Behavioral and Brain Sciences

cambridge.org/bbs

Children as agents of cultural adaptation

Sheina Lew-Levy[a] and Dorsa Amir[b]

[a]Department of Psychology, Durham University, Durham, UK and [b]Department of Psychology & Neuroscience, Duke University, Durham, NC
sheina.lew-levy@durham.ac.uk
dorsa.amir@duke.edu

Target Article

Cite this article: Lew-Levy S and Amir D. (2026) Children as agents of cultural adaptation. *Behavioral and Brain Sciences* **49**, e225: 1–84. doi:10.1017/S0140525X24001377

Target Article Accepted: 14 February 2024 UTC
Target Article Manuscript Online: 26 December 2024 UTC
Commentaries Accepted: 15 November 2024 UTC

Keywords:
human life history; cultural evolution; peer culture; child culture; cultural adaptation; cultural diversity

What is Open Peer Commentary? What follows on these pages is known as a Treatment, in which a significant and controversial Target Article is published along with Commentaries (p. 21) and an Authors' Response (p. 73). See bbsonline.org for more information.

Corresponding author:
Dorsa Amir; Email: dorsa.amir@duke.edu

Abstract

The human capacity for culture is a key determinant of our success as a species. While much work has examined adults' abilities to create and transmit cultural knowledge, relatively less work has focused on the role of children (approximately 3–17 years) in this important process. In the cases where children are acknowledged, they are largely portrayed as *acquirers* of cultural knowledge from adults, rather than cultural producers in their own right. In this paper, we bring attention to the important role that children play in cultural adaptation by highlighting the structure, function, and ubiquity of the large body of knowledge produced and transmitted by children, known as *peer cultures*. Supported by evidence from diverse disciplines, we argue that children are independent producers and maintainers of these autonomous cultures, which exist with regularity across diverse societies, and persist despite compounding threats. Critically, we argue that peer cultures are a source of community knowledge diversity, encompassing both material and immaterial knowledge related to geography, ecology, subsistence, norms, and language. Through a number of case studies, we further argue that peer culture products and associated practices – including exploration, learning, and the retention of abandoned adult cultural traits – may help populations adapt to changing ecological and social conditions, contribute to community resilience, and even produce new cultural communities. We end by highlighting the pressing need for research which more carefully investigate s children's roles as active agents in cultural adaptation.

1. Introduction

The human capacity for culture is a key determinant of our success as a species. Several important behavioral adaptations, such as the ability to innovate, refine, and transmit new cultural products have enabled us to thrive in nearly every ecology on the planet, resulting in unparalleled cultural diversity and complexity. Our species' long childhoods also likely evolved to facilitate the learning and internalization of these complex cultural behaviors, underscoring the importance of childhood to the human success story. Yet, despite the clear importance of both development and culture to human flourishing, there is a tendency to characterize children primarily as *acquirers* of knowledge, vessels ready to be filled with adult culture. Here, we aim to challenge this view by highlighting the importance of children's *peer cultures* – the bodies of cultural knowledge created for and by children. We use "children" and "childhood" in this article as shorthand for the period of development preceding adulthood, between the ages of approximately three and seventeen years. Drawing on experimental and ethnographic studies in psychology, sociology, linguistics, folklore studies, anthropology, and archaeology, we argue that (i) children are independent producers and maintainers of autonomous cultures, (ii) peer cultures are a source of community knowledge diversity, and (iii) peer cultures may be called upon to help communities adapt to episodes of social and/or ecological change. Overall, we will show that the study of peer cultures can extend cultural evolutionary theory to better account for children's *active* role in processes of culture change.

Our paper is structured as follows: first, we briefly describe the basics of cultural evolution, and demonstrate that in this literature, children are routinely depicted as high fidelity-learners of adult cultures, rather than cultural producers in their own right. Next, we define what peer cultures are and describe how they fit into cultural evolutionary theory. Then, we flesh out our main arguments regarding the adaptive advantages that peer cultures may confer to communities. Finally, we highlight the paucity of investigations focused on peer cultures, and lay out important next steps for the study of children's cultures within human evolutionary research.

2. Current models of cultural evolution

Cultural evolution relies on several key components: (1) inheritance via *high-fidelity transmission* (Legare & Nielsen, 2015), (2) selection shaped by content and context *learning biases* (Henrich & McElreath, 2003; Price, Wood, & Whiten, 2017; Wood, Kendal, & Flynn, 2013), and (3) variation introduced by *innovation* (Legare & Nielsen, 2015). Cultural traits are transmitted

through mechanisms such as *teaching* – the modification of behavior to facilitate learning in another individual (Kline, 2015) – and *overimitation* – the copying of both relevant (i.e., causal) and irrelevant actions to achieve an instrumental goal (Lyons, Young, & Keil, 2007). Transmission pathways can take several forms, with cultural knowledge being shared vertically (from parents to offspring), obliquely (from non-parental adults to children), and horizontally (from peer to peer) (Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981). New cultural products can arise through several innovation mechanisms (Galef, 2003), such as serendipity or accident, recombination of existing forms, or incremental improvement (Mesoudi et al., 2013). Some of these innovations might be goal-directed, in the sense that we might be attempting to solve a specific problem, while others are byproducts of exploration or copying error (Deffner & Kandler, 2019; Mesoudi, 2021).

Against this backdrop, developmental researchers have regarded childhood – defined here as encompassing early childhood (approximately 3–6 years), middle childhood (approximately 7–12 years), and adolescence (approximately 13–17 years) – as an important period for cultural learning. A large body of work on cultural evolution overwhelmingly portrays young children as exceptional *learners*, but poor innovators, as we outline below. We believe that these findings reflect an outsized focus on children's roles in cultural *acquisition*, with much less attention paid to their cultural *contributions*. As we will demonstrate, this portrayal is increasingly challenged by emerging research.

2.1. Children as learners

Cultural evolutionary studies regularly show just how good children are at learning: they pay demonstrable attention to subtle cues reflecting pedagogical intent (Gelman, Ware, Manczak, & Graham, 2013), such as pointing (Grassmann & Tomasello, 2010), eye gaze (Baldwin, 1991), and prosody (Bascandziev, LaSorsa, Shafto, & Bonawitz, 2022; Broesch & Bryant, 2015), alongside more overt teaching cues such as demonstration and direct instruction (Kline, 2015). For example, following a pedagogical demonstration of a new toy, 4–6-year-old children focused so exclusively on the target function demonstrated by an adult instructor that they did not discover the toy's other functions (Bonawitz et al., 2011). Further, children across cultures consistently *over*-imitate, even when irrelevant actions are obviously unnecessary (Clegg & Legare, 2016; Hoehl et al., 2019; Lyons et al., 2007; Nielsen & Tomaselli, 2010; Stengelin, Hepach, & Haun, 2019, 2020; but see Berl & Hewlett, 2015). Such high-fidelity learning – absent in other primates (Dean, Vale, Laland, Flynn, & Kendal, 2014; van Leeuwen et al., 2018) – may have evolved to ensure that young humans understand the causal structure and function of complex tools and elaborate rituals, which are often too opaque to acquire through emulation alone (Csibra & Gergely, 2011; Tomasello, 2016).

Another popular line of inquiry into children's learning mechanisms has aimed to understand the biases in whom children prefer to learn from. In the absence of other cues (e.g., reliability; Jaswal & Neely, 2006), children display a relatively strong bias toward imitating adults (Taylor, Cartwright, & Bowden, 1991; Wood, Kendal, & Flynn, 2012), presumably because age acts as a heuristic for expertise and/or because older individuals are more likely to have adopted adaptive behaviors (Deffner & McElreath, 2022; Wood et al., 2013). This age-related bias is evidenced across cultures, with British children preferentially imitating adults in instrumental domains (Wood et al., 2012) while Congolese BaYaka adolescent boys preferentially learn spear-hunting, an especially complex skill, from adult hunters (Lew-Levy, Milks, Kiabiya Ntamboudila, Broesch, & Kline, 2021a).

Importantly, children do not prefer to learn from adults in all domains. In fact, young children actually prefer to learn about toys, play, clothes, games, and food from peers (Kuczynski, Zahn-Waxler, & Radke-Yarrow, 1987; Ryalls, Gul, & Ryalls, 2000; Shutts, Banaji, & Spelke, 2010; VanderBorght & Jaswal, 2009). Children also appear to be particularly good teachers: they facultatively adjust their instruction around learners' mistakes by five years of age (Ziv, Solomon, Strauss, & Frye, 2016), and use generic language in pedagogical contexts to facilitate the learning of more general rules by age six (Gelman et al., 2013). Children are also adept peer learners, regulating their affect and increasing participation in response to pedagogical behavior (Howe & Recchia, 2005; Howe, Recchia, Porta, & Funamoto, 2012; Qiu & Moll, 2022). Studies of children, especially from a cross-cultural perspective, also reveal high levels of peer-to-peer teaching and learning (Lancy, Bock, & Gaskins, 2010). While children do report that adults – and specifically, their parents – are the primary drivers of knowledge transmission (Kline, Boyd, & Henrich, 2013; Lew-Levy et al., 2021c; Schniter, Gurven, Kaplan, Wilcox, & Hooper, 2015), experimental and observational research nonetheless suggests that peer teaching is widespread (Boyette & Hewlett, 2017; Lew-Levy et al., 2020; Maynard, 2002). Similarly, studies conducted in communities outside the post-industrialized West (Maya, Tsimane, NiVanuatu) show that much of the linguistic input received in early childhood actually comes from other children (Cristia, Dupoux, Gurven, & Stieglitz, 2019, 2023; Shneidman & Goldin-Meadow, 2012; see also Labov, 1964).

2.2. Children as innovators

Formal investigation into children's innovative capacities is relatively limited. The bulk of research examining children's innovation has tended to focus on the very specific domain of tool use, probing children's ability to innovate new tools, or use old tools in new ways (Beck, Apperly, Chappell, Guthrie, & Cutting, 2011; Carr, Kendal, & Flynn, 2016). In a benchmark experiment known as the "hook task," for example, children demonstrate their tool innovation abilities by bending a straight pipe cleaner into a hook to retrieve a prize from inside a long narrow tube (Beck et al., 2011). Children do not reliably innovate in the hook task until around eight years of age (Beck et al., 2011; Cutting, Apperly, & Beck, 2011). This has led many researchers to conclude that younger children are simply poor tool innovators. However, this conclusion may be premature: young children may struggle with tool

Dr. Sheina Lew -Levy, PhD, is an associate professor of psychology at Durham University. She integrates theory and methods from anthropology and psychology to explore cultural diversity and the evolution of social learning during childhood, with a particular focus on hunter-gatherer societies. She is the recipient of the European Human Behaviour and Evolution Association's New Investigator Award (2023) and the Philip Leverhulme Prize (2024).

Dr. Do Rsa Amir, PhD, is an assistant professor of psychology & neuroscience at Duke University, where she directs the Mind and Culture Lab. She earned her Ph.D. in anthropology from Yale University in 2018. Her work explores social and cognitive development across diverse cultures, with a focus on children living in foraging and mixed-subsistence societies.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

innovation because it is an ill-structured problem – that is, the steps between the start state and the end state are not clear (Cutting et al., 2011). It is also possible that tool innovation is more cognitively taxing, requiring coordination between causal reasoning, planning, and creativity (Rawlings, 2022), thus reducing young children's ability to succeed in this domain on their own. Thus, a diminished ability to innovate in the domain of tool use may not be reflective of a more domain-general inability to innovate.

It is also important to note that most experimental studies on the development of tool innovation have tested children *individually*. However, recent work has revealed that children are more successful at innovation when problem-solving with their peers (Lancy, 2024, p. 75). Gönül, Hohenberger, Corballis, and Henderson (2019), for instance, found that peer interaction improved Turkish 5–6-year-old's performance in the hook task. Similarly, while Congolese BaYaka forager and Bandongo fisher–farmer children had low success rates in the hook task, they produced novel items during peer play with pipe cleaners (Lew-Levy, Pope, Haun, Kline, & Broesch, 2021b). And, in a micro-society experiment with groups of 3–4-year-olds, children invented and transmitted increasingly complex tools and tool use strategies to solve puzzle boxes (McGuigan et al., 2017). Overall, these studies suggest that children's tool innovations emerge *in groups* rather than individually.

In the linguistic domain, there is consistent evidence for children's innovative capacities (Cekaite, 2018). Young children not only repeat fragments of language they hear, but also create new sentences and phrases according to grammatical rules that are continually constructed and revised (Chomsky, 1976). Young children combine or modify words to fill gaps in their lexicon (Clark, 1982), reflecting high levels of lexical creativity. Children innovated a greater diversity of iconic signs – that is, signs that directly resemble their referent – than adults in an experimental communication task (Lister, Walker, & Fay, 2020). Further, in an experiment in which pairs of children were not allowed to communicate verbally, children invented new referential signs which became increasingly arbitrary, conventional, and grammatical over a 30-minute session (Bohn, Kachel, & Tomasello, 2019).

Finally, work in developmental cognitive science suggests that children are adept at exploration, a trait which may lead to the discovery of innovations. Theoretically, some have argued that childhood may have evolved as a solution to explore–exploit tensions, allowing for periods of "high-temperature" exploration in early life followed by periods of "low-temperature" exploitation in later life, a process referred to as "simulated annealing" in the search and sampling literature (Gopnik, 2020). This developmental shift offers an important route through which local optima can be found and utilized. Empirical research tends to support this notion (e.g., Schulz, Wu, Ruggeri, & Meder, 2019). For example, using data from participants aged 5–55 years, Giron et al. (2023) demonstrate that human development resembles an optimization process of multiple learning parameters, with rapid changes occurring in childhood with a plateau and convergence toward efficiency in adulthood. These data suggest that children may be an important source of behavioral variation, able to produce novel "local" solutions due to their unique exploration strategies.

2.3. A new perspective

The research reviewed above suggests that children and adolescents *can* and *do* transmit knowledge to their peers, and that their innovative capacities are enhanced by peer interaction. Yet, the image of children as learners-not-innovators overwhelmingly persists. We believe that this is largely due to the under-appreciation of an important component of the human cultural milieu: children's *peer cultures*. We contend that peer cultures might be the missing piece needed to make sense of children's active role in the processes of cultural maintenance and change. Specifically, we argue that children's peer cultures consist of autonomous cultural products that are largely distinct from those of adults (see Fig. 1). Further, just as adults transmit knowledge to children, intergenerational transmission is likely *bidirectional*, in that children's cultural products feed into adult culture during rare but salient moments of social and/or ecological change. Overall then, we believe that children's peer cultures may be an important contributor to cultural evolution more broadly. In section 3, we define precisely what we mean by peer cultures, and argue that despite being overlooked, existing research on peer cultures can help restructure our current understanding of the evolution of culture and human life history.

3. What are peer cultures? An evolutionary overview

Peer cultures are the stable set of activities, artifacts, values, and concerns that children and adolescents produce and transmit in interaction with each other (Corsaro & Eder, 1990, p. 197). Peer cultures include playgroup games, rhymes, songs, and stories (Opie & Opie, 1998, 1959, 2013), norms for sharing and bartering food (Katriel, 1987), cures for common childhood ailments (Opie & Opie, 2013), supernatural beliefs (Winter, 2015), child-only subsistence strategies (Crittenden, 2016), and theories of contamination (Morin, 2008). Although there is overlap between adult and peer cultures, peer cultures are *not* merely a copy of adult cultures. Instead, when children do appropriate aspects of adult cultures, they usually reinterpret them to meet their own needs, such as adopting adult conflict resolution to solve disagreements arising during play (Corsaro, 1992).

3.1. The historical study of peer cultures

The first serious engagement with peer cultures was arguably done by anthropologist Edward B. Tylor in the mid-to-late 1800s. In his (now outdated) work on the progressive complexity of culture over time, he suggested that children's cultures were vestiges of the "primitive" cultures that upper-class and Western adults had left behind (Tylor, 1871). Despite the inaccurate framework, Tylor was among the first to cross-culturally compare peer cultures. He argued that children's games often outlived "the serious practice of which it is an imitation" (p. 73), meaning that children's practices persisted even when adult versions of those practices diminished. For example, he noted that while slingshots fell out of use by European adults during the Middle Ages, "the use of the rude old weapon is especially kept up by boys at play" (p. 73). The idea that children's cultures were simply a vestige of practices left over by adults remained a recurring theme in the decades that followed (Morin, 2015).

In the realm of behavioral science, when peer interactions have been studied, the focus tends to be on how these interactions influence *individual* development (Corsaro, 2017). In the behaviorist approach, children largely occupy a passive role in acquiring culture, with the peer group functioning to reinforce adult socialization practices (see Corsaro & Eder, 1990 for review). In the constructivist approach, best represented by Piaget (1947, 1968), children take a more active role in organizing and using

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

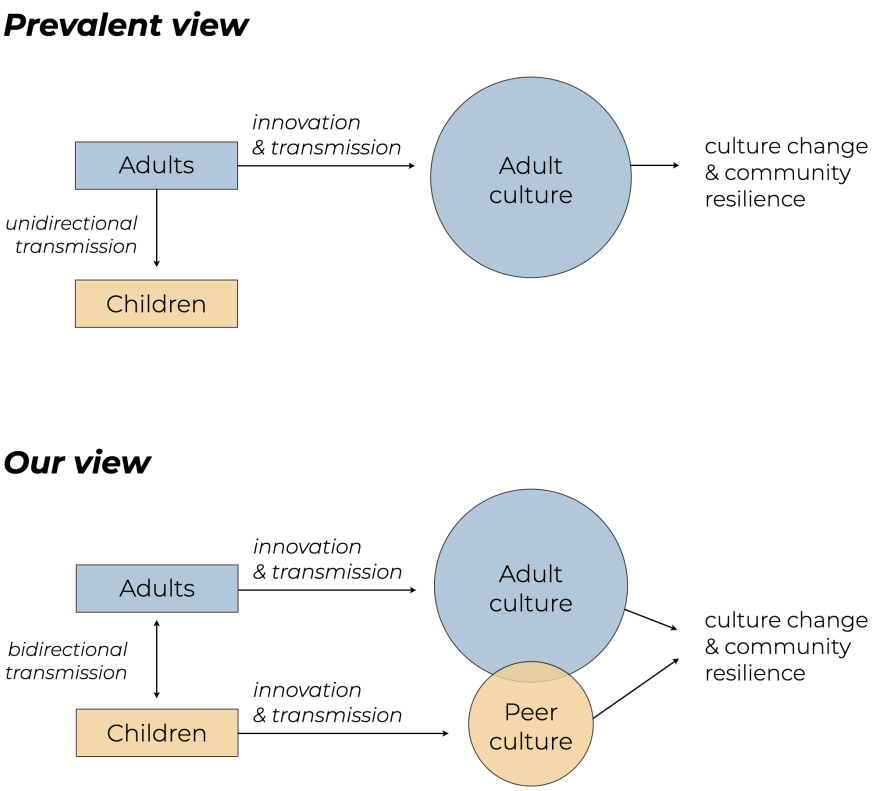

Figure 1. Contrasting views of adult and children's contributions to cultural evolution. The prevalent view (top) tends to consider that adults are at the center of cultural evolution, with transmission largely operating in one direction, from adults to children (Qiu & Moll, 2022), and that adult culture is the engine of culture change and community resilience. Peer culture is largely absent or ignored. Our refined view (bottom) suggests that children and adults maintain distinct cultures with bidirectional knowledge transmission. Cultures produced by *both* children and adults can contribute to culture change and community resilience.

information from the environment in the process of acquiring adult skills and knowledge (Corsaro & Eder, 1990). Building on this perspective, Vygotsky's sociocultural theory emphasizes the central role of peer social interaction in child development, arguing that children scaffold and support each other's learning by guiding learners in their "zone[s] of proximal development" (Vygotsky & Cole, 1978), and that the peer group is critical for optimal social and cognitive development. However, even with a growing appreciation for peer interactions and socialization practices, the function of peer groups has historically been evaluated through the lens of future skill acquisition (Corsaro & Eder, 1990; Hirschfeld, 2002).

3.2. Conceptual, cultural, and logistical hurdles

While the work of anthropologists (e.g., Hirschfeld, 2002; Konner, 2010), sociologists (e.g., Corsaro, 1992), psychologists (e.g., Gauvain & Munroe, 2019; Lancy et al., 2010), and folklorists (e.g., Opie & Opie, 1959, 2013; Sutton-Smith, Mechling, Johnson, & McMahon, 2012) have made important headway in studying children's peer cultures as distinct cultural systems in their own right, this research agenda has remained largely outside the purview of cultural evolutionary theory (see Morin, 2015 as a notable exception). In our view, this oversight reflects hurdles which, while not unique to cultural evolutionary theory, nonetheless have sidelined the more serious study of peer cultures in behavioral science.

First, human childhoods are significantly longer than those of other great apes, and are thought to have evolved as an extended period of time for learning the complex instrumental and social skills necessary to be a successful adult (Kaplan, Hill, Lancaster, & Hurtado, 2000; but see Hawkes, 2003). Yet even in their youngest years, children play a consequential role in subsistence (Kramer, 2014; Lancy, 2015). Without Mayan children's contributions to family maintenance, for instance, parents would have to work two and a half times harder to meet their family's needs, representing unachievable workloads (Kramer, 2002; Lee & Kramer, 2002). Sibling care and peer group socialization are also important mechanisms through which children free parents to perform more high-skill and high-strength tasks (Kramer & Veile, 2018; Page et al., 2021; Weisner et al., 1977). Further, the availability of siblings and peers makes horizontal learning especially convenient (Reyes-García, Gallois, & Demps, 2016). These findings compel us not *only* to consider children's individual learning for their future adulthood, but also the immediate benefits that children's peer group subsistence and educational activities may confer to themselves, their families, and their communities.

Next, and despite efforts to diversify participant study communities, evolutionary researchers themselves remain primarily of European descent (IJzerman et al., 2021), often bringing with them implicit and unexamined ethnotheories regarding childhood learning. This is particularly relevant for the study of peer cultures as research reveals that in post-industrialized Euro-American countries, children have fewer opportunities to assort independently (Lancy & Grove, 2011). This is because children's play is quickly succumbing to adult-made forms of entertainment (Morin, 2015), and because children are increasingly losing access to physical "third spaces" where they can interact outside the purview of adults (Singer, Singer, D'Agnostino, & DeLong, 2009). Thus, from the point of view of Euro-American scholars, peer cultures may seem rare or inconsequential, or relegated entirely to the domain of play. In contrast, scholars from the Global South regularly highlight the centrality of children, their peers, and peer cultures to cultural development. Notably, Nsamenang's (2015) theory of Social Ontogenesis, drawn from his research with the Nso in Cameroon alongside his own life experience as a member of this community, posits that human development is "partly determined

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

by the social ecology in which the development occurs and by how African children, especially in sibling and peer settings, learn from each other in peer cultures," and "less through explicit adult instruction or prodding" (pp. 841–842). Incorporating these perspectives into mainstream cultural evolutionary research can help refine and improve our theoretical frameworks.

Finally, researchers working on the evolution of cultural learning overwhelmingly tend to collect data over short timespans (McElreath & Koster, 2024), an understandable byproduct of the financial and logistical challenges of field-based developmental research. In experiments, this can be as short as a few minutes; in observational research, time is measured in days, or rarely, months; for some lucky few, longitudinal research can span a few years. Only in very rare cases have researchers tracked changes in childhood activities over generations (Greenfield, Maynard, & Childs, 2000; Lancy, 2015; Pollom, Herlosky, Mabulla, & Crittenden, 2020). Yet, as we will show in section 6, a handful of studies suggest that children's activities may have disproportionate effects on community adaptation during episodes of profound social, cultural, and ecological change. In other words, at short time scales, the importance of children, their activities, and their peer cultures may be easily overlooked, despite their importance during rare but salient community-level events that can occur across longer timespans. In sum, there are likely a number of reasons for the paucity of evolutionary work on peer cultures. In sections 3.3 and 3.4, however, we contend that the little we *do* know has much to offer the study of cultural evolution, and relatedly, human life history theory.

3.3. Peer cultures in cultural evolutionary theory

While we canonically think of invention as a single person discovering a new idea ("Eureka!"), it is increasingly recognized that innovations are emergent features of groups (Galesic et al., 2023; Muthukrishna & Henrich, 2016; Whiten, Biro, Bredeche, Garland, & Kirby, 2021). Three features in particular play an important role in innovation frequency (Muthukrishna & Henrich, 2016). First, innovations are more likely to happen in larger populations: more people means more opportunity to learn from the most skilled (Henrich, 2004; Kline & Boyd, 2010). Second, a higher individual rate of fidelity increases mean cultural complexity by ensuring that new innovations are accurately acquired, maintained, and transmitted across generations (Csibra & Gergely, 2011). Third, higher cultural trait diversity can result in a greater variety of techniques and approaches, some of which may be improvements (Collard, Buchanan, O'Brien, & Scholnick, 2013). Transecting all three features, network connectivity also plays a role (Pablo et al., 2022; Smaldino, Moser, Pérez Velilla, & Werling, 2024; Smolla & Akçay, 2019), with partially connected networks allowing for diversity, leading to cumulative improvements through recombination (Derex & Boyd, 2016).

Crucially for our argument, peer cultures evidence all of these features. As members of both peer and adult cultures, children are maximally social, having ample opportunities to recombine information from multiple (child and adult) sources to produce innovations. As we outlined previously, children are not only effective at learning from adults, but also proficient at teaching, and learning from, their peers (Lew-Levy et al., 2023). The knowledge and know-how produced by peer groups is also distinct from that of adults, representing an important source of cultural trait diversity (Pretelli et al., 2024). Finally, peer cultures are autonomous yet partially connected to adult cultures, with occasional (unidirectional) migration as children grow up and leave peer cultures behind. Thus, theoretically, peer cultures may be an adaptive feature of human social organization which bolsters population-level innovation capacity.

As a source of possible solutions for the community as a whole, peer cultures may enable "faster collective adaptation in times of quick, significant changes" (Galesic et al., 2023, p. 9). Indeed, Fogarty and Kandler (2020) show that existing cultural variance – what they call "standing variation" – confers a greater adaptive benefit than new innovations during environmental shifts. This is because a trait that is potentially adaptive for a new environment may already be relatively widespread in the population, facilitating further spread. With foresight towards potential future environmental change, populations can promote cultural variance by maintaining the existence of older traits – an inherent feature of peer cultures (see section. 5.6). Some agent-based models have further suggested that behavioral variants introduced by children are especially adaptive in rapidly changing environments. Deffner and McElreath (2022), for instance, found that a copy-the-young strategy was advantageous in fluctuating environments as a middle ground between social learning and innovation, allowing younger individuals to update their behaviors to their current environment. Similarly, Acerbi and Parisi (2006) showed that, because peers are imperfect teachers who have not yet completed their own learning (see also Deffner & Kandler, 2019), horizontal transmission can add the variability required for cultural evolution to take place. The positive role for such intra-generational transmission is amplified in rapidly changing environments, where novel behaviors more suitable to the new environment are needed. Considering that, by definition, peer cultures represent a corpus of horizontally transmitted knowledge, they may be an important source of adaptive variation.

3.4. Peer cultures in human life history theory

As noted, much research on the evolution of long human childhoods has focused on eventual adulthood. Yet, for children to reach adulthood, they must first learn to navigate the niche of childhood (Bjorklund & Green, 1992). Considering that our genus *Homo* evolved against a backdrop of rapidly changing and unpredictable environmental conditions (Potts, 1998), knowledge that was socially acquired from adults may not always have remained relevant when children themselves reached adulthood. Exploration – may have allowed children to more accurately track environmental circumstances, perhaps better than social learning alone would afford (Gopnik, 2020). Experimental evidence indeed suggests that children possess unique cognitive features that can enable this form of exploration. Younger children, for instance, are better able than adults to infer unlikely hypotheses in instrumental and social experimental tasks (Seiver, Gopnik, & Goodman, 2013; Wente et al., 2019). Adolescents are also more likely than adults to infer unlikely causal relations in social domains (Gopnik et al., 2017).

Several social features inherent to childhood may further bolster children's exploration (Gauvain & Munroe, 2019). Children are cared for and provisioned by community members (Hrdy, 2011), affording them extensive opportunity for creative exploration (Greenbaum et al., 2019). Much of this time is spent in play, primarily social play, which offers an intrinsic motivation to explore one's environment, and which is strongly linked with creativity and innovation (Bateson, 2015; Carr et al., 2016). More goal-directed problem solving may emerge in adolescence, when children have developed enhanced capacities for abstract

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

reasoning, creative thought, and risk-taking (Crone & Dahl, 2012; Hewlett, 2021). Importantly, exploration need not occur individually. From the age of two onwards, children are increasingly peer-focused (Eckerman, Whatley, & Kutz, 1975). Through collaborative exploration, peer interaction can be generative, leading to the discovery of information not initially possessed by either child (Gauvain & Munroe, 2019; Phelps & Damon, 1989). Indeed, educational researchers have demonstrated that peer collaboration and peer tutoring confer benefits to learning in domains including mathematical concepts, Piagetian conservation tasks, moral reasoning, spatial navigation, and instrumental problem solving (Ames & Murray, 1982; Ashley & Tomasello, 1998; Emler & Valiant, 1982; Kruger, 1992; Phelps & Damon, 1989). Through feedback and debate in an atmosphere of mutual respect, children can coordinate their perspectives to abandon misconceptions, creatively search for better solutions, and generate new ideas (Damon, 1984). Together, these features suggest that childhood is not only a time for exploration, but one for exploring *with peers*, potentially leading to the discovery of useful innovations.

In summary, peer cultures may represent an important source of behavioral variation which may be especially adaptive during periods of environmental fluctuation. Further, the evolution of childhood may reflect a careful balance between explore - exploit trade-offs to better track potential environmental changes. Such early-life exploration may be bolstered by peer group interaction. Overall, these theoretical perspectives compel us to more seriously consider whether peer cultures can drive cultural evolution. In sections 4–6, we review the empirical evidence for this proposition. In section 7, we discuss open empirical questions at the intersection of peer cultures, cultural evolution, and human life history theory.

4. Peer cultures are distinct from adult cultures

In this section, we provide evidence that children are producers and maintainers of their own autonomous (i.e., self-governed) cultures. We largely draw from qualitative research in sociocultural anthropology, sociology, and folklore studies, supplemented by examples from the ethnographic canon, to support our arguments. Notably, we consider the possibility that children's peer cultures exhibit distinct transmission mechanisms which overcome specific threats to their proliferation.

4.1. Peer cultures are autonomous

Peer cultures exhibit high levels of autonomous governance. Indeed, the active exclusion of and resistance to adult input appears to be a recurring feature of peer cultures (Corsaro, 1988; Corsaro & Eder, 1990; Opie & Opie, 1959; Robinson & Corsaro, 1987). In his ethnographic work on Melanesian children in the Trobriand Islands, for instance, anthropologist Bronisław Malinowski describes how the "small republic" of children "acts very much as its own members determine, standing often in a sort of collective opposition to its elders" (1929, p. 53). Iona and Peter Opie similarly describe British children's cultural products, such as schoolyard rhymes, as "not intended for adult ears . . . in fact, part of their fun is the thought, usually correct, that adults know nothing about them" (1959, p. 1). More generally, in children's folklore studies, researchers are relatively unanimous in their observations that adult contributions to children's peer culture are either minimal or nonexistent (Fine, 1980; Morin, 2015; Newell, 1883; Opie & Opie, 1959). In addition to the active exclusion of adults from peer cultures, children's peer culture, especially as it matures into adolescence, bears some resemblance to other forms of counter-culture (Corsaro & Eder, 1990), often containing subversive messages about resistance to adult power (Ackerley, 2007; Sutton-Smith, 1997).

Around the second year of life, forager children begin to spend the majority of their time with peers in mixed-age and mixed-gender playgroups (Konner, 1976, 2017; Lew-Levy, Lavi, Reckin, Cristóbal-Azkarate, & Ellis-Davies, 2018). Within these playgroups, children receive relatively little adult intervention and minimal supervision (Crittenden, 2016; Hewlett, 1992; Naveh, 2014). For instance, in contemporary surveys of forager-horticulturalist Tsimané in Bolivia, most parents state they often don't know exactly where their children are (though they do tend to know where they *aren't*) (Davis & Cashdan, 2020). Malinowski also describes the "considerable freedom and independence" of the "republic of children" in the Trobriand Islands (1929, p. 45):

> "Such freedom gives scope for the formation of the children's own little community, an independent group, into which they drop naturally from the age of four or five and continue until puberty . . . If the children make up their minds to do a certain thing, to go for a day's expedition, for instance, the grown-ups and even the chief himself, as I often observed, will not be able to stop them . . . Their spiritual ownership in games and childish activities was acknowledged, and they were also quite capable of instructing me and explaining the intricacies of their play or enterprise."

Margaret Mead's ethnographic work among Samoan children uncovered similar trends; she observed "the development of a group which played continually together and maintained a fairly coherent hostility toward outsiders" (Mead, 1928, p. 61). And, adults in these communities, it appeared, largely ignored children from birth until they were roughly around sixteen years old (Mead, 1928).

Across time and disparate cultures, convergent lines of evidence also suggest that children have a preference for *physically* segregating their play spaces from adult spaces. This remains true even in post-industrial societies. Opie and Opie (1959) describe World War II bomb sites as the preferred play location for British children, who used the space to play hide-and-seek, make fires, and cook potatoes. As landscape architect Kylin (2003) further observed, Swedish children preferred to build playhouses in locations that were hard to find, providing privacy away from their parents. In subsistence societies, play camps and play villages are typically built by children on the edges of adult settlements (Hardenberg, 2010). This pattern is also clear in archeological examinations of children's play spaces (Nowell, 2021): remnants of Thule children's playhouses in Greenland, for example, showed that they were often separated from the actual community settlement, far enough away to allow for undisturbed play without interference from adults (Hardenberg, 2010). In addition to evidencing physical segregation, playhouses also exemplify how children appropriate adult cultural products to assert peer group independence.

In another manifestation of autonomy, children appear to be highly capable of regulating their own activities. Young children frequently develop new rules of social engagement and strategically utilize language to regulate the behavior of their peers in order to create membership categories to include or exclude others, in addition to constructing other components of their own social order (Cobb-Moore, Danby, & Farrell, 2009). Hierarchies regularly rise and fall, relationships evolve, and alliances are formed and broken, all outside the purview of adult engagement or regulation (Danby, 2002; Lancy et al., 2010; Robinson & Corsaro, 1987).

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Within their social orders, children negotiate participatory rights (Corsaro, 2003), and sometimes fall into territorial conflicts (Corsaro, 2017) resolved through peer participation. They also ritualize many aspects of their sharing behavior (Katriel, 1985, 1988), such as the sharing of secrets (Katriel, 1990) and valued items (Katriel, 1988).

4.2. Peer cultures are transmitted

In their work with British schoolchildren, Iona and Peter Opie's meticulous observations demonstrate how peer culture traits circulate "from child to child, usually outside the home, and beyond the influence of the family circle" (1959, p. 1). The transmission pathways found in peer culture also demonstrate several unique features. First, peer cultures evidence what cultural evolutionary researcher Morin (2015) calls *quasi-horizontal transmission*, from older to younger children. Piaget's own work with children provides a clear example of this form of transmission: "The rules of marble games are handed down . . . from one generation to another . . . The little boys who are beginning to play are gradually trained by the older ones in respect for the law" (Piaget, 1948, p. 2). Further, while all populations have some rate of turnover as individuals reach the end of their lifespan (i.e., demographic renewal), peer cultures have exceedingly high rates of turnover since the demographic renewal is not determined by total lifespan, but by the amount of time spent as children (Morin, 2015). To survive in the face of this time pressure, peer cultures must quickly proliferate through frequent transmission to each successive wave of new children. Peer cultures are also transmitted along long, compact, and narrow diffusion chains (Morin, 2015, p. 186) – or webs (Robert Boyd, personal communication) – as a single child only has direct access to a tiny fraction of the full peer population. As a result, peer culture traits must go through a large number of relays to be widely diffused (Morin, 2015). Given the high rate of turnover, a peer cultural product – such as a schoolyard rhyme – that persists over 100 years is roughly equivalent to an adult cultural product persisting through half a millennium of oral transmission (Morin, 2015; Opie & Opie, 1959).

Despite these threats to transmission, peer cultures spread rapidly and with surprisingly high fidelity. Iona and Peter Opie argue that one of the most remarkable features of peer culture is "how comparatively little it alters considering the usage it receives" (1959, p. 11):

> "[Adult-propagated cultural products for children, such as nursery rhymes are] not usually passed on again until the listener has grown up and has children of his own, or even grandchildren. The period between learning a nursery rhyme and transmitting it may be anything from twenty to seventy years. With the [child-propagated cultural products such as] playground lore, however, a rhyme may be excitedly passed on within the very hour it is learnt; and in general, it passes between children who are the same age, or nearly so . . . If, therefore, a playground rhyme can be shown to have been current for a hundred years, or even just for fifty, it follows that it has been transmitted over and over again; very possibly it has passed along a chain of two or three hundred young hearers and tellers, and the wonder is that it remains alive after so much handling, let alone that it bears resemblance to the original wording."

What features promote the transmission of peer culture traits? In the realm of folklore, Iona and Peter Opie suggest that there must be some "art and rhythm" to playground chants that are engaging enough to "hold on a child's mind, although what exactly the quality is which gives some verses immortality is difficult to discover" (1959, p. 13). In this vein, Morin (2015) has examined various hypotheses that may explain the remarkable stability and endurance of peer culture folklore across time. One hypothesis is that children's traditions exist because children are particularly good copiers with a strong preference for high-fidelity imitation (Baucomont, Guibat, Lucile, Pinon, & Soupault, 1961; Opie & Opie, 1959). While it is true that children are conservative imitators, this desire to coordinate would only predict that cultural forms are copied with high fidelity, and not that they diffuse rapidly or are widely adopted. Another hypothesis is that children's cultural traits – such as schoolyard songs – diffuse widely because they appeal in various ways to our minds, such as through memorability (Rubin, 1995) or rhyme and assonance (Opie, 2018). Morin (2015), however, argues that while it is possible that memorability causes the proliferation of certain rhymes, it could also plausibly work the other way: some rhymes may be remembered *because* they were repeated so frequently. The mechanism may thus be selection for proliferation, itself: the cultural forms that survive are those that can elicit frequent repetition.

4.3. Peer cultures vary over time and space

Children regularly engage in the playful creation of new cultural forms which exhibit variation across time and space. In the 1950s, for example, slang words for money among British children included: brass, lolly, tin, dough, mazuma, moolah, dosh, sploosh, bees and honey, and champagne coupons (Opie & Opie, 1959), with new words continually and regularly generated. These innovations, if favored, were quickly integrated into children's cultural repertoires (Meckley, 1994). In addition to explicit invention, traits like novel words can arise through memory errors or mishearing, yet others from creative play with the pace, speed, and shortening of phrases. At a Surrey school, for instance, the pledge "Cub's honour" became "cub's-on-a-car," which was subsequently abridged to simply "car" (Opie & Opie, 1959).

Peer cultures are also responsive to contemporary social themes, figures, and artifacts, reflecting and remixing aspects of an ever-changing popular culture. For instance, much of British schoolchildren's peer lore, rhymes, and games revolved around popular celebrities (Opie & Opie, 1959). Bandongo fisher-farmer children in the Republic of the Congo, meanwhile, manufacture toy cars out of sticks and discarded flip flops, an activity transmitted exclusively within the peer group (Fig. 2). This is despite the fact that no roads or cars reach their village, and young children rarely travel to villages with road access.

Peer culture traits wax and wane in popularity, reflecting contextual forces. For instance, games historically associated with girls, such as singing games, cooperative parlor games, and kissing games became less popular over time (Sutton-Smith & Rosenberg, 1961), potentially reflecting shifts in gender norms and childhood autonomy (see also Van Rheenen, 2012). Evidencing peer culture autonomy, games known to and promoted by adults seem to *decline* in popularity, whereas games considered by adults as difficult (skipping rope) or dangerous (knife throwing) remain popular (Opie & Opie, 2013). As games become more popular, they often become more complex. Popular games attract additional rules and formalities, taking longer to complete, and requiring more skill (Opie & Opie, 2013). Games in decline may be simplified, or broken apart, with fragments being adopted into other games.

Peer cultures also exhibit regional diversity. Children's stories and urban legends, while widespread, tend to be spatially localized to one's own town: "a haunted house is not just any house, but a

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Figure 2. Bandongo boys and girls (Likouala Department, Republic of the Congo) manufacture toy cars from sticks and discarded flip flops. This activity is transmitted solely within the peer group. Photo by Sarah Pope-Caldwell taken in 2018, shared with permission.

house in the child's own neighborhood" (Fine, 1980, p. 182). Children in multicultural communities also exhibit more diverse peer culture traits. According to Iona and Peter Opie, Scottish children "know most of the English children's rhymes . . . and they also have their own . . . rarely known to children outside Scotland" (Opie & Opie, 1959, p. 26). Immigration further diversifies peer cultures. In Australia, for instance, peer cultures have expanded to include rock and pebble games introduced by children of Sudanese origin (Darian-Smith & Pascoe Leahy, 2013).

5. Peer cultures maintain distinct knowledge

In section 4, we outlined the processes of transmission, variation, and innovation which give rise to autonomous peer cultures. We now focus on the distinct peer culture *content* produced by these processes; that is, the products themselves. Historically, children's peer group activities were viewed as strictly imitative of adult culture (Sutton-Smith, 1984). Convergent lines of evidence, however, suggest that peer cultures contain unique traits not usually found in adult culture. In this section, we will provide rich and varied examples of children's distinct knowledge that arise not only through innovation, but also through the maintenance of cultural traits abandoned by adults.

5.1. Geographic knowledge

Within their peer group (and when given the opportunity), children are frequently motivated to explore their surroundings, especially those at the margins of adult use. Among Central African Aka, for instance, nearly three quarters of children's forest play was done out of sight from adults (Boyette, 2016). Terashima (2016) argues that such roaming play instigates careful attention to and interaction with the natural world, leading to discovery, and ultimately, the creation of new ideas and technologies. Such roaming can also lead to the appropriation of liminal spaces. In the Dominican Republic's Santo Domingo metropolitan area, for example, informal settlements have been established along *cañadas*, or narrow streams; these *cañadas* often serve as waste sites (Sletto & Diaz, 2015). Due to the risk of pollution and contamination, parents often warn their children about the dangers of the *cañadas*. This, however, does not impede children, who regularly explore and play in the *cañadas*, sailing toy boats and digging for "magic rocks". Through these activities, "children appropriate and re-construct the meaning of liminality associated with these informal geographies," leading to children's unique place-making (Sletto & Diaz, 2015, p. 1693).

Similarly, in a study of American children's engagement with a nearby forest, Blizard and Schuster (2005) found that children had rich oral histories and traditions associated with the space, such as named places ("The Shady Glade", "The Herb Field", "The Teeter-Totter Tree"), "an extensive knowledge of actual and/or imagined place history" (p. 58), an entire currency system based on pine cones, novel methods for creating natural dyes from local berries, architectural achievements such as stone pathways, and ever-expanding forts. These histories and traditions shared virtually no overlap with adult culture. In addition to aiding coordination,

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

shared mental maps and place names – cultural products sometimes referred to as "topographical gossip" (Lewis, 1976) – serve important functions. Taken together, they comprise a socio-cultural system of navigation that is independent of formalized latitude-longitude grids, and bear structural similarity to the many navigation systems found among adults from small-scale societies (Widlok, 1997). These practices may also bolster children's visual spatial memory, as evidenced in a comparison of Australian Aboriginal children's navigation skills versus those of white Australians (Kearins, 1981).

5.2. Ecological knowledge

Around the world, children have their own vocabulary and use for plants and animals. Among the Eastern Apache in the late nineteenth century (Opler, 1996, p. 41):

> "Many a child has learned to braid with wild iris, candy grass, or clover. Little girls pass the time pleasantly making a long string of the leaves of *Dalea dalea* and then arranging it in several strands with leaves interlocking. From the virgin's bower plant and a species of aster the children obtain toy hats, and Vicia is employed as a dancing robe. The four-leafed clover is considered lucky, and the children have contests to see who can find one first. They blow into the choisey flower to make a sound that is likened to the call of the fawn. The name of the plant is, accordingly, 'that which cries like a deer's child.' Beard-tongue buds are picked and popped. 'Bird tracks' are made in the sand with Bermuda grass, and a leaf transfixed to Bermuda grass 'feet' is called a bird."

