson, J., & Whiten, A. (2011). From over-imitation to super-copying: Adults imitate causally irrelevant aspects of tool use with higher fidelity than young children: From over-imitation to super-copying. *British Journal of Psychology*, *102*(1), 1–18. https://doi.org/10.1348/000712610X493115

Meltzoff, A. N. (2002). Elements of a developmental theory of imitation. In A. N. Meltzoff & W. Prinz (Eds.), *The imitative mind: Development, evolution, and brain bases* (pp. 19–41).

Meltzoff, A. N. (2007). 'Like me': A foundation for social cognition. *Developmental Science*, *10*(1), 126–134.

Migliano, A. B., & Vinicius, L. (2022). The origins of human cumulative culture: From the foraging niche to collective intelligence. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *377*(1843), 20200317. https://doi.org/10.1098/rstb.2020.0317

Morales Picard, A., Hogan, L., Lambert, M. L., Wilkinson, A., Seed, A. M., & Slocombe, K. E. (2017). Diffusion of novel foraging behaviour in Amazon parrots through social learning. *Animal Cognition*, *20*(2), 285–298. https://doi.org/10.1007/s10071-016-1049-3

Morgan, T. J., Laland, K. N., & Harris, P. L. (2015). The development of adaptive conformity in young children: Effects of uncertainty and consensus. *Developmental Science*, *18*(4), 511–524. https://doi.org/10.1111/desc.12231

Musgrave, S., Morgan, D., Lonsdorf, E., Mundry, R., & Sanz, C. (2016). Tool transfers are a form of teaching among chimpanzees. *Scientific Reports*, *6*(1). https://doi.org/10.1038/srep34783

Otsubo, K., Whalen, A., & Buchsbaum, D. (2017). Investigating Sensitivity to Shared Information and Personal Experience in Children's Use of Majority Information. *Proceedings of the 39th Annual Meeting of the Cognitive Science Society*, 2840–2845.

Over, H. (2020). The social function of imitation in development. *Annual Review of Developmental Psychology*, *2*, 93–109.

Pham, T., & Buchsbaum, D. (2020). Children's use of majority information is influenced by pragmatic inferences and task domain. *Developmental Psychology*, *56*(2), 312–323. https://doi.org/10.1037/dev0000857

Pradhan, G. R., Tennie, C., & van Schaik, C. P. (2012). Social organization and the evolution of cumulative technology in apes and hominins. *Journal of Human Evolution*, *63*(1), 180–190. https://doi.org/10.1016/j.jhevol.2012.04.008

Rabb, N., Fernbach, P. M., & Sloman, S. A. (2019). Individual Representation in a Community of Knowledge. *Trends in Cognitive Sciences*, *23*(10), 891–902. https://doi.org/10.1016/j.tics.2019.07.011

Rakoczy, H., Brosche, N., Warneken, F., & Tomasello, M. (2009). Young children's understanding of the context-relativity of normative rules in conventional games. *British Journal of Developmental Psychology*, *27*(2), 445–456.

Reyes-Jaquez, B., & Echols, C. H. (2013). Developmental differences in the relative weighing of informants' social attributes. *Developmental Psychology*, *49*(3), 602–613. https://doi.org/10.1037/a0031674

Rich, A. S., & Gureckis, T. M. (2018). The limits of learning: Exploration, generalization, and the development of learning traps. *Journal of Experimental Psychology: General*, *147*(11), 1553–1570. https://doi.org/10.1037/xge0000466

Rogers, A. R. (1988). Does biology constrain culture? *American Anthropologist*, *90*(4), 819–831.

Ronfard, S., & Corriveau, K. H. (2016). Teaching and preschoolers' ability to infer knowledge from mistakes. *Journal of Experimental Child Psychology*, *150*, 87–98. https://doi.org/10.1016/j.jecp.2016.05.006

Schmidt, M. F., Rakoczy, H., & Tomasello, M. (2011). Young children attribute normativity to novel actions without pedagogy or normative language. *Developmental Science*, *14*(3), 530–539.

Shafto, P., Goodman, N. D., & Frank, M. C. (2012). Learning From Others: The Consequences of Psychological Reasoning for Human Learning. *Perspectives on Psychological Science*, *7*(4), 341–351. https://doi.org/10.1177/1745691612448481

Shafto, P., Goodman, N. D., & Griffiths, T. L. (2014). A rational account of pedagogical reasoning: Teaching by, and learning from, examples. *Cognitive Psychology*, *71*, 55–89. https://doi.org/10.1016/j.cogpsych.2013.12.004

Sloman, S., & Fernbach, P. (2018). *The knowledge illusion: Why we never think alone*. Penguin.