Much of this ecological knowledge is unknown to adults. For example, when Gallois, Duda, and Reyes-García (2017) surveyed Cameroonian Baka, the authors found that some ecological knowledge related to small mammals and birds reported by Baka children was not reported by adults. When asked about the discrepancy, adults claimed to be unaware of many of the items children listed: "Children have their own knowledge about mice. They are always inventing new names!" (p. 73). Adults also argued that mice and small birds were child-specific resources. Further, some of the animal names provided by Baka children were linguistically close to other languages, such as those spoken by their Nzime farmer neighbors. This suggests that children are actively fostering knowledge exchange with other communities through their peer group activities. Similarly, Betsileo children from Madagascar report different wild edible plant species than adults (Porcher et al., 2022). Interestingly, "children cited more introduced species as salient than adults" (p. 10), reflecting the possibility that children's exploration may allow them to better track environmental change, and generate up-to-date ecological knowledge.

5.3. Material culture

Children regularly make and use tools inexistant in adult culture. In the Congo Basin, for instance, BaYaka children manufacture sling shots by harvesting rubber from rubber vines (Lew-Levy, personal observation). These are used to hunt songbirds, species not targeted by adults. Among the Hadza in Tanzania, Crittenden (2016) reports that children make seasonally specific sticky traps for catching weaver birds, sometimes eating them, other times using their feathers for ornamentation. Among the Baka (Dounias, 2016, p. 9):

> "Kids are depositories of a specific sphere of trapping knowledge, which is technically speaking the most diversified, and which they manage on their own. The intervention of adults is minimal since this form of trapping takes place in proximity of the safe homestead. The assembling of these traps combines recreational and educative purposes as it prepares budding trappers for adulthood. The bushmeat captured in the vicinity of villages is generally consumed as snack food by children; it incidentally makes up a valuable part of their diet in its own right."

These technologies may help children solve child-sized problems (Bird & Bliege Bird, 2004): by transmitting subsistence techniques adjusted to their smaller size and lesser strength, children can more readily feed themselves and other children, and through such self-provisioning, maintain the autonomy of the peer group (see Lancy, 2024, pp. 73–74 for extensive review). As we argue in section 6.4, such playful self-provisioning becomes an important source of nutrition during periods of food insecurity.

In non-industrialized settings, children also frequently manufacture their own toys (Lancy, 2016). In a recent survey, Lew-Levy, Andersen, Lavi, and Riede (2022) found that hunter-gatherer children manufactured many play objects such as dolls, games, or play shelters for themselves (see also Lancy, 2024). More than a third of the objects surveyed had no adult corollaries (e.g., figures, games). Riede, Johannsen, Högberg, Nowell, and Lombard (2018, see also Riede, Walsh, Nowell, Langley, & Johannsen, 2021) have argued that children's object manufacturing may not only contribute to the innovation of novel objects in the present, but to children's future innovation capacities via affordance discovery. Supporting this point, among the Dogon, "the fabrication is an activity as important for the child as the very use of the toy; it takes him more time and provides him with a greater distraction by virtue of the fact that it often consists of a difficult technical exercise. It is thus that the toys having springs are much more delicate to cut out than they are to use; the manipulation of the knife, in a material as fragile as millet stalk, demands patience and know-how" (Griaule & Marcus, 1938, p. 31).

5.4. Social norms and customs

Peer cultures contain unique social norms and customs not found in adult culture. In a series of observational studies, for example, Katriel (1987) studied the norms of northern Israeli peer groups, documenting the practice of *xibùdim*. The name of this sharing practice itself reflects a child-marked, phonological deviation from the word *kibudìm*, referring to the adult practice of respect in public life. *Xibùdim* involves the sharing of "bites" of snack foods between groups of children, which starts with the act of buying the treat, usually on the way to or from school. These sharing events occur only with peers, never adults. While such sharing may be opted into by younger children (5–7 years), it becomes ritualized among older children (8–11 years). Katriel ultimately argues that by forgoing self-interest, *xibùdim* reaffirms "the child's affiliation in a broader, loosely structured social network" (p. 317), and ultimately, regulates peer group relationships. Reflecting greater egalitarian values promoted in Israeli education, *xibùdim* nonetheless exhibits linguistic and normative innovations that do not appear in adult society.

Children's customs are not unique to Israeli society. Among Southern African Tsonga (Junod, 1927, p. 63):

> "Boys herding the goats have certain customs. When one of them emits a certain unseemly sound from the rectum, the others say to him: 'Fakisa!' He must answer: 'Cita munyakanya goben.' (I have let out my wind by the rectum). This formula, which is Zulu, is secret. If he does not know it, they beat him and make him look after the goats till the end of the day. Should another boy reveal the answer to the uninitiated, they will punish him in the same way."

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Among the Xavante of Brazil, food is always shared among all male adolescents, who live together in the bachelors' hut. Contrary to sharing practices among adults, food may also be kept for absent peers (Maybury-Lewis, 1967). Among the Manus, the peer group includes all children aged 4 to 12 years and unmarried men. In this group, children "compete in terms of their own capabilities and achievements; they do not invoke the wealth, position, or status of their parents." (Mead, 1937, p. 222).

5.5. Language

Children's linguistic repertoires are replete with unique forms generated by children themselves (Brown, 1973). Children regularly engage in lexical innovations – or neologisms – with intent, following the morphological rules of their language, and relying on their internal knowledge of words and their meanings (Becker, 1994; Brown, 1973; Clark, 2009; Motsiou, 2012; Shimron, 2003). In a longitudinal study of an American boy's speech from two to four years of age, psychologist Judith Becker (1994) documented a "great variety of innovations" across a broad range of linguistic categories: agents, instruments, and contrastive compounds, such as "building-crasher" to refer to an instrument that can knock buildings down, and "nose-beard" to refer to a mustache (p. 200).

Between 5 and 12 years of age, children begin to acquire their local vernacular (Labov, 1964). At this time, their speech tends to become more like that of their peers than that of their caregivers. For example, Kerswill (1996) shows that in Milton Keynes – an English town founded in the late 1960s – 4-year-olds' pronunciation of *ou* showed large variation, and was correlated with that of their caregivers. Children aged between 8 and 12 years, however, showed smaller variation in *ou* pronunciation, and that pronunciation was no longer correlated with that of their caregivers. Kerswill suggests that "the children are focusing on a norm that is different from that of adults [which] may constitute evidence for a new variety" (Kerswill, 1996 p. 192). In a study of Detroit's suburban teenagers, Eckert further showed that, while vowel qualities of younger children reflected their social class, for teenagers, vowel quality instead reflected their association with "jock" or "burnout" peer cultures (Eckert, 1988). Beyond pronunciation, lexical creativity is at the heart of adolescent slang, such as the "shashification" of words (e.g., "session" becomes "sesh") (Fajardo, 2019).

Language activities are also central to adolescent peer group life. For example, "The Dozens" is a form of ritualized verbal sparring once widespread primarily in African American adolescent boys' peer cultures, which usually involves escalating insults (including of the opponent's family) in front of a peer audience (Ayoub & Barnett, 1965; Lefever, 1981). Potentially sharing origin with similar verbal sparring games observed among Nigerian Igbo children and adolescents, this antecedent to rap helps build a sense of solidarity and establish social status within the peer group (Chimezie, 1976; Lefever, 1981; Wald, 2012). Gossip and storytelling also helps adolescents co-construct and transmit peer group gender and behavioural norms (Evaldsson, 2021).

Several studies suggest that innovative language use peaks in adolescence (Baxter & Croft, 2016; Tagliamonte, 2011). And, while there is debate regarding the language-change contributions of younger children, most agree that older children and adolescents (above the age of ten) are agents of language change (see Raviv, Blasi, & Kempe, 2025 for review). For instance, Barbieri (2009) analyzed several corpora of spoken words to examine the distribution of the quotative "be like" (as in, s/he said) in American English over time. "Be like" was typical of adolescent speech between the late 1980s and 1990s, yet considered stigmatized and ungrammatical in a contemporaneous attitudinal survey (Blyth, Recktenwald, & Wang, 1990). The use of "be like" increased by "about 50% among men and 20% among women who were 16–26 in 1995/1996 to the corresponding age-band (the 27–40 year-old) in 2004/2005" (Barbieri, 2009, p. 86). This example illustrates that peer culture language is not necessarily abandoned as adolescents mature into adulthood, but rather can affect lasting language change.

5.6. Abandoned adult knowledge

Transecting the aforementioned domains, peer culture knowledge also seems to act as a repository, or incubator, for abandoned aspects of adult cultures. Medieval historian Aries (1965) claimed that many of the play objects that children prefer are cultural technologies that adults no longer use. As Morin (2015) argues, however, children are not *just* preserving remnants of long-disappeared adult cultures. Instead, children incorporate abandoned adult cultural traits into their own activities, thus reinventing them. For example, Imamura (2016) observed a group of San boys aged 6 to 12 years participating in hunting pretense play in 2012. To create "spears" for their "hunt," the children cut branches and tipped them with bark to prevent injury during play. This technique is reminiscent of the traditional stick throwing games among adults observed until the 1970s, during which young San men would throw sticks tipped with leather onto a sand mound. By the 1990s, Imamura observed this game among children only, arguing that "the old stick-throwing game played by older males persists in altered form as part of this children's game" (p. 183). The incorporation of spears is a further innovation. As San increasingly settled, their hunting activities also diminished. Thus, the use of the spear during pretense play, he argues, "may store and revive traditional San activities and memories" (p. 184).

The continual use of abandoned technologies in children's culture occurs with regularity across societies. Baka boys in Cameroon often play with traps, cultural technologies that adults have largely abandoned in favor of spears and smoke (Dounias, 2016; Gallois et al., 2017). Baka girls forage for wild plants and tubers in the surroundings of the village, a practice that is abandoned in favor of commercial forest products and agriculture in adulthood (Gallois et al., 2017). Among the Karajá, girls six to seven years are adept at spinning thread using a spindle shape "preserved among the children, whereas it seems to have been lost to the adults" (Krause & Schütze, 1911, p. 243). Tylor (1871) also notes that while the friction fire drill had disappeared from use in Europe, at the time of his writing, boys in Switzerland still used it as a toy. Taken together, the literature suggests that children often reappropriate abandoned aspects of adult material and immaterial cultures, and reinterpret them to serve their own peer group needs. In doing so, this cultural knowledge is also preserved.

6. Peer culture and culture change

In the previous sections, we highlighted the largely autonomous nature of peer cultures, and the distinct knowledge they produce. We now address the question: Can peer cultures confer benefits to the community more broadly? Here, we argue that peer culture knowledge may be beneficial and adopted into adult cultures during rare but salient episodes of social and/or ecological change. Targeted research on this topic is currently limited. Nonetheless, illustrative case studies highlight plausible mechanisms through

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

which peer cultures may have measurable fitness benefits. Specifically, we review instances in which children's peer interactions help communities orient themselves towards novel ecological and social conditions, contribute to community resilience, or lead to new cultural communities.

6.1. Matsés children's exploration

The Matsés are an Indigenous Amazonian population consisting of approximately 1,500 people living along the Javari River in Peru and Brazil (Fleck & Harder, 2000). Until the end of the 1960s, Peruvian Matsés lived in scattered mobile settlements in inland forests, and practiced hunting, fishing, horticulture, and the gathering of wild foods (Morelli, 2017). Historically, rivers – sites of (sometimes violent) encounters with outsiders – were dutifully avoided by adults and children alike (Fleck, 2003; Morelli, 2017). When Matsés still largely resided in the forest, much of children's activities involved emulating adult work, or assisting adults during subsistence activities. After contact with missionaries in the 1970s, Matsés began to settle into permanent villages along riverbanks (Fleck, 2003).

In her child-centered study of social change, anthropologist Morelli (2017) found that, as opposed to spending most of their time in the forest with adults, in these newer settlements, Matsés children as young as two years spent more of their time playing and exploring in or near the rivers with minimal supervision (Morelli, 2017). Through playful exploration, children became more closely acquainted with the rivers, learning to maneuver strong currents in small canoes and gaining experience in an ecology that was relatively less familiar to their parents. By middle childhood, children became not only proficient at fishing, but also shared their catch with others. In contrast, adult Matsés subsistence activities continued to be forest-oriented. While adults did collect some fish, this resource was not seen as "proper" food: hunted meat continued to be preferred. In addition to building practical river-based skills, Matsés children developed affective relationships with the river through their exploratory peer play, leading to shifts in cultural markers of prestige (Morelli, 2017). While Matsés adults asked Morelli about her father's hunting skill, children instead inquired as to whether her father had a motor for his canoe.

While canoe-related technologies may have been acquired from non-Matsés, children's playful exploration helped them gain practical skills, ecological knowledge, and cultural orientations distinct from those of adults. As over-hunting in the surrounding villages depletes traditional forest resources (Morelli, 2017), child-produced fishing-related knowledge may become even more salient. This example highlights how children's peer group activities may help communities engage with, and gain command of, new ecologies.

6.2. Mayan children's weaving

When cultural psychologist Patricia Greenfield and her colleagues started their work in the Chiapas region of Mexico, Zinacantec Mayan communities primarily practiced subsistence agriculture (Cancian, 1994). During this period, norms of dress were highly uniform, with one "true" (*bats'i*) design for each item of clothing with minimal inter-individual variation, and high conformity across generations (Greenfield, 2004). At this time, weaving knowledge was transmitted vertically and largely unidirectionally, from mothers and/or grandmothers to daughters, with structured scaffolding and error correction facilitated by highly proximal teaching (Childs & Greenfield, 1980). By the 1990s, however, community members increasingly participated in the cash economy, with girls and women involved in textile-related commerce, such as the embroidering of *servilletas* (napkins) which were used as placemats by tourists and other outsiders (Greenfield et al., 2000). Weavings thus represented an important source of income for the household. Mothers were also less available to support learning, as they were themselves engaged in market-related labor.

In a longitudinal study, Greenfield and her colleagues observed the effects of these market-related changes in household labor on weaving practices. Notably, by the 1990s, girls were increasingly taught to weave by other children (sisters, cousins), rather than by their parents (Greenfield et al., 2000). The method of instruction also changed towards a more distal and learner-led approach, in which novices actively solicited help from their tutors. This more independent style of apprenticeship yielded more opportunities for creative experimentation in weaving design, leading to highly distinct and abstract textile patterns (Greenfield et al., 2000). These novel and more individualistic weaving patterns could then be sold on the regional textile market. In some cases, mothers and grandmothers even copied or were taught the creative designs of their daughters, resulting in reverse vertical transmission (Greenfield, 2004). By 2012, increased participation in formal education, greater market integration, and smaller family size had diminished the importance of weaving as a practice and art in Mayan households (Maynard, Greenfield, Childs, & Weinstock, 2024). This example demonstrates how longitudinal research can capture children's contributions in salient but rare moments of culture change, and how child-to-child transmission can fuel creativity and innovation, which in turn can help communities better adapt to changing economic dynamics.

6.3. Nicaraguan Sign Language

In the 1980s, linguists Ann and Richard Senghas documented the emergence of a spontaneous language among deaf children (aged 10 years and under) who had come into sustained contact for the first time: Nicaraguan Sign Language (Senghas & Coppola, 2001; Senghas, 2003). Before the 1970s, deaf Nicaraguan children, primarily born to hearing parents, had little opportunity for instruction in sign language or interaction with other deaf children (Senghas, 2003). In these contexts, children often communicated at home via homesigns, which varied in form and complexity. With few primary schools for deaf children, peer contact was extremely limited (Senghas, 2003). In 1977, a school for the deaf was founded in Managua, which provided education for 25 elementary-aged children, expanding to 100 children by 1979. In 1980, a vocational school was also opened for adolescents, serving 400 deaf students by 1983. For the first time, many deaf children came together, with opportunities to assort socially as well. While instruction was in Spanish and focused on lip-reading, reading, and writing, outside the classroom children quickly systematized a simple language based on the combination of gestures and homesigns. Importantly, this first cohort had not been initiated into a pre-existing linguistic community (Senghas, 2003). Through "extensive horizontal contact, that is, interaction among peers of each age cohort" children created a new common language (Senghas, 2003, p. 514, but see Raviv, Blasi, & Kempe, 2025 for critical review). Subsequent cohorts improved upon the structures generated by their predecessors by introducing their own innovations, such as spatial modulations, where signs produced in the same location are linked to a common referent (Senghas & Coppola, 2001). Such modulations were nearly absent in the first cohort, but were

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

systematically evidenced in later cohorts. Nicaraguan Sign Language, now formalized into a dictionary with a relatively large number of speakers and a vibrant Deaf community (Senghas, 2003), was invented and complexified by successive cohorts of children, interacting at unprecedented scales. Nicaraguan Sign Language is thus an example of how peer interaction can generate novel cultural forms, and even cultural communities themselves.

6.4. Children's foraging in diverse settings

Peer cultures, especially in non-industrialized settings, may play an important role in community food security. Specifically, Ethnoecologist Dounias (2021) argues that children's peer cultures preserve knowledge of potentially edible resources which adults seldom target (Fig. 3). Some of this knowledge is abandoned by adults: garden trapping among Cameroonian Baka children, for example, represents "a corpus of knowledge and know-how that adults no longer care about, and that still could ensure a reliable portion of meat procurement for domestic consumption" (Dounias, 2016, p. 10). Such knowledge may act as a safety net during periods of short- or long-term resource fluctuation, when food species normally targeted by adults are no longer available.

Examples highlighting the importance of peer cultures to children's foraging practices come from diverse societies. Among Massa and Mussey mixed-subsistence agriculturalists in the Logone region of Cameroon, children are the primary holders of wild food knowledge (e.g., toads, insects, fruit) (de Garine, 2005). While rich in vitamins and minerals, wild resources are not considered "real food" by adults. Wild food knowledge is transmitted from child to child, with minimal intervention from adults (Dounias, 2014). In periods of food shortages, such as when droughts and floods destroy plantations (de Garine, 1993), "food collected by children from the wild are eaten as snacks and may ensure up to 35% of [children's] daily food consumption" (Dounias, 2014, p. 3) Due to pressures including climate change and ethno-tourism, Hadza are increasingly reliant on market-based and agricultural resources for subsistence (Pollom et al., 2020). While fewer children participated in foraging in 2017 compared to 2005 – when 95% of resources consumed by Hadza were non-domesticated – those who did forage in 2017 had a higher average caloric return rate than their predecessors (Pollom et al., 2020). Further, boys in 2017 hunted a larger breadth of animals than those in 2005. Importantly, these hunted species were small animals typical of child-specific foraging activities (Crittenden, 2016; Crittenden, Conklin-Brittain, Zes, Schoeninger, & Marlowe, 2013). These findings suggest that Hadza children are contributing to community food security by applying peer culture knowledge to increasing caloric returns and diet breadth during a vulnerable period of nutritional and ecological shifts. During the Pacific War and Allied Occupation (1941–1952), food shortages affected Japanese children, who were measurably shorter and lighter than their pre-war counterparts (Piel, 2012). To satiate their hunger, children foraged for nuts and fruits "alone, or with neighborhood children" (p. 407). Children also invented novel subsistence strategies: "When asked whether her parents taught her how to do this, Shingū said that she and the other village children came up with the idea together. They devised a novel way to fish for snails using a straw. Her mother boiled the snails for dinner" (p. 407). Overall, this evidence suggests that child-specific foraging knowledge, both transmitted and invented, buffers against diverse causes for food insecurity (Dounias, 2014; Pretelli et al., 2024; Lancy, 2015).

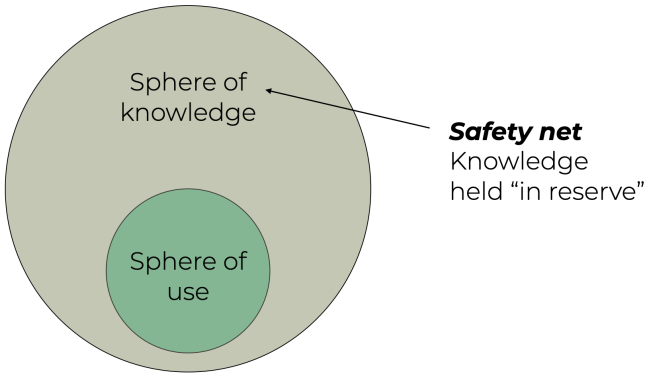

Figure 3. Ethnoecologist Dounias (2021) argues that when a community's "sphere of use" and "sphere of knowledge" completely overlap, knowledge is maximized, but there is little resilience to environmental crises. In contrast, when the "sphere of knowledge" extends beyond the "sphere of use," communities can be highly responsive to environmental change. Dounias argues that children's peer cultures hold in reserve seldom-used knowledge and know-how about potentially edible resources, thus representing a cultural safety net which protects against resource fluctuation.

6.5. Summary of case studies

Overall, these case studies lend naturalistic support to the view that peer cultures can play an important role in community adaptability, especially in times of change. Several mechanisms unique to peer cultures are evident. Children's propensity to explore in new ecological and social settings can produce novel and up-to-date ecological knowledge, subsistence strategies, and linguistic communities. Learning from peers promotes creativity and discovery, leading to material culture innovations. Knowledge incubated within the peer group can act as a cultural safety net, called upon when adult knowledge is insufficient. And arguably, as a buffer against food insecurity, child-specific foraging knowledge is our most tangible evidence for the immediate fitness benefits that peer cultures confer. It is important to note that we do not claim that peer cultures are the *only* mechanism by which communities adjust to change. Instead, in the case studies above, we highlight children's specific contributions, as these are overlooked in the current literature.

7. Toward an integrated study of peer cultures: New research avenues

Informed by related frameworks in cultural evolution and human life history theory, we have argued that children produce autonomous peer cultures, which in turn generate innovations that help communities adjust to social and ecological change. In this section, we now call upon researchers – with or without a specific interest in children – to consider the study of peer cultures in order to expand our understanding of cultural transmission, transformation, and diversity. To do so, we highlight a number of potentially fruitful avenues for future work.

7.1. What can peer culture reveal about cultural evolution?

Since its inception, cultural evolutionary theorists have been interested in understanding the mechanisms through which communities, particularly minorities, maintain distinct identities despite extensive contact (Boyd & Richerson, 1985). Research into this topic has advanced an understanding of in-group psychology (Over, 2018), ethnic markers (Mcelreath, Boyd, & Richerson,

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

2003), and the function of social norms (Bunce, 2021). Studying peer cultures as a case of extreme intercultural contact can make similar inroads. Indeed, how often does one social group (children) maintain its culture despite overwhelmingly inhabiting spaces controlled by another social group (adults)–including *living in their home*?

In addition to living in an adult-dominated world, peer cultures experience additional threats to maintenance unobserved in adult cultures. For instance, peer cultures do not rely on formal institutions (e.g., schools, rites of passage) which facilitate highly efficient cultural transmission. In the absence of vertical and oblique transmission, peer cultures are transmitted through many horizontal or quasi-horizontal relays, risking copying error related stress. Peer group populations are rapidly replaced, meaning that traits must be spread quickly if they are to survive at all. By examining how peer cultures persist despite these compounding threats, modelers and fieldworkers alike can shed light on alternative mechanisms through which cultures can evolve. As of now, only Morin (2015) has proposed such a mechanism, *selection for proliferation*, by which peer culture traits themselves elicit frequent repetition, leading to their maintenance and spread. Whether such selection extends beyond children's folklore to traits such as material culture or ecological knowledge is currently not known. Structured observations are needed to elucidate how and from whom peer culture traits are invented and transmitted. Combined with observations, retrospective interviews with adults of different ages can help us understand why some traits persist for generations while others are almost immediately forgotten. Systematic quantitative surveys of existing peer culture traits are also needed to investigate how these differ in form and function from adult traits, and thus, how exactly children contribute to adaptive cultural variance (Fogarty & Kandler, 2020; Smaldino et al., 2024).

In this paper, we have focused on aspects of peer cultures that may benefit wider communities. However, we do not claim that all cultural traits produced within the peer group will be adaptive, nor that children are capable of producing all types of adaptive innovations. Indeed, many aspects of peer cultures are likely to evidence cultural evolutionary drift (Hahn & Bentley, 2003). Further, generating novel ecological knowledge may be useful when entering a novel ecological niche, but may provide no added benefit when entering a new social or economic niche. In this latter case, novel social norms (e.g., those associated with trade) may instead be more important. Based on the theoretical and empirical literature reviewed above, we posit that peer cultures are more likely to contribute innovations discovered via broad spatial (e.g., novel food patches) and social (e.g., communication norms) exploration. In contrast, we found little evidence for peer cultures producing complex technological innovations, potentially because learning to make and use complex technologies tends to occur in later adolescence and into early adulthood (Reyes-García et al., 2016). Instead, peer culture exploration may lay the groundwork for more goal-directed innovation for complex tasks in later life (Mesoudi, 2021). Overall then, future research is needed which helps elucidate causes for variation in peer culture traits, as well as the contexts in which these traits are adaptive and in which they are not.

7.2. Did peer culture contribute to the evolution of long human childhoods?

Researchers aiming to understand the evolution of long childhoods have increasingly incorporated horizontal learning into their models. Specifically, a multi-stage model whereby children gain basic competencies through practice with peers, after which they receive more specialized teaching from adults, has gained theoretical and empirical support (Gurven, Davison, & Kraft, 2020; Lehmann, Wakano, & Aoki, 2013; Reyes-García et al., 2016). While important, these studies overwhelmingly focus on how peer learning contributes to *future* skill acquisition. Yet, recent work suggests that under conditions of uncertainty, organisms are unlikely to trade-off immediate rewards for delayed ones, even if the delayed reward has a much higher payoff (Villmoare, Klein, Lienard, & McHale, 2024). In other words, the benefits of learning high-yield adult skills may be insufficient to justify developmental temporal discounting of long low-yield learning periods (Kramer, 2011). Accounting for the immediate products that peer learning confers – that is, peer cultures – can help resolve this contradiction. We have argued that peer cultures act as safety nets, incubators, and innovation generators. Bidirectional knowledge transfers between children and adults, more so than unidirectional transmission of stable culture from adults to children, can reduce the uncertainty of delayed rewards by ensuring that relevant knowledge is always up-to-date. This possibility is supported by research into collective adaptation, which suggests that *any* transient diversity, whereby a group maintains diverse solutions before converging on a common solution, "will improve the quality of the solution on which the group ultimately converges" (Smaldino et al., 2024, p. 454).

Connecting life history theory with collective adaptation to explain the evolution of long human childhoods compels two important areas of inquiry. First, experimental research is needed to assess whether "immature" cognition may in fact partly reflect adaptations for peer cultures. We previously noted that children are unable to produce adult-like goal-directed innovation until 8 years (Rawlings, 2022). In contrast, children are better able to infer unlikely hypotheses than adults (Liquin & Gopnik, 2022), and can generate new knowledge through peer interaction (Damon, 1984). Such findings may reflect an age-graded division of cognitive labor (Wu et al., 2023), rather than cognitive immaturity on the part of children. Incorporating diverse forms of transmission – including horizontal and reverse vertical – into models aiming to understand the evolution of developmental plasticity (e.g., Frankenhuis & Walasek, 2020; Ratikainen & Kokko, 2019) can shed light on how age-graded divisions of cognitive labor help individuals adjust to varying environmental conditions.

Second, our argument highlights a potentially important role for the "reverse vertical" transmission of traits from peer to adult cultures. While this area of research has received significantly less attention than warranted, there are numerous examples of children transmitting knowledge to adults in other domains: children frequently teach their parents about new technology (e.g., digital media) and social norms (e.g., in immigration contexts) (Correa, 2016; White, Ní Laoire, Tyrrell, & Carpena-Méndez, 2011), reflecting the plausibility of this pathway. Further, the case studies reviewed in section 6, as well as modeling research (e.g., Deffner & McElreath, 2022) suggest that learning from younger generations is most likely to occur during episodes of profound social, cultural, and ecological change. Longitudinal, comparative, ethnographic research tracking exogenous forces such as climate change and market integration, and endogenous forces such as changes in population structure can elucidate how and when adults may benefit from adopting peer culture traits from children.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

7.3. How do peer cultures intersect with cognitive development?

Throughout this paper, we described evidence for peer cultures at all stages of development: early childhood, middle childhood, and adolescence. In doing so, we demonstrated that peer cultures exist and are likely consequential at all ages. In what follows, we outline some predicted developmental shifts in the form and function of peer cultures through cognitive maturation.

Prior to the age of three years, children are "simply not adapted for collaborating with peers, but only with adults" (Tomasello, 2024, p. 73). Reflecting improvements in joint attention (Tomasello, 2020) and self-regulation of executive thinking (Tomasello, 2024), three-year-olds begin to more successfully collaborate with same-aged peers (Brownell & Carriger, 1990). The emergence of sensitivity to intergroup relations and in-group status (Nesdale, Maass, Griffiths, & Durkin, 2003) also paves the way for new forms of social and cultural interactions with peers, and the development of a unique peer group identity (in-group) distinct from that of adults (out-group). Thus, equipped with these new cognitive representations and tools at around the age of three, children debut into the world of peer culture.

In early childhood, children utilize a variety of exploration techniques to learn the affordances of their physical and social worlds (e.g., Meder, Wu, Schulz, & Ruggeri, 2021) This exploration can even result in gathering information that adults miss, due to flatter priors and openness to less conventional hypotheses (e.g., Liquin & Gopnik, 2022). In experimental contexts, children at this age are capable of engaging in the building blocks of cultural evolution, such as complex innovation and transmission (McGuigan et al., 2017). Thus, we believe that early childhood is a critical period for forming underlying epistemic schemas for how the natural and social world works, in ways which can diverge from those of the adults in their community. More formal modeling and empirical work is needed to better understand how early divergence in epistemic schemas can lead to divergent downstream innovations.

Children in middle childhood evidence sophisticated understandings of norms, morality, and their intersection with group identity (Amir et al., 2023; House et al., 2019; e.g., Karadağ & Soley, 2023; Schmidt & Tomasello, 2012). During this stage, children may develop their own norms and methods for maintaining those norms (e.g., Katriel, 1987), behaviors which may have lasting implications if these persist into adulthood (Reckin, Lew-Levy, Lavi, & Ellis-Davies, 2020). In many subsistence societies, middle childhood is also marked by increased social responsibility, rule-governed and skill-oriented play, and (especially for boys) freedom of movement (Lancy & Grove, 2011). We suspect that the equal importance of work and play during middle childhood gives rise to novel technologies adjusted to children's size and strength, the discovery of new foraging patches, and associated ecological knowledge. Horizontal transmission also becomes more pronounced and sophisticated during this period (Strauss & Ziv, 2012), helping spread such peer-group inventions. Much more research is needed on peer-to-peer teaching and learning in this developmental stage, along with greater focus on how children create peer-specific technologies and norms.

In adolescence, peers become an increasingly dominant force for socialization. For example, in an experimental task, Italian and Singaporean adolescents were more likely to follow the sharing suggestions of peers than adults (Ruggeri, Luan, Keller, & Gummerum, 2018). This life stage is also associated with increased cognitive flexibility, sensitivity to sociocultural influences, and risk-taking (Blakemore & Mills, 2014; Crone & Dahl, 2012). Notably, risk-taking can enhance individual learning: in an incentivized risk task, adolescents were more likely to take risks, and also to learn more in the task, "behavioral patterns . . . [which] serve an adaptive function with respect to resource acquisition" (McCormick & Telzer, 2017, p. 417). Ethnographic research also suggests that adolescents are early adopters, rather than producers, of complex instrumental innovations (Hewlett, 2021). Instead, their innovations likely occur in social domains, particularly in the realm of language. As noted in section 5.5, language is central to adolescent peer cultures, encompassing verbal sparring, story telling, and gossip (Corsaro & Eder, 1990; Opie & Opie, 1959). It is not surprising, then, that adolescents are also considered key drivers of language change (Cheshire, Fox, Kerswill, & Torgersen, 2008; Raviv, Blasi, & Kempe, 2025; Wiese, 2009). Future work should examine the unique role of peer cultures in the invention and incubation of new linguistic forms. Further, as they are biologically and socially in closest proximity to adults, future studies should examine the role of adolescents in brokering between peer and adult cultures, and the contributions of such brokering to innovation through recombination.

7.4. How do peer cultures vary across contexts?

It is well recognized that developmental psychology suffers from a persistent sampling bias whereby children from the post-industrialized West are overrepresented, calling into question the generalizability of existing theory and findings to diverse cultural communities (Amir & McAuliffe, 2020; Nielsen, Haun, Kärtner, & Legare, 2017). In response, cross-cultural research is becoming more widespread, with studies documenting important variation and similarities in social learning and innovation. However, we do not currently know the extent to which peer cultures also vary across diverse societies.

Many of the social and contextual factors that vary across societies can theoretically have downstream consequences for peer cultures. Some shared factors may lead to cultural convergence. For example, contamination games, such as cooties, appear spontaneously in many cultural contexts. Morin (2008) argues that contamination games which "best appealed to the universal mechanisms of social disgust were those which managed to be transmitted to the next generation of children" (p. 11, translated from French), explaining their similarities despite independent origins. Other factors are likely to drive variation. The demographic makeup of the population and the rates of peer interaction seem particularly relevant. In societies where institutions lead to sharp age-based segregation (e.g., elementary, middle, and high schools), multiple age-specific peer cultures may arise independently. Further, rates of child caretaking can "affect the sex composition of the play group and the physical and social mobility and exploration possible for certain children; and, where caretaking is not limited to one's own siblings, it may shape contacts with children not in one's immediate family" (Weisner et al., 1977, p. 177). Population size also likely plays a role; while larger and more diverse peer groups may in theory produce more diverse cultural traits (Post, Lia, DiTomaso, Tirpak, & Borwankar, 2009), Lancy (1984, p. 231) notes that multi-aged groups "had a ceiling effect on play complexity . . . Games all had to be simple enough to be played by toddlers." Ecological context may also shape what games can be played: Griaule and Marcus (1938, p. 12) note that Dogon children do not play ball games because these "simply cannot operate on

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

cliffs, nor in the heavily wooded savannahs which are spread out at their feet." Cross-cultural studies examining how peer culture trait quantity and diversity co-vary with age segregation, task assignment, peer group size and composition, and ecology, can help us understand how and why peer cultures differ across contexts.

In post-industrial settings, access to physical spaces where children can assort independently from adults is waning. Instead, peer cultures are increasingly expressed online (Beavis, 2015; Tan, 2021): "Digital spaces are today's arcades and malls. They are the first place that young people go to feel connected . . . They are the sites that Gen Z uses to form a collective sense of generational culture" (Boffone, 2021, p. 21). In virtual reality spaces, for example, children evidenced age-graded peer cultures: young children focused on exploring the affordances of the virtual space, younger adolescents exchanged avatars, and older adolescents often clustered together to tell jokes and tease each other (Maloney, Freeman, & Robb, 2020). Children not only instructed each other on how to navigate virtual spaces, but also frequently helped adults solve the technological problems they encountered (Maloney et al., 2020). Children can also affect significant change in the digital ecosystem. For example, adolescents in particular frequently repurpose technology (e.g., apps) to meet their own needs, often in ways unintended by the developers, which can lead to large-scale changes in the market and the functionality of new apps (Boffone, 2021). Online spaces can also accelerate the speed of peer culture transmission. As an example, the spread of Sheng – a Kenyan Youth Language originating from Nairobi – to rural areas has been facilitated by online media such as Facebook and Instagram (Erastus, Orwenjo, & Gathigia, 2022). Overall then, and alongside waning physical spaces, children may use virtual spaces to enact, invent, and transmit peer cultures. As virtual worlds and social media are increasingly recognized as sites for cultural evolution (e.g., Acerbi, 2016; Carrignon, Bentley, & Ruck, 2019; Vélez, Wu, Gershman, & Schulz, 2024), we encourage researchers to attend to how children transform these spaces.

8. Conclusion

In this article, we have argued that children are independent producers and maintainers of autonomous cultures. Despite near-exclusive horizontal transmission, peer cultures are long-lasting and resilient. They may be an important source of community knowledge diversity, including both material and immaterial knowledge related to geography, ecology, subsistence, norms, and language. These diverse and distinct cultural repertoires may represent a source for new behaviors and technologies, and may keep others from disappearing. Cultural traits maintained within the peer culture reservoir may then be "reactivated" to help communities adapt to rare but salient social and ecological change. Case studies from anthropology, psychology, linguistics, and ethnoecology suggest that peer group activities, including exploration, peer learning, and the propensity to maintain abandoned adult cultural traits, may contribute to community adaptation, resilience, and in some cases (e.g., Nicaraguan Sign Language) may even produce new cultural communities.

Critically, our perspective has implications for theories about the evolution of long human childhoods: rather than just more time for learning adult skills, long childhoods may also allow for the generation and maintenance of peer cultural products. The ubiquity and regularity of peer cultures across societies further bolsters this point, suggesting that there may have been active selection pressure for the social and cognitive features that support peer cultures. Children's strong tendencies to explore, in addition to their natural abilities as peer teachers, may also have evolved not just to facilitate learning *adult culture from adults*, but also for creating *peer culture with peers*.

We do not claim that peer cultures are the only mechanism by which communities adjust to change. Nor do we claim that we have presented irrefutable evidence for these processes. Instead, we hope to stimulate new theoretical and empirical work which aims to fully understand the prevalence, variation in, and impact of peer cultures on cultural evolutionary processes. If our hypotheses are supported, such research can uncover new mechanisms by which cultures evolve. If they are not, research can still shed new light on a cross-culturally robust yet understudied social phenomenon central to children's development. We thus hope that this paper serves to validate this area of inquiry, and galvanize other researchers to more seriously consider children's role as active agents in cultural adaptation.

Acknowledgments. First and foremost thank you to the BaYaka, Bandongo, Hadza, and Shuar children and families who inspired these ideas. Thanks to Ilaria Pretelli, Edmond Dounias, Marco Smolla, Felix Riede, Alyssa Crittenden, Lee Gettler, Luke Glowacki, Zachary Garfield, Sarah Pope-Caldwell, Bruce Rawlings, Keren MacLennan, Patricia Greenfield, Michael Tomasello, and members of the Durham Cultural Evolution Research Center for sanity checks throughout the writing process. Thanks to Julia Bainbridge for reviewing examples from the Human Relations Area Files. Thanks to David Lancy, Rob Boyd, April Nowell, Limor Raviv, Damian Blasi, and Vera Kempe for extensive feedback on the manuscript, which helped strengthen our argument. Thanks to Domink Deffner and four anonymous reviewers for their feedback.

Financial support. This work was supported by the Templeton World Charity Foundation (#TWCF-2021-20639). SLL was funded by a Starting Grant from the European Research Council (ERC) under the European Union's Horizon Europe research and innovation programme (grant agreement No 101160788).

Competing interests. None.

References

Acerbi, A. (2016). A cultural evolution approach to digital media. *Frontiers in Human Neuroscience*, *10*, 1–12. https://doi.org/10.3389/fnhum.2016.00636.

Acerbi, A., & Parisi, D. (2006). Cultural transmission between and within generations. *Journal of Artificial Societies and Social Simulation*, *9*(1), 1–9.

Ackerley, J. (2007). The subversive world of New Zealand children's playground rhymes. *Journal of Folklore Research*, *44*(2/3), 205–225.

Ames, G. J., & Murray, F. B. (1982). When two wrongs make a right: Promoting cognitive change by social conflict. *Developmental Psychology*, *18*(6), 894–897. https://doi.org/10.1037/0012-1649.18.6.894

Amir, D., & McAuliffe, K. (2020). Cross-cultural, developmental psychology: Integrating approaches and key insights. *Evolution and Human Behavior*, *41*(5), 430–444. https://doi.org/10.1016/j.evolhumbehav.2020.06.006

Amir, D., Melnikoff, D., Warneken, F., Blake, P. R., Corbit, J., Callaghan, T. C., . . . McAuliffe, K. (2023). Computational signatures of inequity aversion in children across seven societies. *Journal of Experimental Psychology: General*, *152*(10), 2882–2896. https://doi.org/10.1037/xge0001385.

Aries, P. (1965). *Centuries of childhood: A social history of family life*. Vintage.

Ashley, J., & Tomasello, M. (1998). Cooperative problem-solving and teaching in preschoolers. *Social Development*, *7*(2), 143–163. https://doi.org/10.1111/1467-9507.00059

Ayoub, M. R., & Barnett, S. A. (1965). Ritualized verbal insult in white high school culture. *The Journal of American Folklore*, *78*(310), 337–344. https://doi.org/10.2307/538441

Baldwin, D. A. (1991). Infants' contribution to the achievement of joint reference. *Child Development*, *62*(5), 875–890.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Barbieri, F. (2009). Quotative be like in American English: Ephemeral or here to stay? *English World-Wide*, *30*(1), 68–90. https://doi.org/10.1075/eww.30.1.05bar.

Bascandziev, I., LaSorsa, M., Shafto, P., & Bonawitz, E. (2022). Can children recognize pedagogical intent in the prosody of speech? In J. Culbertson, A. Perfors, H Rabagliati, & V. Ramenzoni (Eds.), Proceedings of the 44th Annual Conference of the Cognitive Science Society (pp. 3956). https://escholarship.org/uc/item/7dg0w70j

Bateson, P. (2015). Playfulness and creativity. *Current Biology*, *25*(1), R12–R16. https://doi.org/10.1016/j.cub.2014.09.009

Baucomont, J., Guibat, F., Lucile, T., Pinon, R., & Soupault, P. (1961). *Les comptines de langue française*. University of Michigan Press.

Baxter, G., & Croft, W. (2016). Modeling language change across the lifespan: Individual trajectories in community change. *Language Variation and Change*, *28*(2), 129–173.

Beavis, C. (2015). Young people, online gaming culture, and education. In J. Wyn & H. Cahill (Eds.), *Handbook of children and youth studies* (pp. 1–11). Springer. https://doi.org/10.1007/978-981-4451-96-3_32-2

Beck, S. R., Apperly, I. A., Chappell, J., Guthrie, C., & Cutting, N. (2011). Making tools isn't child's play. *Cognition*, *119*(2), 301–306. https://doi.org/10.1016/j.cognition.2011.01.003

Becker, J. A. (1994). "Sneak-shoes", "sworders" and "nose-beards": A case study of lexical innovation. *First Language*, *14*(41), 195–211. https://doi.org/10.1177/014272379401404104

Berl, R. E. W., & Hewlett, B. S. (2015). Cultural variation in the use of over-imitation by the Aka and Ngandu of the Congo Basin. *PLOS ONE*, *10*(3), e0120180. https://doi.org/10.1371/journal.pone.0120180

Bird, D., & Bliege Bird, R. (2004). Mardu children's hunting strategies in the Western Desert, Australia: Implications for the evolution of human life histories. In Barry S. Hewlett, & Michael E. Lamb (Eds.), *Hunter-Gatherer childhoods* (pp. 129–146). Aldine de Gruyter.

Bjorklund, D. F., & Green, B. L. (1992). The adaptive nature of cognitive immaturity. *American Psychologist*, *47*(1), 46–54. https://doi.org/10.1037/0003-066X.47.1.46

Blakemore, S.-J., & Mills, K. L. (2014). Is adolescence a sensitive period for sociocultural processing? *Annual Review of Psychology*, *65*(1), 187–207. https://doi.org/10.1146/annurev-psych-010213-115202

Blizard, C., & Schuster, R. (2005). "They all cared about the forest": Elementary school children's experiences of the loss of a wooded play space at a private school in upstate New York. In Proceedings of the 2004 Northeastern Recreation Research *Symposium* (pp. 57–63). U.S. Department of Agriculture, Forest Service, Northeastern Research Station.

Blyth, C., Recktenwald, S., & Wang, J. (1990). I'm like, "say what?!": A new quotative in American oral narrative. *American Speech*, *65*(3), 215–227. https://doi.org/10.2307/455910

Boffone, T. (2021). *Renegades: Digital dance cultures from Dubsmash to TikTok*. Oxford University Press.

Bohn, M., Kachel, G., & Tomasello, M. (2019). Young children spontaneously recreate core properties of language in a new modality. Proceedings of the National Academy of Sciences, 116(51), 26072–26077. https://doi.org/10.1073/pnas.1904871116

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. (1985). Culture and the evolutionary process (pp. viii, 331). University of Chicago Press.

Boyette, A. H. (2016). Children's play and the integration of social and individual learning: A cultural niche construction perspective. In H. Terashima & B. S. Hewlett (Eds.), *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 159–169). Springer Japan. https://doi.org/10.1007/978-4-431-55997-9_13

Boyette, A. H., & Hewlett, B. S. (2017). Autonomy, equality, and teaching among Aka foragers and Ngandu farmers of the Congo Basin. *Human Nature*, *28*(3), 289–322. https://doi.org/10.1007/s12110-017-9294-y

Broesch, T. L., & Bryant, G. A. (2015). Prosody in infant-directed speech is similar across western and traditional cultures. *Journal of Cognition and Development*, *16*(1), 31–43. https://doi.org/10.1080/15248372.2013.833923

Brown, R. (1973). A first language: The early stages (pp. xx, 437). Harvard University Press.

Brownell, C. A., & Carriger, M. S. (1990). Changes in cooperation and self-other differentiation during the second year. *Child Development*, *61*(4), 1164. https://doi.org/10.2307/1130884

Bunce, J. A. (2021). Cultural diversity in unequal societies sustained through cross-cultural competence and identity valuation. *Humanities and Social Sciences Communications*, *8*(1), Article 1. https://doi.org/10.1057/s41599-021-00916-5

Cancian, F. (1994). *The decline of community in Zinacantan: Economy, public life, and social stratification, 1960-1987*. Stanford University Press. https://books.google.com/books?hl=en&lr=&id=WkOdgfDr3A8C&oi=fnd&pg=PR16&dq=The+Decline+of+Community+in+Zinacantan:+Economy,&ots=HR3ins498n&sig=KDYARoqeMfcf6MYHwl2qu3kJxn0

Carr, K., Kendal, R. L., & Flynn, E. G. (2016). Eureka!: What is innovation, how does it develop, and who does it? *Child Development*, *87*(5), 1505–1519. https://doi.org/10.1111/cdev.12549

Carrignon, S., Bentley, R. A., & Ruck, D. (2019). Modelling rapid online cultural transmission: Evaluating neutral models on Twitter data with approximate Bayesian computation. *Palgrave Communications*, *5*(1), 1–9. https://doi.org/10.1057/s41599-019-0295-9

Cavalli-Sforza, L. L., & Feldman, M. W. (1981). *Cultural transmission and evolution: A quantitative approach*. Princeton University Press.

Cekaite, A. (2018). Microgenesis of language creativity: Innovation, conformity and incongruence in children's language play. *Language Sciences*, *65*, 26–36. https://doi.org/10.1016/j.langsci.2017.01.007

Cheshire, J., Fox, S., Kerswill, P., & Torgersen, E. (2008). Ethnicity, friendship network and social practices as the motor of dialect change: Linguistic innovation in London. *Sociolinguistica*, *22*(1), 1–23. https://doi.org/10.1515/9783484605299.1

Childs, C. P., & Greenfield, P. M. (1980). Informal modes of learning and teaching: The case of Zinacanteco weaving. Studies in *Cross-Cultural Psychology*, *2*, 269–316.

Chimezie, A. (1976). The dozens: An African-heritage theory. *Journal of Black Studies*, *6*(4), 401–420.

Chomsky, C. (1976). Creativity and innovation in child language. *The Journal of Education*, *158*(2), 12–24.

Clark, E. V. (1982). The young word maker: A case study of innovation in the child's lexicon. In Eric Wanner, & Lila R. Gleitman (Eds.), Language Acquisition: The State of the Art (pp. 390–425) (Cambridge University Press).

Clark, E. V. (2009). *First language acquisition* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511806698

Clegg, J. M., & Legare, C. H. (2016). A cross-cultural comparison of children's imitative flexibility. *Developmental Psychology*, *52*(9), 1435.

Cobb-Moore, C., Danby, S., & Farrell, A. (2009). Young children as rule makers. *Journal of Pragmatics*, *41*(8), 1477–1492. https://doi.org/10.1016/j.pragma.2007.04.013

Collard, M., Buchanan, B., O'Brien, M. J., & Scholnick, J. (2013). Risk, mobility or population size? Drivers of technological richness among contact-period western north American hunter–gatherers. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *368*(1630), 20120412. https://doi.org/10.1098/rstb.2012.0412

Correa, T. (2016). Acquiring a new technology at home: A parent-child study about youths' influence on digital media adoption in a family. Journal of Broadcasting & Electronic Media, 60(1), 123–139. https://doi.org/10.1080/08838151.2015.1127238

Corsaro, W. A. (1988). Peer culture in the preschool. *Theory Into Practice*, *27*(1), 19–24. https://doi.org/10.1080/00405848809543326

Corsaro, W. A. (1992). Interpretive reproduction in children's peer cultures. *Social Psychology Quarterly*, *55*(2), 160–177. https://doi.org/10.2307/2786944

Corsaro, W. A. (2003). *We're friends, right?: Inside kids' culture*. Joseph Henry Press.

Corsaro, W. A. (2017). *The sociology of childhood*. Sage Publications.

Corsaro, W. A., & Eder, D. (1990). Children's peer cultures. *Annual Review of Sociology*, *16*(1), 197–220.

Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (2019). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development*, *90*(3), 759–773. https://doi.org/10.1111/cdev.12974

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Cristia, A., Gautheron, L., & Colleran, H. (2023). Vocal input and output among infants in a multilingual context: Evidence from long-form recordings in Vanuatu. *Developmental Science*, *26*(4), e13375. https://doi.org/10.1111/desc.13375

Crittenden, A. N. (2016). Children's foraging and play among the Hadza. Origins and Implications of the Evolution of Childhood, *34*, 155–172.

Crittenden, A. N., Conklin-Brittain, N. L., Zes, D. A., Schoeninger, M. J., & Marlowe, F. W. (2013). Juvenile foraging among the Hadza: Implications for human life history. *Evolution and Human Behavior*, *34*(4), 299–304.

Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social–affective engagement and goal flexibility. *Nature Reviews Neuroscience*, *13*(9), 636–650. https://doi.org/10.1038/nrn3313

Csibra, G., & Gergely, G. (2011). Natural pedagogy as evolutionary adaptation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1567), 1149–1157. https://doi.org/10.1098/rstb.2010.0319

Cutting, N., Apperly, I. A., & Beck, S. R. (2011). Why do children lack the flexibility to innovate tools? *Journal of Experimental Child Psychology*, *109*(4), 497–511. https://doi.org/10.1016/j.jecp.2011.02.012

Damon, W. (1984). Peer education: The untapped potential. *Journal of Applied Developmental Psychology*, *5*(4), 331–343. https://doi.org/10.1016/0193-3973(84)90006-6

Danby, S. (2002). The communicative competence of young children. *Australasian Journal of Early Childhood*, *27*(3), 25–30. https://doi.org/10.1177/183693910202700306

Darian-Smith, K., & Pascoe Leahy, C. (Eds.). (2013). *Children, childhood and cultural heritage*. Routledge.

Davis, H. E., & Cashdan, E. (2020). You don't have to know where your kids are, just where they aren't: Exploring free-range parenting in the Bolivian Amazon. In *Parents and caregivers across cultures: Positive development from infancy through adulthood* (pp. 59–74). Springer.

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

Deffner, D., & Kandler, A. (2019). Trait specialization, innovation, and the evolution of culture in fluctuating environments. *Palgrave Communications*, *5*(1), 1–10. https://doi.org/10.1057/s41599-019-0360-4

Deffner, D., & McElreath, R. (2022). When does selection favor learning from the old? Social learning in age-structured populations. *PLOS ONE*, *17*(4), e0267204. https://doi.org/10.1371/journal.pone.0267204

de Garine, I. (1993). Coping strategies in case of hunger of the most vulnerable groups among the Massa and Mussey of northern Cameroon. *GeoJournal*, *30*(2), 159–166.

de Garine, I. (2005). Nourriture de brousse chez les Muzey et les Masa du Nord-Cameroun. In C. Raimond, É. Garine & O. Langlois (Eds.), *Ressources vivrières et choix alimentaires dans le bassin du lac Tchad* (pp. 47–62). IRD Éditions. https://doi.org/10.4000/books.irdeditions.1626

Derex, M., & Boyd, R. (2016). Partial connectivity increases cultural accumulation within groups. Proceedings of the National Academy of Sciences, 113(11), 2982–2987. https://doi.org/10.1073/pnas.1518798113

Dounias, E. (2014). From Foraging to . . . foraging. Non-Wood Forest Products Newsletter of FAO.

Dounias, E. (2016). From subsistence to commercial hunting: Technical shift in cynegetic practices among southern Cameroon forest dwellers during the 20th century. *Ecology and Society*, *21*(1), 1–13. https://www.jstor.org/stable/26270329.

Dounias, E. (2021, December 9). Signs of the times. Biotemporal indicators and their guidance role in Indigenous Food Systems. Norwegian Council for Africa.

Eckerman, C. O., Whatley, J. L., & Kutz, S. L. (1975). Growth of social play with peers during the second year of life. *Developmental Psychology*, *11*(1), 42–49. https://doi.org/10.1037/h0076131

Eckert, P. (1988). Adolescent social structure and the spread of linguistic change. *Language in Society*, *17*(2), 183–207.

Emler, N., & Valiant, G. L. (1982). Social interaction and cognitive conflict in the development of spatial coordination skills. *British Journal of Psychology*, *73*(2), 295–303. https://doi.org/10.1111/j.2044-8295.1982.tb01812.x

Erastus, F. K., Orwenjo, D. O., & Gathigia, M. N. (2022). Escaping the margins of society: New media and youth language practices across the rural urban divide in Kenya. Multilingual Margins: A Journal of Multilingualism from the Periphery, *9*(1), 83–100. https://www.epubs.ac.za/index.php/mm/article/view/1412.

Evaldsson, A.-C. (2021). Examining girls' peer culture-in-action: Gender, stance, and category work in girls' peer language practices. In Jo Angouri, & Judith Baxter (Eds.), *The Routledge handbook of language, gender, and sexuality* (pp. 304–319). Routledge.

Fajardo, J. A. S. (2019). Exploring the "shashification" of teenage slang. *English Today*, *35*(3), 49–54. https://doi.org/10.1017/S0266078418000251

Fine, G. A. (1980). Children and their culture: Exploring Newell's paradox. *Western Folklore*, *39*(3), 170–183. https://doi.org/10.2307/1499799

Fleck, D. W. (2003). *A grammar of Matses*. Rice University.

Fleck, D. W., & Harder, J. D. (2000). Matses Indian rainforest habitat classification and mammalian diversity in Amazonian Peru. *Journal of Ethnobiology*, *20*, 1–36.

Fogarty, L., & Kandler, A. (2020). The fundamentals of cultural adaptation: Implications for human adaptation. *Scientific Reports*, *10*(1), 14318.

Frankenhuis, W. E., & Walasek, N. (2020). Modeling the evolution of sensitive periods. *Developmental Cognitive Neuroscience*, *41*, 100715. https://doi.org/10.1016/j.dcn.2019.100715

Galef, B. (2003). Animal innovation. In S.M. Reader, & K.M. Laland (Eds.), *Social Learning: Promoter or Inhibitor of Innovation?* (pp. 137–154). Oxford University Press.

Galesic, M., Barkoczi, D., Berdahl, A. M., Biro, D., Carbone, G., Giannoccaro, I., . . . Stein, D. L. (2023). Beyond collective intelligence: Collective adaptation. *Journal of the Royal Society Interface*, *20*(200), 20220736. https://doi.org/10.1098/rsif.2022.0736

Gallois, S., Duda, R., & Reyes-García, V. (2017). Local ecological knowledge among Baka children: A case of "children's culture"? *Journal of Ethnobiology*, *37*(1), 60–80.

Gauvain, M., & Munroe, R. L. (2019). Children's experience during cultural change. *Child Development Perspectives*, *13*(1), 65–70. https://doi.org/10.1111/cdep.12318

Gelman, S. A., Ware, E. A., Manczak, E. M., & Graham, S. A. (2013). Children's sensitivity to the knowledge expressed in pedagogical and non-pedagogical contexts. *Developmental Psychology*, *49*(3), 491–504. https://doi.org/10.1037/a0027901

Giron, A. P., Ciranka, S., Schulz, E., van den Bos, W., Ruggeri, A., Meder, B., & Wu, C. M. (2023). Developmental changes in exploration resemble stochastic optimization. *Nature Human Behaviour*, *7*(11), 1955–1967. https://doi.org/10.1038/s41562-023-01662-1

Gönül, G., Hohenberger, A., Corballis, M., & Henderson, A. M. E. (2019). Joint and individual tool making in preschoolers: From social to cognitive processes. *Social Development*, *28*(4), 1037–1053. https://doi.org/10.1111/sode.12373

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., O'Grady, S., Lucas, C. G., Griffiths, T. L., Wente, A., Bridgers, S., . . . Dahl, R. E. (2017). Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood. Proceedings of the National Academy of Sciences, 114(30), 7892–7899. https://doi.org/10.1073/pnas.1700811114

Grassmann, S., & Tomasello, M. (2010). Young children follow pointing over words in interpreting acts of reference. *Developmental Science*, *13*(1), 252–263.

Greenbaum, G., Fogarty, L., Colleran, H., Berger-Tal, O., Kolodny, O., & Creanza, N. (2019). Are both necessity and opportunity the mothers of innovations? *Behavioral and Brain Sciences*, *42*, e199. https://doi.org/10.1017/S0140525X19000207.

Greenfield, P. M. (2004). Weaving generations together: Evolving creativity in the Maya of Chiapas (illustrated edition). School of American Research Press.

Greenfield, P. M., Maynard, A. E., & Childs, C. P. (2000). History, culture, learning, and development. *Cross-Cultural Research*, *34*(4), 351–374. https://doi.org/10.1177/106939710003400404

Griaule, M., & Marcus, M. A. (1938). Dogon games. Institut d'Ethnologie. https://ehrafworldcultures.yale.edu/document?id=fa16-013

Gurven, M. D., Davison, R. J., & Kraft, T. S. (2020). The optimal timing of teaching and learning across the life course. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1803), 20190500. https://doi.org/10.1098/rstb.2019.0500

Hahn, M. W., & Bentley, R. A. (2003). Drift as a mechanism for cultural change: An example from baby names. Proceedings of the Royal Society B: Biological Sciences, 270(Suppl 1), S120–S123. https://doi.org/10.1098/rsbl.2003.0045

Hardenberg, M. (2010). In search of Thule children: Construction of playing houses as a means of socializing children. *Geografisk Tidsskrift-Danish Journal of Geography*, *110*(2), 201–214. https://doi.org/10.1080/00167223.2010.10669507

Hawkes, K. (2003). Grandmothers and the evolution of human longevity. *American Journal of Human Biology*, *15*(3), 380–400. https://doi.org/10.1002/ajhb.10156

Henrich, J. (2004). Demography and cultural evolution: How adaptive cultural processes can produce maladaptive losses – the Tasmanian case. *American Antiquity*, *69*(2), 197–214. https://doi.org/10.2307/4128416

Henrich, J., & McElreath, R. (2003). The evolution of cultural evolution. *Evolutionary Anthropology*, *12*(3), 123–135. https://doi.org/10.1002/Evan.10110

Hewlett, B. S. (1992). The parent-infant relationship and social-emotional development among Aka pygmies. In Roopnarine, & Carter (Eds.), *Parent-Child Socialization in Diverse Cultures* (pp. 223–243). Bloomsbury.

Hewlett, B. (2021). Social learning and innovation in adolescence. *Human Nature*, *32*(1), 239–278. https://doi.org/10.1007/s12110-021-09391-y

Hirschfeld, L. A. (2002). Why don't anthropologists like children? *American Anthropologist*, *104*(2), 611–627. https://doi.org/10.1525/aa.2002.104.2.611

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

House, B. R., Kanngiesser, P., Barrett, H. C., Broesch, T., Cebioglu, S., Crittenden, A. N., … Silk, J. B. (2019). Universal norm psychology leads to societal diversity in prosocial behaviour and development. *Nature Human Behaviour*, *4*(1), 36–44.

Howe, N., & Recchia, H. (2005). Playmates and teachers: Reciprocal and complementary interactions between siblings. *Journal of Family Psychology: JFP: Journal of the Division of Family Psychology of the American Psychological Association (Division 43)*, *19*(4), 497–502. https://doi.org/10.1037/0893-3200.19.4.497

Howe, N., Recchia, H., Porta, S. D., & Funamoto, A. (2012). "The driver doesn't sit, he stands up like the Flintstones!": Sibling teaching during teacher-directed and self-guided tasks. *Journal of Cognition and Development*, *13*(2), 208–231. https://doi.org/10.1080/15248372.2011.577703

Hrdy, S. B. (2011). Mothers and others: The evolutionary origins of mutual understanding (Illustrated edition). The Belknap Press.

IJzerman, H., Dutra, N., Silan, M., Adetula, A., Brown, D. M. B., & Forscher, P. (2021). Psychological science needs the entire globe, part 1. *APS Observer*, 34. https://www.psychologicalscience.org/observer/global-psych-science

Imamura, K. (2016). Hunting play among the San children: Imitation, learning, and play. In H. Terashima, & B.S. Hewlett (Eds.), *Social Learning and Innovation in Contemporary Hunter-Gatherers: Evolutionary and Ethnographic Perspectives* (pp. 179–186). Springer Japan.

Jaswal, V. K., & Neely, L. A. (2006). Adults don't always know best: Preschoolers use past reliability over age when learning new words. *Psychological Science*, *17*(9), 757–758. https://doi.org/10.1111/j.1467-9280.2006.01778.x

Junod, H. A. (1927). The life of a South African tribe: Vol. *2*. Macmillan and Co., Limited. https://ehrafworldcultures.yale.edu/document?id=ft06-002

Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A. M. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology: Issues, News, and Reviews*, *9*(4), 156–185. https://doi.org/10.1002/1520-6505(2000)9:4<156::AID-EVAN5>3.0.CO;2-7

Karadağ, D., & Soley, G. (2023). Children intend to teach conventional but not moral norms selectively to ingroup members. *Developmental Psychology*, *59*(3), 567–578. https://doi.org/10.1037/dev0001455

Katriel, T. (1985). Brogez: Ritual and strategy in Israeli children's conflicts. *Language in Society*, *14*(4), 467–490.

Katriel, T. (1987). "Bexibùdim!": Ritualized sharing among Israeli children. *Language in Society*, *16*(3), 305–320.

Katriel, T. (1988). Haxlafot: Rules and strategies in children's swapping exchanges. *Research on Language & Social Interaction*, *22*(1–4), 157–178.

Katriel, T. (1990). Sodot: Secret-sharing as a social form among Israeli children. *Research on Language & Social Interaction*, *24*(1–4), 141–157.

Kearins, J. M. (1981). Visual spatial memory in Australian aboriginal children of desert regions. *Cognitive Psychology*, *13*(3), 434–460. https://doi.org/10.1016/0010-0285(81)90017-7

Kerswill, Paul. (1996). Children, adolescents, and language change. *Language Variation and Change*, *8*(2), 177–202. https://doi.org/10.1017/S0954394500001137.

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.

Kline, M. A., & Boyd, R. (2010). Population size predicts technological complexity in Oceania. Proceedings of the Royal Society B: Biological Sciences, 277(1693), 2559–2564. https://doi.org/10.1098/rspb.2010.0452

Kline, M. A., Boyd, R., & Henrich, J. (2013). Teaching and the life history of cultural transmission in Fijian villages. *Human Nature*, *24*(4), 351–374. https://doi.org/10.1007/s12110-013-9180-1

Konner, M. (1976). Maternal care, infant behavior and development among the! Kung. In Richard B. Lee, & Irven DeVore (Eds.), *Kalahari hunter-gatherers: Studies of the !Kung San and their neighbors* (pp. 218–245). Harvard University Press.

Konner, M. (2010). *The evolution of childhood: Relationships, emotion, mind*. Harvard University Press.

Konner, M. (2017). Hunter-gatherer infancy and childhood. In B. S. Hewlett & M. E. Lamb (Eds.), *Hunter-gatherer childhoods* (1st ed., pp. 19–64). Routledge. https://doi.org/10.4324/9780203789445-3

Kramer, K. L. (2002). Variation in juvenile dependence: Helping behavior among Maya children. *Human Nature*, *13*, 299–325.

Kramer, K. L. (2011). The evolution of human parental care and recruitment of juvenile help. *Trends in Ecology & Evolution*, *26*(10), 533–540. https://doi.org/10.1016/j.tree.2011.06.002

Kramer, K. L. (2014). Why what juveniles do matters in the evolution of cooperative breeding. *Human Nature*, *25*(1), 49–65. https://doi.org/10.1007/s12110-013-9189-5

Kramer, K. L., & Veile, A. (2018). Infant allocare in traditional societies. *Physiology & Behavior*, *193*, 117–126. https://doi.org/10.1016/j.physbeh.2018.02.054

Krause, F., & Schütze, F. (1911). *In the wilderness of Brazil: Report and results of the Leipzig Araguaia expedition of 1908*. R. Voigtländers Verlag. https://ehrafworldcultures.yale.edu/document?id=sp09-005

Kruger, A. C. (1992). The effect of peer and adult-child transactive discussions on moral reasoning. *Merrill-Palmer Quarterly*, *38*(2), 191–211.

Kuczynski, L., Zahn-Waxler, C., & Radke-Yarrow, M. (1987). Development and content of imitation in the second and third years of life: A socialization perspective. *Developmental Psychology*, *23*(2), 276–282. https://doi.org/10.1037/0012-1649.23.2.276

Kylin, M. (2003). Children's Dens. *Children, Youth and Environments*, *13*(1), 30–55.

Labov, W. (1964). Stages in the acquisition of standard English. In R.W. Shuy (Ed.), *Social Dialects and Language Learning* (pp. 77–104). National Council of Teachers of English.

Lancy, D. F. (1984). Play in anthropological perspective. In P.K. Smith (Ed.), *Play in Animals and Humans* (pp. 295–303). Basil Blackwell.

Lancy, D. F. (2015). Children as a reserve labor force. *Current Anthropology*, *56*(4), 545–568. https://doi.org/10.1086/682286

Lancy, D. F. (2016). Playing with knives: The socialization of self-initiated learners. *Child Development*, *87*(3), 654–665. https://doi.org/10.1111/cdev.12498

Lancy, D. F. (2024). *Learning without lessons: Pedagogy in indigenous communities*. Oxford University Press.

Lancy, D. F., & Grove, M. (2011). Marbles and Machiavelli: The role of game play in children's social development. *American Journal of Play*, *3*, 489–499.

Lancy, D. F., Bock, J., & Gaskins, S. (2010). The anthropology of learning in childhood. Rowman Altamira.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Lee, R. D., & Kramer, K. L. (2002). Children's economic roles in the Maya family life cycle: Cain, Caldwell, and Chayanov revisited. *Population and Development Review*, *28*(3), 475–499.

Lefever, H. G. (1981). "Playing the dozens": A mechanism for social control. *Phylon (1960–)*, *42*(1), 73–85. https://doi.org/10.2307/274886

Legare, C. H., & Nielsen, M. (2015). Imitation and innovation: The dual engines of cultural learning. *Trends in Cognitive Sciences*, *19*(11), 688–699.

Lehmann, L., Wakano, J. Y., & Aoki, K. (2013). On optimal learning schedules and the marginal value of cumulative cultural evolution. *Evolution*, *67*(5), 1435–1445.

Lew-Levy, S., Lavi, N., Reckin, R., Cristóbal-Azkarate, J., & Ellis-Davies, K. (2018). How do hunter-gatherer children learn social and gender norms? A meta-ethnographic review. *Cross-Cultural Research*, *52*(2), 213–255.

Lew-Levy, S., Kissler, S. M., Boyette, A. H., Crittenden, A. N., Mabulla, I. A., & Hewlett, B. S. (2020). Who teaches children to forage? Exploring the primacy of child-to-child teaching among Hadza and BaYaka Hunter-Gatherers of Tanzania and Congo. *Evolution and Human Behavior*, *41*(1), 12–22. https://doi.org/10.1016/j.evolhumbehav.2019.07.003

Lew-Levy, S., Milks, A., Kiabiya Ntamboudila, F., Broesch, T., & Kline, M. A. (2021a). Bayaka adolescent boys nominate accessible adult men as preferred spear hunting models. *Current Anthropology*, *62*(5), 631–640. https://doi.org/10.1086/716853

Lew-Levy, S., Pope, S. M., Haun, D. B. M., Kline, M. A., & Broesch, T. (2021b). Out of the empirical box: A mixed-methods study of tool innovation among Congolese BaYaka forager and Bondongo fisher–farmer children. *Journal of Experimental Child Psychology*, *211*, 105223. https://doi.org/10.1016/j.jecp.2021.105223

Lew-Levy, S., Ringen, E. J., Crittenden, A. N., Mabulla, I. A., Broesch, T., & Kline, M. A. (2021c). The life history of learning subsistence skills among Hadza and BaYaka foragers from Tanzania and the Republic of Congo. *Human Nature*, *32*(1), 16–47. https://doi.org/10.1007/s12110-021-09386-9

Lew-Levy, S., Andersen, M. M., Lavi, N., & Riede, F. (2022). Hunter-gatherer children's object play and tool use: An ethnohistorical analysis. *Frontiers in Psychology*, *13*, 1–11. https://www.frontiersin.org/articles/10.3389/fpsyg.2022.824983.

Lew-Levy, S., van den Bos, W., Corriveau, K., Dutra, N., Flynn, E., O'Sullivan, E., … Wood, L. (2023). Peer learning and cultural evolution. *Child Development Perspectives*, *17*(2), 97–105. https://doi.org/10.1111/cdep.12482

Lewis, D. (1976). Observations on route finding and spatial orientation among the aboriginal peoples of the western desert region of central Australia. *Oceania*, *46*(4), 249–282.

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

Lister, C. J., Walker, B., & Fay, N. (2020). Innovation and enculturation in child communication: A cross-sectional study. Evolutionary Human *Sciences*, *2*, e56. https://doi.org/10.1017/ehs.2020.57

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. https://doi.org/10.1073/pnas.0704452104

Malinowski, B. (1929). *The sexual life of savages in northwestern Melanesia*. Liveright.

Maloney, D., Freeman, G., & Robb, A. (2020). A virtual space for all: Exploring children's experience in social virtual reality. Proceedings of the Annual Symposium on Computer-Human Interaction in Play, 472–483. https://doi.org/10.1145/3410404.3414268

Maybury-Lewis, D. (1967). *Akw -Shavante Society*. Clarendon Press. https://ehrafworldcultures.yale.edu/document?id=sp26-001

Maynard, A. E. (2002). Cultural teaching: The development of teaching skills in Maya sibling interactions. *Child Development*, *73*(3), 969–982. https://doi.org/10.1111/1467-8624.00450

Maynard, A. E., Greenfield, P. M., Childs, C. P., & Weinstock, M. (2024). Social change, cultural evolution, weaving apprenticeship, and development: Informal education across three generations and 42 years in a Maya community. *Applied Developmental Science*, *28*(1), 82–105. https://doi.org/10.1080/10888691.2022.2151445

McCormick, E. M., & Telzer, E. H. (2017). Adaptive adolescent flexibility: Neurodevelopment of decision-making and learning in a risky context. *Journal of Cognitive Neuroscience*, *29*(3), 413–423. https://doi.org/10.1162/jocn_a_01061

McElreath, R., & Koster, J. (2024). The end of human behavioral ecology. *Human Behavioral Ecology*, *92*, 402.

Mcelreath, R., Boyd, R., & Richerson, P. J. (2003). Shared norms and the evolution of ethnic markers. *Current Anthropology*, *44*(1), 122–129. https://doi.org/10.1086/345689

McGuigan, N., Burdett, E., Burgess, V., Dean, L., Lucas, A., Vale, G., & Whiten, A. (2017). Innovation and social transmission in experimental micro-societies: Exploring the scope of cumulative culture in young children. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1735), 20160425. https://doi.org/10.1098/rstb.2016.0425

Mead, M. (1928). Coming of age in Samoa: A Psychological Study of Primitive Youth for Western Civilisation. W. Morrow & Company. https://ehrafworldcultures.yale.edu/document?id=ou08-003

Mead, M. (1937). The Manus of the Admiralty islands. In M. Mead (Ed.), *Cooperation and competition among primitive peoples* (pp. 210–239). McGraw-Hill Book Company. https://doi.org/10.1037/13891-007

Meckley, A. M. (1994). *The social construction of young children's play*. University of Pennsylvania.

Meder, B., Wu, C. M., Schulz, E., & Ruggeri, A. (2021). Development of directed and random exploration in children. *Developmental Science*, *24*(4), e13095. https://doi.org/10.1111/desc.13095

Mesoudi, A. (2021). Blind and incremental or directed and disruptive? On the nature of novel variation in human cultural evolution. *American Philosophical Quarterly*, *58*(1), 7–20. https://doi.org/10.2307/48600682

Mesoudi, A., Laland, K. N., Boyd, R., Buchanan, B., Flynn, E., McCauley, R. N., … Tennie, C. (2013). The cultural evolution of technology and science. In P. J. Richerson, M. H. Christiansen, P. J. Richerson & M. H. Christiansen (Eds.), Cultural evolution: Society, technology, language and religion (pp. 193–216). MIT Press.

Morelli, C. (2017). The river echoes with laughter: A child-centred analysis of social change in Amazonia. *Journal of the Royal Anthropological Institute*, *23*(1), 137–154.

Morin, O. (2008). Les miasmes de l'exclusion: Les jeux de contamination dans les cultures enfantines. *Chantiers Politiques*, *6*, 98–112.

Morin, O. (2015). *How traditions live and die*. Oxford University Press.

Motsiou, E. (2012). Lexical innovations (neologisms) in children's speech: Evidence from Greek. Contrastive *Linguistics*, *2*, 22–31.

Muthukrishna, M., & Henrich, J. (2016). Innovation in the collective brain. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1690), 20150192. https://doi.org/10.1098/rstb.2015.0192

Naveh, D. (2014). Knowing and learning among Nayaka hunter-gatherers. *Eastern Anthropologist*, *67*, 345–362.

Nesdale, D., Maass, A., Griffiths, J., & Durkin, K. (2003). Effects of in-group and out-group ethnicity on children's attitudes towards members of the in-group and out-group. *British Journal of Developmental Psychology*, *21*(2), 177–192. https://doi.org/10.1348/026151003765264039

Newell, W. W. (1883). *Games and songs of American children*. Harper & brothers.

Nielsen, M., & Tomaselli, K. (2010). Overimitation in Kalahari Bushman children and the origins of human cultural cognition. *Psychological Science*, *21*(5), 729–736.

Nielsen, M., Haun, D., Kärtner, J., & Legare, C. H. (2017). The persistent sampling bias in developmental psychology: A call to action. *Journal of Experimental Child Psychology*, *162*, 31–38. https://doi.org/10.1016/j.jecp.2017.04.017

Nowell, A. (2021). *Growing up in the Ice Age: Fossil and archaeological evidence of the lived lives of Plio-Pleistocene children*. Oxbow Books.

Nsamenang, A. B. (2015). Ecocultural theories of development. *International Encyclopedia of the Social & Behavioral Sciences*, *6*(2), 838–844.

Opie, I. (2018). Playground rhymes and the oral tradition. In Peter Hunt (Ed.), *Intl comp ency child lit E2 V1* (pp. 275–286). Routledge.

Opie, I., & Opie, P. (1959). *The lore and language of schoolchildren*. Oxford University Press.

Opie, I., & Opie, the late P. (1998). Children's games with things: Marbles, fivestones, throwing and catching, gambling, hopscotch, chucking and

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

pitching, ball-bouncing, skipping, tops and tipcat (1st ed.). Oxford University Press.
Opie, I., & Opie, P. (2013). *Children's games in street and playground*. Floris Books.
Opler, M. E. (1996). *An Apache life-way: The economic, social, and religious institutions of the Chiricahua Indians*. University of Nebraska Press. https://books.google.com/books?hl=en&lr=&id=JC3QD47hu24C&oi=fnd&pg=PR21&dq=Opler,+Morris+Edward.+1941.+An+Apache+Life-Way:+The+Economic,+Social,+and+Religious+Institutions+of+the+Chiricahua+Indians.+Chicago:+University+of+Chicago+Press.&ots=zBDKNO7MkN&sig=VeXIuJXXXUEGDCH1Q5iP0ZNmMuM
Over, H. (2018). The influence of group membership on young children's prosocial behaviour. *Current Opinion in Psychology*, *20*, 17–20. https://doi.org/10.1016/j.copsyc.2017.08.005
Pablo, J. F.-L. d., Romano, V., Derex, M., Gjesfjeld, E., Gravel-Miguel, C., Hamilton, M. J., … Lozano, S. (2022). Understanding hunter–gatherer cultural evolution needs network thinking. *Trends in Ecology & Evolution*, *37*(8), 632–636. https://doi.org/10.1016/j.tree.2022.04.007
Page, A. E., Emmott, E. H., Dyble, M., Smith, D., Chaudhary, N., Viguier, S., & Migliano, A. B. (2021). Children are important too: Juvenile playgroups and maternal childcare in a foraging population, the Agta. Philosophical Transactions of the Royal *Society B: Biological Sciences*, *376*(1827), rstb.2020.0026, 20200026. https://doi.org/10.1098/rstb.2020.0026
Phelps, E., & Damon, W. (1989). Problem solving with equals: Peer collaboration as a context for learning mathematics and spatial concepts. *Journal of Educational Psychology*, *81*(4), 639–646. https://doi.org/10.1037/0022-0663.81.4.639
Piaget, J. (1947). *The psychology of intelligence*. Routledge.
Piaget, J. (1948). The moral judgment of the child (pp. ix, 418). Free Press.
Piaget, J. (1968). Six psychological studies (D. Elkind, Ed.). Vintage Books.
Piel, L. H. (2012). Food rationing and children's self-reliance in Japan, 1942–1952. *The Journal of the History of Childhood and Youth*, *5*(3), 393–418.
Pollom, T. R., Herlosky, K. N., Mabulla, I. A., & Crittenden, A. N. (2020). Changes in juvenile foraging behavior among the Hadza of Tanzania during early transition to a mixed-subsistence economy. *Human Nature*, *31*, 123–140.
Porcher, V., Carrière, S. M., Gallois, S., Randriambanona, H., Rafidison, V. M., & Reyes-García, V. (2022). Growing up in the Betsileo landscape: Children's wild edible plants knowledge in Madagascar. *PLOS ONE*, *17*(2), e0264147. https://doi.org/10.1371/journal.pone.0264147
Post, C., Lia, E. D., DiTomaso, N., Tirpak, T. M., & Borwankar, R. (2009). Capitalizing on thought diversity for innovation. *Research Technology Management*, *52*(6), 14–25. https://doi.org/10.1080/08956308.2009.11657596
Potts, R. (1998). Variability selection in hominid evolution. *Evolutionary Anthropology: Issues, News, and Reviews*, *7*(3), 81–96.https://doi.org/10.1002/(SICI)1520-6505(1998)7:3<81::AIDEVAN3>3.0.CO;2-A
Pretelli, I., Crittenden, A. N., Dounias, E., Friant, S., Koster, J., Kramer, K. L., … Lew-Levy, S. (2024). Child and adolescent foraging: New directions in evolutionary research. *Evolutionary Anthropology*, *33*(2), e22020. https://doi.org/10.1002/evan.22020.
Price, E. E., Wood, L. A., & Whiten, A. (2017). Adaptive cultural transmission biases in children and nonhuman primates. *Infant Behavior and Development*, *48*, 45–53. https://doi.org/10.1016/j.infbeh.2016.11.003
Qiu, F. W., & Moll, H. (2022). Children's pedagogical competence and child-to-child knowledge transmission: Forgotten factors in theories of cultural evolution. *Journal of Cognition and Culture*, *22*, 421–435. https://doi.org/10.1163/15685373-12340143.
Ratikainen, I. I., & Kokko, H. (2019). The coevolution of lifespan and reversible plasticity. *Nature Communications*, *10*(1), 538.
Raviv, L., Blasi, D. E., & Kempe, V. (2025). Children are not the main agents of language change. *Psychological Review*. Advance online publication. https://doi.org/10.1037/rev0000580
Rawlings, B. S. (2022). After a decade of tool innovation, what comes next? *Child Development Perspectives*, *16*(2), 118–124. https://doi.org/10.1111/cdep.12451
Reckin, R., Lew-Levy, S., Lavi, N., & Ellis-Davies, K. (2020). Mobility, autonomy and learning: Could the transition from egalitarian to non-egalitarian social structures start with children? McDonald Institute for Archaeological Research. https://www.repository.cam.ac.uk/bitstreams/2f268764-19e5-4c55-b163-38bc1b83e73d/download.
Reyes-García, V., Gallois, S., & Demps, K. (2016). A multistage learning model for cultural transmission: Evidence from three indigenous societies. In H. Terashima & B. S. Hewlett (Eds.), Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives (pp. 47–60). Springer Japan. https://doi.org/10.1007/978-4-431-55997-9_4
Riede, F., Johannsen, N. N., Högberg, A., Nowell, A., & Lombard, M. (2018). The role of play objects and object play in human cognitive evolution and innovation. *Evolutionary Anthropology: Issues, News, and Reviews*, *27*(1), 46–59. https://doi.org/10.1002/evan.21555
Riede, F., Walsh, M. J., Nowell, A., Langley, M. C., & Johannsen, N. N. (2021). Children and innovation: Play, play objects and object play in cultural evolution. *Evolutionary Human Sciences*, *3*, e11.
Robinson, I., & Corsaro, W. (1987). Friendship and peer culture in the early years. *Contemporary Sociology*, *16*, 567. https://doi.org/10.2307/2069960
Rubin, D. C. (1995). *Memory in oral traditions: The cognitive psychology of epic, ballads, and counting-out rhymes*. Oxford University Press.
Ruggeri, A., Luan, S., Keller, M., & Gummerum, M. (2018). The influence of adult and peer role models on children' and adolescents' sharing decisions. *Child Development*, *89*(5), 1589–1598. https://doi.org/10.1111/cdev.12916
Ryalls, B. O., Gul, R. E., & Ryalls, K. R. (2000). Infant imitation of peer and adult models: Evidence for a peer model advantage. *Merrill-Palmer Quarterly*, *46*(1), 188–202.
Schmidt, M. F. H., & Tomasello, M. (2012). Young children enforce social norms. *Current Directions in Psychological Science*, *21*(4), 232–236. https://doi.org/10.1177/0963721412448659
Schniter, E., Gurven, M., Kaplan, H. S., Wilcox, N. T., & Hooper, P. L. (2015). Skill ontogeny among Tsimane forager-horticulturalists. *American Journal of Physical Anthropology*, *158*(1), 3–18. https://doi.org/10.1002/ajpa.22757
Schulz, E., Wu, C. M., Ruggeri, A., & Meder, B. (2019). Searching for rewards like a child means less generalization and more directed exploration. *Psychological Science*, *30*(11), 1561–1572. https://doi.org/10.1177/0956797619863663
Seiver, E., Gopnik, A., & Goodman, N. D. (2013). Did she jump because she was the big sister or because the trampoline was safe? Causal inference and the development of social attribution. *Child Development*, *84*(2), 443–454. https://doi.org/10.1111/j.1467-8624.2012.01865.x
Senghas, A. (2003). Intergenerational influence and ontogenetic development in the emergence of spatial grammar in Nicaraguan Sign Language. *Cognitive Development*, *18*(4), 511–531.
Senghas, R. J. (2003). New ways to be deaf in Nicaragua: Changes in language, personhood, and community. In Leila Monaghan, Constanze Schmaling, Karen Nakamura, & Graham H. Turner (Eds.), *Many Ways to Be Deaf: International Variation in Deaf Communities* (pp. 260–282). Washington D.C.: Gallaudet University Press.
Senghas, A., & Coppola, M. (2001). Children creating language: How Nicaraguan sign language acquired a spatial grammar. *Psychological Science*, *12*(4), 323–328. https://doi.org/10.1111/1467-9280.00359
Shimron, J. (Ed.). (2003). *Language processing and acquisition in languages of semitic, root-based, morphology*. Benjamins.
Shneidman, L. A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: How important is directed speech? *Developmental Science*, *15*(5), 659–673. https://doi.org/10.1111/j.1467-7687.2012.01168.x
Shutts, K., Banaji, M. R., & Spelke, E. S. (2010). Social categories guide young children's preferences for novel objects. *Developmental Science*, *13*(4), 599–610. https://doi.org/10.1111/j.1467-7687.2009.00913.x
Singer, D. G., Singer, J. L., D'Agnostino, H., & DeLong, R. (2009). Children's pastimes and play in sixteen nations: Is free-play declining? *American Journal of Play*, *1*(3), 283–312.
Sletto, B., & Diaz, O. O. (2015). Inventing space in the Cañada: Tracing children's agency in Los Platanitos, Santo Domingo, Dominican Republic. *Environment and Planning A: Economy and Space*, *47*(8), 1680–1696. https://doi.org/10.1177/0308518X15597104

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Smaldino, P. E., Moser, C., Pérez Velilla, A., & Werling, M. (2024). Maintaining transient diversity is a general principle for improving collective problem solving. *Perspectives on Psychological Science*, *19*(2), 454–464. https://doi.org/10.1177/17456916231180100

Smolla, M., & Akçay, E. (2019). Cultural selection shapes network structure. *Science Advances*, *5*(8), eaaw0609. https://doi.org/10.1126/sciadv.aaw0609

Stengelin, R., Hepach, R., & Haun, D. B. M. (2019). Being observed increases overimitation in three diverse cultures. *Developmental Psychology*, *55*(12), 2630–2636. https://doi.org/10.1037/dev0000832

Stengelin, R., Hepach, R., & Haun, D. B. M. (2020). Cross-cultural variation in how much, but not whether, children overimitate. *Journal of Experimental Child Psychology*, *193*, 104796. https://doi.org/10.1016/j.jecp.2019.104796

Strauss, S., & Ziv, M. (2012). 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

Sutton-Smith, B. (1984). A performance theory of peer relations. In K.M. Borman (Ed.), *The social life of children in a changing society* (pp. 65–77). Psychology Press.

Sutton-Smith, B. (1997). The ambiguity of play (pp. x, 276). Harvard University Press.

Sutton-Smith, B., & Rosenberg, B. G. (1961). Sixty years of historical change in the game preferences of American children. *The Journal of American Folklore*, *74*(291), 17–46. https://doi.org/10.2307/538197

Sutton-Smith, B., Mechling, J., Johnson, T. W., & McMahon, F. (2012). Children's folklore: A sourcebook. Routledge.

Tagliamonte, S. A. (2011). *Variationist sociolinguistics: Change, observation, interpretation*. John Wiley & Sons. https://books.google.com/books?hl=en&lr=&id=_8TIizweqz8C&oi=fnd&pg=PR10&dq=+Tagliamonte,+S.+A.+Variationist+Sociolinguistics:+Change,+Observation,+Interpretation.+(John+963+Wiley+%26+Sons,+2011).&ots=i_bOw6-y2L&sig=k3PUyhNIl7WV7DyvCv_hQsmCCig

Tan, S. (2021). Childhood in the age of digital culture. *Youth Theatre Journal*, *35*(1–2), 1–14. https://doi.org/10.1080/08929092.2020.1824950

Taylor, M., Cartwright, B. S., & Bowden, T. (1991). Perspective taking and theory of mind: Do children predict interpretive diversity as a function of differences in observers' knowledge? *Child Development*, *62*(6), 1334–1351.

Terashima, H. (2016). Hunter-gatherers and learning in nature. In H. Terashima & B. S. Hewlett (Eds.), Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives (pp. 253–266). Springer Japan. https://doi.org/10.1007/978-4-431-55997-9_22

Tomasello, M. (2016). The ontogeny of cultural learning. *Current Opinion in Psychology*, *8*, 1–4. https://doi.org/10.1016/j.copsyc.2015.09.008

Tomasello, M. (2020). The adaptive origins of uniquely human sociality. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1803), 20190493. https://doi.org/10.1098/rstb.2019.0493

Tomasello, M. (2024). *Agency and cognitive development*. Oxford University Press. https://books.google.com/books?hl=en&lr=&id=e54bEQAAQBAJ&oi=fnd&pg=PP1&dq=agency+tomasello&ots=hHxNSuqGqf&sig=NnuMflWHI92rVT233Aoim-fVgbw

Tylor, E. B. (1871). *Primitive culture: Researches into the development of mythology, philosophy, religion, art, and custom*. J. Murray.

VanderBorght, M., & Jaswal, V. K. (2009). Who knows best? Preschoolers sometimes prefer child informants over adult informants. Infant and Child Development, *18*(1), 61–71. https://doi.org/10.1002/icd.591

van Leeuwen, E. J. C., Cohen, E., Collier-Baker, E., Rapold, C. J., Schäfer, M., Schütte, S., & Haun, D. B. M. (2018). The development of human social learning across seven societies. *Nature Communications*, *9*(1), 1–7. https://doi.org/10.1038/s41467-018-04468-2.