Sobel, D. M., & Kushnir, T. (2013). Knowledge matters: How children evaluate the reliability of testimony as a process of rational inference. *Psychological Review*, *120*(4), 779–797. https://doi.org/10.1037/a0034191

Stephens, E., Suarez, S., & Koenig, M. (2015). Chapter Five - Early Testimonial Learning: Monitoring Speech Acts and Speakers. In J. B. Benson (Ed.), *Advances in Child Development and Behavior* (pp. 151–183). JAI. https://doi.org/10.1016/bs.acdb.2014.11.004

Strauss, S., & Ziv, M. (2012). Teaching Is a Natural Cognitive Ability for Humans: Teaching Is a Natural Cognitive Ability for Humans. *Mind, Brain, and Education*, *6*(4), 186–196. https://doi.org/10.1111/j.1751-228X.2012.01156.x

Taylor, M. G. (2013). Gender influences on children's selective trust of adult testimony. *Journal of Experimental Child Psychology*, *115*(4), 672–690.

Tecwyn, E. C., Seed, A. M., & Buchsbaum, D. (2020). Sensitivity to ostension is not sufficient for pedagogical reasoning by toddlers. *Proceedings of the 42nd Annual Meeting of the Cognitive Science Society*.

Templeton, J. J., Kamil, A. C., & Balda, R. P. (1999). Sociality and social learning in two species of corvids: The pinyon jay (Gymnorhinus cyanocephalus) and the Clark's nutcracker (Nucifraga columbiana). *Journal of Comparative Psychology*, *113*(4), 450–455. https://doi.org/10.1037/0735-7036.113.4.450

Tennie, C., Call, J., & Tomasello, M. (2009). Ratcheting up the ratchet: On the evolution of cumulative culture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *364*(1528), 2405–2415.

Terrier, N., Bernard, S., Mercier, H., & Clément, F. (2016). Visual access trumps gender in 3- and 4-year-old children's endorsement of testimony. *Journal of Experimental Child Psychology*, *146*, 223–230. https://doi.org/10.1016/j.jecp.2016.02.002

Thornton, A., & McAuliffe, K. (2006). Teaching in Wild Meerkats. *Science*. https://doi.org/10.1126/science.1128727

Tomasello, M. (1994). The question of chimpanzee culture. *Chimpanzee cultures* (pp. 301–317). Harvard University Press.

Tomasello, M. (1999). The human adaptation for culture. *Annual Review of Anthropology*, *28*(1), 509–529.

van de Waal, E., Borgeaud, C., & Whiten, A. (2013). Potent Social Learning and Conformity Shape a Wild Primate's Foraging Decisions. *Science*. https://doi.org/10.1126/science.1232769

Walker, M. B., & Andrade, M. G. (1996). Conformity in the Asch Task as a Function of Age. *The Journal of Social Psychology*, *136*(3), 367–372. https://doi.org/10.1080/00224545.1996.9714014

Whalen, A., Griffiths, T. L., & Buchsbaum, D. (2018). Sensitivity to Shared Information in Social Learning. *Cognitive Science*, *42*(1), 168–187. https://doi.org/10.1111/cogs.12485

Whiten, A., & Flynn, E. (2010). The transmission and evolution of experimental microcultures in groups of young children. *Developmental Psychology*, *46*(6), 1694.

Whiten, A., Spiteri, A., Horner, V., Bonnie, K. E., Lambeth, S. P., Schapiro, S. J., & de Waal, F. B. M. (2007). Transmission of Multiple Traditions within and between Chimpanzee Groups. *Current Biology*, *17*(12), 1038–1043. https://doi.org/10.1016/j.cub.2007.05.031

Wood, L. A., Kendal, R. L., & Flynn, E. G. (2012). Context-dependent model-based biases in cultural transmission: Children's imitation is affected by model age over model knowledge state. *Evolution and Human Behavior*, *33*(4), 387–394. https://doi.org/10.1016/j.evolhumbehav.2011.11.010

Wood, L. A., Kendal, R. L., & Flynn, E. G. (2013). Whom do children copy? Model-based biases in social learning. *Developmental Review*, *33*(4), 341–356. https://doi.org/10.1016/j.dr.2013.08.002

Xu, F., & Kushnir, T. (2013). Infants are rational constructivist learners. *Current Directions in Psychological Science*, *22*(1), 28–32.

Yousif, S. R., Aboody, R., & Keil, F. C. (2019). The Illusion of Consensus: A Failure to Distinguish Between True and False Consensus. *Psychological Science*, *30*(8), 1195–1204. https://doi.org/10.1177/0956797619856844