Van Rheenen, D. (2012). A century of historical change in the game preferences of American children. *Journal of American Folklore*, *125*(498), 411–443.

Vélez, N., Wu, C. M., Gershman, S. J., & Schulz, E. (2024). The rise and fall of technological development in virtual communities. OSF. https://doi.org/10.31234/osf.io/tz4dn

Villmoare, B., Klein, D., Lienard, P., & McHale, T. (2024). Evolutionary origins of temporal discounting: Modeling how time and uncertainty constrain optimal decision-making strategies across taxa. *PLoS ONE*, *19*(11), e0310658. https://doi.org/10.1371/journal.pone.0310658.

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard University Press.

Wald, E. (2012). *The dozens: A history of rap's mama*. Oxford University Press.

Weisner, T. S., Gallimore, R., Bacon, M. K., … Williams, T. R. (1977). My brother's keeper: Child and sibling caretaking [and comments and reply]. *Current Anthropology*, *18*(2), 169–190. https://doi.org/10.1086/201883

Wente, A. O., Kimura, K., Walker, C. M., Banerjee, N., Fernández Flecha, M., MacDonald, B., … Gopnik, A. (2019). Causal learning across culture and socioeconomic status. *Child Development*, *90*(3), 859–875. https://doi.org/10.1111/cdev.12943

White, A., Ní Laoire, C., Tyrrell, N., & Carpena-Méndez, F. (2011). Children's roles in transnational migration. *Journal of Ethnic and Migration Studies*, *37*(8), 1159–1170. https://doi.org/10.1080/1369183X.2011.590635

Whiten, A., Biro, D., Bredeche, N., Garland, E. C., & Kirby, S. (2021). The emergence of collective knowledge and cumulative culture in animals, humans and machines. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *377*(1843), 20200306. https://doi.org/10.1098/rstb.2020.0306

Widlok, T. (1997). Orientation in the wild: The shared cognition of Hai||om bushpeople. *The Journal of the Royal Anthropological Institute*, *3*(2), 317–332. https://doi.org/10.2307/3035022

Wiese, H. (2009). Grammatical innovation in multiethnic urban Europe: New linguistic practices among adolescents. *Lingua*, *119*(5), 782–806. https://doi.org/10.1016/j.lingua.2008.11.002

Winter, L. (2015). Bloody Mary in the mirror: A comparative examination of a living tradition. Masters thesis, Memorial University of Newfoundland. http://research.library.mun.ca/id/eprint/8392

Wood, L. A., Kendal, R. L., & Flynn, E. G. (2012). Context-dependent model-basedbiases 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

Wu, C. M., Deffner, D., Kahl, B., Meder, B., Ho, M. H., & Kurvers, R. H. J. M. (2023). Visual-spatial dynamics drive adaptive social learning in immersive environments (p. 2023.06.28.546887). bioRxiv. https://doi.org/10.1101/2023.06.28.546887

Ziv, M., Solomon, A., Strauss, S., & Frye, D. (2016). Relations between the development of teaching and theory of mind in early childhood. *Journal of Cognition and Development*, *17*(2), 264–284. https://doi.org/10.1080/15248372.2015.1048862

Open Peer Commentary

Let the kids play: Children's folklore, Newell's paradox, and the triviality barrier

Brandon Barker*, Gwyn Harris and Eric McGoffin

Indiana University, Department of Folklore & Ethnomusicology, Bloomington, IN, USA
barkerbr@iu.edu
gwroharr@iu.edu
ecmcgoff@iu.edu
https://folklore.indiana.edu/about/faculty/barker-k.html

*Corresponding author.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

doi:10.1017/S0140525X25101854, e226

Abstract

Lew-Levy and Amir (L&A)'s hypothesis that peer cultures contribute to cultural adaptation pulls from findings in children's folklore studies. We consider the implications of two central theoretical concerns in children's folklore scholarship, the *triviality barrier* and *Newell's paradox*, and argue that the playful, parodical, and taboo-breaking nature of children's folklore will be important for L&A's hypothesis. Additionally, we suggest that adults' tendencies to trivialize children's folklore support the resilience of peer cultures in an adult-dominated world.

The triviality barrier

Fifty-five years ago, psychologist and children's folklorist Brian Sutton-Smith (1970) argued that a *triviality barrier* kept his fellow psychologists from studying the expressive play forms of children. For Sutton-Smith, the problem of the triviality barrier is difficult precisely because of modern civilization's central concerns with work, rationality, science, sex, food, etc. Not unlike Sutton-Smith, L&A face down a triviality barrier in (at least) Euro-American cultural evolution studies that deem peer cultures "inconsequential" or "relegated entirely to the domain of play" (sect. 3.2, para. 3). We applaud L&A for looking past the triviality barrier to attend to children's folklore. If their hypothesis that peer cultures contribute to cultural evolution holds water, and if children's folklore scholarship ends up supporting their claim, we suspect that peer culture's prowess in the domains of play and expressive behaviors will be important.

Newell's paradox

L&A claim that participants in peer cultures are both high-fidelity learners (i.e., capable of high-fidelity transmission) and effective innovators. Their claim runs parallel to old ideas in children's folklore studies, going back to Newell's (1883) recognition that children's folklore is simultaneously conservative and inventive. While L&A cite Fine (1980) in their discussion of localization and urban legends (sect. 4.3, para. 4), they do not mention the primary concern of that study, which is to identify possible solutions for what Fine calls *Newell's Paradox*. If peer culture is both conservative and creative in ways that are distinct from adult culture, why is this so?

Fine suggests that certain folkloric forms are conserved because they align with developmental needs that remain similar from generation to generation. Indeed, folkloristic data demonstrate that forms of childlore are consistently performed in developmental bands. Verbal examples include tongue twisters (Nikolić & Bakarić, 2016), knock-knock jokes (Bauman, 2024 [1982]), and folktales and legends (Tucker, 1999). In our study of children's play with perceptual illusions, we have shown that simple prank-like forms of folk illusions, such as an older family member "stealing" the nose of a child, stop when the victim is about 5 years of age, while folk illusions that require particular acts of dexterity, such as the Rubber Pencil trick, begin around 7 years, and illusions that are embedded in a narrative frame, e.g., the size-weight lifting illusions known in English as Light as a Feather, begin closer to adolescence (Barker & Rice, 2019).

Conversely, inventiveness arises from processes of localization (as discussed by L&A) and from idiosyncrasies of individual performances. For example, McDowell (1999) reports a single children's riddling session, recorded in the 1970s, involving four six-year-old Chicano children in Austin, Texas that features both rote memorization of traditional riddles and the presentation of novel (if less semantically impressive) items modeling the form of traditional riddles: What did X say to Y? Note, riddle 1 is traditional, whereas riddles 2, 3, and 4 are nontraditional inventions:

1. What did the big chimney say to the little chimney? (Answer – *You're too young to smoke.*)
2. What did the burp say to the great white? (Answer – *I can make more noise than you can.*)
3. What did Spiderman say to Ironman? (Answer – *You don't have no brains.*)
4. What did the Martian say to the human? (No answer)

On one hand, the Chicano children's riddling session aligns with L&A's assertions that children are innovative language users (sect. 2.2, para. 3). Though riddles 2–4 are not traditional, they evince transmission as cognitive activation of the riddling form, where young participants learn the riddle's form before they master the art of making familiar subjects strange in order to hide the riddle's solution. Similarly, the inclusion of Spiderman and Ironman demonstrates L&A's assertion that one way peer cultures vary is through "remixing aspects of an ever-changing popular culture" (sect. 4.3, para. 2).

On the other hand, the Chicano children's riddling session complicates L&A's report that children's folklorists unanimously agree that adults' contributions to children's folklore are "minimal or nonexistent" (sect. 4.1, para.1). In fact, the traditional Chicano children's riddle 1 acquires and parodies adults' rules against children smoking. While we agree that there are folkloric forms and expressions across cultures that remain specific to peer culture – e.g., counting-out rhymes (Arleo, 1991) – the demarcation between culture belonging to the adult and culture belonging to the child is not always clear. Jay Mechling (1997) cites a well-known traditional rhyme in English performed by Boy Scouts in California that parodies both food taboos and popular/commercial culture: "Great green gobs of greasy, grimy gopher guts/ Itty bitty birdy feet,/ Mutilated monkey meat,/ One-pint portion of all-purpose porpoise pus,/ And me without a spoon!/ (But here's a straw!)/ (Have it your way, have it your way!) [sung to Burger King jingle]/ (Take that, McDonald's!)." We find a host of examples of the importance of parody, satire, and nonsense play in children's folklore and children's folklore scholarship (e.g., Stewart, 1978; Beresin, 2010).

Irreverent portrayal of adult forms goes beyond the domain of language. As Bronner (1988) has shown with folkloric traditions for making paper airplanes, paper frogs, paper fortune tellers, etc., children acquire and play with contributions from adults by adopting the materials of industrial culture and transforming them into something that belongs distinctly to their peer culture. While L&A make the point that children prefer to learn play behaviors from peers (sect. 2.1, para. 3), the role that adult cultures play as sources of content and behaviors to be playfully replicated and ridiculed demonstrates another way that peer culture supports both conservative cultural inheritance and creative cultural variation.

Folklore, play, and the triviality barrier

In this journal, Palagi, Stanyon, and Demuru (2015) have argued that play "only seemingly serves no function and has no apparent, immediate benefits, but the incredible phylogenetic depth of play strongly suggests that play is a functional and adaptive behavior." Children's folklore, especially of early childhood and middle

childhood, is playful, expressive, parodical, taboo-breaking, and frequently trivialized. Perhaps the triviality barrier helps to protect the sphere of knowledge L&A claim peer cultures hold in reserve.

Acknowledgements. N/A.

Financial support. This research supporting this commentary received no specific grant from any funding agency.

Competing interests. None.

References

Arleo, A. (1991). Strategy in counting-out: Evidence from Saint-Nazaire, France. *Children's Folklore Review*, *14*(1), 25–30. https://scholarworks.iu.edu/journals/index.php/cfr/article/view/25272

Barker, K. B., & Rice, C. (2019). *Folk illusions: Children, folklore, and sciences of perception*. Indiana University Press.

Bauman, R. (2024). Ethnography of children's folklore. *Children's Folklore Review*, *42*(1), 61–86. https://doi.org/10.14434/cfr.2024.vol42.39023

Beresin, A. (2010). *Recess battles: Playing, fighting, and storytelling*. University Press of Mississippi.

Bronner, S. J. (Ed.). (1988). *American children's folklore*. August House.

Fine, G. A. (1980). Children and their culture: Exploring newell's paradox. *Western Folklore*, *39*(3), 170–183. https://doi.org/10.2307/1499799

McDowell, J. H. (2012). The transmission of children's folklore. In *Children's folklore* (pp. 49–62). Routledge. https://doi.org/10.4324/9780203056127

Mechling, J. (1997). Newell's Paradox Redux. In T. Tuleja (Ed.), *Usable pasts: Traditions and group expressions in North America* (pp. 140–155). University Press of Colorado. https://doi.org/10.2307/j.ctt46nrkh.12

Newell, W. W. (1883). *Games and songs of American children*. Harper & brothers.

Nikolić, D., & Bakarić, N. (2016). What makes our tongues twist?: Computational analysis of croatian tongue-twisters. *Journal of American Folklore*, *129*(511), 43–54. https://doi.org/10.5406/jamerfolk.129.511.0043

Palagi, E., Stanyon, R., & Demuru, E. (2015). Play to learn, teach by play. *Behavioral and Brain Sciences*, *38*, e53. https://doi.org/10.1017/S0140525X14000557

Stewart, S. A. (1979). *Nonsense: Aspects of intertextuality in folklore and literature*. John Hopkins University Press.

Sutton-Smith, B. (1970). Psychology of childlore: The triviality barrier. *Western folklore*, *29*(1), 1–8. https://doi.org/10.2307/1498679

Tucker, E. (2012). Tales and legends. In *Children's folklore* (pp. 193–211). Routledge. https://doi.org/10.4324/9780203056127

Children and adults are examples, respectively, of marked and unmarked social categories

Will M. Bennis*

Faculty of Business Administration, Prague University of Economics and Business, Prague, Czech Republic
will.bennis@vse.cz

*Corresponding author.

doi:10.1017/S0140525X25101957, e227

Abstract

By failing to recognize that adulthood and childhood are just examples – the former of an *unmarked* social category inappropriately used to generalize about *people* – the latter of a *marked* social category commonly overlooked in theories about our species, Lew-Levy and Amir miss an opportunity to make an important observation about social-cultural diversity and what it means to be human.

Lew-Levy and Amir make a convincing case, with admirable depth and breadth, that children's peer groups contribute to cultural adaptation (see also, Hirschfeld, 2002). This commentary seeks to qualify that argument, starting with what would otherwise be a minor quibble: although the authors do not say so explicitly, they suggest that cultural-evolution scholars *claim* that adults, and not children, drive cultural adaptation. A more apt description would be that children have mostly been ignored, with adult samples serving as an *unmarked* standard by which to generalize about *people,* and with few explicit claims one way or the other about the relative contribution of children. This is not just an observation about cultural-evolution scholarship, but about most cultural research (Hirschfeld, 2002), and perhaps about the social and behavioral sciences more broadly. The term "unmarked" borrows from the linguistic conception of unmarked grammatical forms, such as the (now more marked) use of the masculine "he" or "man" to refer to the gender-neutral broader categories "he or she" or "human," respectively (Irvine & Gal, 2000; Lakoff, 1973). *Adults* are unmarked in the sense that they are treated as natural, normal, or representative examples of a broader category (*people*).

As many cultural psychologists have noted (perhaps most compellingly Arnett, 2008, and Henrich, Heine, & Norenzayan, 2010), the problem of unmarked social categories goes beyond just cultural research to non-cultural work seeking to make generalizations about human psychology. Similar concerns have been raised in other fields, such as education (Medin & Bang, 2014) and biomedical science (e.g., Heiat, Gross, & Krumholz, 2002). Henrich and colleagues have referred to that unmarked group in psychological science as WEIRD (**W**estern, **E**ducated, **I**ndustrialized, **R**ich, **D**emocratic), preferring that acronym because their evidence suggests WEIRD people are outliers, *less* representative than other cultural groups, despite their overrepresentation in sample populations. The compelling acronym notwithstanding, many other categories could have been selected: urban, English-speaking, Global North, etc. Hirschfeld's (2002) work suggests that *adults* should be added to that list. Lew-Levy and Amir's target article could have valuably added to that conversation.

A useful frame for this is *the home-field disadvantage* (Medin, Bennis, & Chandler, 2010; Medin & Bang, 2014), a paradoxical reference to the typical advantage enjoyed by home teams in sports, pointing to the often-unrecognized disadvantage stemming from researchers' social distance from their sample populations. Home-field samples (e.g., American university students) are less *marked*, with researchers readily generalizing from them to *people*, while such generalizations from non-home-field samples (e.g., Inuit hunter-gatherers) would be immediately recognized as problematic. Social distance does not just depend on *demographic similarity*, it depends on any factors that may impact the familiarity of a social-cultural category. *Majority*, *higher status*, and *starting-point* groups tend to be less marked than minority, lower-status, or novel ones. *Adults* are a good example of a home-field group since researchers *are* adults (*similarity*), there are more adults than children (at least among WEIRD people), adults are higher status,

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

and adults have been a long-time convenience sample for experimental research (*starting point*). The home-field disadvantage contributes to overgeneralization (e.g., from adults to people) and to overlooking important differences across social-cultural groups (e.g., children). But it also impacts methods and the interpretation of results. For example, stimuli originally designed for home-field samples, by virtue of their better fit, are more likely to result in publishable significance levels, one possible reason WEIRD samples tend to be outliers when those original, hypothesis-confirming stimuli are later used in cross-cultural research with non-WEIRD samples (Bennis & Medin, 2010).

Two examples help clarify why the home-field disadvantage is relevant to the target article. The first concerns the child-adult dichotomy itself. The emphasis on *children* as the neglected group blurs the extent to which *age* matters to whether and how children contribute to cultural adaptation. It also masks the extent to which adults also form distinct, age-relevant peer cultures (Neugarten, Moore, & Lowe, 1965), some of which are marked and neglected similarly to children. Consider one of Lew-Levy and Amir's childhood category, *adolescents* (13- to 17-year-olds), an age range that would be classified as *adult* rather than *child* by many non-WEIRD cultures (see, e.g., Whiting & Whiting, 1975). As such, that key demographic of overlooked *children* driving cultural adaptation could just as well have been framed as an example of overlooked adults. The elderly are another, unambiguously adult example (e.g., Heiat et al., 2002; North, 2025).

Second, there are innumerable social-cultural categories differing widely across cultures that are not defined by age but that nonetheless form peer cultures with different dynamics for cultural adaptation. Limiting the examples to just WEIRD cultures, research scientists, politicians, and tech entrepreneurs, for example, each form peer cultures that innovate and transmit culture differently. But non-home-field sub-cultural groups within WEIRD countries (e.g., minorities or lower-status groups) may *asymmetrically* contribute to cultural adaptation given their lower populations and status, specifically *because* their *markedness* promotes the formation of more coherent, self-contained, identity-based peer groups (Lamont & Molnár, 2002). By the time such peer cultures' innovations eventually "escape" their peer cultures, they may be more fully formed and impactful, having had time to evolve independently and enter mainstream culture as recognizably novel. For examples of this with minority and low-SES peer cultures with *music*, see Baraka (2002) or Roy (2010), but parallel examples can be seen in minority and low-power groups' influences on a broad range of domains from clothing styles, to cuisine, to vernacular.

In short, while any article can only do so much, and Lew-Levy and Amir's piece does a great job highlighting the underappreciated role of children in cultural adaptation, it would have benefited by acknowledging that both adults and children are just examples (albeit good ones), the former of an *unmarked* group inappropriately used to generalize about cultural evolution, and the latter of a *marked* group, inappropriately overlooked. When reified as a privileged two categories driving cultural adaptation, they risk reinforcing the underappreciation of social-cultural diversity in what it means to be human.

Acknowledgments. The author would like to thank Douglas Medin for his helpful feedback.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. None.

References

Arnett, J. J. (2008). The neglected 95%: Why American psychology needs to become less American. *American Psychologist*, *63*(7), 602–614. https://doi.org/10.1037/0003-066X.63.7.602

Baraka, A. (2002). *Blues people: Negro music in White America*. Harper Perennial.

Bennis, W. M., & Medin, D. L. (2010). Weirdness is in the eye of the beholder. *Behavioral and Brain Sciences*, *33*(2–3), 85–86. https://doi.org/10.1017/S0140525X1000004X

Heiat, A., Gross, C. P., & Krumholz, H. M. (2002). Representation of the elderly, women, and minorities in heart failure clinical trials. *Archives of Internal Medicine*, *162*(15), 1682–1688. https://doi.org/10.1001/archinte.162.15.1682

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, *33*(2–3), 61–83. https://doi.org/10.1017/S0140525X0999152X

Hirschfeld, L. A. (2002). Why don't anthropologists like children? *American Anthropologist*, *104*(2), 611–627. https://doi.org/10.1525/aa.2002.104.2.611

Irvine, J. T., & Gal, S. (2000). Language ideology and linguistic differentiation. In P. V. Kroskrity (Ed.), *Regimes of Language: Ideologies, Polities, and Identities* (pp. 35–84). School of American Research Press.

Lakoff, R. (1973). Language and woman's place. *Language in Society*, *2*(1), 45–79. https://doi.org/10.1017/S0047404500000051

Lamont, M., & Molnár, V. (2002). The study of boundaries in the social sciences. *Annual Review of Sociology*, *28*(1), 167–195. https://doi.org/10.1146/annurev.soc.28.110601.141107

Medin, D. L., & Bang, M. (2014). *Who's asking?: Native science, western science, and science education*. MIT Press.

Medin, D. L., Bennis, W. M., & Chandler, M. J. (2010). Culture and the home-field disadvantage. *Perspectives on Psychological Science*, *5*(6), 708–713. https://doi.org/10.1177/1745691610388772

Neugarten, B. L., Moore, J. W., & Lowe, J. C. (1965). Age norms, age constraints, and adult socialization. *American Journal of Sociology*, *70*(6), 710–717. https://doi.org/10.1086/223965

North, M. S. (2025). Age. In D. T. Gilbert, S. T. Fiske, E. J. Finkel, & W. B. Mendes (Eds.), *The handbook of social psychology* (6th ed.). Situational Press. https://doi.org/10.70400/EBML6140

Roy, W. G. (2010). *Reds, whites, and blues: Social movements, folk music, and race in the United States*. Princeton University Press. https://doi.org/10.1515/9781400835164

Whiting, B. B., & Whiting, J. W. M. (1975). *Children of six cultures: A psycho-cultural analysis*. Harvard University Press. https://doi.org/10.4159/harvard.9780674593770

Group transmission and niche construction in peer cultures

Temechegn Gutu Bira[a]* and Barry S. Hewlett[b]

[a]Department of Anthropology, Washington State University, Pullman, WA, USA and [b]Department of Anthropology, Washington State University, Vancouver, WA, USA

temechegn.bira@wsu.edu

hewlett@wsu.edu

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

*Corresponding author.

doi:10.1017/S0140525X25101799, e228

Abstract

Our commentary expands upon Lew-Levy and Amir's insights into the role of peer culture in cultural evolution. Drawing on field data from the Koygu, Nyangatom, and Aka communities, we identify two modes of group transmission (concerted and cumulative) that contribute to the stability of peer cultures over time. We describe how culturally constructed niches shape peer learning, helping explain the intercultural diversity of peer cultures.

Lew-Levy and Amir's paper presents a compelling argument for recognizing peer cultures as central to cultural evolution. They demonstrate that children do not merely acquire adult knowledge but actively produce, refine, and transmit cultural elements within peer groups. Our recent field data with hunter–gatherers and pastoralists support several of their claims. For example, in 160 hours of observation among transitional hunter–gatherers and pastoralists, we found that child-to-child teaching was common, occurring in 42% of learning events. While our findings align with some of Lew-Levy and Amir's insights, our commentary focuses on two aspects of peer culture that help explain cultural evolutionary issues raised in the paper: concerted and cumulative group-based modes of transmission that may contribute to the stability of peer culture and culturally constructed niches that shape the diversity and evolution of peer cultures. We draw on field data from Koygu transitional hunter–gatherers, Nyangatom pastoralists in Ethiopia, and Aka hunter–gatherers in the Central African Republic.

The authors note the relatively stable nature of peer cultures but do not elaborate on the mechanisms maintaining this stability. We hypothesize that two modes of group transmission – concerted and cumulative – may contribute to peer culture stability over time (Hewlett et al., 2024). Concerted transmission occurs when multiple group members communicate the same skill or knowledge to an individual (Cavalli-Sforza et al., 1982). This mode, observed in 38% of 494 learning events among the Koygu and Nyangatom, fosters group homogeneity and trait conservation and reduces rates of culture change. Notably, 45.5% of these concerted transmission events occurred in child-only groups, with an average of 3.7 children per event – more than in mixed adult-child groups (3.1).

It may be useful to provide examples of concerted transmission. Among the Aka, an entire group of children will make sounds of disgust if a child takes more than their share of food, does not share food, or hits another child. Spear hunting for mice is a child-only activity among the Aka, and it is common for multiple children to comment on how to throw the spear, where the mouse is, or how to divide it with others.

Another example from the Koygu involves a mixed-age group of boys (6–15) swimming in the Omo River. When the youngest hesitated to swim, an older boy invited him in and offered help. After some teasing from the group, the younger child agreed to try. The older boy reassured him, offering his hand in the water and instructing him to move his hands and legs. Another child demonstrated the motions, guiding the younger boy's leg, while the rest encouraged his efforts.

Another mode of group transmission we want to consider is cumulative transmission. This mode refers to specific knowledge or skills individuals acquire from repeated multimodal experiences and interactions with several group members with those skills or knowledge (Hewlett et al., 2024). It is cumulative because the transmission builds upon the child's previous lived experiences; i.e., it involves scaffolding of abilities. It tends to contribute to group homogeneity and trait stability over time.

For instance, the Aka are net hunters, and children participate with other children on net hunts. They make nets together, pick up nets sitting around camp, and try to trap chickens together; they joke about children who made mistakes on the hunt (chasing game animals in the wrong direction) and listen to imaginative stories about net hunting from older children.

Similarly, among the Nyangatom, cumulative cultural transmission is evident in herding games. Young children often played herding games together, building miniature kraals and placing small stones inside to represent cattle. They also followed older boys to herding fields and, by 8–10 years old, began herding goats themselves.

While Lew-Levy and Amir describe peer cultures across societies, they do not explore how cultural niche construction influences the diversity and evolution of peer cultures. For example, child teaching occurred in 52.4% of learning events among the Koygu but only 35.3% among the Nyangatom. Similarly, concerted transmission was more frequent among the Koygu (57.9%) than the Nyangatom (32.9%). Koygu child-only concerted transmission events involved an average of 4.5 children, compared to 3.6 among the Nyangatom.

Culturally constructed niches (Laland et al., 2001) can help explain some of the observed variability in peer cultures. Foundational schema (ways of thinking and feeling that pervade several domains of life: Shore, 1996), social structures, settlement patterns, and proxemics are part of these niches to which children have to adapt. Among the Nyangatom, generational hierarchy is a dominant schema: respect for elders, especially male elders, governs much of social life (Tornay, 1981; Bedasso, 2016). These ways of thinking and structures contribute to hierarchical teaching from adults. In contrast, the egalitarian nature of the Koygu provides individuals autonomy to navigate their environment with others. Constraints do not exist for children teaching children, and adults minimize their interventions in children's learning.

Settlement patterns also affect adaptations and evolution in peer cultures. The Koygu live in large, densely populated villages (some over 100 households with houses only a few feet apart), partly due to inter-ethnic conflict and the need for security (Turton, 1986). This proximity creates ample opportunities for peer interaction and learning. The Nyangatom, while more populous overall, live in smaller, more dispersed villages – some larger villages have 10–15 households, others as small as 1–5. These spatial arrangements limit the size and frequency of peer group interactions.

Koygu egalitarianism and dense social living help explain why both child-only concerted transmission and child teaching are more frequent than among the Nyangatom. The contrast between the egalitarian, densely populated Koygu villages and more hierarchical, dispersed Nyangatom settlements illustrates how these niches create divergent developmental ecologies that shape peer culture and cultural evolution.

Lew-Levy and Amir provide a foundation for understanding the central role of peer cultures in cultural evolution. Our data from the Koygu, Nyangatom, and Aka communities complement and build upon their insights by identifying two forms of transmission that contribute to the stability of peer cultures over time (concerted and cumulative transmission) and describing how culturally constructed niches contribute to the diversity of peer cultures.

Financial support. This Koygu and Nyangatom research was supported by the National Science Foundation (Award number 2314653).

Competing interests. The authors declare none.

References

Bedasso, E. A. (2016). *Living on the margin: Masculinity, violence and development intervention in Nyangatom, Southwest Ethiopia*. Unpublished PhD Dissertation, University of Bergen.

Cavalli-Sforza, L. L., Feldman, M. W., Chen, K. H., & Dornbusch, S. M. (1982). Theory and observation in cultural transmission. *Science*, *218*(4567), 19–27. https://doi.org/10.1126/science.7123211

Hewlett, B. S., & Roulette, C. J. (2016). Teaching in hunter–gatherer infancy. *Royal Society Open Science*, *3*(1), 150403. https://doi.org/10.1098/rsos.150403

Hewlett, B. S., Boyette, A. H., Lew-Levy, S., Gallois, S., & Dira, S. J. (2024). Cultural transmission among hunter-gatherers. *Proceedings of the National Academy of Sciences*, *121*(48), e2322883121. https://doi.org/10.1073/pnas.2322883121

Laland, K. N., Odling-Smee, J, & Feldman, M. W. (2001) Cultural niche construction and human evolution. *Journal of Evolutionary Biology*, *14* (1), 22–33. http://doi.org/10.1046/j.1420-9101.2001.00262.x

Lewis-Beck, M., Bryman, A. E., & Liao, T. F. (2003). Event sampling. In *The Sage encyclopedia of social science research methods* (Eds). (pp. 347–347). Sage Publications, Inc. https://doi.org/10.4135/9781412950589.n304

Shore, B. (1996). *Culture in mind: Cognition, culture, and the problem of meaning*. Oxford University Press.

Tornay, S. (1981). The Nyangatom: An outline of their ecology and social organization. In M. L. Bender (Eds), *Peoples and cultures of the Ethio-Sudan Borderlands* (pp. 137–178). East Lasting, Michigan State University Press

Turton, D. (1986). A problem of domination at the periphery: The Kwegu and the Mursi. In D. Donham, & W. James (Eds.), *The Southern marches of imperial Ethiopia: Essays in history and social anthropology* (pp. 148–171). Cambridge University Press.

Social cognitive development prepares children to be agents of cultural adaptation: bidirectionality of peer interaction and cognitive development across urban and indigenous landscapes

Emily R. R. Burdett[a]* and Frankie T. K. Fong[b]

[a]School of Psychology, University of Nottingham, Nottingham, UK and [b]School of Psychological Sciences, Victoria University of Wellington, Wellington, New Zealand

emily.burdett@nottingham.ac.uk

frankie.fong@vuw.ac.nz

*Corresponding author.

doi:10.1017/S0140525X25101982, e229

Abstract

Greater emphasis on the *bidirectionality* of peer interaction and cognitive development would complement the suggested framework of children's contribution to cultural evolution. We outline different aspects/forms of socio-cognitive development to illustrate their roles in cultural processes: social learning, theory of mind, and pretend play. We encourage the consideration of peer cultures in urban settings and the role siblings play.

Lew-Levy and Amir provide a strong rationale for the important role children and peer culture play in cultural adaptation. We agree that peer interaction plays a pivotal role in acquiring, transmitting, maintaining, and innovating culture. However, absent from this target article is how peer-to-peer interactive experiences can inspire learning of new skills and accelerate the development of particular cognitive capacities fundamental to peer culture. Thus, we would like the authors to consider the *bidirectionality* of the role cognitive development plays in these cultural processes and how these social interactions shape cognition. We further note the importance of paying equal attention to Indigenous and urban observations to avoid a biased representation of peer culture.

Firstly, the paper would benefit from some acknowledgment that peer interactions provide unique social learning opportunities that a child does not otherwise experience in adult–child interactions. These opportunities may foster further development of key cognitive skills vital for acquiring and creating culture. For example, the authors describe a study by McGuigan et al. (2017) where 3- to 4-year-olds worked together and collectively innovated and transmitted increasingly complex tools to solve a novel puzzle box. However, they missed a crucial point: the skills and insights gained from collaborative social learning are what enabled these preschoolers to achieve what 3- to 4-year-olds could not do on their own in an asocial condition or in a typical dyadic, pedagogical interaction with an adult. Prior work has shown that children younger than 8 years are not able to create the tools required to solve these tasks on their own, largely in part to immature cognitive skills (Beck et al., 2011; Cutting, Apperly, & Beck, 2011; Rawlings, 2022). Thus, peer-to-peer interaction may shape preschooler's learning in unique ways.

Secondly, we emphasize that social cognitive skills are needed for social interaction, and social interaction facilitates the development of these skills. Theory of mind is one example of an important cognitive skill where development is enhanced with social experiences and, in turn, eases social interactions where children attempt to understand intention and perspective of others (Lane & Bowman, 2021). Indeed, social interest and opportunities of observation of others advance the development of theory of mind (e.g., Brink, Lane, & Wellman, 2015; Moore, Bosacki, & Macgillivray, 2011), especially compared to children who are socially anxious and disengage from social situations (e.g., Lane et al., 2013).

Additionally, Lew-Levy and Amir include an example of pretend play in San children (section 5.6) as an activity that enables the preservation of traditional knowledge, but details about the underlying mechanisms and functions seem lacking. Joint pretend play is a rich context where social cognitive skills are utilized amongst peers to explore and experiment with novel ideas inspired by their daily encounters, forming the foundations for cultural

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

adaptations (Chylińska & Gut, 2020). It allows children to re-enact different plausible social scenarios and solutions for problems, enhancing their evaluation and generation of cultural knowledge (Harris, 2021; Nielsen 2012), as well as informing the kinds of novel knowledge they want to acquire through other future interactions (Harris, 2024).

Notably, some children also spend a substantial amount of time with their siblings. In some cultures, they even tend to interact more with siblings and young relatives than with friends outside of an extended family circle (e.g., Yucatec Mayan, see Gaskins, 2006). It is, thus, logical to view sibling interaction as a form of peer interaction. Sibling interaction has been shown to benefit a child with more than one sibling with a richer understanding of false belief compared to children who only have one sibling (Perner, Ruffman, & Leekam, 1994). In the context of knowledge transmission and exchange, (Barr & Hayne, 2003) reported how older siblings facilitated replication of new behaviors in young children through playful sibling interactions. Older siblings may serve as cultural experts or credible authority figures, though the extent to which the bond between siblings is different from the connection between friends requires further investigation.

Lastly, we note that this target article concentrates primarily on small-scale and Indigenous communities, and this bias may risk over-generalization of Indigenous peer interaction contexts to urban settings. According to a recent observation of Yucatec Maya and US toddlers (Padilla-Iglesias et al, 2024), focusing on instances when toddlers were accompanied by other children, an adult was present almost all of the time in the US sample, whereas Maya toddlers were left spending time with peers/siblings without an adult half of the time. This is just one example of how peer interaction context may differ across cultures. Alternatively, it may provide a false impression that peer culture is not as prevalent in urban settings. Urban peer interactions at kindergartens/schools, playgrounds, hobby classes, or playdates are also understudied and worth equal attention. For example, Flynn and Whiten (2012) revealed intriguing social learning patterns when they gave British children an open diffusion task. They found that children paid attention to and also copied older children and those who are perceived as more dominant and popular. Comparing these model-based biases across Indigenous and urban samples would help illuminate motivations for imitation and spread of culture in peer cultures, including whether there are culture-specific social learning biases.

In general, we think the proposed framework of children's contributions to cultural evolution (Figure 2, target article) could improve by considering children's cognitive development: how peer interaction can expand knowledge, reinforce culture and norms, and accelerate cognition by providing opportunities to strengthen social cognition beyond what a single child could normally acquire or achieve on his or her own. Children's cultural experiences and cognitive development are closely related (Bohn et al., 2024). Taking into account the crucial roles of peer-to-peer social learning, peer observation for theory of mind development, joint pretend play, and sibling interactions, across Indigenous and urban settings, will contribute to a more holistic view of children's contribution to cultural adaptation.

Acknowledgments. n/a.

Financial support. Both Burdett and Fong are supported by a grant from the John Templeton Foundation (grant number 61542).

Competing interests. The authors declare none.

References

Barr, R., & Hayne, H. (2003). It's not what you know, it's who you know: Older siblings facilitate imitation during infancy. *International Journal of Early Years Education*, *11*(1), 7–21. https://doi.org/10.1080/09669760304714

Beck, S. R., Apperly, I. A., Chappell, J., Guthrie, C., & Cutting, N. (2011). Making tools isn't child's play. *Cognition*, *119*(2), 301–306. https://doi.org/10.1016/j.cognition.2011.01.003

Bohn, M., Fong, F. T. K., Pope-Caldwell, S., et al. (2024). Understanding cultural variation in cognition one child at a time. *Nature Reviews Psychology*, *3*, 641–643. https://doi.org/10.1038/s44159-024-00351-8

Brink, K. A., Lane, J. D., & Wellman, H. M. (2015). Developmental pathways for social understanding: Linking social cognition to social contexts. *Frontiers in Psychology*, *6*, 1–11. https://doi.org/10.3389/fpsyg.2015.00719

Chylińska, M., & Gut, A (2020). Pretend play as a creative action: On the exploratory and evaluative features of children's pretense. *Theory & Psychology*, *30*(4), 548–566. https://doi.org/10.1177/0959354320931594

Cutting, N., Apperly, I. A., & Beck, S. R. (2011). Why do children lack the flexibility to innovate tools?. *Journal of Experimental Child Psychology*, *109*(4), 497–511. https://doi.org/10.1016/j.jecp.2011.02.012

Flynn, E. & Whiten, A. (2012). Experimental "Microcultures" in young children: Identifying biographic,cognitive, and social predictors of information transmission. *Child Development*, *83*(3), 911–925. https://doi.org/10.1111/j.1467-8624.2012.01747.x

Gaskins, S. (2006). The cultural organization of yucatec mayan children's social interactions. In X. Chen, D. C. French, & B. H. Schneider (Eds.), *Peer relationships in cultural context* (pp. 283–309). Cambridge University Press. https://doi.org/10.1017/CBO9780511499739.013

Harris, P. L. (2021). Early constraints on the imagination: The realism of young children. *Child Development*, *92*(2), 466–483. https://doi.org/10.1111/cdev.13487

Harris, P. L. (2024). Somewhere, somehow: Young children imagine possibilities and ask about them. *Annual Review of Developmental Psychology*, *6*(1), 185–201. https://doi.org/10.1146/annurev-devpsych-010923-103059

Howe, N., Rosciszewska, J., & Persram, R. J. (2017). "I'm an ogre so I'm very hungry!" "I'm assistant ogre": The social function of sibling imitation in early childhood. *Infant and Child Development*, *27*(1), e2040. https://doi.org/10.1002/icd.2040

Lane, J. D., & Bowman, L. C. (2021). How children's social tendencies can shape their theory of mind development: Access and attention to social information. *Developmental Psychology*, *61*, 100977, https://doi.org/10.1016/j.dr.2021.100977

Lane, J. D., Wellman, H. M., Olson, S. L., Miller, A. L., Wang, L., & Tardif, T. (2013). Relations between temperament and theory of mind development in the United States and China: Biological and behavioral correlates of preschoolers' false-belief understanding. *Developmental Psychology*, *49*, 825–836. https://doi.org/10.1037/a0028825

McGuigan, N., Burdett, E., Burgess, V., Dean, L., Lucas, A., Vale, G., & Whiten, A. (2017). Innovation and social transmission in experimental micro-societies: Exploring the scope of cumulative culture in young children. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1735), Article 20160425. https://doi.org/10.1098/rstb.2016.0425

Moore, C., Bosacki, S. L., & Macgillivray, S. (2011). Theory of mind and social interest in zero-acquaintance play situations. *Child Development*, *82*, 1163–1172. https://doi.org/10.1111/j.1467-8624.2011.01602.x

Nielsen, M. (2012). Imitation, pretend play, and childhood: Essential elements in the evolution of human culture?. *Journal of Comparative Psychology*, *126*(2), 170–181. https://doi.org/10.1037/a0025168

Padilla-Iglesias, C., Basargekar, A., Woodward, A. L., & Shneidman, L. A. (2024). Exploring intra-and inter-cultural differences in toddlers' time allocation in a Yucatec Maya and US community. *Social Development*, *33*(1), e12703. https://doi.org/10.1111/sode.12703

Perner, J., Ruffman, T., & Leekam, S. R. (1994). Theory of mind is contagious: You catch it from your sibs. *Child Development*, *65*(4), 1228–1238. https://doi.org/10.1111/j.1467-8624.1994.tb00814.x

Rawlings, B. (2022). After a decade of tool innovation, what comes next? *Child Development Perspectives*, *16*(2), 118–124. https://doi.org/10.1111/cdep.12451

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Making peer culture audible: long-form recordings and the case for early child-to-child input

Joseph Coffey[a] and Camila Scaff[a,b*]

[a]PSL University, Laboratoire de Sciences Cognitives et de Psycholinguistique (ENS, EHESS, CNRS, DEC), Paris France and [b]Institute of Evolutionary Medicine (IEM), University of Zurich, Zurich, Switzerland
jcoffey@ens.psl.eu
camillescaff@gmail.com
https://sites.google.com/g.harvard.edu/josephcoffey/home
https://camilascaff.com/

*Corresponding author.

doi:10.1017/S0140525X2510191X, e230

Abstract

Lew-Levy and Amir note that by adolescence, children shift from speaking like their parents to using the vernacular of their peers, suggesting that children attend closely to linguistic input from other children. But unlike adult input, peer input has been neglected in research. We believe this is due to methodological limitations that long-form audio recordings are uniquely equipped to overcome.

We agree with Lew-Levy and Amir that peer culture is a vital yet underexplored aspect of children's early learning environments. However, we argue that the importance of peer language input has been systematically overlooked, particularly before age three, due to limited means of capturing naturalistic interactions between children. But with the emergence of tools for processing long-form audio recordings, which offer a discrete and hands-off way of studying peer cultures, this barrier is being overcome.

Long-form recordings refer to a suite of methods for analyzing naturalistic audio recordings of everyday events collected via child-worn recording devices. Tools like Language Environment Analysis (LENA) (Gilkerson et al., 2017) and Voice Type Classifier (VTC) (Lavechin et al., 2020) allow researchers to distinguish between child, adult, and peer speech from other sources of noise with increasing accuracy, even in multilingual and under-resourced settings (e.g., Cristia et al., 2023; Coffey et al., under review). These systems leverage new advances in automated speech analysis, allowing researchers to collect and process massive amounts of speech data from nearly any setting. These features greatly expand the possible scope of language studies and offer new answers to major assumptions in early linguistic development. For instance, a study of over 38,000 hours of home recordings in the U.S. suggested that the word gap between high- and low-income families is far smaller than previously estimated (4 million words by 4 years per Gilkerson et al., 2017 vs. 30 million per Hart & Risley, 1995). Another large-scale cross-cultural study over 40,000 hours of audio taken from families in 12 countries found little evidence of socio-economic or gender differences in the rates that young children vocalize (Bergelson et al., 2023).

These methods are potentially transformative for the study of peer culture. As the authors note, peer cultures are not only distinct from those of adults but also tend to "insulate" themselves from adult presence. Traditional research methods, such as in-person observation, interviews, lab-based experiments, and non-portable recording devices, have failed to capture their naturalistic everyday dynamics. Much of what we know about children's language environments has been captured in the presence of adults. Studies suggest that children are more performative around adults and vocalize more in lab settings than in natural environments (Lewedag, Oller, & Lynch, 1994; Bergelson et al., 2019), and much of their time is spent away from adult eyes (Davies & Cashdan, 2020). Our personal interactions with research participants support these claims. For instance, a Tsimane mother from the Amazon laughed upon hearing a recording of her 4-year-old child pretending to be a pilot during a game with his siblings. She explained she had never heard him speak that way – he never told those kinds of stories to her. As this moment exemplifies, much of what we know about child development has been filtered through the "adult gaze," effectively obscuring the very peer-to-peer input that appears so critical in shaping children's social and linguistic growth.

With these systems, researchers have been able to shed new light on the uniquely peer-driven aspects of language development that have gone unnoticed in traditional observational studies. Studies using long-form recordings in small-scale subsistence-based societies have routinely found that young children hear more speech input from other children than adults as they age and that children's vocalizations are better predicted by input from other children than from adults, contrasting sharply with findings from societies where sibling caregiving is less common (Weber Fernald, & Diop, 2017; Casillas, Brown, & Levinson, 2021; Cristia, Gautheron, & Colleran, 2023; Scaff et al., 2024; Coffey et al., under review). While transcribed studies of peer input in these settings were limited in the number of children that could be observed (e.g., $n = 15$ in Shneidman & Goldin-Meadow, 2012; $n = 3$ in Loukatou et al., 2022), these systems have massively increased the data available to study, from $n = 24$ in Scaff et al. (2024) to $n = 276$ in Coffey et al. (under review). In urban Western settings, long-form recordings have been used in classroom settings, where many of these trends have also been observed: children talk more amongst each other than they do their teachers, and their speech production is better predicted by peer input than adult input (Dykstra et al., 2013; Perry et al., 2018).

These methods are widely available to researchers looking to supplement their research, not just limited to language studies but also as a proxy for interaction or social networks. LENA is available through the LENA Foundation with specialty programs for home-based or classroom-based research. VTC is available through ChildProject, an open-source collection of tools for analyzing long-form recordings, consisting of over 40 data sets, drawing from over 1000 children across 6 continents and dozens of languages (Gautheron, Rochat, & Cristia, 2023). Although long-form recordings cannot tell researchers the content about what is said between peers, software analysis allows for selective sampling of speech from different sources or from periods of high volubility for further manual annotation (Casillas, Brown, & Levinson, 2020; 2021; Bunce et al., 2025). There are also tools in development that use these systems to identify segments of speech to deploy automated transcription of child speech (e.g., Radford et al., 2023; Chaparro-Moreno et al., 2024; Pelfrey et al.,

2024; Sun et al., 2024). Thus, long-form recordings can be used as a viable alternative to direct observation as a method of collecting naturalistic speech, which is key to understanding peer speech practices, as well as the innovation of novel words and linguistic forms.

Long-form recordings are a powerful solution to a blind spot in developmental science: the systematic neglect of peer language input, particularly before age three. By capturing naturalistic, peer-driven speech across diverse settings, long-form recordings reveal that much of children's language development occurs beyond adult observation. By vastly increasing the kind and amount of data available to researchers, these systems will play a vital role in unlocking peer culture.

Financial support. J. S. McDonnell Foundation Understanding Human Cognition Scholar Award; European Research Council under the European Union's Horizon 2020 research and innovation programme (ExELang, Grant agreement No. 101001095).

Competing interests. None.

References

Bergelson, E., Amatuni, A., Dailey, S., Koorathota, S., & Tor, S. (2019). Day by day, hour by hour: Naturalistic language input to infants. *Developmental science*, *22*(1), e12715.

Bergelson, E., Soderstrom, M., Schwarz, I. C., Rowland, C. F., Ramírez-Esparza, N., Hamrick, L. R.., ... & Cristia, A. (2023). Everyday language input and production in 1,001 children from six continents. *Proceedings of the National Academy of Sciences*, *120*(52), e2300671120.

Bunce, J., Soderstrom, M., Bergelson, E., Rosemberg, C., Stein, A., Alam, F., ... Casillas, M. (2025). A cross-linguistic examination of young children's everyday language experiences. *Journal of Child Language*, *52* (4), 786–814.

Casillas, M., Brown, P., & Levinson, S. C. (2020). Early language experience in a Tseltal Mayan village. *Child Development*, *91* (5), 1819–1835.

Casillas, M., Brown, P., & Levinson, S. C. (2021). Early language experience in a Papuan community. *Journal of Child Language*, *48* (4), 792–814.

Chaparro-Moreno, L. J., Villasanti, H. G., Justice, L. M., Sun, J., & Schmitt, M. B. (2024). Accuracy of automatic processing of speech-language pathologist and child talk during school-based therapy sessions. *Journal of Speech, Language, and Hearing Research*, *67* (8), 2669–2684.

Coffey, J. R., Baranov, V., Hu, X., Contreras Suarez, D., Cameron, L., & Cristia, A. (under review). Talking in Timor-Leste: leveraging speaker diarization to study children's verbal environments. OSF preprint.

Cristia, A., Gautheron, L., & Colleran, H. (2023). Vocal input and output among infants in a multilingual context: Evidence from long-form recordings in vanuatu. *Developmental Science*, *26* (4), e13375.

Davis, H. E., & Cashdan, E. (2020). You don't have to know where your kids are, just where they aren't: Exploring free-range parenting in the Bolivian Amazon. In Ashdown, B.K., Faherty, A.N. (eds) *Parents and Caregivers Across Cultures*. Cham: Springer.

Dykstra, J. R., Sabatos-DeVito, M. G., Irvin, D. W., Boyd, B. A., Hume, K. A., & Odom, S. L. (2013). Using the Language Environment Analysis (LENA) system in preschool classrooms with children with autism spectrum disorders. *Autism*, *17*(5), 582–594.

Gautheron, L., Rochat, N. & Cristia, A. (2023). Managing, storing, and sharing long-form recordings and their annotations. *Language Resources & Evaluation 57*, 343–375.

Gilkerson, J., Richards, J. A., Warren, S. F., Montgomery, J. K., Greenwood, C. R., Kimbrough Oller, D., ... & Paul, T. D. (2017). Mapping the early language environment using all-day recordings and automated analysis. *American Journal of Speech-Language Pathology*, *26* (2), 248–265.

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. P.H. Brookes.

Lavechin, M., Bousbib, R., Bredin, H., Dupoux, E., & Cristia, A. (2020). An open-source voice type classifier for child-centered daylong recordings. *Interspeech*.

Lewedag, V. L., Oller, D. K., & Lynch, M. P. (1994). Infants' vocalization patterns across home and laboratory environments. *First Language*, *14*(42–43), 49–65.

Loukatou, G., Scaff, C., Demuth, K., Cristia, A., & Havron, N. (2022). Child-directed and overheard input from different speakers in two distinct cultures. *Journal of Child Language*, *49* (6), 1173–1192.

Pelfrey, G. L., Justice, L. M., Gonzalez Villasanti, H., & Foster, T. J. (2024). Evaluating the accuracy of automated processing of child and adult language production in preschool classrooms. *Frontiers in Psychology*, *15*, 1322665.

Perry, L. K., Prince, E. B., Valtierra, A. M., Rivero-Fernandez, C., Ullery, M. A., Katz, L. F., ... & Messinger, D. S. (2018). A year in words: The dynamics and consequences of language experiences in an intervention classroom. *PloS one*, *13*(7), e0199893.

Radford, A., Kim, J. W., Xu, T., Brockman, G., McLeavey, C., & Sutskever, I. (2023). Robust speech recognition via large-scale weak supervision. *International Conference on Machine Learning*, 28492–28518. PMLR.

Scaff, C., Casillas, M., Stieglitz, J., & Cristia, A. (2024). Characterization of children's verbal input in a forager-farmer population using long-form audio recordings and diverse input definitions. *Infancy*, *29* (2), 196–215.

Shneidman, L. A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: How important is directed speech?. *Developmental Science*, *15* (5), 659–673.

Sun, A., Londono, J. J., Elbaum, B., Estrada, L., Lazo, R. J., Vitale, L., ... & Messinger, D.S. (2024). Who said what? An automated approach to analyzing speech in preschool classrooms. *2024 IEEE International Conference on Development and Learning (ICDL)*, 1–8. IEEE.

Weber, A., Fernald, A., & Diop, Y. (2017). When cultural norms discourage talking to babies: Effectiveness of a parenting program in rural senegal. *Child Development*, *88* (5), 1513–1526.

Peer cultures as untapped resources for climate action

Dominik Deffner[a,b*], Ira Elisa Herwig[c], Vanessa Knobl[c], Lydia Paulin Schidelko[d] and Jutta Mata[b,c]

[a]University of Marburg, Department of Psychology, Computational Modelling of Behaviour, Marburg, Germany; [b]Center for Adaptive Rationality, Max Planck Institute for Human Development, Berlin, Germany; [c]University of Mannheim, School of Social Sciences, Health Psychology, Mannheim, Germany and [d]Max-Rubner-Institut (MRI), Federal Research Institute of Nutrition and Food, Institute of Physiology and Biochemistry of Nutrition, Karlsruhe, Germany

dominik.deffner@uni-marburg.de
herwig@uni-mannheim.de
knobl@uni-mannheim.de
jutta.mata@uni-mannheim.de
Lydia.Schidelko@mri.bund.de

*Corresponding author.

doi:10.1017/S0140525X25101945, e231

Abstract

Children's peer cultures hold the potential to drive cultural evolution, depending on demography and social transmission pathways. Understanding their interactions can inform cultural-evolutionary theory and promote adaptable cultural institutions. Here, we outline the next steps for theoretical models, clarifying the importance of peer cultures, and introduce sustainable behavior as a compelling test case for children- and youth-driven cultural change.

Through their special tendencies to explore the world, children may generate a particularly diverse set of cultural variants, potentially helping populations adapt in times of environmental change (Fogarty & Kandler, 2020; Smaldino et al., 2024). Whether stable peer cultures form and whether they influence wider cultural dynamics not only depends on the way children learn and interact themselves but on the demographic and cultural forces guiding information flow among age groups. For example, in post-industrial societies, demographic shifts to lower mortality and fertility reduce the number of younger individuals and might, therefore, make it harder for peer cultures to form. At the same time, widespread online communication might facilitate information exchange among peers, and greater parental emphasis on children's preferences might promote bottom-up transmission within households, both increasing the cultural influence younger generations have.

Cultural evolutionary models are ideal tools to disentangle the complex interactions between micro-level social interactions and macro-level societal outcomes, providing principled predictions about the prerequisites and impact of peer cultures (Smaldino, 2023). Importantly, to build more realistic models of children's role in cultural transmission, cultural information cannot be studied in isolation. Instead, we must investigate social dynamics in populations where average life spans, family size, and the age distribution are not hard-coded but arise endogenously from demographic processes (Deffner & McElreath, 2022). This is important because cultural traits evolve within ever-changing populations, and the relative size of different age groups as well as the connectivity between them will crucially shape the emergence and impact of peer cultures. Such simulations follow dynamically changing populations of agents as they are born, grow up, have offspring, and, eventually, die. On top of realistic demographics, researchers can contrast the effect of different cultural transmission pathways on metrics like cultural diversity, complexity, or success rates of new adaptive variants. As a more realistic demography is introduced, model complexity increases rapidly, requiring even more careful examination of assumptions and targeted model analysis. Still, to truly appreciate the potential role of children in cultural evolution, we need to embrace that additional complexity and study the intricate interplay between demography and culture.

Even if cultural evolutionary models can help identify abstract forces shaping peer cultures, it is not trivial to close the gap between theoretical models and real-world data – an important outstanding issue in cultural evolution (Deffner et al., 2024). Despite the wealth of plausible anecdotes reported by Lew-Levy and Amir, we still need convincing case studies demonstrating that peer culture and bottom-up transmission have a quantitative impact on cultural change. We argue that sustainable behavior, and plant-based diets in particular, could be such a case study. Climate change is probably the most serious and rapidly evolving adaptive challenge we are currently facing, threatening not only global ecosystem functioning and biodiversity but also human health and well-being (IPCC, 2023; Grant et al., 2025). Cultural evolution has been nominated as a powerful framework to model and predict responses to climate change as well as to guide possible interventions (Pisor, Lansing, & Magargal, 2023; Turner et al., 2023). Not only did the younger generation found "Fridays for Future," inspiring parental and grandparental generations to follow them with "Parents for Future" and "Grandparents for Future," but younger generations are also more likely to support ambitious climate policies (Belz et al., 2022; Tyson, Kennedy, & Funk, 2021); and, at least partially, they also adopt more sustainable behaviors. For example, adolescents in Germany reduced their meat consumption compared to the generation of their parents: the percentage of 14- to 29-year-olds eating vegetarian or vegan diets increased from 12% in 2019 to 20% in 2024; this is 2.5 times higher than in their parents' age group (45–59 years), with 8% in 2024 (Bundesministerium für Ernährung und Landwirtschaft, 2019, 2024). They also frequently state sustainability as a key reason for their diets (Zühlsdorf et al., 2021) and have been identified as potential drivers of more sustainable eating, particularly when the younger generation argues for sustainable eating or engages in sustainable eating themselves (Knobl & Mata, 2024; Mata, Knobl & Takezawa, 2025).

Understanding the role of younger generations for adaptive cultural change within a cultural evolutionary framework requires three major steps (Deffner et al., 2024): (1) Building complementary models that formalize scientific understanding of how a certain behavior is acquired and passed on between individuals. Such models allow simulating how the frequencies of behavioral alternatives in the population change over time as a function of different forms of social influence, such as peer learning or conformity to norms. Simulations could, for example, also determine how many young "innovators" are required for social innovations like plant-based diets to succeed, or how homophilic interactions or selective displays of behaviors influence their spread. (2) Estimating those social-influence parameters from data, using, for example, large-scale longitudinal or historical data sets. This allows inferring how individual choices are influenced by the choices of others and how important hypothesized psychological processes really are. (3) Linking individual-level processes back to population dynamics by simulating from the models based on the parameter values inferred from the data. Such simulations allow testing in silico how adaptive climate behaviors might spread in the future and probing how different interventions might facilitate that spread. For instance, we could simulate the consequences of children-planned family meals (Knobl & Mata, 2024; Mata, Knobl & Takezawa, 2025), advertisement campaigns targeting certain age groups, or programs fostering political engagement among youths.

In sum, combining cultural evolutionary simulations with real-world data on sustainable behaviors could provide a uniquely relevant test case for the role of younger generations in adaptive cultural change. Understanding such processes also allows building political institutions that could facilitate the spread of up-to-date information and adaptive practices. If younger generations, introducing and experimenting with more sustainable practices, indeed provide an untapped resource for successful climate action, it becomes a key societal challenge to facilitate the diffusion of

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

those practices, as well as to find novel ways to better integrate the perspectives of younger generations, promoting societies that are better prepared for the major challenges ahead.

Financial support. The authors did not receive any specific funding for this research.

Competing interests. The authors have no conflicts of interest to declare.

References

Belz, J., Follmer, R., Hölscher, J., Stiess, I., Sunderer, G., & Birzle-Harder, B. (2022). Umweltbewusstsein in Deutschland 2020: Ergebnisse einer repräsentativen Bevölkerungsumfrage. Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz (BMUV).

Bundesministerium für Ernährung und Landwirtschaft. (2024). Deutschland, wie es isst – Der BMEL-Ernährungsreport 2024.

Bundesministerium für Ernährung und Landwirtschaft. (2019). Deutschland, wie es isst – Der BMEL-Ernährungsreport 2019.

Deffner, D., Fedorova, N., Andrews, J., & McElreath, R. (2024). Bridging theory and data: A computational workflow for cultural evolution. *Proceedings of the National Academy of Sciences*, *121*(48), e2322887121.

Deffner, D., & McElreath, R. (2022). When does selection favor learning from the old? Social learning in age-structured populations. *PloS one*, *17*(4), e0267204.

Fogarty, L., & Kandler, A. (2020). The fundamentals of cultural adaptation: Implications for human adaptation. *Scientific reports*, *10*(1), 14318.

Grant, L., Vanderkelen, I., Gudmundsson, L., Fischer, E., Seneviratne, S. I., & Thiery, W. (2025). Global emergence of unprecedented lifetime exposure to climate extremes. *Nature*, *641*(8062), 374–379.

IPCC, 2023: *Climate* Change *2023: Synthesis Report.* Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35–115.

Kandler, A., Fogarty, L., & Karsdorp, F. (2023). The interplay between age structure and cultural transmission. *PLOS Computational Biology*, *19*(7), e1011297.

Knobl, V., & Mata, J. (2024). Intersecting perspectives: Advocating for sustainable family meals across generations. *Appetite*, *201*, 107618.

Mata, J., Knobl, V., & Takezawa, M. (2025). Exploring the role of adolescents in healthier, more sustainable family meals: A decision study on meat consumption. *Appetite*, 107916.

Pisor, A., Lansing, J. S., & Magargal, K. (2023). Climate change adaptation needs a science of culture. *Philosophical Transactions of the Royal Society B*, *378*(1889), 20220390.

Smaldino, P. (2023). *Modeling social behavior: Mathematical and agent-based models of social dynamics and cultural evolution.* Princeton University Press.

Smaldino, P. E., Moser, C., Pérez Velilla, A., & Werling, M. (2024). Maintaining transient diversity is a general principle for improving collective problem solving. *Perspectives on Psychological Science*, *19*(2), 454–464.

Turner, M. A., Singleton, A. L., Harris, M. J., Harryman, I., Lopez, C. A., Arthur, R. F., … & Jones, J. H. (2023). Minority-group incubators and majority-group reservoirs support the diffusion of climate change adaptations. *Philosophical Transactions of the Royal Society B*, *378*(1889), 20220401.

Tyson, A., Kennedy, B., & Funk, C. (2021). Gen Z, Millennials stand out for climate change activism, social media engagement with issue. *Pew Research Center*, *26*(2), 6–7.

Zühlsdorf, A., Jürkenbeck, K., Schulze, M., & Spiller, A. (2021). Politicized eater: Jugendreport zur Zukunft nachhaltiger Ernährung. *Göttingen*, *106*, 31.

Beyond the individual: toward a relational and inclusive cultural evolutionary science of childhood

Natalia B. Dutra*

Núcleo de Teoria e Pesquisa do Comportamento, Federal University of Pará, Belém, Pará, Brazil
nataliabdutra@ufpa.br
https://sigaa.ufpa.br/sigaa/public/docente/portal.jsf?siape=1689637

*Corresponding author.

doi:10.1017/S0140525X25101787, e232

Abstract

In this commentary I critique individualist biases in developmental and cultural evolutionary science, highlighting the need to study children's peer cultures as relational and culturally situated. Emphasizing perspectives from the Global South, I call for a genuinely inclusive framework that integrates non-Western developmental theories into the core of cultural evolutionary research.

Lew-Levy and Amir's piece is a welcome reprieve from the hegemonic Western scientific narrative that pervades cultural evolutionary and developmental sciences – a narrative which tends to focus on isolated individuals, often neglecting the embeddedness of human development in social and cultural contexts (Chaudary et al., 2022). I have been struggling with the challenges of overcoming this individual-centric paradigm myself.

Research focusing on pairs or groups of individuals is both costly and time-consuming; however, given that humans are inherently social beings (Tomasello, 2019), a significant portion of relevant developmental phenomena is excluded from most mainstream studies. In such studies, children are often paired with unfamiliar peers or adults in artificial conditions (Rogoff, Dahl, & Callanan, 2018). In some cases, humans are replaced by puppets (Packer & Moreno-Dulcey, 2022) or animated geometric shapes (Lucca et al., 2025). When addressing familiar or cultural variables, these studies are highlighted as addressing only one aspect of human behavior and are often published in specialty journals (e.g., Journal of Cross-Cultural Psychology). These omissions risk distorting our understanding of how developmental processes unfold in real-world settings, where interpersonal interactions play a central role.

Lew-Levy and Amir's emphasis on children as *independent producers of culture*, and on peer cultures as *autonomous* from adult culture, is both insightful and necessary. However, despite the strengths of their paper, the focus on independence and autonomy, two core values from Western societies, demonstrates

that the authors also grapple with fully escaping the gravitational pull of dominant narratives. While children's peer cultures are often depicted as distinct, self-contained systems, they are in fact situated and relational (Rogoff et al, 2018). Children's lives are frequently conceptualized as separate from those of adults. Yet in practice, children's experiences are deeply intertwined with adult life. Although children may not be expected to behave like adults in many domains, the boundaries between childhood and adulthood is permeable, overlapping, and culturally contingent. The ambiguity of this transition period underscores the need for nuanced frameworks that resist age-based essentialism and instead focus on social roles, relationships, and culturally mediated practices.

Western theoretization tends to focus on the isolation of phenomena. Cultural evolutionary theorists initially adopted genetic evolution as a metaphor (Creanza, Kolodny, & Feldman, 2017). One of the central issues with this approach is that, while genetics includes identifiable (though complex and still debated) units of transmission, an equivalent unit for cultural transmission remains highly controversial (Hirschfeld, 2018). Likewise, developmental psychology faced challenges around the concept of developmental stages. Traditional stage-based models (Feldman, 2004) – have dominated the field, but other frameworks offer a more dynamic and context-sensitive alternative. For instance, the Developmental Systems Theory (Griffiths & Tabery, 2013) defines development as a cascade of events occurring within certain biological and environmental parameters, allowing for individual variability in developmental trajectories. Hence, evolutionary, cultural, and developmental changes share a common feature: their milestones are theory-laden – whether those theories are scientific, cultural, or folk-based. A cultural evolutionary perspective on peer cultures stands to gain significantly from incorporating diverse viewpoints, particularly from scholars and communities beyond the Western academic canon.

To avoid reproducing the pitfalls of Western behavioral science – such as its emphasis on linearity, hierarchy, individualism, and universalism – the contributions of Global South researchers must be more than tokenistically acknowledged. The broader research community must go further and seek to dialog with non-Western knowledge. However, many efforts to include these perspectives in the global academic conversation remain superficial. They are often limited to Western researchers forming short-term collaborations with a small number of local scholars to showcase "local" features, or compiling "international" publications that highlight diversity without integrating it into the theoretical core. These practices risk reinforcing the very hierarchies they claim to disrupt.

Furthermore, research culture and resource availability differ greatly across countries, affecting not only the type of research that can be conducted but also the kinds of questions that are asked. As research on group behavior and relational dynamics is particularly resource-intensive, researchers in the Global South – who may already face structural and funding constraints – are placed at a disadvantage when attempting to conduct such studies.

A truly inclusive cultural evolutionary approach to peer cultures must move beyond superficial inclusion and genuinely integrate the theoretical and empirical contributions of scholars from outside Western contexts. This involves not only citing their work but also rethinking dominant assumptions in light of these perspectives. Even in academic circles, which are heavily influenced by Western canon worldwide, Global South contributions are unheard of outside their countries. There exists a rich variety of developmental theories emerging outside the Western world – even when they are partially shaped by Western thought.

For example, cultural historical psychology, which originated in the Soviet Union, has profoundly influenced Brazilian developmental psychology and educational theory (Asbahr, Souza, & Barroco, 2024). This cross-pollination illustrates that non-Western theories are not mere reflections of Western ones, but rather reinterpret and extend them in culturally meaningful ways. Regarding the study of children's peer cultures in Brazil, a theoretical framework developed in the 1980s led to multiple approaches to children's cultural practices (Carvalho & Beraldo, 1989). These were influenced by historical-cultural theory, anthropology, and ethology (Otta, 2017; Pontes & Magalhães, 2003; Queiroz, Maciel, & Branco, 2006). Although much of this work focused on children's play, it consistently portrayed children as active participants in learning and social interaction across a range of settings, including nurseries, families, and communities. Importantly, these frameworks challenge the notion that play is merely preparation for adulthood; instead, play is recognized as a culturally significant activity in its own right.

To conclude, the very notion of what constitutes a "unit" of culture, a "stage" of development, or a "peer culture" must be re-evaluated through cross-cultural and interdisciplinary collaboration. Development does not unfold in a vacuum – it is shaped by histories, ecologies, institutions, and relationships. Peer cultures are not static or isolated; they are fluid, negotiated, and shaped in relation to adult cultures, economic structures, and local epistemologies. Lew-Levy and Amir's paper opens an important space in developmental and cultural evolutionary science. However, for the field to advance, it must take seriously the contributions of Global South scholars, adopt more relational and context-sensitive frameworks, and question the assumptions underlying Western models of childhood, development, and culture.

Acknowledgements. The author acknowledges Lew-Levy and Amir for the invitation to submit a commentary to this paper.

Financial support. The author is currently funded by the CNPq/MCTI Nº 10/2023, grant number 408887/2023-0.

Competing interests. The author is a research collaborator of both Lew-Levy and Amir.

References

Asbahr, F. D. S. F., Souza, M. P. R. D., & Barroco, S. M. S. (2024). Historical-cultural psychology in research groups in the CNPq directory in Brazil. *Psicologia: Teoria e Pesquisa*, *40*, e40311. https://doi.org/10.1590/0102.3772e40311.en

Carvalho, A. M. A., & Beraldo, K. E. A. (1989). Interação criança-criança: Ressurgimento de uma área de pesquisa e suas perspectivas. *Cadernos de Pesquisa*, *71*, 55–61.

Chaudhary, N., Misra, G., Bansal, P., Valsiner, J., & Singh, T. (2022). Making sense of culture for the psychological sciences. *Review of General Psychology*, *26*(4), 399–415. https://doi.org/10.1177/10892680211066473

Creanza, N., Kolodny, O., & Feldman, M. W. (2017). Cultural evolutionary theory: How culture evolves and why it matters. *Proceedings of the National Academy of Sciences*, *114*(30), 7782–7789. https://doi.org/10.1073/pnas.1620732114

Feldman, D. H. (2004). Piaget's stages: The unfinished symphony of cognitive development. *New Ideas in Psychology*, *22*(3), 175–231. https://doi.org/10.1016/j.newideapsych.2004.11.005

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Griffiths, P. E. & Tabery, J. (2013). Developmental systems theory. In P. E. Griffiths & J. Tabery (eds.), *Advances in child development and behavior* (pp. 65–94). Elsevier. https://doi.org/10.1016/b978-0-12-397947-6.00003-9

Hirschfeld, L. A. (2018). The Rutherford atom of culture. *Journal of Cognition and Culture*, *18*(3–4), 231–261. https://doi.org/10.1163/15685373-12340029

Lucca, K., Yuen, F., Wang, Y., Alessandroni, N., Allison, O., Alvarez, M., Axelsson, E. L., Baumer, J., Baumgartner, H. A., Bertels, J., Bhavsar, M., Byers-Heinlein, K., Capelier-Mourguy, A., Chijiiwa, H., Chin, C. S. -S., Christner, N., Cirelli, L. K., Corbit, J., Daum, M. M., . . . & Hamlin, J. K. (2025). Infants' social evaluation of helpers and hinderers: A large-scale, multi-lab, coordinated replication study. *Developmental Science*, *28*(1), e13581. https://doi.org/10.1111/desc.13581

Otta, E. (2017). Brincar na perspectiva psicoetológica: Implicações para pesquisa e prática. *Psicologia USP*, *28*(3), 358–367. https://doi.org/10.1590/0103-656420160122

Packer, M. J., & Moreno-Dulcey, F. A. (2022). Theory of puppets?: A critique of the use of puppets as stimulus materials in psychological research with young children. *Cognitive Development*, *61*, 101146. https://doi.org/10.1016/j.cogdev.2021.101146

Pontes, F. A. R. & Magalhães, C. C. (2003). A transmissão da cultura da brincadeira. *Psicologia: Reflexão e Crítica, v.6* n.1, 117-124.

Queiroz, N. L. N. D., Maciel, D. A., & Branco, A. U. (2006). Brincadeira e desenvolvimento infantil: Um olhar sociocultural construtivista. *Paidéia (Ribeirão Preto)*, *16*(34), 169–179. https://doi.org/10.1590/s0103-863x2006000200005

Rogoff, B., Dahl, A., & Callanan, M. (2018). The importance of understanding children's lived experience. *Developmental Review*, *50*, 5–15. https://doi.org/10.1016/j.dr.2018.05.006

Suárez-Orozco, C. (2015). Introduction to the special issue on emerging adulthood. *Journal of Adolescent Research*, *30*(5), 535–537. https://doi.org/10.1177/074355841559369

Tomasello, M. (2019). *Becoming human: A theory of ontogeny*. The Belknap Press of Harvard University Press.

The dismantling and reconstitution of mental models by child peer groups

Liane Gabora*

Department of Psychology, University of British Columbia (Okanagan Campus), Fipke Centre for Innovative Research, Kelowna, Canada
liane.gabora@ubc.ca

*Corresponding author.

doi:10.1017/S0140525X25101921, e233

Abstract

The target paper brings a new dimension to cultural evolution research. The findings it reports are consistent with the hypothesis that it is integrated cognitive networks – i.e., ways of structuring knowledge – that evolve through culture, as opposed to discrete units of cultural knowledge. The impact of child peer groups on cultural evolution could be modeled using methods from network science.

I applaud the fresh perspective this paper brings. The argument that child peer groups are largely independent active producers and maintainers of autonomous cultures goes against the grain of much cultural evolution research, which has focused almost exclusively on adults and assumed children to be passive recipients of vertically transmitted cultural knowledge. The authors' evidence that child peer groups impact how human culture evolves is convincing. Also welcome is the target article's focus on the role of creative processes in maintaining cultural diversity, which, with a few exceptions (Enquist, Ghirlanda, & Eriksson, 2011; Fogarty, Creanza, & Feldman, 2015; Gabora, 2008; Gabora & Smith, 2019), receives little attention.

The authors note that, "Rather than just more time for learning adult skills, long childhoods also allow for the generation and maintenance of peer cultural products." Presumably, the *making* of these products develops their minds in new ways. Since peer cultures incorporate complex, contextual relationships amongst products, peer cultures – and the mental structures behind them – are most aptly modeled, not as "collections" of cognitive traits, but as networks. Thus, the approach taken here is consistent with network science approaches to cultural evolution (Buskell, Enquist, & Jansson, 2019; Gabora, 1998) and with the hypothesis that it is integrated cognitive networks – i.e., ways of structuring knowledge – that evolve through culture, as opposed to discrete units of cultural knowledge (Gabora, 2004). The authors write, "Through collaborative exploration, peer interaction can be generative, leading to the discovery of information not initially possessed by either child," and this too is amenable to network science methods. They have been applied not just to cultural evolution but to the development of children's mental models (Beckage, Aguilar, & Colunga, 2015; Beckage, Smith, & Hills, 2011; Stella, Beckage, & Brede, 2017), including the interactive development of a shared mental model extending across multiple children (Gabora, Beckage, & Steel, 2022).

It was interesting to learn that, prior to age three, children are not adapted for collaborating with peers, only with adults. This is consistent with the proposal that the density of causal and associative links connecting mental representations in the toddler's mind crosses a percolation threshold, such that it undergoes a phase transition from discrete islands of connectivity to an integrated network (Gabora, Beckage, & Steel, 2022). It seems reasonable that, before this threshold is crossed, obtaining enough knowledge to form an integrated (initially small) world model is best achieved through interactions with adults, while after it is crossed, playful exploration and growth of this primitive cognitive structure is best achieved through interactions with peers. After all, with age, thinking can become more rigid, and views can become entrenched, potentially stifling new ideas and perspectives (Candeias & Galindo, 2021; Ross et al., 2023). This kind of phase transition in cognitive development can be modeled using autocatalytic networks. Autocatalytic networks have been used to model not just how concepts coalesce into an integrated network in a young child's mind but also cognitive changes underlying the origins of the capacity for cumulative, adaptive, open-ended cultural evolution (Gabora & Steel, 2017, 2020a,b). Autocatalytic network models distinguish (1) innate knowledge (nature) and knowledge obtained from the environment, *e.g.,* through social

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

learning (nurture), from (2) *derived knowledge* generated autonomously by the individual(s) in question. While nature and nurture provide the raw conceptual materials for an integrated understanding of the world, derived knowledge establishes relationships amongst these raw materials, and fills in gaps through the generation of new ideas (Gabora & Robertson, 2025). This distinction enables us to track the products and changes that individuals (or interacting groups) contribute to cultural lineages. Thus, autocatalytic networks might be particularly suitable for modelling cognitive change through children's cultural interactions with peers.

This research may help uncover new mechanisms by which cultures evolve. It suggests that child peer cultures facilitate a cycle of dismantling and reconstituting of mental models that enables each new generation to escape the mental ruts of the previous generation, and adapt to environmental changes. If this is the case, then culture may evolve, not just because knowledge accumulates, but because, during childhood, each generation collectively establishes new cognitive scaffolds that constrain and enable what thought trajectories and cultural contributions are possible, both in childhood and later in life. Further investigation of this hypothesis using network-based computer models of cultural evolution, and comparison of results with and without child peer group subcultures, could potentially constitute a landmark contribution to research at the intersection of cognitive development and cultural evolution.

Although the target paper is not the first to do so, the use of the term "inheritance" in reference to cultural traits is ill-advised. An *inherited trait* is transmitted vertically (e.g., from parent to offspring) by way of a self-assembly code (e.g., DNA) and therefore does not need to be re-learned or re-acquired by the next generation. This is not the case with respect to cultural traits (Gabora, 2011; Smith, Gabora, & Gardner-O'Kearny, 2018); for example, if you know how to ride a bike, your child doesn't automatically know how to ride a bike but must learn this skill from scratch. Biologists use the term *acquired traits* to refer to traits that are obtained not through inheritance but through interaction with the environment (e.g., social learning), and it seems prudent to adhere to this distinction in the cultural evolution literature as well (Gabora, 2011).

"Selection" is also misleading when applied in a cultural context. In its scientific usage, the term *selection* is applicable when an evolutionary process occurs due to differential replication of randomly generated heritable variations in a population over generations, such that some traits become more prevalent than others. In culture, rarely are multiple variants randomly generated, and distinctions between variants are not heritable (see above). Cultural change is primarily due to whatever is *biasing* the generation of variants away from random factors, such as intelligence, planning, and intuition, which are not random but based on pattern completion (Bowers, Farvolden, & Mermigis, 1995; Gigerenzer, 2023).

Financial support. This research was funded in part by a grant GR026749 to LG from the Natural Sciences and Engineering Research Council of Canada (NSERC).

Competing interests. No competing interests to declare.

References

Beckage, N., Aguilar, A., & E. Colunga, E. (2015). Modeling lexical acquisition through networks. *Proceedings of the 37th Annual Conference of the Cognitive Science Society*, Cognitive Science Society, Austin, TX, USA.

Beckage, N., Smith, L., & Hills, T. (2011). Small worlds and semantic network growth in typical and late talkers. *PLoS ONE*, *6*(5), Article ID e19348.

Bowers, K., Farvolden, P., & Mermigis, L. (1995). Intuitive antecedents of insight. In. S. Smith, T. Ward, & R. Finke (Eds.), *The creative cognition approach* (pp. 27–51). MIT Press. https://doi.org/10.7551/mitpress/2205.003.0005

Buskell, A., Enquist, M., & Jansson, F. (2019). A systems approach to cultural evolution. *Palgrave Communications*, *5*(1), 1–15.

Candeias, A. A., & Galindo, E. (2021). Cognitive aging: Why we need creativity to increase cognitive preservation. *Health Psychology Report*, *10*(4), 257–265. https://doi.org/10.5114/hpr.2021.109537

Enquist, M., Ghirlanda, S., & Eriksson, K. (2011). Modelling the evolution and diversity of cumulative culture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1563), 412–423.

Fogarty, L., Creanza, N., & Feldman, M. W. (2015). Cultural evolutionary perspectives on creativity and human innovation. *Trends in Ecology & Evolution*, *30*(12), 736–754.

Gabora, L. (1998). Autocatalytic closure in a cognitive system: A tentative scenario for the origin of culture. *Psycoloquy*, *9*(67).

Gabora, L. (2004). Ideas are not replicators but minds are. *Biology & Philosophy*, *19*(1), 127–143.

Gabora, L. (2008). Modeling cultural dynamics. *Proceedings of the Association for the Advancement of Artificial Intelligence (AAAI) Fall Symposium 1: Adaptive Agents in a Cultural Context* (pp. 18-25). Menlo Park, CA: AAAI Press.

Gabora, L. (2011). Five clarifications about cultural evolution. *Journal of Cognition and Culture*, *11*, 61–83.

Gabora, L. (2024). How does culture evolve? In M. Gelfand, C. Chiu, & Y. Hong (Eds.), *10th Volume of the annual series on advances in culture and psychology* (pp. 1–52). Oxford University Press.

Gabora, L., Beckage, N., & Steel, M. (2022). An autocatalytic network model of conceptual change. *Topics in Cognitive Science*, *14*(1), 163–188. https://doi.org/10.1111/tops.12583

Gabora, L., & Robertson, C. (2025). Nature, nurture, and nous: The role of reflection and reason in the nature-nurture debate. In J. Pérez-Jara, & Í. Ongay (Eds.), *Overcoming the nature versus nurture debate: New and old perspectives on human multidimensionality*. Springer Synthese.

Gabora, L., & Steel, M. (2017). Autocatalytic networks in cognition and the origin of culture. *Journal of Theoretical Biology*, *431*, 87–95.

Gabora, L., & Steel, M. (2020a). Modeling a cognitive transition at the origin of cultural evolution using autocatalytic networks. *Cognitive Science*, *44*(9), e12878. https://doi.org/10.1111/cogs.12878

Gabora, L., & Steel, M. (2020b). A model of the transition to behavioral and cognitive modernity using reflexively autocatalytic networks. *Journal of the Royal Society Interface*, *17*(171), 1720200545. http://doi.org/10.1098/rsif.2020.0545

Gabora, L., & Smith, C. (2019). Exploring the psychological basis for transitions in the archaeological record. In T. Henley, E. Kardas, & M. Rossano (Eds.), *Handbook of cognitive archaeology: A psychological framework* (pp. 218–239). Routledge/Taylor & Francis. https://doi.org/10.4324/9780429488818

Gigerenzer, G. (2023). *The intelligence of intuition*. Cambridge University Press.

Smith, C., Gabora, L., & Gardner-O'Kearny, W. (2018). The extended evolutionary synthesis facilitates evolutionary models of culture change. *Cliodynamics: The Journal of Quantitative History and Cultural Evolution*, *9*(2), 84–107.

Ross, S. D., Lachmann, T., Jaarsveld, S., Riedel-Heller, S. G., & Rodriguez, F. S. (2023). Creativity across the lifespan: Changes with age and with dementia. *BMC Geriatrics*, *23*(160). https://doi.org/10.1186/s12877-023-03825-1

Stella, M., Beckage, N., & Brede, M. (2017). Multiplex lexical networks reveal patterns in early word acquisition in children. *Scientific Reports*, *7*, Article ID 46730.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Children's natural curiosity, playfulness, sociability, and future orientation as forces for cultural adaptation and innovation

Peter Gray*

Dept. of Psychology, Boston College, Chestnut Hill, MA, USA
grayp@bc.edu
https://www.petergray.org/

*Corresponding author.

doi:10.1017/S0140525X25101994, e234

Abstract

Children's natural curiosity, playfulness, sociability, and future orientation predispose them for cultural adaptation. I exemplify this with Sugata Mitra's "hole in the wall experiment," adolescents' role in the computer revolution, and the likely role of play in children's development of Nicaraguan Sign Language; and I give an example of juvenile play resulting in cultural innovation in Macaques.

Kudos to Sheina Lew-Levy and Dorsa Amir for bringing overdue attention to children's role in cultural adaptation. My intent here is to link their thesis to four human drives or dispositions that are generally stronger in children than adults. These are: (1) *curiosity*, the drive to understand the world around one; (2) *playfulness*, the drive to behave creatively with the artifacts, routines, and ideas in one's physical and social world; (3) *sociability,* the drive to associate with and thereby learn from others, especially peers; and (4) *future-orientation*, the special interest afforded to material and social changes likely to impact future ways of living. From an evolutionary perspective, these characteristics are strongest in children because they are how children make sense of and adapt to the world into which they are born and the evolving world with which they must deal as they grow into adulthood (Gray, 2016). These characteristics of children are implicit in the target article. I just want to make them explicit and elaborate with examples.

Lew-Levy and Amir aptly discuss children's role in the digital technology revolution. Research as well as common observation reveals that when computers and the Internet first came into homes in the 1990s, teenagers were generally the first to learn how to use them (Lenhart & Madden, 2005). In most homes with teenagers, the teens quickly became the family computer gurus who helped their parents solve computer problems (Kiesler et al., 2000). Teens also – motivated by playfulness, sociability, and curiosity – expanded the possibilities of this new technology for games, connecting with friends, and finding information. Their future orientation no doubt played a role as they likely knew, at some level, that computers would be an ever-more-essential tool of their future. The older generation might wish to hang on to the past, but not the younger generation. Throughout history, whenever a revolutionary new technology appears, kids glom on to it while many of the older generation are suspicious of it (Springhall, 1998).

An excellent example of how these four innate characteristics combine in children's innovative learning lies in Sugata Mitra's classic "hole in the wall experiment." In 1999, Mitra, who was the science director of an educational technology firm in India, installed a computer in a hole in the outside wall of the building where he worked, a wall facing one of the poorest slums in New Delhi, where most children were at that time unschooled, illiterate, and had never previously seen a computer. He simply turned the computer on, left it there, and told the children who gathered that they could play with it. His famous observation was that groups of children, mostly age 7 to 13, crowded around the computer, quickly learned to use its basic functions, and within days were using it for such purposes as playing games, playing music, painting with a paint program, and finding information (Mitra, 2003).

Here is how I have explained Mitra's observation with reference to the four innate characteristics (Gray, 2013). *Curiosity* drew the children to the computer and motivated them to explore its functions. *Playfulness* motivated them to play with those functions, once discovered, and thereby learn to use them skillfully and creatively. *Sociability* allowed each child's learning about the computer's functions to spread like wildfire to dozens of other children who crowded around and played collectively. And I suspect, *future orientation,* coupled with at least a vague notion that this thing would be a tool of the future, helped motivate their continued interest.

Lew-Levy and Amir also describe the invention of Nicaraguan Sign Language by deaf children who had been brought together in a school for the deaf, where they were taught lip-reading in Spanish, not a sign language. The sign language emerged over time, involving successive overlapping cohorts of students, through their natural interactions with one another outside of the classroom. Although the social contexts for this development are not described by those who documented the emerging language, it seems likely that much of it would have occurred on the playground. Children are highly motivated to play with one another, and social play requires almost continuous communication to coordinate the activities. Even if they could lip read, mouthing words and reading lips is too slow, cumbersome, and private to be effective in group play. To read lips, you must be face to face. One can imagine that, at first, children used a few simple signs to indicate their intentions and reactions, and over time they added to these, and, with more time, a grammar emerged. Relevant to this argument is a research study revealing that the language used by preschoolers in the context of social play was far more complex and profuse than the language the same children used in classroom discussions with their teacher or when sitting around a table eating lunch (Fekonja, Marjanovic-Umek, & Kranjc, 2005).

Finally, it seems worth mentioning that the limited cultural innovations observed in non-human primates appear to originate most often, if not always, in juveniles' play. An example is that of shore-living macaques that acquired the ability to crack open shellfish by smashing them with rocks (Tan, 2017). Young macaques were often observed playfully smashing rocks together, apparently just to enjoy the sounds. At some point, this behavior evolved from smashing rocks against rocks for fun to smashing rocks against clams for food. Nobody saw the transition, but the first instance almost certainly was carried out by a juvenile, as no adults had been observed playing with rocks. This new means of acquiring food quickly spread among the juveniles and was not

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

mimicked by the adults. Only when these juveniles became adults did the behavior become part of the adult food-acquisition repertoire, and then it was subsequently learned by their young through imitation. A study of how many human technological innovations came about originally for fun in children's play, to be refined later for practical purposes, would be fascinating.

Financial support. The author received no funding for this work.

Competing interests. The author declares no competing interests.

References

Fekonja, U., Marjanovic-Umek, L., & Kranjc, S. (2005). Free play and other daily preschool activities as a context for child's language development. *Studia Psychologica*, *47*, 103–116.

Gray, P. (2013). *Free to learn: Why unleashing the instinct to play will make our children happier, more self-reliant, and better students for life*. Basic Books.

Gray, P. (2016). Mother nature's pedagogy: How children educate themselves. In H. Lees, & N. Noddings (Eds.), *Palgrave international handbook of alternative education* (pp. 49–62). Palgrave.

Kiesler, S., Zdaniuk, B., Lundmark, V., & Kraut, R. (2000). Troubles with the internet: The dynamics of help at home. *Human-Computer Interaction*, *15*, 323–351.

Lenhart, A. & Madden, M. (2005). Teens and technology. Pew Research Center report, July 27, 2005. https://www.pewresearch.org/internet/2005/07/27/teens-and-technology/ (accessed April 23, 2025).

Mitra, S. (2003). Minimally invasive education: A progress report on the 'hole-in-the-wall' experiments. *British Journal of Educational Technology*, *34*, 267–371.

Springhall, J. (1998), *Youth, popular culture, and moral panic: Penny gaffs to gangsta-rap, 1830-1996*. St. Martin's Press.

Tan, A.W.Y. (2017). From play to proficiency: The ontogeny of stone-tool use in coastal-foraging long-tailed macaques (*Macaca fascicularis*) from a comparative perception-action perspective. *Journal of Comparative Psychology*, *131*, 89–141.

Both social change and child development play a role in the cultural capacity to innovate

Patricia M. Greenfield*

Department of Psychology, University of California, Los Angeles, USA
greenfield@psych.ucla.edu

*Corresponding author.

doi:10.1017/S0140525X25101866, e235

Abstract

Innovation does not occur in all environments. Rather, it is a cultural product of particular socioecological conditions, for example, schooling and commercial activity. Tool innovation is a product of cognitive development. It requires a developmental process that enables concrete cognition around age eight and abstract cognition in the teenage years. These conclusions arise from long-term study of textile production in a Maya community.

Congratulations to authors Sheina Lew-Levy and Dorsa Amir for calling attention with masterful scholarship to an important issue in cultural evolution: the active role of the youngest generation in helping populations adapt to changing ecological and social conditions. Lew-Levy and Amir focus on cultural products, including a case study (Section 6.2) from our long-term investigation of the cultural evolution of woven and embroidered textiles in Nabenchauk, a Maya community in Chiapas, Mexico. In this commentary, I maintain the focus on cultural products, drawing out new implications of our long-term research for one topic in the target article: Children as innovators.

Innovation is not always valued

My most basic point is that innovation itself is culturally variable. Innovation is not valued in every environment and can even be considered a negative in some ecologies and value systems. The target article in contrast assumes that innovation is a key to human evolution and therefore implicitly assumes its universal positive valence. However, I have evidence to the contrary. During observations of the subsistence period of my study community (1969 and 1970), "the Tzotzil" term "different" (tos'o), when applied to textiles (as to life in general) was a term of opprobrium. To be "different" was to be "bad." (Greenfield, 2004, p. 171). The connotation was "something like 'deviating from a norm'" (Greenfield, 2004, p.153). In other words, innovation was not positively valued; conforming to community norms was.

Socioecological shifts over historical time: innovation acquires cultural value

Community shifts from subsistence to commerce changed innovation's valence from negative to positive. In 1992, teenager Lupa Z'us proudly told me that the blouse she had selected as her best embroidery was *tos'o* (different) (Greenfield, 2004). Her embroidered blouse (Figure 1) was an innovative postmodern textile, integrating and transforming multiple pattern sources: printed patterns from Mexico City, the traditional zig-zag mountain pattern, and a design Lupa had seen on a woven poncho. My theoretical and empirical analysis indicated that new commercial activities in the village – including textile commerce – had brought with them a role for innovation (Greenfield, 2000, 2009). Creating something "different" had shifted over historical time to become a valued skill in the new entrepreneurial world. Not only commerce but also schooling, both elements in the socioecological syndrome of *Gesellschaft* (Tönnies, 1957) were factors in the development of innovative techniques.

Innovation reflects both cultural evolution and human development

By 1993, with a commercial economy in full swing, girls in Nabenchauk, from age 8 or 9 years through older teenagers, were innovating techniques to create textile designs. However, this social change was expressed developmentally. My exploration of textile design in Nabenchauk revealed age-graded stages in the development of new technical tools for creating innovative textile designs. Younger girls were creating simpler techniques, such as cutouts that could then be transferred to textiles and embroidered (Figure 2); older girls were creating more complex techniques and

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Figure 1 (Greenfield). Blouse made by Lupa Z'us in 1992, with the three printed patterns used to create it. Photograph by Don Cole.

Figure 2 (Greenfield). A girl draws designs to use for embroidery as her sister looks on. Designs that have already been drawn and cut out lie on the ground. Nabenchauk, 1991. © Lauren Greenfield.

tools. It is interesting that experimental evidence from the W.E.I.R.D. world, summarized in the target article, agrees with real-world textile design in Nabenchauk that 8-year-old is the minimum age for creating new tools.

However, the environment of 8-year-old had also changed in Nabenchauk. The girls in Figure 2 were attending school. In the photo, they are using pen and paper skills learned in school (Figure 3) to innovate designs that will be embroidered on textiles such as *servilletas* (placemats/tortilla covers) to sell to outsiders (Greenfield, 2004).

In terms of developmental change, older teenagers in the 1990s were inventing more complex design tools such as pulled threads to make columns (Figure 4) or grids (Figure 5) to guide the embroidery process. Their design tools were also more abstract than those of the younger girls. For example, see Figure 6, which shows a 14-year-old's color planning system; she laid out yarn balls

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

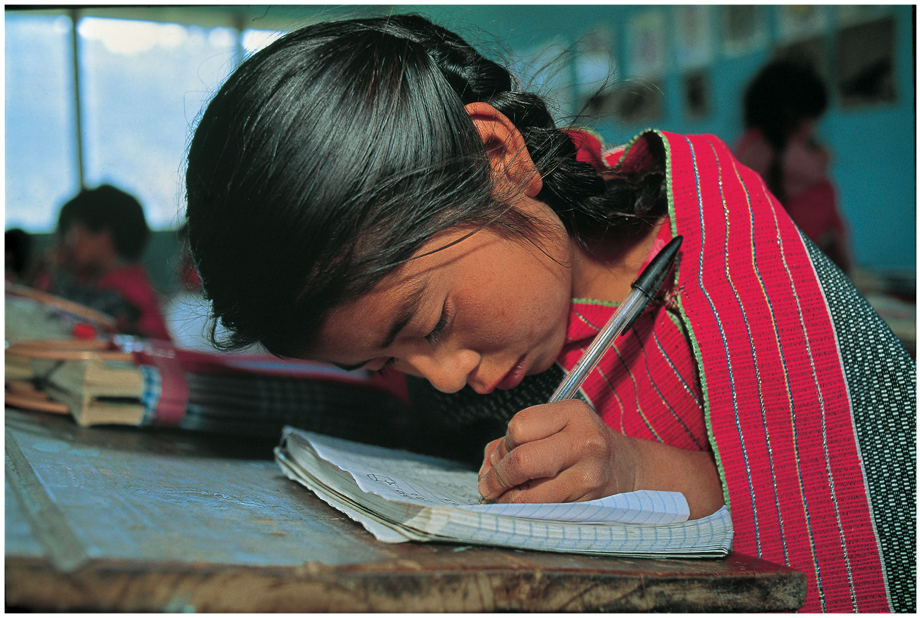

Figure 3 (Greenfield). The same girl shown drawing in Figure 2 writes in her notebook at school. Nabenchauk, 1991. © Lauren Greenfield.

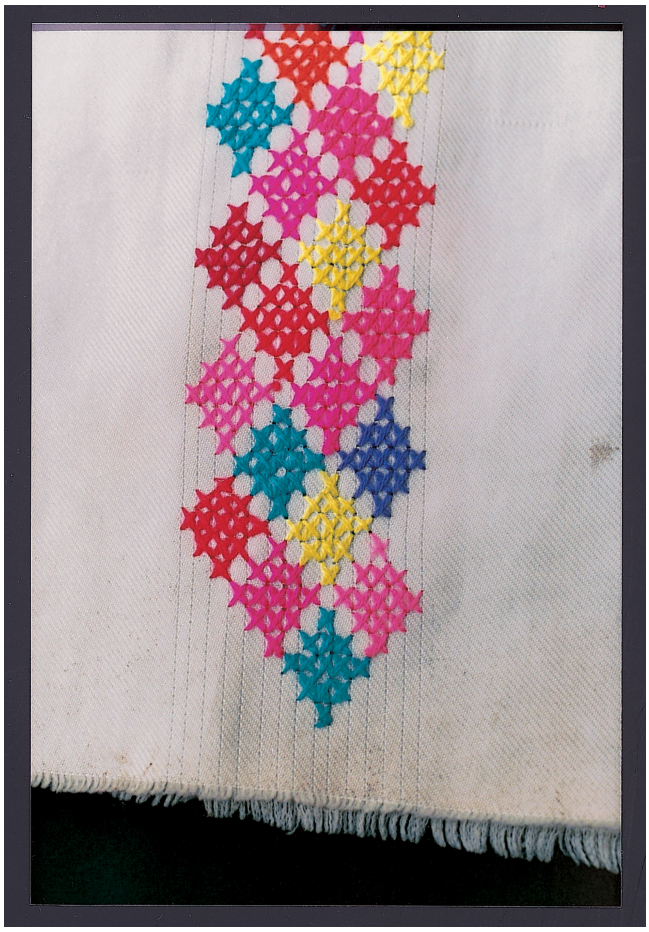

Figure 4 (Greenfield). Pulled threads in evenly spaced, parallel lines guide geometric embroidery. Detail from a blouse by Maruch 205. Nabenchauk, 1993. Photograph by Patricia Greenfield.

of different colors to indicate embroidery color for different areas in the design. Figure 7 shows another color planning system: a 15-year-old is sewing short threads of various colors into the drawn design to indicate areas where embroidery of each color will be placed (Greenfield, 2004). All these techniques are more abstract than the younger girls' techniques – in the sense that they do not replicate the design directly through iconic representation (images) but provided representations that are more distal from the finished design. I believe it is significant that these more abstract color planning systems were created by girls who are not only older, but also have been to school, the 14-year-old for 2 years, and the 15-year-old for 6 years. In contrast, the girls who used the less abstract pulled-thread techniques had no school experience.

Studying innovation experimentally

Dealing with novelty is one facet of innovation; this facet was incorporated into an intergenerational study of pattern representation. In this cognitive experiment, children of different ages were asked to place colored sticks in a frame in order to continue novel striped patterns (patterns not seen in their village environment) begun by the experimenter (Figure 8). Skill in representing novel patterns increased with age; age was the largest single causal factor (Greenfield et al., 2003).

However, environmental factors were also implicated. My theory predicts that the locus of greatest social change in the Gesellschaft direction should be the factor driving improved skill with novel patterns. Between Generation 1 and Generation 2, the major social change was the development of a commercial economy. Statistical modeling confirmed that, between Generation 1 and Generation 2, this was the change that improved performance in representing novel patterns. Between Generation 2 and Generation 3, completing elementary school was the major social change. Statistical modeling confirmed that, between Generation 2 and Generation 3, this was the change that improved performance

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Figure 5 (Greenfield). Pulled threads in two dimensions on a white background cloth form a grid that aids in the design process. This example is by Paxku 136. The pulled threads from a grid that is analogous to printed cross-stitch embroidery patterns. Nabenchauk, 1993. Photograph by Patricia Greenfield.

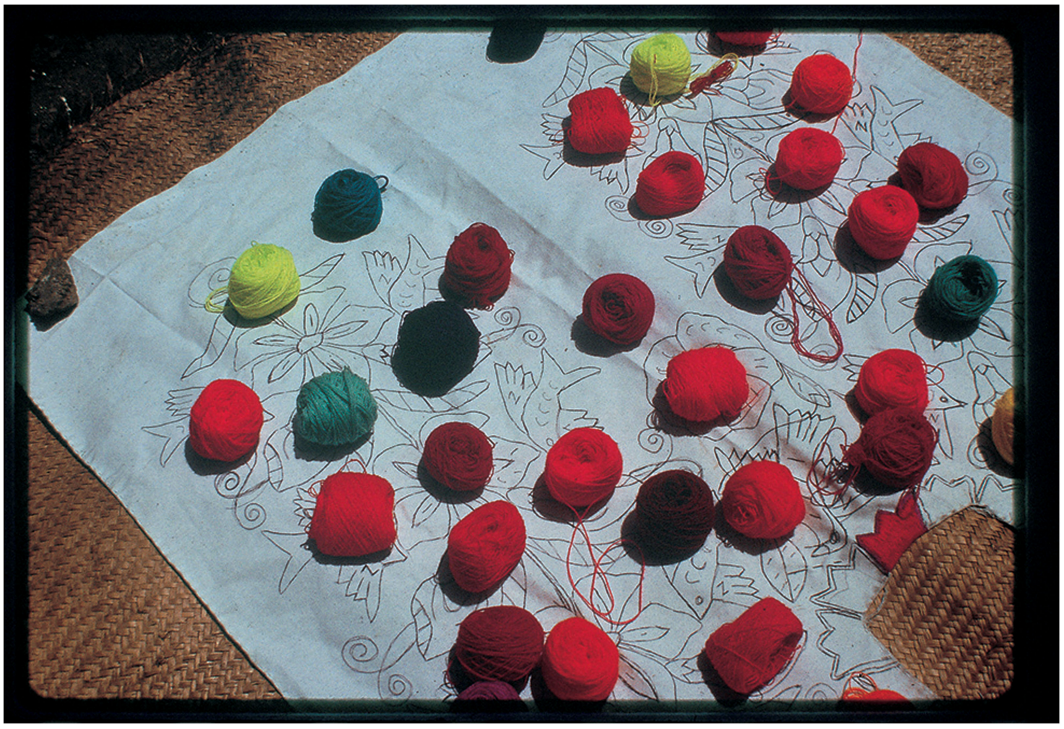

Figure 6 (Greenfield). Xunka 3's color planning system involving balls of colored thread placed on parts of the design. Nabenchauk, 1991. Photograph by Patricia Greenfield.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Figure 7 (Greenfield). X 201's color planning system in which she sewed bits of colored thread onto the design. Nabenchauk, 1993. Photograph by Patricia Greenfield.

Figure 8 (Greenfield). Paxku' Pavlu studies a culturally novel green-and-yellow striped pattern that Carla Childs, the experimenter, has started for her to continue. Nabenchauk, 1991. © Copyright Lauren Greenfield.

in representing novel patterns (Maynard et al., 2015). Hence, theoretically based predictions were confirmed.

Conclusion

Innovation does not occur in all environments. Rather, it is a cultural product of particular socioecological conditions, for example, schooling and commercial activity. Nor is innovation a constant across stages of human development. Tool innovation requires cognitive development that enables concrete cognition around 8 years of age and abstract cognition in the teenage years.

Acknowledgments. None.

Financial support. This commentary received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. None

References

Greenfield, P. M. (2004). *Weaving generations together: Evolving creativity in the Maya of Chiapas*. Santa Fe, NM: SAR Press.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Greenfield, P. M. (2009). Linking social change and developmental change: Shifting pathways of human development. *Developmental Psychology*, *45*, 401–418. Translated into French by B. Troadec: Variabilité du developpement humain: Relier le changement social et le changement individual. In B. Troadec (Ed.), *Psychologies et cultures* (Pp. 63–119). Paris: L'Harmattan.

Greenfield, P. M., Maynard, A. E., & Childs, C. P. (2000). History, culture, learning, and development. *Cross-Cultural Research*, *34,* 351–374.

Greenfield, P. M., Maynard, A. E., & Childs, C. P. (2003). Historical change, cultural learning, and cognitive representation in Zinacantec Maya children. *Cognitive Development*, 18, 455–487.

Maynard, A. E., Greenfield, P. M., & Childs, C. P. (2015). Developmental effects of economic and educational change: Cognitive representation across 43 years in a Maya community. *International Journal of Psychology*, *50,* 12–19.

Tönnies, F. (1957). *Community and society* (C. P. Loomis, Ed. & Trans.). Michigan State University Press. (Original work published 1887)

Young children do not change language

Vera Kempe[a], Damián Blasi[b] and Limor Raviv[c,d]*

[a]Abertay University, Dundee, UK; [b]Catalan Institute for Research and Advanced Studies, Barcelona, Spain; [c]Language Evolution and Adaptation in Diverse Situations (LEADS) group, Max-Planck-Institute of Psycholinguistics, Nijmegen, The Netherlands and [d]Donders Centre for Cognition (DCC), Faculty of Social Sciences, Radboud University, Nijmegen, The Netherlands
v.kempe@abertay.ac.uk
damianblasi@gmail.com
limor.raviv@mail.huji.ac.il
https://www.limorravivevolang.com

*Corresponding author.

doi:10.1017/S0140525X25101891, e236

Abstract

Language differs from other cultural domains in its high degree of normativity and conventionality; hence, many linguistic innovations by young children are considered acquisition errors that do not diffuse into language communities. Moreover, young children's cognitive-pragmatic limitations hinder their ability to introduce structure into novel communication systems. Consequently, children are unlikely agents of language change or drivers of language emergence.

Lew-Levy and Amir argue that children's peer cultures play an important role as drivers of innovation in cultural transmission. We examine how this proposal aligns with evidence about children's role (or lack thereof) in the cultural transmission of language – arguably the most prominent human trait. While LL&A reference language in support of their proposal, we argue that current evidence for children's role in language change is less compelling. Unlike other cultural practices discussed by LL&A, language presents a unique challenge for young children to exert influence on the wider community, thus making them unlikely agents of change. Moreover, in the context of novel communication systems, adopting, maintaining, and spreading structured and meaningful linguistic innovations through peer interaction requires cognitive and pragmatic maturity that young children in their first decade of life do not yet possess. These limitations may also have restricted the role of young children's peer culture in language emergence.

Crucially, language differs from other cultural traits in its high degree of normativity and conventionalization, which renders most input-divergent variation produced by child learners **errors** rather than innovations that offer functional – and therefore adaptive – solutions for communication. Such errors are well documented in the domains of phonology (e.g., introduction of new phonetic variants, see Dodd et al., 2003), morpho-syntax (e.g., regularization and reinterpretation of grammatical structures, see Hudson-Kam & Newport, 2005), and the lexicon (e.g., over-extensions and colexification, see Brochhagen et al., 2023). While some suggest that these acquisition errors can affect language change (Cournane, 2019), language development research shows that children typically recover from these errors before participating in vertical transmission as adults (Ambridge et al., 2015). Moreover, social learning biases such as the prestige and frequency bias (Henrich et al., 2001) do not favor children as models, and therefore make the adoption of children's acquisition errors by the broader community highly unlikely. While we cannot exclude the possibility that children had greater prominence and social standing in preagricultural hunter-gatherer societies, there is currently no evidence to suggest that the acquisition errors of individual children propagate through wider linguistic communities.

In fairness, LL&A do not claim that *individual* children are agents of cultural adaptation and transmission, but rather that children's innovations may propagate once they gain social or functional significance within their peer groups. For peer groups of older children and adolescents, this claim is well supported by sociolinguistic evidence: when linguistic variation (e.g., phonological shifts, morpho-syntactic innovations, or neologisms) acquires social or functional significance, it can trigger vernacular change (Kerswill, 1996). Examples of adolescent vernacular change include the adoption of copula deletion (e.g., *"He tall"),* negative concord (e.g., *"I don't know nothing"),* or quotative *be like* (e.g., *"She's like 'Oh!'")* (Labov, 1972; Martínez, 2011; Tagliamonte & D'Arcy, 2004). Such adolescent innovations carry sufficient social prestige and group relevance to be subsequently adopted by younger children (Tagliamonte & D'Arcy, 2009). This transmission pathway aligns with cross-cultural observations showing that – as LL&A point out – in many societies, children receive most linguistic input from other children, predominantly older siblings (Cristia et al., 2019). Some adolescent linguistic innovations are also adopted by adults, albeit to a more limited extent (Buchstaller, 2015; Tagliamonte & D'Arcy, 2009).

However, for younger children (i.e., 3–10-year-olds), there is no evidence that the ubiquitous phonological, morpho-syntactic, and lexical variation characteristic of their acquisition errors would be adopted by peer groups and diffuse from there into the wider community. Even though young children engage in improvised language play as an in-group affiliation device (Cekaite, 2018), we are not aware of observations of these transient forms of language use spreading to wider peer groups, including older children. The lack of knowledge about what linguistic innovations are taken up by peer interactions of young children may be a consequence of the fact that the study of children's acquisition errors has focussed primarily on infants' and young children's communication with adult caregivers. This focus is facilitated by long-standing data collection efforts centered around the TalkBank repository, including the CHILDES database (MacWhinney, 2025). As a

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

result, it is unclear whether acquisition errors such as linguistic regularizations, overgeneralizations, and mispronunciations (e.g., **goed* for *went*) are adopted by younger peer groups. However, even if they were, there is no evidence that such errors spread further into the community.

LL&A also invoke the argument that children can introduce systematic structure when linguistic systems emerge *de novo*, a claim that has been made for creoles (Bickerton, 1984), emerging sign languages (Senghas & Coppola, 2001), and artificial gestural systems (Bohn, Kachel, & Tomasello, 2019). Thus, even if children do not contribute to change in established languages, they might drive the emergence of new ones (Senghas, 2021). However, adults are more likely agents of creolization (Arends & Bruyn, 1994; Roberts, 1995) and work on Nicaraguan Sign Language (Senghas, Kita, & Ozyurek, 2004) cannot disentangle whether structural innovations are specific to children or are attributable to a later position in an iterated learning chain (Kirby, Cornish, & Smith, 2008). In fact, young children find it difficult to avoid ambiguity and are much less likely than adults to introduce meaningful structure into novel communication systems (Kempe et al., 2019; Raviv & Arnon, 2018). These difficulties are partly due to children's pragmatic limitations arising from an immature Theory of Mind, required to invent motivated signs, and partly due to their limited cognitive capacity, required to scan the semiotic affordances of referential domains and monitor alignment with an interlocutor. Young children require adult scaffolding (Matthews, Lieven, & Tomasello, 2007) to reach communicative efficiency and do not achieve effective peer communication up until 10–11 years of age (Garrod & Clark, 1993; Girbau, 2001). Even though children can produce gestural innovations when communicating about familiar meanings (Bohn et al., 2019), this ability improves with age, and there is no evidence that their innovations have greater functionality than those of adults.

Taken together, we argue that language is likely a special case: linguistic variation in the form of acquisition errors does not spread to the wider community, making young children unlikely agents of language change. Moreover, children's pragmatic and cognitive limitations constrain their role in language emergence.

Financial support. The authors received no funding for the writing of this commentary.

Competing interests. The authors declare no competing interests.

References

Ambridge, B., Bidgood, A., Twomey, K. E., Pine, J. M., Rowland, C. F., & Freudenthal, D. (2015). Preemption versus entrenchment: Towards a construction-general solution to the problem of the retreat from verb argument structure overgeneralization. *PloS One*, *10*(4), e0123723.

Arends, J., & Bruyn, A. (1994). 10. Gradualist and developmental hypotheses. In *Pidgins and Creoles* (pp. 111–120). John Benjamins.

Bickerton, D. (1984). The language bioprogram hypothesis. *Behavioral and Brain Sciences*, *7*(02), 173–188.

Bohn, M., Kachel, G., & Tomasello, M. (2019). Young children spontaneously recreate core properties of language in a new modality. *Proceedings of the National Academy of Sciences*, *116*(51), 26072–26077.

Brochhagen, T., Boleda, G., Gualdoni, E., & Xu, Y. (2023). From language development to language evolution: A unified view of human lexical creativity. *Science*, *381*(6656), 431–436.

Buchstaller, I. (2015). Exploring linguistic malleability across the life span: Age-specific patterns in quotative use. *Language in Society*, *44*(4), 457–496.

Cekaite, A. (2018). Microgenesis of language creativity: Innovation, conformity and incongruence in children's language play. *Language Sciences*, *65*, 26–36.

Cournane, A. (2019). A developmental view on incrementation in language change. *Theoretical Linguistics*, *45*(3–4), 127–150.

Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (2019). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development*, *90*(3), 759–773.

Dodd, B., Holm, A., Hua, Z., & Crosbie, S. (2003). Phonological development: A normative study of British English-speaking children. *Clinical Linguistics & Phonetics*, *17*(8), 617–643.

Garrod, S., & Clark, A. (1993). The development of dialogue coordination skills in school children. *Language and Cognitive Processes*, *8*(1), 101–126.

Girbau, D. (2001). Children's referential communication failure: The ambiguity and abbreviation of message. *Journal of Language and Social Psychology*, *20*(1–2), 81–89.

Henrich, J. (2001). Cultural transmission and the diffusion of innovations: Adoption dynamics indicate that biased cultural transmission is the predominate force in behavioral change. *American Anthropologist*, *103*(4), 992–1013.

Hudson Kam, C. L., & Newport, E. L. (2005). Regularizing unpredictable variation: The roles of adult and child learners in language formation and change. *Language Learning and Development*, *1*(2), 151–195.

Kempe, V., Gauvrit, N., Gibson, A., & Jamieson, M. (2019). Adults are more efficient in creating and transmitting novel signalling systems than children. *Journal of Language Evolution*, *4*(1), 44–70.

Kerswill, P. (1996). Children, adolescents, and language change. *Language Variation and Change*, *8*(2), 177–202.

Kirby, S., Cornish, H., & Smith, K. (2008). Cumulative cultural evolution in the laboratory: An experimental approach to the origins of structure in human language. *Proceedings of the National Academy of Sciences*, *105*(31), 10681–10686.

Labov, W. (1972). Negative attraction and negative concord in english grammar. *Language*, *48*(4), 773–818.

Lew-Levy, S., Milks, A., Kiabiya Ntamboudila, F., Broesch, T., & Kline, M. A. (2021). BaYaka Adolescent Boys Nominate Accessible Adult Men as Preferred Spear Hunting Models. *Current Anthropology*, *62*(5), 631–640.

MacWhinney, B. (2025). Understanding language through talkbank. *Current Directions in Psychological Science*.

Martínez, I. M. P. (2011). The Language of British Teenagers. A Preliminary Study of its Main Grammatical Features / El lenguaje de los jóvenes británicos. Estudio preliminar de los rasgos gramaticales de mayor relevancia. *Atlantis*, *33*(1), 105–126.

Matthews, D., Lieven, E., & Tomasello, M. (2007). How toddlers and preschoolers learn to uniquely identify referents for others: A training study. *Child Development*, *78*(6), 1744–1759.

Raviv, L., & Arnon, I. (2018). Systematicity, but not compositionality: Examining the emergence of linguistic structure in children and adults using iterated learning. *Cognition*, *181*, 160–173.

Roberts, J. M. (1995). Pidgin Hawaiian: A Sociohistorical Study. *Journal of Pidgin and Creole Languages*, *10*(1), 1–56.

Senghas, A. (2021). Connecting language acquisition and language evolution: Clues from the emergence of Nicaraguan Sign Language. In *Minnesota symposia on child psychology: Human communication: Origins, mechanisms, and functions* (Vol. *40*, pp. 57–85). Hoboken, NJ, USA: John Wiley & Sons, Inc.

Senghas, A., & Coppola, M. (2001). Children creating language: How Nicaraguan Sign Language acquired a spatial grammar. *Psychological Science*, *12*(4), 323–328.

Senghas, A., Kita, S., & Ozyurek, A. (2004). Children creating core properties of language: Evidence from an emerging sign language in Nicaragua. *Science*, *305*(5691), 1779–1782.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Tagliamonte, S., & D'Arcy, A. (2004). He's like, she's like: The quotative system in Canadian youth. *Journal of Sociolinguistics*, *8*(4), 493–514.
Tagliamonte, S. A., & D'arcy, A. (2009). Peaks beyond phonology: Adolescence, incrementation, and language change. *Language*, *85*(1), 58–108.

Hidden cultures: How parental control shapes children's cultural adaptation in East Asian societies

Xiaoxue Kong[a] and Xuechen Ding[b]*

[a]Department of Psychology, University of Northern British Columbia, Prince George, Canada and [b]School of Psychology, Shanghai Normal University, Shanghai, China
xiaoxue.kong@unbc.ca
dingxuechen@shnu.edu.cn
https://www.unbc.ca/people/kong-dr-xiaoxue-sonia
https://teacher.shnu.edu.cn/psy/dxc/list.htm

*Corresponding author.

doi:10.1017/S0140525X25102057, e237

Abstract

Lew-Levy and Amir highlight children as agents of cultural adaptation and widespread presence of peer cultures across populations, but their account underestimates peer culture in East Asian societies. Drawing on East Asian contexts, we show how strict family, school, and social structures lead peer culture to take on more covert forms, underscoring the need for broader cross-cultural perspectives.

Lew-Levy and Amir present an important perspective that children are cultural creators and maintainers, playing a crucial role in cultural transmission, innovation, and adaptation. However, we believe that their account has some gaps regarding how peer cultures vary across different contexts that we would like to address and expand upon.

This target article described several cases to support how children create and sustain unique cultures through peer interactions. However, those cases are almost exclusively drawn from small-scale, underdeveloped tribes or regions. In these settings, children are receiving relatively less supervision and control, allowing them greater autonomy to explore and organize their own activities and, in turn, develop peer cultures. This article does not fully explain the formation and maintenance of peer cultures in East Asian cultural societies, where parents have a high level of control, supervision, and involvement in children's lives (Pomerantz & Wang, 2009).

The target article briefly mentions that children in post-industrial Western countries are gradually losing opportunities to access spaces outside adult supervision, thereby reducing their ability to independently choose social partners (Singer et al., 2009). A similar yet distinct situation exists in East Asian societies, where strict family, school, and social order are emphasized (Rozman, 2014). This raises an important question: does the dual control system of family and school in East Asian cultures further impact children's ability to independently create culture and develop peer cultures?

In high-control societies, such as China, Japan, and South Korea, children's daily lives are highly structured, with little unsupervised time for organic peer culture development (Pomerantz & Wang, 2009). East Asian cultures are largely influenced by Confucian traditions, which emphasize obedience and conformity within families and schools (Sung, 2010). This cultural emphasis on family relationships, intergenerational transmission, and social status results in a socialization process where children's behavior, friendships, and cultural exposure are closely monitored by adults (Chen et al., 1999; Xiong et al., 2020), potentially limiting children's ability to independently create culture and develop peer cultures (Rozman, 2014). For example, children's extracurricular activities and social interactions are often strictly guided by parents (Hu & Mu, 2020), and heavy academic workloads leave children with limited time for free exploration, leading to the predominance of "adult-directed children's culture" rather than spontaneous peer cultures (Dunne et al., 2010). This raises the following question: can peer cultures exist in societies where autonomy is suppressed, and if so, how do they manifest?

In such an environment, even if children develop certain forms of culture and peer cultures, these cultures tend to be more covert. Examples include the use of "Lou Go (ルー語, code switching)" in Japanese schools, and "shadow social circles" amongst South Korean students. These cultural phenomena are often unrecognized or unnoticed by adults (Kim, 2016; Winch, 2015). As a result, East Asian children are likely to shift their cultural interactions online to avoid excessive adult interference (Farrall, 2012). These examples suggest that even in highly controlled environments, children find ways to create and transmit peer-specific knowledge, albeit in ways that differ from the largely autonomous peer cultures described in the target article.

Another significant adaptation of peer culture in East Asian high-control societies is its strategic shift to digital spaces. In contexts where children's offline autonomy is limited by intense parental and school control, online environments have become not just platforms for socialization, but they function as culturally significant refuges where peer culture can survive, adapt, and thrive (Farrall, 2012; Zhu et al., 2024). Unlike children in small-scale societies who develop independent play cultures in physical settings, East Asian children increasingly rely on digital platforms to circumvent adult supervision and sustain peer solidarity (Manago & McKenzie, 2022; Tang et al., 2021; Yamada et al., 2021). For example, China's Generation Z articulates emotional fatigue through "Sang Culture" on social media, fostering both individual release and collective belonging (Yang et al., 2024). Digital spaces, including gaming communities, social media, and messaging apps (e.g., QQ, WeChat, LINE), serve as virtual playgrounds, enabling the creation, circulation, and evolution of peer-driven cultural forms (Lee et al., 2016; Steinberg, 2020). Although both parents and schools are making efforts to prohibit students from using smartphones, children still tend to use them secretly to avoid supervision (e.g., Seo & Lee, 2017). Within these tightly networked and often carefully guarded spaces, highly covert forms of peer culture can emerge, often invisible to adult oversight. This systematic relocation of peer culture from public, physical settings into digital domains illustrates how digital peer culture emerges as a cultural adaptation to a highly regulated social environment in

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

East Asia. Ultimately, it demonstrates that peer culture is not absent but instead takes on more covert, negotiated, or digitally mediated forms due to the specific sociocultural constraints on children's autonomy in East Asian societies.

While the target article posits that peer cultures naturally emerge from children's spontaneity and creativity, evidence from East Asian societies complicates this assumption. In contexts such as China, Japan, and South Korea, the formation and function of peer cultures are heavily shaped by intersecting forces of family and school. These cultures emphasize obedience, hierarchy, and academic achievement, which often result in rigid educational structures and intensive adult supervision. Such conditions impose significant constraints on children's autonomy and curtail the development of independent peer cultures. Instead, as discussed above, East Asian children are more likely to develop "adaptive cultures," cultural forms negotiated within and shaped by high levels of adult involvement and social expectation. The target article would benefit from incorporating more cross-cultural research, particularly from high-control societies such as those in East Asia. Such an expansion would offer a more nuanced understanding of how children's cultures are formed, transmitted, and maintained under varying levels of adult regulation. It would also shed light on the ways parental control, social norms, and educational systems constrain or shape children's cultural development.

Financial support. This research was supported by the National Natural Science Foundation of China (32000756).

Competing interests. None.

Reference

Chen, X., Rubin, K. H., Li, B., & Li, D. (1999). Adolescent outcomes of social functioning in Chinese children. *International Journal of Behavioral Development*, *23*(1), 199–223. https://doi.org/10.1080/016502599384071.

Dunne, M. P., Sun, J., Do Nguyen, N., Truc, T. T., Loan, K. X., & Dixon, J. (2010). The influence of educational pressure on the mental health of adolescents in East Asia: methods and tools for research. *Journal of Science Hue University*, *61*, 109–122. https://hueuni.edu.vn/portal/data/doc/tapchi/61_10.pdf.

Farrall, K. (2012). Online collectivism, individualism and anonymity in East Asia. *Surveillance and Society*, *9*(4), 424–440. https://doi.org/10.24908/ss.v9i4.4344

Hu, S., & Mu, Z. (2020). Some time is better spent than other time: Chinese adolescents' time use and developmental outcomes. *Child Indicators Research*, *13*(5), 1739–1765. https://doi.org/10.1007/s12187-020-09718-8

Kim, Y. C. (2016). *Shadow education and the curriculum and culture of schooling in South Korea*. Palgrave Macmillan US.

Lee, J. Y., Park, S., Na, E. Y., & Kim, E. M. (2016). A comparative study on the relationship between social networking site use and social capital among Australian and Korean youth. *Journal of Youth Studies*, *19*(9), 1164–1183. https://doi.org/10.1080/13676261.2016.1145637

Manago, A. M., & McKenzie, J. (2022). Culture and digital media in adolescent development. In J. Nesi, E. H. Telzer & M. J. Prinstein (Eds.), *Handbook of adolescent digital media use and mental health* (pp. 162–187). Cambridge University Press.

Pomerantz, E. M., & Wang, Q. (2009). The role of parental control in children's development in Western and East Asian countries. *Current Directions in Psychological Science*, *18*(5), 285–289. https://doi.org/10.1111/j.1467-8721.2009.01653.x

Rozman, G. (Ed.). (2014). *The East Asian region: Confucian heritage and its modern adaptation*. Princeton University Press.

Seo, H., & Lee, C. S. (2017). Emotion matters: what happens between young children and parents in a touch screen world. *International Journal of Communication*, *11*, 20. https://ijoc.org/index.php/ijoc/article/viewFile/4233/1919

Singer, D. G., Singer, J. L., D'Agnostino, H., & DeLong, R. (2009). Children's pastimes and play in sixteen nations: is free-play declining? *American Journal of Play*, *1*(3), 283–312.

Steinberg, M. (2020). LINE as super app: platformization in East Asia. *Social Media+ Society*, *6*(2), 2056305120933285. https://doi.org/10.1177/2056305120933285

Sung, H. Y. (2010). The influence of culture on parenting practices of East Asian families and emotional intelligence of older adolescents: a qualitative study. *School Psychology International*, *31*(2), 199–214. https://doi.org/10.1177/0143034309352268

Tang, L., Omar, S. Z., Bolong, J., & Mohd Zawawi, J. W. (2021). Social media use among young people in China: a systematic literature review. *Sage Open*, *11*(2), 21582440211016421. https://doi.org/10.1177/21582440211016421

Winch, J. (2015). *Code-switching: A new language in Japan?*. University of Sussex.

Xiong, Y., Qin, L., Wang, M., & Pomerantz, E. M. (2020). Parents' peer restriction in the United States and China: a longitudinal study of early adolescents. *Developmental Psychology*, *56*(9), 1760–1774. https://doi.org/10.1037/dev0001088

Yamada, M., Sekine, M., Tatsuse, T., & Asaka, Y. (2021). Prevalence and associated factors of pathological Internet use and online risky behaviors among Japanese elementary school children. *Journal of Epidemiology*, *31*(10), 537–544. https://doi.org/10.2188/jea.JE20200214

Yang, W., Rahim, N., Hoong, B., & Hassim, N. (2024). Sang culture: social comparisons of generation Z youths in China on social media. *Jurnal Komunikasi: Malaysian Journal of Communication*, *40*(1), 248–266. https://journalarticle.ukm.my/23838/1/komunikasi_14.pdf

Zhu, X., Li, W., Zhao, H., & Hu, J. (2024). Surfing into trouble? How internet use influences early adolescent behavior through diverse pathways?. *Humanities and Social Sciences Communications*, *11*(1), 1413–1417. https://doi.org/10.1057/s41599-024-03956-9

"Street kids and peer culture"

David F. Lancy*

Anthropology, Utah State University, Logan, USA
David.Lancy@usu.edu

*Corresponding author.

doi:10.1017/S0140525X25102069, e238

Abstract

This brief commentary offers another source of evidence for the arguments made in the target article. The lives of street kids are usually seen as deplorable, as a social blight that must be eradicated. But ethnographic literature can turn this shibboleth on its head. Scholars like the authors have forced us to see the enormous capacity that autonomous children have for acquiring, transmitting, and creating culture. Street kids provide an excellent illustration of this argument.

The authors make an excellent case for the existence of a distinctive peer culture that is relatively free of adult intervention. They build their case and probe the evolutionary implications of peer culture by drawing on research and theory across disciplines. Throughout the paper, they identify linkages that could be examined in greater depth. They refer to these links as "New Research Avenues." I plan to lay out one such avenue – Street Kids – that can be tied to many of the characteristics of peer culture. For example, the authors

document peer culture as enabled by the great autonomy granted to children in indigenous communities. Peers fulfill many of the parenting responsibilities that WEIRD culture assigns exclusively to adults. Street kids enjoy even greater autonomy from adult control and are reluctant to relinquish it in exchange for the comfort and safety of an orphanage. There are many similarities in the play of street and village kids. As the Opies demonstrated, well-established game rules are altered to suit the situation, giving greater flexibility to innovate and expand the game's utility (Lancy & Grove, 2011). Play takes place in public spaces unsupervised by adults. Children's play and games lead to innovation *and* serve as a repository for many cultural traditions.

"Children as agents of cultural adaptation" is a central theme of this article that could be robustly supported by the literature on street kids. Children in the streets are compelled to "apprentice" themselves to older and/or better-established peers to learn the skills to cope with an ever-changing postindustrial environment. Street kids are often reported as commuters, returning temporarily to rural villages with "modern" artifacts, language, and ideas to pass on.

Another aspect of the culture of street kids that is supportive of the authors' position is the invention of novel words and speech forms developed to separate themselves from adult society as well as from rival "gangs" (Davies, 2008). In addition, street kids, like their village counterparts, claim a recognizable territory for their activities and, consequently, discover resources ignored by adults.

Many of the ethnographic examples cited by the authors describe village children learning subsistence skills in the company of peers. Tasks are distributed among the group by older members in accordance with each child's skill and physical strength. Weisner notes that "children care for other children within indirect chains of support" (1996, 308). In the streets, the youngest children are readily qualified as beggars. Somewhat older children are grouped with other young scavengers or paired with an older boy to learn how to earn tips from guarding parked cars (Lancy, 2010). Older children "graduate to more lucrative means of earning a living . . . forming discrete occupational geographies" (Frankland, 2007). In short, there are close parallels between the foraging parties seen among Hadza children in Tanzania and children's foraging parties in the heart of the city.

Because children are not "held back," they plunge into learning opportunities, leading to a universal precocity, which is certainly seen in street kids. For example, "The best thing that ever happened to me was to become an adult and manage my own life," noted Jorge, age 12 (Kenny, 2007, 63). Aptekar and Stoecklin (2014) have conducted fieldwork with street children in many cities and find that in the absence of parents, siblings do a more than adequate job of caring for their young kin (Lancy, 2022, 570).

In short, there is evidence that children's capacity to acquire, build, and sustain culture is subtly on display in what may seem a very unpromising environment.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. None.

References

Aptekar, L. & Stoecklin, D. (2014). *Street children and homeless youth: A cross-cultural perspective*. Springer.

Davies, M. (2008). A childish culture? Shared understandings, agency and intervention: An anthropological study of street children in Northwest Kenya. *Childhood*, *15*(3), 309–330. https://doi.org/10.1177/0907568208091

Frankland, S. (2007) No money, no life: Surviving on the streets of Kampala. In J. Staples (Ed.), *Livelihoods at the margins: Surviving the city* (pp. 31–51). Left Coast Press.

Kenny, M. L. (2007). *Hidden heads of households: Child labor in urban northeast Brazil*. Broadview.

Lancy, D.F. (2010). Children's learning in new settings. In D.F. Lancy, S. Gaskins, & J. Bock (Eds.), *The anthropology of learning in childhood* (pp. 443–463). Alta-Mira Press.

Lancy, D.F. (2022). *The anthropology of childhood: Cherubs, chattel, changelings* (3rd ed.). Cambridge University Press.

Lancy, D.F. & Grove, M. A. (2011). Marbles and Machiavelli: The role of game play in children's social development. *American Journal of Play*, *3*(4), 489–499. https://www.museumofplay.org/app/uploads/2022/01/3-4-article-lancy-grove-marbles-and-machiavelli.pdf

Weisner, Thomas S. (1996). Why ethnography should be the most important method in the study of human development. In R. Jessor, A. Colby, & R.W. Shweder (Eds.), *Ethnography and human development: Context and meaning in social inquiry* (pp. 305–324). University of Chicago Press.

What's special about peer cultures? The opportunity for disagreement

Antonia F. Langenhoff[a]*, Carolyn Baer[b] and Jamie Amemiya[c]

[a]Stanford University, Stanford, CA, US; [b]Trent University, Peterborough, Ontario, Canada and [c]Occidental College, Los Angeles, CA, US
antonial@stanford.edu
carolynbaer@trentu.ca
amemiya@oxy.edu

*Corresponding author.

doi:10.1017/S0140525X25101878, e239

Abstract

Lew-Levy and Amir begin to identify mechanisms through which peer interactions can drive cultural change. We highlight an additional important mechanism: peer disagreement. We propose that the egalitarian and learning-oriented nature of peer disagreements prompts children to reflect on the limitations of their knowledge, and to evaluate and integrate competing perspectives, thereby providing fertile ground for the co-creation of new insights.

Lew-Levy and Amir identify three unique mechanisms through which peer cultures shape community knowledge and drive cultural change; exploratory peer play, peer-to-peer teaching, and the propensity to maintain abandoned adult traits. We propose an additional mechanism that we believe most clearly highlights children's role as active agents in cultural adaptation: *peer disagreement*. We define peer disagreements as interactions between equals who hold conflicting views and collaboratively work through their differences to resolve them. As we will argue, such

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

interactions provide ideal conditions for the co-creation of new knowledge.

While adults often avoid open disagreement due to potential social risks (Simons & Green, 2018) – such as damaged relationships or harm to their reputation – observational studies show that preschool and elementary school children engage in disagreement with notable regularity (Laursen & Hartup, 1989; Maynard, 1985). One reason for children's willingness to disagree with one another may lie in the egalitarian and learning-oriented nature of these interactions. Children's disagreements often seem to be characterized by a shared understanding that everyone involved has limited experience of the world (Piaget & Cook, 1952; Perret-Clermont, 2022) but is equally motivated to explore, learn, and generate new insights (see Liquin & Gopnik, 2022). This creates an environment where differing viewpoints are met with openness, curiosity, and a willingness to learn from one another, rather than defensiveness or fear of being proven wrong (see Dweck & Leggett, 1988).

In line with this idea, recent research suggests that children view disagreements as opportunities for learning and knowledge creation (Langenhoff et al., 2025; Ransom, Blakey, & Ronfard, 2025). From as young as age four – and in some cases, even age three – children who encounter disagreement, rather than agreement (e.g., about which box contains a reward), are more likely to double-check the evidence on which their beliefs are based (e.g., peeking inside the boxes; Helming, O'Madagain, & Tomasello, 2024; O'Madagain et al., 2022), to remember the sources of their knowledge (e.g., recalling whether they learned about the box's content by looking inside or by being told; Baer et al., 2025; Mahr et al., 2021), and to reduce their confidence in their beliefs, despite being typically known for their overconfidence (Langenhoff, Srinivasan, & Engelmann, 2024). These findings suggest that disagreement prompts young children to *critically reflect on their existing beliefs* – an important first step in children's developing ability to learn and generate knowledge from disagreement.

As children get older, they develop a more nuanced understanding of disagreements, their underlying causes, and processes of resolution. Starting around age five, children increasingly judge that in disagreements over subjective matters (e.g., personal preferences), both perspectives can be right, while in disagreements over more objective issues (e.g., empirical facts), the competing perspectives can – and should – be resolved through relevant evidence (e.g., Wainryb et al., 2004; Yang et al., 2023). At the same age, children begin to spontaneously articulate the reasoning or evidence underlying their own beliefs when encountering disagreement from peers, and expect their peers to do the same (Köymen & Tomasello, 2018; Schleihauf et al., under review). Moreover, children actively *compare* the evidence supporting their own and their peer's beliefs, and rationally revise their beliefs in line with that evidence: They maintain their initial belief when their own evidence is stronger, adopt the peer's belief when their own evidence is weaker, and suspend judgment when both have equally strong evidence (Langenhoff, Engelmann, & Srinivasan, 2023). This emerging ability to *evaluate competing perspectives in light of empirical evidence* reflects a core component of scientific reasoning and constitutes a second critical step in children's growing capacity to collaboratively generate knowledge through disagreement.

As children approach middle childhood, their reasoning about disagreement becomes even more sophisticated. By age 10, children typically understand that even when individuals have access to the same evidence, they may still disagree because they interpret that evidence differently (Amemiya, Walker, & Heyman, 2021; Amemiya, Heyman, & Gerstenberg, 2024). Around the same age, children also learn to sensibly integrate the judgments of disagreeing agents based on their respective levels of confidence (Baer, Engelmann, & Kidd, 2025). The insight that in many disagreements, both participants can be partially right or wrong – and that *differing perspectives can each contribute valuable insights toward a more complete understanding of the truth* – marks a third key step in children's emerging ability to co-create knowledge from disagreement.

While much of the research so far has focused on how working through disagreement helps children acquire knowledge in domains where the answers are already known and typically taught by adults (such as determining whether an object will sink or float; Yang et al., 2023), it seems plausible that disagreement functions similarly in more open-ended domains, where there is greater potential for the co-construction of genuinely new ideas. To illustrate, consider the example from Piel (2012), cited by Lew-Levy and Amir, in which Japanese children explained that they "came up with the idea together" when asked how they had learned to fish for snails using straws. It is easy to imagine that this process involved disagreement. For example, one child may have suggested using a straw, while another proposed using a net to catch the snails, and it was only by combining these ideas into something new that they arrived at the most effective strategy: dislodging the snails from the rocks with the straw and scooping them with the net once they floated to the surface.

In summary, we have argued and provided initial evidence that peer disagreements constitute unique contexts for learning and the co-creation of knowledge. However, many promising directions for future research remain. For instance, it would be interesting to investigate whether the presence of disagreement enhances children's tool innovation capacities beyond the benefits of general peer interactions shown in prior research (Gönül et al., 2019). Moreover, future studies should determine whether the factors of peer disagreements we have identified as being particularly conducive to learning and knowledge creation – such as shared goals and a learning-oriented mindset (see Dweck, 2006) – can be manipulated to influence the outcomes of these interactions. Ultimately, we believe that a full understanding of children's contributions to cultural adaptation must include the study of peer disagreement.

Acknowledgments. NA

Financial support. Antonia Langenhoff is funded by a Walter Benjamin Postdoctoral Fellowship from the German Research Foundation. Carolyn Baer receives support from a Social Sciences and Humanities Research Council of Canada Insight Development Grant.

Competing interests. The authors have no competing interests to declare.

References

Amemiya, J., Walker, C. M., & Heyman, G. D. (2021). Children's developing ability to resolve disagreements by integrating perspectives. *Child Development*, *92*(6), e1228–e1241.

Amemiya, J., Heyman, G. D., & Gerstenberg, T. (2024). Children use disagreement to infer what happened. *Cognition*, *250*, 105836.

Baer, C., Engelmann, J.M., & Kidd, C. (2025). Children use the relative confidence of people with conflicting perspectives to form their own beliefs. *Developmental Science*, *28*(4), e70024

Baer, C., Langenhoff, A., Keşşafoğlu, D., Mohtezebsade, W., Kidd, C., Küntay, A. C., Engelmann, J.M., & Köymen, B. (2025). Anticipating disagreement enhances source memory in English-and Turkish-speaking preschool children. *Developmental Psychology*. Advance online publication.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random House.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*(2), 256–273.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Gönül, G., Hohenberger, A., Corballis, M., & Henderson, A. M. E. (2019). Joint and individual tool making in preschoolers: From social to cognitive processes. *Social Development*, *28*(4), 1037–1053.
Helming, K., O'Madagain, C., & Tomasello, M. (2024). Three-and 5-year-old children know their current belief might be wrong. *Journal of Experimental Child Psychology*, *246*, 106001.
Köymen, B., & Tomasello, M. (2018). Children's meta-talk in their collaborative decision making with peers. *Journal of Experimental Child Psychology*, *166*, 549–566.
Langenhoff, A. F., Engelmann, J. M., & Srinivasan, M. (2023). Children's developing ability to adjust their beliefs reasonably in light of disagreement. *Child Development*, *94*(1), 44–59.
Langenhoff, A. F., Srinivasan, M., & Engelmann, J. M. (2024). Disagreement reduces overconfidence and prompts exploration in young children. *Child Development*, *95*(5), 1616–1627.
Langenhoff, A.F., Thompson, B., Srinivasan, M. & Engelmann, J.M. (2025). Disagreement Drives Metacognitive Development. *Trends in Cognitive Sciences*. S1364-6613(25)00139-1. Advance online publication.
Laursen, B., & Hartup, W. W. (1989). The dynamics of preschool children's conflicts. *Merrill-Palmer Quarterly*, *35*(3), 281–297.
Liquin, E. G., & Gopnik, A. (2022). Children are more exploratory and learn more than adults in an approach-avoid task. *Cognition*, *218*, 104940.
Mahr, J. B., Mascaro, O., Mercier, H., & Csibra, G. (2021). The effect of disagreement on children's source memory performance. *PLoS One*, *16*(4), e0249958.
Maynard, D. W. (1985). How children start arguments. *Language in Society*, *14*(1), 1–29.
O'Madagain, C., Helming, K. A., Schmidt, M. F., Shupe, E., Call, J., & Tomasello, M. (2022). Great apes and human children rationally monitor their decisions. *Proceedings of the Royal Society B*, *289*(1971), 20212686.
Perret-Clermont, A. N. (2022). Socio-cognitive conflict. In *The Palgrave encyclopedia of the possible* (pp. 1517–1524). Springer International Publishing.
Piaget, J., & Cook, M. (1952). *The origins of intelligence in children* (Vol. *8*, No. 5, pp. 18–1952). International Universities Press.
Piel, L. H. (2012). Food rationing and children's self-reliance in Japan, 1942–1952. *The Journal of the History of Childhood and Youth*, *5*(3), 393–418.
Ransom, A., Blakey, K. H., & Ronfard, S. (2025). Children's developing understanding of the value of disagreement for learning. *Child Development*, *96*(4), 1373–1384.
Schleihauf, H.*, Langenhoff, A. F.*, Zhang, Z., Köymen, B., Herrmann, E., & Engelmann, J.M. (under review). Children across diverse societies exchange reasons to resolve disagreements **equal contribution as first author.*
Simons, J. J., & Green, M. C. (2018). Divisive topics as social threats. *Communication Research*, *45*(2), 165–187.
Wainryb, C., Shaw, L. A., Langley, M., Cottam, K., & Lewis, R. (2004). Children's thinking about diversity of belief in the early school years: Judgments of relativism, tolerance, and disagreeing persons. *Child Development*, *75*(3), 687–703.
Yang, Q. T., Sleight, S., Ronfard, S., & Harris, P. L. (2023). Young children's conceptualization of empirical disagreement. *Cognition*, *241*, 105627.

The role of juveniles in animal culture

Katherine McAuliffe[a]* and Alex Thornton[b]

[a]Department of Psychology and Neuroscience, Boston College, Chestnut Hill, MA, USA and [b]Centre for Ecology and Conservation, University of Exeter, Penryn Campus, Penryn, Cornwall, UK
mcaulikg@bc.edu
alex.thornton@exeter.ac.uk

*Corresponding author.

doi:10.1017/S0140525X25101817, e240

Abstract

Lew-Levy and Amir argue that the cultural role of human children has been overlooked. Juveniles have been similarly overlooked in research on animal culture. Youngsters are often innovative, and ample opportunities exist for cultural transmission to peers and adults. We review the evidence and argue that the young may be a powerful cultural force in human and nonhuman societies alike.

In the target article, Lew-Levy and Amir argue persuasively that human children are important agents of cultural innovation and transmission and that their role in cultural evolution should be more fully appreciated. However, to understand the origins of human culture and processes of cultural evolution more broadly, it is critical to also consider other species. It is well established that culturally transmitted forms of behaviour are common in many nonhuman animal (hereafter animal) species (Whiten, 2021). Here, we argue that, as in humans, juveniles are likely to play a crucial – though largely overlooked – role in this process. To support this argument, we draw on three lines of evidence: (1) juveniles are often innovators in animal culture; (2) there are ample opportunities for cultural transmission within juvenile groups; and (3) recent work points to potential pathways for the transmission of social information from young to old in animal taxa.

As Lew-Levy and Amir point out, a standard model of cultural transmission is one in which older individuals transmit cultural information to younger individuals. This transmission pathway is undoubtedly important in animal societies and will often be adaptive as older, more experienced individuals are likely to possess valuable skills and knowledge. Indeed, there are many examples of cultural transmission in animal systems that fit this model (e.g., Dugatkin & Godin, 1993; Coelho et al., 2015; Arbon et al., 2023). Yet, this model does not fit all observations. Take, for example, what can arguably be considered one of the first and certainly among the most famous examples of cultural transmission in animals: sweet potato washing in Japanese macaques. This tradition, in which macaques clean grit off provisioned sweet potatoes in the sea, presumably to make them more palatable, originated with a young female named Imo and spread among community members. Remarkably, this behaviour spread upward, from Imo and her peers to older community members, including Imo's mother (Kawai, 1965).

Across a diverse range of species, immature individuals – like Imo – are highly exploratory and innovative, and so may serve as valuable originators of cultural information (Biro et al., 2003; Thornton & Malapert, 2009; Morand-Ferron et al., 2011; Benson-Amram et al., 2014; Coelho et al., 2015; Carter et al., 2018). One reason may lie in the old adage that necessity is the mother of invention: juveniles are typically low-ranking members of their groups and may, therefore, need to find creative ways to secure resources (Morand-Ferron et al., 2011). For instance, field experiments show that juvenile great tits and blue tits are particularly likely to solve novel food puzzles (Morand-Ferron et al., 2011) while in vampire bats, meerkats and chimpanzees, youngsters are most likely to explore novel objects, foraging tasks or food types (Biro et al., 2003; Thornton & Malapert, 2009; Carter et al., 2018). Young, naive individuals are also likely to be particularly reliant on social learning (Arbon et al., 2025a).

If juveniles innovate, peer-to-peer social learning could, in principle, lead to the formation of juvenile cultures akin to those seen in human societies. Relatively little research has explored this explicitly, though there is evidence of social learning among juveniles in certain species such as lemon and Port Jackson sharks (Guttridge et al., 2013; Pouca et al., 2020). Many animals form age-structured societies in which youngsters have ample opportunities to interact with and learn from each other. For instance, juvenile creches in many bird species and playful social interactions among juveniles in primates and other mammals are likely to provide ample opportunities for the transmission of foraging skills and the acquisition of social conventions (Marzluff & Balda, 1992; Wanker, Bernate, & Franck, 1996; Perry et al., 2003).

Might the cultural innovations of juvenile animals spread to affect the behaviour of adults, as Lew-Levy and Amir describe in humans? In some species, strong biases towards learning from older or more dominant individuals may prevent the transmission of cultural information from juveniles. For instance, some authors speculate that such social learning biases may be responsible for restricting the accumulation of cultural traditions in chimpanzee societies (Kendal et al., 2015). As such, juveniles – despite their innovativeness – could represent something of a cultural dead-end. Yet, there are at least three possible pathways via which this dead-end could be avoided. First, juveniles may retain their learned behaviour as they grow up. In tufted capuchin monkeys, for example, juveniles showed particularly high rates of nut-cracking behaviour. Upon reaching adulthood, other group members then copied their behaviour, leading to the transmission of nut-cracking through the group (Coelho et al., 2015). Second, some animals have been shown to learn from successful individuals irrespective of their age (e.g. Seppänen et al., 2011; Aplin et al., 2015). Finally, some species may flexibly alter their social information-use strategies. For example, jackdaws typically gather information from adults, but in a recent field experiment, adults learned to show social tolerance towards juveniles, using them as a source of information indicating the presence of food (Arbon et al., 2025b). Such flexibility may well allow some animals to capitalise on the innovativeness of youngsters, facilitating the spread of culture through groups.

Despite the relative dearth of research, multiple lines of evidence suggest that youngsters are likely to play a critical role in cultural transmission not only in humans, as argued by Lew-Levi and Amir, but also in many other species. Research on nonhuman animals, therefore, offers great potential, not least because of the feasibility of controlled experiments in the laboratory and in the field, which would be ethically and logistically difficult to conduct with humans. An explicit focus on the potential for peer-to-peer transmission among juveniles and from juveniles to adults should be an urgent research priority, not only for our fundamental understanding of cultural evolution, but also applied work harnessing social learning to enhance conservation (Arbon et al., 2025a). The discovery that social learning operates as a "second inheritance system" (alongside genetic transmission) from parents to offspring has revolutionised biology and anthropology (Whiten, 2017). If this system allows information to spread up as well as down the generations, it may be even more powerful and versatile than we realised.

Acknowledgements. We are grateful to our research groups – The Cooperation Lab at Boston College and the Wild Cognition Research Group at Exeter – for ongoing conversations that contributed to these ideas. We are especially grateful to Josh Arbon and Fred Ispanze for engaging discussions about animal culture. A.T. is supported by a Leverhulme Trust Research Grant (RGP-2020-170), and KM is supported by a Jacobs Foundation Research Fellowship.

Financial support. The authors have no funding do declare.

Competing interests. The authors declare no competing interest.

References

Aplin, L. M., Farine, D. R., Morand-Ferron, J., Cockburn, A., Thornton, A., & Sheldon, BC. (2015). Experimentally induced innovations lead to persistent culture via conformity in wild birds. *Nature*, *518*, 538–541. https://doi.org/10.1038/nature13998

Arbon, J. J., Hahn, L. G., McIvor, G. E., & Thornton, A. (2023). Competition and generalization impede cultural formation in wild jackdaws. *Proceedings of the Royal Society B*, *290*, 20230705.

Arbon, J. J., Boogert, N. J., Jordan, N. R., & Thornton, A. (2025a). The flexibility of social learning and its conservation implications in mammals and beyond. *Philosophical Transactions B*, *380*, 20240136.

Arbon, J. J., Truskanov, N., Stott, E., McIvor, G. E., & Thornton, A. (2025b). Wild jackdaws learn to tolerate juveniles to exploit new foraging opportunities. *Biology Letters*, *21*, 20250179. https://doi.org/10.1101/2024.08.29.609864

Benson-Amram, S., Heinen, V. K., Gessner, A., Weldele, M. L., & Holekamp, K. E. (2014). Limited social learning of a novel technical problem by spotted hyenas. *Behavioural Processes*, *109*, 111–120. https://doi.org/10.1016/j.beproc.2014.09.019

Biro, D., Inoue-Nakamura, N., Tonooka, R., Yamakoshi, G., Sousa, C., & Matsuzawa, T. (2003). Cultural innovation and transmission of tool use in wild chimpanzees: Evidence from field experiments. *Animal Cognition*, *6*, 213–223. https://doi.org/10.1007/s10071-003-0183-x

Carter, G. G., Forss, S., Page, R. A., & Ratcliffe, J. M. (2018). Younger vampire bats (*Desmodus rotundus*) are more likely than adults to explore novel objects. *PLoS ONE*, *13*, 1–11. https://doi.org/10.1371/journal.pone.0196889

Coelho, C. G., Falótico, T., Izar, P., Mannu, M., Resende, B. D., Siqueira, J. O., & Ottoni, E. B. (2015). Social learning strategies for nut-cracking by tufted capuchin monkeys (*Sapajus* spp.). *Animal Cognition*, *18*, 911–919. https://doi.org/10.1007/s10071-015-0861-5

Dugatkin, L. A., & Godin, J. G. J. (1993). Female mate copying in the guppy (*Poecilia reticulata*): Age-dependent effects. *Behavioral Ecology*, *4*, 289–292. https://doi.org/10.1093/beheco/4.4.289

Guttridge, T. L., van Dijk, S., Stamhuis, E. J., Krause, J., Gruber, S. H., & Brown, C. (2013). Social learning in juvenile lemon sharks, *Negaprion brevirostris*. *Animal cognition*, *16*, 55–64.

Kawai, M. (1965). Newly-acquired pre-cultural behavior of the natural troop of Japanese monkeys on Koshima Islet. *Primates*, *6*, 1–30.

Kendal, R., Hopper, L. M., Whiten, A., Brosnan, S. F., Lambeth, S. P., Schapiro, S. J., & Hoppitt, W. (2015). Chimpanzees copy dominant and knowledgeable individuals: Implications for cultural diversity. *Evolution and Human Behavior*, *36*, 65–72.

Marzluff, J. M., & Balda, R. P. (1992). *The pinyon jay: Behavioral ecology of a colonial and cooperative corvid*. Academic Press.

Morand-Ferron, J., Cole, E. F., Rawles, J. E. C., & Quinn, J. L. (2011). Who are the innovators? A field experiment with 2 passerine species. *Behavioral Ecology*, *22*, 1241–1248. https://doi.org/10.1093/beheco/arr120

Perry, S., Baker, M., Fedigan, L., GrosLouis, J., Jack, K., MacKinnon, K., Manson, J., Panger, M., Pyle, K., & Rose, L. (2003). Social conventions in wild white-faced capuchin monkeys: Evidence for traditions in a neotropical primate. *Current Anthropology*, *44*, 241–268.

Pouca, C. V., Heinrich, D., Huveneers, C., & Brown, C. (2020). Social learning in solitary juvenile sharks. *Animal Behaviour*, *159*, 21–27.

Seppänen, J. T., Forsman, J. T., Mönkkönen, M., Krams, I., & Salmi, T. (2011). New behavioural trait adopted or rejected by observing heterospecific tutor fitness. *Proceedings of the Royal Society B*, *278*, 1736–1741. https://doi.org/10.1098/rspb.2010.1610

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Thornton, A., & Malapert, A. (2009). Experimental evidence for social transmission of food acquisition techniques in wild meerkats. *Animal Behaviour*, *78*(2) 255–264.
Wanker, R., Bernate, L. C., & Franck, D. (1996). Socialization of spectacled parrotlets Forpus conspicillatus: The role of parents, crèches and sibling groups in nature. *Journal für Ornithologie*, *137*, 447–461.
Whiten, A.. (2021). The burgeoning reach of animal culture. *Science*, *372*, eabe6514.
Whiten, A. (2017). A second inheritance system: The extension of biology through culture. *Interface Focus*, *7*, 20160142.

Variable cultural acquisition costs may explain contextual variation in peer cultures

Alex Mesoudi*

Centre for Ecology and Conservation, University of Exeter, Penryn, UK
a.mesoudi@exeter.ac.uk
https://www.alexmesoudi.com/

*Corresponding author.

doi:10.1017/S0140525X2510201X, e241

Abstract

Lew-Levy and Amir highlight contextual variation across both traits and societies in the influence of childhood peer cultures on mainstream adult culture. I suggest that this contextual variation can be explained in part by variable cultural acquisition costs, where some traits (e.g., technology) and societies (e.g., post-industrial) comprise accumulated cultural knowledge that is too costly for children to acquire.

Towards the end of their compelling and persuasive target article, Lew-Levy and Amir discuss how childhood peer cultures might vary across contexts. I think it is worth elaborating further on the drivers of this variation.

Lew-Levy and Amir identify variation first in the type of cultural trait involved (see Section 7.1: "What can peer culture reveal about cultural evolution?"). Children are more likely to innovate in spatial (e.g., location of food), linguistic (e.g., new vocabulary or grammatical rules), and social (e.g., communication norms) domains, rather than technological domains. Second, there is variation across societies (see Section 7.4: "How do peer cultures vary across contexts?"). While the influence of peer cultures seems frequent and persuasive in small-scale (e.g., forager) societies, it seems less likely in post-industrial societies where, while peer cultures still seem to be relatively autonomous (e.g., the playground games and rhymes of British children observed by the Opies), they are less likely to contribute to society-wide cultural innovation and change.

Both of these observations might plausibly be explained by variable cultural acquisition costs (Mesoudi, 2011). Even in small-scale societies, technology typically comprises multiple interacting parts that must be assembled in several steps, often without obvious causal links between a tool's eventual performance and its form or manufacturing process (Harris, Boyd, & Wood, 2021). And even if a novel technology works better than existing forms, there are still numerous social barriers preventing it from actually being adopted by others (Rogers, 1995). This makes technological innovation intrinsically harder than, say, linguistic or social innovation, where new word forms or customs can be invented and acquired easily, including by children. For technology, the lengthy acquisition of previously accumulated cultural knowledge represents a much greater limitation on the contributions that children can make to society-wide innovation, compared to non-technological domains.

Similarly, post-industrial societies have seen the exponential accumulation of scientific and technological knowledge over the last few centuries (Enquist et al., 2008; May, 1966; Price, 1963), accelerated by key cultural innovations such as the scientific method, mass communication, and tools such as microscopes and computers. As knowledge accumulates, however, so does the time and effort needed to acquire what previous generations have discovered or invented. Evidence for such increasing cultural acquisition costs comes from analyses showing that the mean age at which prominent scientists and inventors made their most significant advance increased from 32 years in 1900 to 38 years in 2000, with this increase specifically attributable to increased training periods (Jones, 2010). Consequently, it is not surprising that children are unable to innovate in post-industrial societies and have been relegated to receptacles of existing knowledge. Formal systems of education likely partly arose in response to these increasing acquisition costs, further removing children from situations in which they can influence wider cultural change.

Perhaps, however, this is too coarse-grained and too pessimistic. Derex (2021) recently argued that cumulative cultural evolution exhibits two dynamics: (i) periods of incremental optimisation of existing knowledge, interspersed with (ii) the opening of a new niche or domain, typically exploiting a new natural phenomenon. While the former requires the lengthy acquisition of incrementally accrued knowledge, the latter may be more amenable to innovation without lengthy acquisition costs, given the lack of established knowledge to acquire. For example, the advent of home computers in the 1980s led to a British computer games industry led by self-taught teenagers who mastered programming in their bedrooms entirely independently from either their parents or their teachers, at least until computer technology became so advanced that large teams of professionally trained programmers were needed (Andrews, 2020).

Further considerations of the dynamics of cumulative cultural evolution, particularly regarding the costs of acquiring previously accumulated knowledge and how this limits the opportunities for innovation, might help to elucidate exactly when, for what traits, and in what kind of societies, children are likely to contribute to society-wide cultural adaptation.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. None.

References

Andrews, S. (2020, July 14). Whatever happened to the 1980s coding heroes? *IT Pro*. https://www.itpro.com/development/programming/356430/whatever-happened-to-the-1980s-coding-heroes
Derex, M. (2021). Human cumulative culture and the exploitation of natural phenomena. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *377*(1843), 20200311. https://doi.org/10.1098/rstb.2020.0311

Enquist, M., Ghirlanda, S., Jarrick, A., & Wachtmeister, C. A. (2008). Why does human culture increase exponentially? *Theoretical Population Biology*, *74*(1), 46–55. https://doi.org/10.1016/j.tpb.2008.04.007
Harris, J. A., Boyd, R., & Wood, B. M. (2021). The role of causal knowledge in the evolution of traditional technology. *Current Biology*, *31*(8), 1798–1803.e3. https://doi.org/10.1016/j.cub.2021.01.096
Jones, B. F. (2010). Age and great invention. *The Review of Economics and Statistics*, *92*(1), 1–14. https://doi.org/10.1162/rest.2009.11724
May, K. O. (1966). Quantitative growth of the mathematical literature. *Science*, *154*(3757), 1672. https://doi.org/10.1126/science.154.3757.1672
Mesoudi, A. (2011). Variable cultural acquisition costs constrain cumulative cultural evolution. *PLOS One*, *6*(3), e18239. https://doi.org/10.1371/journal.pone.0018239
Price, D. J. S. (1963). *Little science, big science*. Columbia Univ. Press.
Rogers, E. (1995). *The diffusion of innovations*. Free Press.

Peer cultures in long-term cultural evolution

Elena Miu, Mathilde Vestergaard Meyer and Felix Riede*

Department of Archaeology and Heritage Studies, Aarhus University, Højbjerg, Denmark
elena.miu@cas.au.dk
mathilde.meyer@cas.au.dk
f.riede@cas.au.dk

*Corresponding author.

doi:10.1017/S0140525X25101970, e242

Abstract

Lew-Levy and Amir's contribution highlights issues with our current frameworks and methods for understanding the evolution of human behaviour. We fully concur that more attention should be paid to integrating children's learning into models of cultural evolution and to positioning cultural adaptation in a long-term perspective to better understand the role of children in both the past and the present.

As scholars of childhood in the past and across evolutionary time, we warmly welcome Lew-Levy and Amir's work as an important, timely, and stimulating contribution to the behavioural sciences. It will doubtlessly generate productive research programmes. Here, we make three points about the consequences of this paper for cultural evolutionary work and our understanding of childhood in the present and past.

Firstly, although the authors do mention material culture, often cultural knowledge and products achieve momentous complexity over time through intergenerational processes of innovation and cultural transmission (Henrich, 2016; Mesoudi & Thornton, 2018). Moreover, material culture may persist across and transcend generations. Salient contributions in such domains require both the time to master the accumulated knowledge and a level of expertise not available without years of practice, which may begin as play but often requires practice and instruction. It is unclear from the present work what the role of children's learning and the ensuing peer cultures would be for skills and technology that require intergenerational accumulation and expertise. This is not a shortcoming of the target paper specifically but rather highlights blind spots in cultural evolutionary theory, which so far has not engaged seriously with differences across individuals (but do see Molleman, van den Berg, & Weissing, 2014; van den Berg, Van, & Molleman, 2024) or across the lifespan – in fact, children's learning has been virtually absent from formal investigations of cultural evolution (but see Deffner & McElreath, 2022; Frankenhuis & Panchanathan, 2011; Kandler, Fogarty, & Karsdorp, 2023, and our own work Miu et al., 2025). Moreover, while cultural evolutionary processes require both an understanding of the generation of novelty and its spread, most recent work in cultural evolution has focused exclusively on processes of cultural transmission, with innovation tending to be black-boxed or treated as random, as an error, or as a mutation-like process.

Cultural evolution needs to incorporate theories of creativity and innovation if it is to develop into a mature science of human behaviour that, as it likes to claim, can integrate across levels of explanation. This might require us to focus more on individual-level cognitive processes and to re-integrate the individual into our formal and experimental frameworks designed to study cultural transmission. While these calls to action are not new (Acerbi & Mesoudi, 2015; Perry et al., 2020; Singh et al., 2021), we suggest that focusing on children and their role in innovation can be a productive place to start. Developmental psychology makes specific claims about learning and exploration strategies that vary across the lifespan (Gopnik, 2020; Gopnik et al., 2017) that can be readily integrated into our models. Children's cognitive tendencies to explore broadly might be exactly the type of variation generation process that populations can build on even in the context of intergenerational accumulation in order to achieve better solutions (Miu et al., 2025). And these cognitive tendencies need to be situated cross-culturally and historically (Muthukrishna, Henrich, & Slingerland, 2021).

Second, the paper's rich behavioural examples are compelling, but from a long-term perspective the minimal focus on materials and material proxies for peer cultures is unfortunate. True longitudinal studies that demonstrate genuine peer-culture longevity will only be possible by integrating a deeper ethno-historical or archaeological perspective (where children are now beginning to be considered seriously; see Meyer & Riede, 2025; Milks et al., 2021; Nowell, 2021; Nowell & French, 2020; Riede et al., 2021), which, in turn, is only possible via material proxies. Much work in evolutionary human behavioural sciences, including at times the target article, often assumes rather than demonstrates that behaviour like peer cultures is adaptive, i.e., that it increases the fit between individuals or groups and their environment. This is partly an issue of time scales and partly of data collection – it is nigh impossible to capture true adaptiveness from the type of cross-sectional data typical of ethnographic studies, nor in the absence of considering real ecological changes. This can only be achieved by incorporating truly long-term perspectives and data sources beyond the behavioural sciences (i.e., genetics and the environmental sciences).

Lastly, while the current paper usefully summarises a wealth of evidence on peer cultures across societies, we felt that it lacked a more elaborate discussion on present-day children in Western societies. While it is indeed the case that childhood in these societies looks very different from childhood throughout most human history, there is still considerable variation between childhoods in the West that we expect would have consequences for the evolution of peer cultures. For instance, the US and Denmark differ greatly in terms of child safety and autonomy, the

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

availability of third spaces, and the demographic makeup of children's social circles, all factors affected by both historical and cultural factors but also by political and social institutions. At the same time, children's online presence and the emergence of online peer cultures are timely and pressing issues that require more study, especially in the context of our emerging understanding of human behaviour and learning in an increasingly online world (Acerbi, 2019). Finally, the target article focuses – with understandable passion but perhaps also somewhat unduly so – on the positive and generative aspects of peer culture rather than accounting for the trade-off between cooperation and conflict that has long been a mainstay of adult-focused behavioural science. Such trade-offs are very likely present in child cultures as well. Here, bullying, control, status allocation, and physical violence are as present as camaraderie and play are, and very likely manifest in the online sphere as well. Improving our understanding of the lighter and darker shades of peer cultures in these contexts would have important consequences not just within the academic realm, but also for educational policy, reform, and practice.

Acknowledgements. We thank our funders for supporting our research, and we also thank Lew-Levy and Amir for bringing the issue of children's culture to the fore with energy and insight. Our work has benefited from discussions within the CLIOARCH Collaboratory and the P|O|P research group.

Financial support. EM and FR's contribution was supported by the Aarhus University Research Foundation (NOVA grant # AUFF-E-2021-9-4). MVM is funded by a PhD stipend from Aarhus University.

Competing interests. The authors declare no competing interests.

References

Acerbi, A. (2019). *Cultural evolution in the digital age*. Oxford University Press.

Acerbi, A., & Mesoudi, A. (2015). If we are all cultural Darwinians what's the fuss about? Clarifying recent disagreements in the field of cultural evolution. *Biology & Philosophy*, *30*, 481–503. https://doi.org/10.1007/s10539-015-9490-2

Deffner, D., & McElreath, R. (2022). When does selection favor learning from the old? Social learning in age-structured populations. *PLoS ONE*, *17*(4), e0267204. https://doi.org/10.1371/journal.pone.0267204

Frankenhuis, W. E., & Panchanathan, K. (2011). Individual differences in developmental plasticity may result from stochastic sampling. *Perspectives on Psychological Science*, *6*(4), 336–347. https://doi.org/10.1177/1745691611412602

Gopnik, A. (2020). Childhood as a solution to explore-exploit tensions. *Philosophical Transactions of the Royal Society B*, *375*, 20190502.

Gopnik, A., O'Grady, S., Lucas, C. G., Griffiths, T. L., Wente, A., Bridgers, S., Aboody, R., Fung, H., & Dahl, R. E. (2017). Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(30), 7892–7899. https://doi.org/10.1073/pnas.1700811114

Henrich, J. (2016). *The secret of our success: How culture is driving human evolution, domesticating our species, and making us smarter*. Princeton University Press.

Kandler, A., Fogarty, L., & Karsdorp, F. (2023). The interplay between age structure and cultural transmission. *PLoS Computational Biology*, *19*(7), e1011297. https://doi.org/10.1371/journal.pcbi.1011297

Mesoudi, A., & Thornton, A. (2018). What is cumulative cultural evolution ? *Proceedings of the Royal Society B: Biological Sciences*, *285*(1880), 20180712. https://doi.org/10.1098/rspb.2018.0712

Meyer, M. V., & Riede, F.. (2025). Playing to survive: Children and innovation during the little ice age in Greenland. *European Journal of Archaeology 28*(1), 81–100. https://doi.org/10.1017/eaa.2024.36

Milks, A., Lew-Levy, S., Lavi, N., Friesem, D. E., & Reckin, R. (2021). Hunter-gatherer children in the past: An archaeological review. In *Journal of Anthropological Archaeology*, *64*, 101369. https://doi.org/10.1016/j.jaa.2021.101369

Miu, E., Andersen, M. M., Lew-Levy, S., & Riede, F. (2025). Childhood exploration drives population-level innovation in cultural evolution. *BioRxiv*, 2025.03.28.645934. https://doi.org/10.1101/2025.03.28.645934

Molleman, L., van den Berg, P., & Weissing, F. J. (2014). Consistent individual differences in human social learning strategies. *Nature Communications*, *5*, 3570. https://doi.org/10.1038/ncomms4570

Muthukrishna, M., Henrich, J., & Slingerland, E. (2021). Psychology as a Historical Science. *Annual Review of Psychology*, *72*(1), 717–49. https://doi.org/10.1146/annurev-psych-082820-111436

Nowell, A. (2021). *Growing up in the Ice Age: Fossil and archaeological evidence of the lived lives of Plio-Pleistocene children*. Oxbow Books.

Nowell, A., & French, J. C. (2020). Adolescence and innovation in the European Upper Palaeolithic. *Evolutionary Human Sciences*, *2*, e36. https://doi.org/10.1017/ehs.2020.37

Perry, S., Carter, A., Smolla, M., Akcay, E., Nöbel, S., Foster, J., & Healy, S. (2020). Not by transmission alone – the role of invention in cultural evolution. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *376*(n°1828), 1–25. https://doi.org/10.31235/osf.io/x2acu

Riede, F., Walsh, M. J., Nowell, A., Langley, M. C., & Johannsen, N. N. (2021). Children and innovation: Play, play objects and object play in cultural evolution. *Evolutionary Human Sciences*, *3*. https://doi.org/10.1017/ehs.2021.7

Singh, M., Acerbi, A., Caldwell, C. A., Danchin, É., Isabel, G., Molleman, L., Scott-Phillips, T., Tamariz, M., Van Den Berg, P., Van Leeuwen, E. J. C., & Derex, M. (2021). Beyond social learning. In *Philosophical Transactions of the Royal Society B: Biological Sciences*, *376*(1828), 20200050. https://doi.org/10.1098/rstb.2020.0050

Van den Berg, P., Van, Vu, T., & Molleman, L. (2024). Unpredictable benefits of social information can lead to the evolution of individual differences in social learning. *Nature Communications*, *15*(1), 5138. https://doi.org/10.1038/s41467-024-49530-4

Children's peer culture and the « selection for proliferation » hypothesis

Olivier Morin

Institut Jean Nicod, Département d'études cognitives, ENS, EHESS, CNRS, PSL University, UMR 812929 rue d'Ulm, Paris, France
olivier.morin@ens.psl.eu
https://www.oliviermorin.net

doi:10.1017/S0140525X25101969, e243

Abstract

Lew-Levy and Amir rightly see children's peer culture as an overlooked engine of human cultural evolution. Researchers who share this view can now take up the burden of proving that the longevity of children's traditions is indeed comparable to that of adults and of explaining why. The « selection for proliferation » hypothesis suggests a way.

Evolutionary approaches to culture have much to gain from studying children's peer culture. Lew-Levy and Amir's much-needed contribution does an outstanding job of unifying the wealth of anthropological data supporting the existence of an autonomous peer culture, chiefly transmitted from child to child. Once their

existence is admitted, children's peer cultures raise a series of questions that our field is yet to tackle – starting with the puzzle of their existence. How do children's peer cultures manage to maintain themselves across time? In nearly all cultures, as Lew-Levy and Amir show, children form a sub-society that is not, on the face of it, well-suited for maintaining lasting traditions. Children's peer societies reside in the midst of an adult culture that dominates their own in almost every way. Compared to adults, they only have limited time to acquire and then transmit their peer culture, because children do not stay children for very long – they have, in other words, unusually high turnover rates (Opie & Opie, 1959, Morin, 2016).

According to the "selection for proliferation" hypothesis (Morin, 2016), the endurance of children's peer culture is, somewhat paradoxically, due precisely to the high population turnover rate that should make it difficult to sustain. High turnover implies that children's traditions must be constantly transmitted in order to survive. But, while this cultural transmission treadmill eliminates the greater share of the least appealing cultural practices, the « selection for proliferation » hypothesis claims that it allows some of them to survive longer. The traditions that survive frequent population turnover are (the hypothesis assumes) more likely than others to be frequently transmitted. High turnover selects those « proliferating » traditions, eliminates others, and thus makes it easier for proliferating traditions (lacking competition) to proliferate even more. The result is a limited repertoire of enduring traditions, detaching itself from a much larger cohort of ephemeral practices. The claim, in other words, is that high population turnover causes an increase in the variance of tradition's longevity, causing short-lived traditions to disappear quickly but allowing long-lived traditions to endure more. For children's peer culture, the most visible outcome is a set of traditions that can last as long as comparable adult traditions.

Assessing and explaining the longevity of children's traditions is important if the field is to take children's peer cultures seriously – to see them as repositories of genuine traditions on a par with adults'. Lew-Levy & Amir emphasise the contribution that children's peer cultures can make to the cultural resilience of entire human societies, thanks to their capacity to serve as repositories for otherwise neglected knowledge. To back this up, they cite persuasive evidence for resilient and lasting juvenile traditions. Yet a question remains (one that I also address to myself): To what extent is the longevity of children's peer culture really comparable to that of the most resilient adult traditions? Cultural longevity can be extreme, even in cultures that rely solely on oral transmission: claims of narratives being precisely transmitted for 7,000 years can be substantiated by compelling evidence (Nunn, 2020, Nunn & Reid, 2016).

Measuring and comparing the longevity of cultural traditions is difficult for two reasons, both having to do with granularity – with the precision we bring to recording and defining children's traditions, and adults'.

First, to measure the lifespans of a set of traditions, we should ideally sample the historical record at regular intervals in time and detect every time whether the tradition is present or not – longevity being inferred from the length of time separating the two most extreme instances where a tradition was detected. With historical data, the times at which we can sample the record are never controlled by us, and they vary widely from one tradition to another. Typically, children's traditions are less documented, and thus the rate at which we can sample the historical record is lower for them. This can be a problem for two reasons. First, more documented traditions are more likely to be recorded as present, biasing our longevity estimates in their favour. Second, cultural practices generally show greater rates of change when observed over shorter timescales (Perreault, 2012, 2020). Second, adult traditions are likely to be classified in a more granular way compared to equivalent practices common in children – again because adults pay more attention to their own culture and document it better. Data on Renaissance games in children and adults differentiates 15 games of card but only 4 games of tag (Morin, 2016, appendix). This time, the bias would lead us to overestimate the longevity of children's games: the same game can appear as one long-lasting game when described with low granularity or as three short-lived games under a finer grain of description.

Can such difficulties be remedied? Perhaps, because something unprecedented is happening to children's peer cultures: older children (in rich countries) are now writing to one another without adult supervision, often publicly, and with considerable linguistic creativity. Online language data escapes many of the biases that affect anthropological or folklore material. Comparable adult and children's innovations can be sampled at identical intervals and with the same grain of description. Time depth will necessarily be inferior to that of historical data, but online communication might have a decently long future, and in any case, the proliferation hypothesis makes a prediction that can be tested on short timeframes: there should be more short-lived linguistic innovations among children than among adults. Thus, I join Lew-Levy and Amir's invitation to study children's online worlds, equipped with cultural evolutionary hypotheses.

Financial support. OM benefitted from the "Frontiers in Cognition" EUR grant, ANR-17-EURE-0017 EUR. This work has received support under the Major Research Program of PSL Research University "CultureLab" launched by PSL Research University and implemented by ANR (ANR-10-IDEX-0001).

Competing interests. None.

References

Morin, O. (2016). *How traditions live and die*. Oxford University Press.

Nunn, P. (2020). *The edge of memory: Ancient stories, oral tradition and the post-glacial world*. Bloomsbury Sigma.

Nunn, P. D., & Reid, N. J. (2016). Aboriginal memories of inundation of the Australian coast dating from more than 7000 years ago. *Australian Geographer*, *47*(1), 11–47. https://doi.org/10.1080/00049182.2015.1077539

Opie, I., & Opie, P. (1959). *The lore and language of schoolchildren*. Oxford University Press.

Perreault, C. (2012). The pace of cultural evolution. *PLOS ONE*, *7*(9), e45150. https://doi.org/10.1371/journal.pone.0045150

Perreault, C. (2020). *The quality of the archaeological record*. University of Chicago Press.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Are childhood cultures legitimately special?

Mark Nielsen*

The University of Queensland, School of Psychology, Brisbane, QLD, Australia
nielsen@psy.uqedu.au

*Corresponding author.

doi:10.1017/S0140525X25101829, e244

Abstract

Lew-Levy and Amir propose that children develop meaningful cultures with the potential to undergird lasting and meaningful societal change. Identifying the domains in which this claim has traction is necessary if we are to accept that there is something special about childhood cultures that transcends considering them as fleeting expressions of an immature life stage.

Humans constantly develop new ways of doing things that become progressively incorporated into a population's stock of skills and knowledge, generating ever more sophisticated repertoires. This cumulative culture pivots on the cognitive engines of imitation (copying what others do) and innovation (developing new ways of doing things; Legare & Nielsen, 2015). The contention that childhood, as a human autapomorphic life stage (Bogin, 1990; Bogin & Smith, 1996), has been a key to the emergence of cumulative culture (Nielsen, 2012) fits with the thesis outlined by Lew-Levy and Amir: childhood is an evolutionary adaptation characterised by its own independent cultures that afford opportunity for innovative, norm-altering behaviours to emerge. However, whereas arguments that children form their own cultures are convincing, the contention that these cultures have lasting meaning that facilitates true cultural change seems flimsier.

Let us take supernatural belief systems as an example. Most of the world's population adhere to a system of this kind, many of which fall under the moniker of organised religion. Yet while there are thousands of supernatural agents to believe in, most individuals will choose the same one(s) as their parents or, at the very least, that of their immediate cultural in-group (Smith, 2020). As Hitchens (2007) wrote: *"If religious instruction were not allowed until the child had attained the age of reason, we would be living in a quite different world."* This inclination children have to adopt the normed religious attitudes of those around them can be best seen in the realm of rituals.

In a series of recent studies, Zhao and colleagues (Zhao et al., 2024a, 2024b, 2025) documented the willingness of young children to adopt an adult's costly novel ritualised actions. In Zhao et al. (2024b), children could win stickers by inserting tokens into a tube within a given time: the more tokens inserted, the more stickers won. Half the children observed an experimenter model an approach that incorporated the initial placement of the tokens on the floor in a measured flower-like pattern, whereas the other half watched the experimenter model only the essential steps. Children in the ritual condition replicated the experimenter's approach faithfully, despite the consequence of retrieving fewer stickers. Lew-Levy and Amir allude to the strong inclination children have for imitating, but that children do so to the extent outlined here seems misaligned with a framework in which children are creating their own lasting, meaningful cultures. If childhood cultures are meaningful, why are children not less inclined to worship the God(s) of those around them (indeed, why don't they develop, and keep as real, their own)?

One domain where lasting change might be evident is in new technology. In the space of a single generation, the digital landscape has shifted dramatically (Munzer, Barr, & Nielsen, 2025). Children now have ready access to devices that their parents would have at one time thought of as fanciful. A recent survey (Mann et al., 2025) found that 40% of children have their own tablet by 2 years of age, with that number increasing to 60% by 4 years – remarkable given that the iPad was only made commercially available in 2010. Alongside the proliferation of device types are changes in programme availability, with, for example, a growing proportion of screen media time spent on YouTube, with slightly less than one-fifth of children under 2 years accessing online videos (Henderson et al., 2024). What this change might lead to is a shift in how screen media is perceived and processed.

In Fong and colleagues (Fong et al., 2021), children aged 4 to 6 years observed a videotaped model demonstrating the use of two tools in retrieving a sticker from a novel apparatus. Both tools could functionally complete the task, but one was more efficient and easier to use. The model incentivised use of the inefficient tool ("everybody here uses this") while disincentivising the efficient tool ("or you could use this, but nobody here uses this"). Surprisingly, children who viewed the demonstration on a laptop displayed stronger tendencies to select the inefficient but socially sanctioned tool than those in a live condition. Children reverted to selecting the instrumental tool when the demonstration was projected from a mini-projector onto a small whiteboard, suggesting that experience with the medium may be altering perception of screen-based information. Fong and colleagues speculate that contemporary digital environments are leading children to interpret the detail they provide as normatively valuable. If this contention is valid, screens are becoming reliable sources of cultural detail and are viewed as not just passive sources of information and entertainment but as engaging, active guides to what is socially valuable. Screens might potentially become more relevant than live peers. When those who are presently children become adults, it may not only be the way they engage with screens that is manifestly different from how it is now, but also the ways they engage with each other. If we take our interpersonal cues from someone on a screen rather than someone in our immediate physical space, cultures will surely change.

One of the single most defining features of any cultural group is its supernatural belief system. Children appear highly adapted to saturate themselves with the one they are most prominently exposed to, regardless of any alternative perspective they might develop with their peers. In this way, childhood cultures appear not to impact the broader cultures they sit within. Conversely, the landscape of screen technology is rapidly changing, and with it comes new approaches to interacting with others. The ways screens are engaged with are becoming embedded early in developing minds in ways that engender change. This suggests childhood cultures do have the potential to impact the broader cultures they sit within. In their target article, Lew-Levy and Amir present a new way to consider childhood, one that will catalyse new empirical and theoretical endeavours. Endeavours that will be richer once we can

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

identify the extent to which they are enduring and manifest in meaningful change.

Acknowledgements. None

Financial support. None

Competing interests. None

References

Bogin, B. (1990). The evolution of human childhood. *Bioscience*, *40*, 16–25.
Bogin, B., & Smith, B. (1996). Evolution of the human life sycle. *American Journal of Human Biology*, *8*, 703–716.
Fong, F. T. K., Imuta, K., Redshaw, J., & Nielsen, M. (2021). The digital social partner: Preschool children display stronger imitative tendency in screen-based than live learning. *Human Behavior and Emerging Technologies*, *3*, 585–594. https://doi.org/10.1002/hbe2.280
Henderson, D., Bailes, T., Sturza, J., Robb, M. B., Radesky, J. S., & Munzer, T. G. (2024). YouTube for young children: what are infants and toddlers watching on the most popular video-sharing app? *Frontiers in Developmental Psychology*, *2*. https://doi.org/10.3389/fdpys.2024.1335922
Hitchens, C. (2007). *God is not great: How religion poisons everything*. Twelve Books.
Legare, C. H., & Nielsen, M. (2015). Imitation and innovation: The dual engines of cultural learning. *Trends in Cognitive Sciences*, *19*, 688–699. https://doi.org/10.1016/j.tics.2015.08.005
Mann, S., Calvin, A., Lenhart, A., & Robb, M. B. (2025). *The common sense census: Media use by kids zero to eight, 2025*. Common Sense Media.
Munzer, T., Barr, R., & Nielsen, M. (2025). Editorial: Early media exposure. *Frontiers in Developmental Psychology*, *3*. https://doi.org/10.3389/fdpys.2025.1574111
Nielsen, M. (2012). Imitation, pretend play and childhood: Essential elements in the evolution of human culture? *Journal of Comparative Psychology*, *126*, 170–181. http://doi.org/10.1037/a0025168
Smith, J. (2020). Transmission of faith in families: The influence of religious ideology. *Sociology of Religion*, *82*, 332–356. https://doi.org/10.1093/socrel/sraa045
Zhao, M., Fong, F. T. K., Whiten, A., & Nielsen, M. (2024a). Children's distinct drive to reproduce costly rituals. *Child Development*, *95*(4), 1161–1171. https://doi.org/10.1111/cdev.14061
Zhao, M., Fong, F. T. K., Whiten, A., & Nielsen, M. (2024b). Do children imitate even when it is costly? New insights from a novel task. *British Journal of Developmental Psychology*, *42*, 18–35.
Zhao, M., Fong, F. T. K., Whiten, A., & Nielsen, M. (2025). Children's imitation of costly rituals: Insights into early cultural learning. *Evolution and Human Behavior*, *46*. https://doi.org/10.1016/j.evolhumbehav.2025.106706.

Intrinsic motivation is key to understanding peer cultures

Jérémy Perez[a]*, Maxime Derex[b], Pierre-Yves Oudeyer[a] and Clément Moulin-Frier[a]

[a]Flowers AI & CogSci Lab, Centre INRIA de l'université de Bordeaux, Talence, France and [b]Institute for Advanced Study in Toulouse, Toulouse, France
jeremy.perez@inria.fr
maxime.derex@iast.fr
pierre-yves.oudeyer@inria.fr
clement.moulin-frier@inria.fr

*Corresponding author.

doi:10.1017/S0140525X25101805, e245

Abstract

The authors make an intriguing case that peer cultures could play a key role in cultural adaptation by generating qualitatively different cultural variation compared to adult cultures. However, the mechanisms responsible for this distinction remain unclear. We here discuss how accounting for the role of intrinsic motivation in shaping the content of peer cultures may help explain their evolutionary dynamics.

Shedding light on the specificity of the evolutionary dynamics of peer cultures requires an examination of the selective pressures that shape their content. We suggest that drawing from theories of motivation may provide interesting insights about what makes those selective forces peculiar. Indeed, whether a cultural trait will propagate or decline crucially depends on whether individuals will invest their time and energy in learning, remembering, modifying, and transmitting it – that is, whether they will be motivated to do so.

Psychologists typically distinguish intrinsic motivation from extrinsic motivation (Ryan & Deci, 2000). Intrinsic motivation is defined as "*the doing of an activity for its inherent satisfaction rather than for some separable consequence*" (Ryan & Deci, 2000, p. 56). By contrast, extrinsically motivated behaviors are driven by the prospect of an external reward. In childhood, intrinsic motivation plays a major role in driving behavior. Indeed, as pointed out by the authors, children are cared for and provisioned by adults, thus reducing the necessity to engage in extrinsically motivated activities. In contrast, adults may have less time to allocate to intrinsically motivating activities. These differences may translate into different selective pressures on cultural traits: in peer cultures, the fitness of a cultural trait may depend more on its capacity to elicit intrinsic motivation, whereas in adult cultures, successful variants may be those that effectively serve an external goal (e.g., fulfilling physiological needs).

Understanding what shapes the evolutionary dynamics of peer cultures may thus require to describe which features of an activity make it intrinsically interesting. The literature on intrinsic motivation is rich in theories identifying such features (Ten, Oudeyer, & Moulin-Frier, 2022). These include optimal incongruity (Dember & Earl, 1957; Hunt, 1965), intermediate novelty (Berlyne, 1960), optimal challenge (Csikszentmihalyi, 1990), or learning progress (Poli et al., 2022; Poli et al., 2025; Ten et al., 2021). A common point of these theories is that they posit that intrinsic motivation is maximized when individuals find themselves in a sweet spot between the trivial and the impossible. Activities need to be challenging enough to prevent boredom, but not too challenging to avoid creating anxiety or discouragement (Csikszentmihalyi, 1990). This predicts that the evolutionary dynamics in intrinsically motivated populations would differ markedly from those in extrinsically motivated ones. Among intrinsically motivated individuals, cultural packages are expected to include traits that offer an optimal level of challenge. In contrast, among extrinsically motivated individuals, cultural packages are likely to consist of traits that become increasingly efficient at fulfilling their specific function.

A second key difference between extrinsic and intrinsic selective pressures is that the latter depend on the current knowledge of group members. Extrinsically motivated individuals should always select the most efficient cultural trait, regardless of their current

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

knowledge. In contrast, the intrinsic value of an activity depends on the current skills of the individual: for instance, a chess puzzle that is engaging for a beginner will be boring for an advanced player. As a result, while incentives shaped by extrinsic pressures remain stable, intrinsic selective pressures produce shifting incentives that evolve with the individual's skill level, rendering the cultural fitness landscape more dynamic over time. This could for instance explain the observation reported by the authors that popular games often become increasingly complex, while games in decline become simpler. Indeed, as a game gets more popular, children may be more familiar with the rules and strategies, thus reducing how challenging the game is. To remain within the sweet spot of optimal difficulty, the game may thus need to become more complex.

That peer cultures are directed toward moving targets may be central to explaining their contribution to cultural adaptation. By steering evolution toward what is unknown, yet learnable, intrinsic selective pressures may allow peer cultures to follow gradients of increasing complexity, even if those are not associated with any external utility. Eventually, this repertoire of complex skills and knowledge may be useful for achieving an external goal, at which point it could be exapted for extrinsic purposes. This is one possible interpretation of the case study of Matsé children reported by the authors: their proficiency at fishing may have originated in a curiosity for discovering river areas. Over time, this curiosity would have led them to build an increasingly complex repertoire of river-related skills, ultimately allowing them to exploit it for foraging.

It is worth emphasizing that adults also engage in curiosity-driven activities and, for example, have been shown to track their own learning progress when choosing tasks (Ten et al., 2021). This suggests that studying peer cultures can illuminate evolutionary forces that are also at play in adult culture but are often overlooked. Indeed, much of the current research on cultural evolution assumes an external objective, such as in models implementing payoff-biased social learning (Henrich, 2004; Kendal et al., 2018) or in experiments where participants are incentivized to maximize their score (Caldwell & Millen, 2009; Derex et al., 2019). As a result, our understanding of cultural evolution is heavily skewed toward scenarios where extrinsic motivation drives the evolution of cultural traits. Recognizing the role of intrinsic motivation could help generate more nuanced predictions about cultural dynamics in both peer and adult contexts. For instance, cultural traits shaped by extrinsic selective pressures may be tightly constrained by functional requirements, whereas those shaped by intrinsic motivation may exhibit greater variability. This pattern may be reflected in a recent ethnographic study (Kaaronen et al., 2025) comparing knots and string figures, which suggests that "the state space of string figures (Kaaronen et al., 2024), a common game or pastime across cultures worldwide, seems to have been explored much more thoroughly and creatively than that of knots." This illustrates how the design space of cultural traits can be explored independently of extrinsic utility, a process that may be key to understanding the open-ended nature of human cultural evolution.

Overall, we believe that a comprehensive understanding of cultural dynamics requires a clearer specification of the mechanisms underlying intrinsically motivated exploration. Studying peer cultures offers a promising path toward this goal and may illuminate important, yet overlooked, evolutionary forces. However, as the vast majority of research on intrinsic motivation has been conducted with Western participants, and largely outside the context of cultural evolution, further work is needed to build a more complete and cross-culturally valid picture of motivational mechanisms.

Financial support. This research was partially funded by the French National Research Agency (ANR, project ECOCURL, Grant ANR-20-CE23-0006, and ANR, project DeepCuriosity, Grant ANR-19-CHIA-0004, and ANR, project OPTILEARN, Grant ANR−21-CE28−0019−01). M.D. acknowledges Institute for Advanced Study in Toulouse (IAST) funding from the French National Research Agency (ANR) under grant no. ANR-17-EURE-0010 (Investissements d'Avenir program).

Competing interests. None.

References

Berlyne, D. E. (1960). *Conflict, arousal, and curiosity (p. xii, 350)*. McGraw-Hill Book Company. https://doi.org/10.1037/11164-000

Caldwell, C. A., & Millen, A. E. (2009). Social learning mechanisms and cumulative cultural evolution: Is imitation necessary?. *Psychological Science*, *20*(12), 1478–1483.

Csikszentmihalyi, M. (1990). *Flow : The Psychology of Optimal Experience*.

Dember, W. N., & Earl, R. W. (1957). Analysis of exploratory, manipulatory, and curiosity behaviors. *Psychological Review*, *64*(2), 91–96. https://doi.org/10.1037/h0046861

Derex, M., Bonnefon, J.-F., Boyd, R., & Mesoudi, A. (2019). Causal understanding is not necessary for the improvement of culturally evolving technology. *Nature human behaviour*, *3*(5), 446–452.

Henrich, J. (2004). Demography and cultural evolution: How adaptive cultural processes can produce maladaptive losses: The tasmanian case. *American Antiquity*, *69*(2), 197–214. https://doi.org/10.2307/4128416

Hunt, J. M. (1965). Intrinsic motivation and its role in psychological development. *Nebraska Symposium on Motivation*, *13*, 189–282.

Kaaronen, R. O., Henrich, A. K., Manninen, M. A., Walsh, M. J., Wisher, I., Eronen, J. T., & Riede, F. (2025). The ties that bind : Computational, cross-cultural analyses of knots reveal their cultural evolutionary history and significance. *Cambridge Archaeological Journal*, *35*(3), 472–488. https://doi.org/10.1017/S0959774325000071

Kaaronen, R. O., Walsh, M. J., Henrich, A. K., Wisher, I., Miu, E., Manninen, M. A., Eronen, J. T., & Riede, F. (2024). A global cross-cultural analysis of string figures reveals evidence of deep transmission and innovation. *Journal of The Royal Society Interface*, *21*(221), 20240673. https://doi.org/10.1098/rsif.2024.0673

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

Poli, F., Meyer, M., Mars, R. B., & Hunnius, S. (2022). Contributions of expected learning progress and perceptual novelty to curiosity-driven exploration. *Cognition*, *225*, 105119. https://doi.org/10.1016/j.cognition.2022.105119

Poli, F., Meyer, M., Mars, R. B., & Hunnius, S. (2025). Exploration in 4-year-old children is guided by learning progress and novelty. *Child Development*, *96*(1), 192–202. https://doi.org/10.1111/cdev.14158

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations : Classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54–67. https://doi.org/10.1006/ceps.1999.1020

Ten, A., Kaushik, P., Oudeyer, P.-Y., & Gottlieb, J. (2021). Humans monitor learning progress in curiosity-driven exploration. *Nature communications*, *12*(1), 5972.

Ten, A., Oudeyer, P.-Y., & Moulin-Frier, C. (2022). *Curiosity-driven exploration: Diversity of mechanisms and functions.* https://doi.org/10.1017/9781009026949

Children contribute to cultural evolution beyond peer culture

Fanxiao Wani Qiu[a]* and Henrike Moll[a,b]

[a]Department of Psychology, University of Southern California, Los Angeles, CA, USA and [b]Hanse-Wissenschaftskolleg, Institute for Advanced Study, Germany
fanxiaoq@usc.edu
hmoll@usc.edu
https://dornsife.usc.edu/henrike-moll/

*Corresponding author.

doi:10.1017/S0140525X25102021, e246

Abstract

Lew-Levy and Amir contend that children are cultural producers in their own right, contributing to cumulative culture through peer culture. We argue that children's pedagogical contributions extend beyond the social world of peers. Children not only transmit child-relevant knowledge from peer to peer, but also actively share, with children and adults alike, knowledge both that ultimately stemmed from cognitively mature agents.

Lew-Levy and Amir argue that children are cultural producers in their own right, contributing to cumulative culture through the creation and maintenance of peer culture. They emphasize that children independently generate and sustain their own body of knowledge, which can benefit their communities and serve as a source of cultural diversity. While we agree that children's role as propagators of cultural knowledge is both understudied and underappreciated (see Qiu & Moll, 2022), we contend that much of the knowledge children transmit originates from adults – be it factual information, such as "There are no polar bears in Antarctica" or procedural knowledge, such as how to properly harvest, prepare, and cook cassava (Ankei, 2023). We argue that children contribute to cumulative culture primarily by transmitting this adult-originated knowledge. Objects of transmission span across the practical (e.g., household chores, skill acquisition) and theoretical (e.g., factual knowledge, reasoning) domains (Howe et al., 2012; Maynard, 2002; Pueschel et al., 2023; Qiu et al., 2025b). It is precisely in their role as transmitters of culturally valuable knowledge – initially acquired from adults – that children primarily make their contribution to cumulative culture.

Children's exceptional ability to teach others is now well-documented (Qiu & Moll, 2022; Sobel & Letourneau, 2016; Strauss, Ziv, & Stein, 2002). From a young age, children have a pedagogical capacity that lets them share general and relevant knowledge and adapt it to specific learners (Qiu et al., 2024). This pedagogical knack suggests that children do not simply absorb culture but actively shape and refine it through teaching. By preschool age, children already exhibit an adult-like understanding of teaching. They selectively pass on information that is true, objective, generalizable, and relevant to learners. They also modify their instruction based on the learner's needs and goals, demonstrating awareness of teaching as a cooperative, bidirectional process. Our recent meta-analysis (Qiu et al., 2025a) found that most experimental work investigating children's selective teaching focuses on factual information in the epistemic domain, further illustrating our point that children's teaching is not limited to peer culture. For example, experimental paradigms have examined children's transmission of factual knowledge (e.g., "Umbrellas protect you from the rain," Baer & Friedman, 2018; "Ice melts when it gets hot," Danovitch et al., 2023), as well as procedural knowledge, such as how to operate a novel box (Bridgers, Jara-Ettinger, & Gweon, 2020) or a causally ambiguous toy (Gweon & Schulz, 2019).

In naturalistic studies, sibling caretakers play an important role in socializing their younger siblings, teaching them language, routines, and appropriate behavior (Ochs, 1988; Watson-Gegeo & Gegeo, 1989; Zukow-Goldring, 2002). For example, relative clauses such as "*take that car that is blue*" occur more frequently in child-to-child conversations than in adult-to-child exchanges, and it was found that in Southern Africa, children with more sibling interaction acquire more complex linguistic forms than their counterparts without such experiences (Demuth, 1984). In small agrarian societies in Central Mexico, older siblings were found to teach younger ones how to make tortillas – from gathering ingredients to cooking the dough on a comal (Zukow-Goldring, 2002). Similarly, in Mayan communities, Zinacantec children teach each other daily tasks that originated from adults, such as hand washing or water pouring (Maynard, 2002). Across cultures, children's teaching reliably involves the transmission of knowledge that stemmed from adults and transcends peer culture, driving cumulative culture far beyond circulating knowledge related to dance, song, rhyme, and play among same-aged peers.

Lew-Levy and Amir stress that children generate knowledge and ideas in their own right, but also that these ideas are spread on a horizontal plane – thus creating a child or youth culture that exists in parallel to adult culture. They maintain that in rare moments of social change, peer culture can influence adult culture and benefit the community more broadly, such as Matés children's fishing expertise or the unique weaving patterns that arose from Mayan children. We propose that child-to-adult transmission is far more common and frequent than previously acknowledged. Children act as cultural brokers across a range of contexts. In immigrant families, for instance, children translate for non-native-speaking parents and grandparents (Orellana, 2009; Weisskirch, 2006) and introduce technology to connect their families to the local community (Katz, 2010). Adolescents engaged in civics education may also initiate political conversations at home, increasing their parents' civic competence (McDevitt & Chaffee, 2002). Children feed their knowledge back into the adult world not only in rare moments of ecological change, but regularly and meaningfully in their daily lives.

While we agree with Lew-Levy and Amir's thesis that children are not merely passive recipients but active benefactors of cultural evolution, we argue that teaching is a primary mechanism through which children shape culture outside of the confines of peer interaction. Theories of cultural evolution must therefore expand their focus beyond peer exchanges and recognize that children's teaching of adult-originated information drives knowledge transmission across social contexts, influencing both their peers and adult culture.

Acknowledgments. We would like to thank all the members of the USC Minds in Development lab for helpful discussion. We thank the Hanse-Wissenschaftskolleg (HWK) for their support of this work with a fellowship granted to HM.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. The authors declare none.

References

Ankei, T. (2023). Diffusion of cassava detoxification in Africa: A reconsideration of its biocultural history. *African Study Monographs. Supplementary Issue.*, *61*, 93–138.

Baer, C., & Friedman, O. (2018). Fitting the message to the listener: Children selectively mention general and specific facts. *Child Development*, *89*(2), Article 2. https://doi.org/10.1111/cdev.12751

Bridgers, S., Jara-Ettinger, J., & Gweon, H. (2020). Young children consider the expected utility of others' learning to decide what to teach. *Nature Human Behaviour*, *4*(2), Article 2. https://doi.org/10.1038/s41562-019-0748-6

Danovitch, J. H., Scofield, J., Williams, A. J., Davila, L., & Bui, C. (2023). Children's selective information transmission in STEM and non-STEM domains. *Cognitive Development*, *66*, 101332. https://doi.org/10.1016/j.cogdev.2023.101332

Demuth, K. (1984). The acquisition of pragmatic word order in Sesotho. In *Proceedings from the 23rd Conference on Language Development*, *23*, 3340.

Gweon, H., & Schulz, L. (2019). From exploration to instruction: Children learn from exploration and tailor their demonstrations to observers' goals and competence. *Child Development*, *90*(1), Article 1. https://doi.org/10.1111/cdev.13059

Howe, N., Recchia, H., Della Porta, S., & Funamoto, A. (2012). "The driver doesn't sit, he stands up like the Flintstones!": Sibling teaching during teacher-directed and self-guided tasks. *Journal of Cognition and Development - J COGN DEV*, *13*, 208–231. https://doi.org/10.1080/15248372.2011.577703

Katz, V. S. (2010). How children of immigrants use media to connect their families to the community: The case of Latinos in South Los Angeles. *Journal of Children and Media*, *4*(3), 298–315. https://doi-org.libproxy1.usc.edu/10.1080/17482798.2010.486136

Maynard, A. E. (2002). Cultural teaching: The development of teaching skills in Maya sibling interactions. *Child Development*, *73*(3), Article 3. https://doi.org/10.1111/1467-8624.00450

McDevitt, M., & Chaffee, S. (2002). From top-down to trickle-up influence: Revisiting assumptions about the family in political socialization. *Political Communication*, *19*(3), 281–301. https://doi-org.libproxy2.usc.edu/10.1080/01957470290055501

Ochs, E. (1988). *Culture and language development: Language acquisition and socialization in a Samoan village*. Cambridge University Press

Orellana, M. F. (2009). Public para-phrasing. In M. F. Orellana (Ed.), *Translating childhoods: Immigrant youth, language, and culture* (pp. 66–78). Rutgers University Press. http://www.jstor.org/stable/j.ctt5hj1hn.8

Pueschel, E. B., Shen, Y., Byrd, K., Indik, O., & Moll, H. (2023). Four-year-olds share general knowledge and use generic language when teaching. *The Journal of Genetic Psychology*, *184*(3), Article 3. https://doi.org/10.1080/00221325.2022.2163875

Qiu, F. W., Gottesman, E., Cox, J., & Moll, H. (2025b). Young children teach objective facts as opposed to subjective opinion. *Developmental Psychology*. https://doi.org/10.1037/dev0001946

Qiu, F. W., Ipek, C., Gottesman, E., & Moll, H. (2024). Know thy audience: Children teach basic or complex facts depending on the learner's maturity. *Child Development*, *95*(4), 1406–1415. https://doi.org/10.1111/cdev.14077

Qiu, F. W., & Moll, H. (2022). Children's pedagogical competence and child-to-child knowledge transmission: Forgotten factors in theories of cultural evolution. *Journal of Cognition and Culture*, *22*(5), 421–435.

Qiu, F. W., Park, J., Vite, A., Patall, E., & Moll, H. (2025a). Children's selective teaching and informing: A meta-analysis. *Developmental Science*, *28*(1), e13576. https://doi.org/10.1111/desc.13576

Sobel, D. M., & Letourneau, S. M. (2016). Children's developing knowledge of and reflection about teaching. *Journal of Experimental Child Psychology*, *143*, 111–122.

Strauss, S., Ziv, M., & Stein, A. (2002). Teaching as a natural cognition and its relations to preschoolers' developing theory of mind. *Cognitive Development*, *17*(3–4), 1473–1487. https://doi.org/10.1016/S0885-2014(02)00128-4

Watson-Gegeo, K. A., & Gegeo, D. W. (1989). The role of sibling interaction in child socialization. In P. G. Zukow*(Ed.), Sibling interaction across cultures. Theoretical and methodological issues* (pp. 54–76). Springer-Verlag.

Weisskirch, R. S. (2006). Emotional aspects of language brokering among Mexican American adults. *Journal of Multilingual and Multicultural Development*, *27*(4), 332–343. https://doi.org/10.2167/jmmd421.1

Zukow-Goldring, P. (2002). Sibling caregiving. In M. H. Bornstein (Ed.), *Handbook of parenting: Vol. 3. Status and social conditions of parenting* (2nd ed., pp. 253–286). Erlbaum.

"If it ain't broke, don't fix it": Conservation vs. innovation in homo tool industries

Michelle Scalise Sugiyama*

Department of Anthropology, University of Oregon, Eugene, OR, USA
mscalise@uoregon.edu
https://blogs.uoregon.edu/humananimallab/

*Corresponding author.

doi:10.1017/S0140525X25102033, e247

Abstract

If childhood was critical to cultural adaptation, we would expect to see regular innovation in *Homo* tool industries. However, the Acheulean, Mousterian, and early *H. sapiens* industries are remarkably stable. Evidence of prolific innovation is largely absent before the European Middle-Upper Paleolithic transition, which is associated with increased longevity in *H. sapiens*, suggesting that innovation was sparked by grandparenthood.

The authors note that, although children today "frequently teach their parents about new technology," they "found little evidence for [children's] peer cultures producing complex technological innovations." The *Homo* material record exhibits a similar lack of evidence. If children were active agents in cultural adaptation, we would expect to see regular innovation in *Homo* tool industries. However, from *H. erectus* to *H. Neanderthalensis* to early *H. sapiens*, these industries are remarkable for their stability. The Acheulean industry lasted over a million years (Boyd & Silk, 2018), and the Neanderthals "show technological inertia in the development and use of lithic tools for 200,000 years" (Bocquet-Appel & Tuffreau, 2009:287). Similarly, in their exhaustive survey of the *H. sapiens* material record in Africa, McBrearty and Brooks conclude that the transition from Middle to Late Stone Age technology was gradual and that "both human anatomy and human behavior were intermittently transformed from an archaic to a more modern pattern over a period of more than 200,000 years" (2000:458). The stability of these technologies suggests that, until relatively recently – most notably the "creative explosion" (Pfeiffer, 1982) of Upper Paleolithic Europe – the human cultural pattern was predominantly one of conservation, not innovation.

The burst of innovation that coincided with the migration of anatomically modern humans (AMH) into Europe ~45 kya is widely regarded as evidence of behavioral modernity and as an archaeological anomaly that begs explanation (e.g., Mithen, 1996;

Powell, Shennan, & Thomas, 2009). In other words, behavioral modernity is characterized as a pronounced diversification in cultural adaptation strategies *and* a departure from the preceding material record. Behavioral modernity is characterized by improved blade and burin technology, exploitation of novel raw materials, use of personal ornaments, complex art forms, symbolic notation systems, musical instruments, long-distance exchange networks, and improved missile technology (Mellars, 2005). Although research shows that many of these behaviors appeared 30,000–40,000 years earlier in Africa (in a more gradual, piecemeal fashion; McBrearty & Brooks, 2000; Mellars, 2005), they are nevertheless of relatively recent emergence, evinced only by AMH. In contrast, the extended human subadult period began evolving ~2 mya, in conjunction with the dietary shift and associated brain expansion (Aiello & Wheeler, 1995; Kaplan et al., 2000; Leonard, Robertson, & Snodgrass, 2007).

Thus, a logical place to look for evidence that children contributed to innovation is the Middle-Upper Paleolithic transition in Europe. Demographics played a key role in this shift. Compared to Neanderthals, AMH populations were larger (Powell et al., 2009) and had a higher proportion of older adults (Caspari & Lee, 2004). Neanderthal populations may have been up to ten times smaller than those of their AMH contemporaries (Boyd & Silk, 2018:316), and few of their members survived to age 40 (Trinkaus, 2011) or even 30 (Caspari & Lee, 2004). Consequently, there were few individuals and little time in the lifespan for making and transmitting new discoveries (Bocquet-Appel & Degioanni, 2013). In contrast, increased longevity and group size in *H. sapiens* exponentially increased opportunities for knowledge accumulation (including new discoveries) and intergenerational knowledge transfer. A striking conclusion follows: the spark that ignited the explosion of cumulative culture was grandparents, not children (Caspari, 2011).

These findings are supported by the modern hunter–gatherer ethnographic record. Cumulative culture depends heavily on the conservation of knowledge, which in turn depends on accurate transmission across generations (Palmer, 2010; Scalise Sugiyama & Reilly, 2023; Scalise Sugiyama, 2024). In hunter–gatherer and other traditional cultures, this task falls largely to older adults, who are widely regarded as the most knowledgeable members of the community and most proficient transmitters of cultural lore (e.g., Schniter et al., 2015). For example, "Younger Ju/'hoan people, when asked for stories, most often protest that they 'have not grown old enough to have learned the things that old people know'" (Biesele, 1993:18). This is not false modesty: Biesele further observes that "in general their narrative abilities are less well formed" (1993:19) than those of their elders. Similarly, "Older people in Aboriginal society are regarded as reserves of important knowledge concerning the Dreaming and the physical resources of the landscape. By virtue of their survival experience, older people in society are often considered to have immense spiritual power" (Clarke, 2003:49).

This appreciation of greater life experience and the power (i.e., autonomy) it confers manifests itself as an ethos of respect for elders. For example, Nunamiut and Tareumiut "children are accustomed to whisper in conversing with adults and to remain quiet. The child was expected to obey all older people, and fell into this regimen fairly readily" (Spencer, 1959:237). Similarly, the "first and chief duties that … [Ainu] children were taught were obedience to parents … and reverence for the old men of their village. They were to speak when spoken to, and at other times to be seen, but not heard. By no means were they allowed to interrupt their elders when engaged in conversation" (Batchelor, 1892:109). These imperatives indicate that children were not regarded as fonts of useful knowledge and were not encouraged to explore new ways of doing things. Rather, forager education emphasized mastery of traditional teachings and technology. This is seen in the training of Nunamiut and Tareumiut hunters: when a boy's voice changed, "he was permitted to share in hunting and whaling, not yet as a fully fledged participant, but as an *observer* and *apprentice*. This was considered to form a vital part of his education" (Spencer, 1959:241; my emphasis). Amid such restrictions, if children did indeed contribute to cultural adaptation, it was likely an uphill battle.

A striking feature of children's culture is that its products mirror adult culture: foraging technologies, processing techniques, ecological knowledge, verbal skills, social norms, etc. Thus, like Baka play-trapping, which "combines recreational and educative purposes as it prepares budding trappers for adulthood" (Dounias, 2016:9), children's peer culture can be seen as a set of play activities that teach them how to be "cultural" at a level of complexity compatible with their cognitive and anatomical limitations. I second the authors' call for more targeted research on this topic.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. The author declares no competing interests.

References

Aiello, L., & Wheeler, P. (1995). The expensive-tissue hypothesis: The brain and the digestive system in human and primate evolution. *Current Anthropology*, *36*(2), 199–221.

Batchelor, J. (1892). *The ainu of Japan*. The Religious Tract Society.

Biesele, M. (1993). *Women like meat: The folklore and foraging ideology of the kalahari Ju/'hoan*. Indiana University Press.

Bocquet-Appel, J-P., & Degioanni, A. (2013). Neanderthal demographic estimates. *Current Anthropology*, *54*(S8), S202–S213.

Bocquet-Appel, J-P., & Tuffreau, A. (2009). Technological responses of Neanderthals to macroclimatic variations (240,000-40,000 BP). *Human Biology*, *81*(2–3), 287–307.

Boyd, R., & Silk, J. (2018). *How humans evolved*. (8th edition) W. W. Norton & Co.

Caspari, R., & Lee, S. H. (2004). Older age becomes common late in human evolution. *Proceedings of the National Academy of Sciences*, *101*(30), 10895–10900.

Caspari, R. (2011). The evolution of grandparents. *Scientific American*, *305*(2), 44–49.

Clarke, P. (2003). *Where the ancestors walked: Australia as an aboriginal landscape*. Allen & Unwin.

Dounias, E. (2016). From subsistence to commercial hunting: Technical shift in cynegetic practices among southern Cameroon forest dwellers during the 20th century. *Ecology and Society*, *21*(1), 1–14. https://www.jstor.org/stable/26270329

Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A. M. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology*, *9*(4), 156–185.

Leonard, W. R., Robertson, M. L., & Snodgrass, J. J. (2007). Energetics and the evolution of brain size in early homo. *Guts and Brains: An Integrative Approach to the Hominin Record*, 29–46.

McBrearty, S., & Brooks, A. S. (2000). The revolution that wasn't: A new interpretation of the origins of modern human behavior. *Journal of Human Evolution*, *39*(5), 453–563.

Mellars, P. (2005). The impossible coincidence: A single-species model for the origins of modern human behavior in Europe. *Evolutionary Anthropology*, *14*, 12–27.

Mithen, S. J. (1996). *The prehistory of the mind: A search for the origins of art, religion, and science*. Thames & Hudson.

Palmer, C. T. (2010). Cultural traditions and the evolutionary advantages of noninnovation. In M. J. O'Brien, & S. Shennan (Eds.), *Innovation in cultural*

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

systems: Contributions from evolutionary Anthropology (pp. 161–174). MIT Press. https://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=291844

Pfeiffer, J. E. (1982). *The creative explosion: An inquiry into the origins of art and religion*. Harper & Row.

Powell, A., Shennan, S., & Thomas, M. (2009). Late Pleistocene demography and the appearance of modern human behavior. *Science*, *324*, 1298–1301.

Scalise Sugiyama, M. (2024). Oral storytelling: Humanity's first data management system? *Evolution and Human Behavior*, *45*(3), 241–251.

Scalise Sugiyama, M., & Reilly, K. J. (2023). Cross-cultural forager myth transmission rules: Implications for the emergence of cumulative culture. *Evolution and Human Behavior*, *44*(6), 566–583.

Schniter, E., Gurven, M., Kaplan, H. S., Wilcox, N. T., & Hooper, P. L. (2015). Skill ontogeny among Tsimane forager-horticulturalists. *American Journal of Physical Anthropology*, *158*(1), 3–18.

Spencer, R. F. (1959). The North Alaskan Eskimo: A study in ecology and society. *Bureau of American Ethnology Bulletin*, *171*, 1–237. http://www.biodiversitylibrary.org/item/87893

Trinkaus, E. (2011). Late Pleistocene adult mortality patterns and modern human establishment. *Proceedings of the National Academy of Sciences*, *108*(4), 1267–1271.

A missing piece of the puzzle? Applying the peer culture concept to the study of human cultural origins

William Daniel Snyder[a]* and Elisa Bandini[b]

[a]Eberhard Karls University of Tübingen, Working Group Paleoanthropology, Senckenberg Centre for Human Evolution and Palaeoenvironment, Tübingen, Germany and [b]University of Zürich, Animal Behaviour Group, Department of Evolutionary Biology and Environmental Sciences, Zürich, Switzerland
wdspaleo@gmail.com
elisa-bandini@hotmail.it

*Corresponding author.

doi:10.1017/S0140525X25101933, e248

Abstract

Lew-Levy & Amir hypothesize that peer cultures have implications for the evolution and ecological adaptiveness of *Homo sapiens*. Here, we explore the feasibility of finding evidence of peer cultures in prehistory based on the current state of prehistoric archaeology. Accordingly, we recommend new experimental research with child knappers to improve our ability to infer children's activities in the archaeological record.

Lew-Levy & Amir convincingly argue for the importance of peer cultures for the cultural niche and cumulative cultural evolution in recent *Homo sapiens*. They extend this argumentation by suggesting a relevance of peer cultures to hunter-gatherer prehistory and human adaptiveness for overcoming environmental change. These ideas, however, require additional development if we are to integrate the peer culture concept into the wider constellation of evolving human cognitive and cultural traits.

Because peer cultures (with the full suite of components *sensu* Lew-Levy & Amir) seem to be unique to humans, investigation into the evolutionary context of peer cultures should be targeted at the *preserved* evidence in the archaeological record, i.e., material culture like stone tools (Bandini, Harrison, & Motes-Rodrigo, 2022; Schick & Toth, 1994; Toth & Schick, 2018). Debates on the cultural and linguistic abilities of extinct hominins notwithstanding (Morgan et al., 2015; Putt, Woods, & Franciscus, 2014; Snyder, Reeves, & Tennie, 2022; Stout et al., 2008, 2019; Tennie et al., 2017; Toth & Schick, 2018), there is no *non*-material culture (e.g., the *H. erectus* equivalent of nursery rhymes) that we can analyze directly as can be done with living cultures.

The archaeological record can generally be rather sparse and incomplete (Dibble et al., 2017; Perreault, 2019). First, taphonomic processes can simply "erase" much of what was originally produced and left behind by hominins. There are also theoretical and methodological constraints limiting our ability to properly identify cognitive processes and cultural phenomena from the past (Dibble et al., 2017). Depending on what contexts we look at, peer cultures and/or their underlying prerequisites (like extended childhoods) could also have simply been absent to start with. Which prompts the question: can we find peer cultures *sensu stricto* in the archaeological record (see also Meneganzin & Currie, 2025)?

Theoretically, we could identify prehistoric peer cultures based on the features outlined by Lew-Levy & Amir, including both processes (i.e., high-fidelity transmission including biased horizontal transmission *between children* and variation-generation via innovation) and observable outcomes (i.e., segregation of child and adult spaces; parallel, distinct peer and adult cultures; and the preservation of abandoned adult knowledge).

However, behavioral and cognitive processes do not fossilize and can be difficult to reconstruct (Dibble et al., 2017; Schick & Toth, 1994). High-fidelity transmission (or, "know-how copying": Bandini et al., 2020; Tennie et al., 2020) alone is a matter of intense debate in archaeology involving many distinct accounts (Morgan et al., 2015; Snyder et al., 2022; Stout et al., 2019; Tennie et al., 2017; one account is shown in Figure 1). Furthermore, learning biases and (play-driven) innovation are practically impossible to track down in (earlier) periods with our current methodologies. Pre-existing child knapping anecdotes and experiments illustrate child knapping innovation potential (Ferguson, 2003; Sternke & Sørensen, 2009), but these cases involved *vertical* transmission from adults to children. It is also unclear if and how material outcomes of children's innovation processes differ from outcomes resulting from human adults' innovation processes (Pargeter et al., 2023; Snyder et al., 2022; or even adult apes; Toth et al., 1993).

If we look at outcomes in the archaeological record rather than at processes, we still run into issues. But, archaeological sites, especially in earlier prehistory, tend to be time-averaged and spatially adjacent materials are not always from temporally related events (Perreault, 2019). Consequently, peer culture outcomes (segregation of child and adult spaces and parallel peer and adult cultures, *if* they were present) may be undetectable due to the poor spatiotemporal resolution at many evolutionarily relevant sites. Finding the "preservation of abandoned adult knowledge" could also be difficult. "Simpler" technological modes re-appear and

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

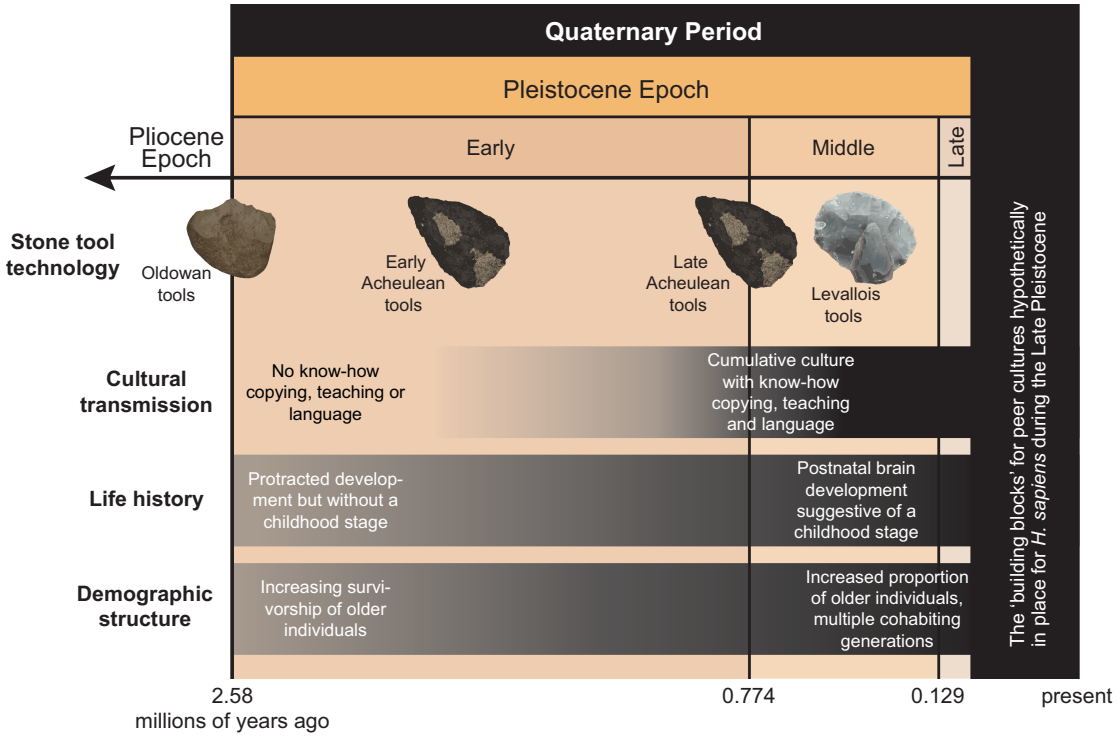

Figure 1 (Snyder and Bandini). A simplified evolutionary timeline of traits prerequisite for the emergence of peer cultures (Caspari & Wolpoff, 2013; Gunz et al., 2010, 2020; Meneganzin & Currie, 2025; Paige & Perreault, 2024; Snyder et al., 2022; van Schaik, Pradhan, & Tennie, 2019).

co-occur with more "advanced" modes throughout prehistory, but with current methods, determining whether maintenance of older technological modes is due to children versus adults is impossible. For example,

Late Neandertals may have used both "simpler" Mode 1 and "advanced" Mode 3 tools due to convenience or utility (Shipton et al., 2013) and not as part of parallel peer cultures, although such a hypothesis would be worth considering.

Overall, it would be difficult to find unequivocal evidence in Pleistocene contexts for peer cultures *sensu* Lew-Levy & Amir. But what if we first take a step back: can we find more general evidence of hominin children's activities, i.e., by differentiating children's cultural products from adult's cultural products? There has been concerted attention given to children's activities in later prehistory (*H. sapiens* from the Late Paleolithic onwards; e.g., Finlay, 2015; Riede et al., 2021). Empirical investigation of children even earlier – necessary for evaluating peer cultures as a driver of human evolution – has been more limited (see work of Nowell, 2021).

Testing this requires observable outcomes like artifact attributes and assemblage-level patterns, which might vary according to the toolmaking agent's age. Here, we especially need markers that can distinguish child novice toolmakers from adult novices (for early stone toolmaking and not, e.g., Mesolithic toolmaking; Sternke & Sørensen, 2009). For example, child knappers make smaller flakes compared to adult experts, but so do adult novices (e.g., Pargeter, Khreisheh, & Stout, 2019, 2023). Smaller flakes can also relate to economic or technological decisions by knappers (e.g., Gallotti & Mussi, 2015). Thus, more precise methods of discerning between different sources of artifact and assemblage variation need to be developed.

To make inferences about the activities of children in early prehistory – from our perspective – we require experimentally produced reference datasets. Knapping experiments (on early stone toolmaking in the Pliocene to Middle Pleistocene) with human children can elucidate the ontogenetic and cultural processes relevant to toolmaking, while also giving better indications of what children's cultural products would look like. Ethical concerns (related to consent and safety) have been a major obstacle to such studies, but recent advances in artificial knapping materials (e.g., Snyder et al., 2025), 3D-printing, and virtual reality should allow safer and easier experimental data collection.

Acknowledgments. Replica Oldowan and Acheulean artifacts were made by the first author and Moritz Kuhn, respectively, and photographed by the first author. The image of replica Levallois artifacts is courtesy of Elena Moos.

Financial support. No funding was received for this work.

Competing interests. None.

References

Bandini, E., Motes-Rodrigo, A., Steele, M. P., Rutz, C., & Tennie, C. (2020). Examining the mechanisms underlying the acquisition of animal tool behaviour. *Biological Letters*, *16*, 20200122.

Bandini, E., Harrison, R. A., & Motes-Rodrigo, A. (2022). Examining the suitability of extant primates as models of hominin stone tool culture. *Humanities and Social Sciences Communications*, *9*(1), 1–18.

Caspari, R., & Wolpoff, M. H. (2013). The process of modern human origins: The evolutionary and demographic changes giving rise to modern humans. In F. H. Smith, J. C. M. Ahern, (Eds.) *The origins of modern humans: Biology reconsidered* (pp. 355–391). John Wiley & Sons.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Dibble, H. L., Holdaway, S. J., Lin, S. C., Braun, D. R., Douglass, M. J., Iovita, R., McPherron, S. P., Olszewski, D. I., & Sandgathe, D. (2017). Major fallacies surrounding stone artifacts and assemblages. *Journal of Archaeological Method and Theory*, *24*, 813–851.
Ferguson, J. R. (2003). An experimental test of the conservation of raw material in flintknapping skill acquisition. *Lithic Technology*, *28*(2), 113–131.
Finlay, N. (2015). Kid-knapped knowledge: Changing perspectives on the child in lithic studies. *Childhood in the Past*, *8*(2), 104–112.
Gallotti, R., & Mussi, M. (2015). The unknown Oldowan: ~1.7-million-year-old standardized obsidian small tools from Garba IV, Melka Kunture, Ethiopia. *PLoS ONE*, *10*(12), e0145101.
Gunz, P., Neubauer, S., Maureille, B., & Hublin, J.-J. (2010). Brain development after birth differs between Neanderthals and modern humans. *Current Biology*, *20*(21), R921–R922.
Gunz, P., Neubauer, S., Falk, D., Tafforeau, P., Le Cabec, A., Smith, T. M., Kimbel, W. H., Spoor, F., & Alemseged, Z. (2020). *Australopithecus afarensis* endocasts suggest ape-like brain organization and prolonged brain growth. *Science Advances*, *6*(14), eaaz4729.
Meneganzin, A., & Currie, A. (2025). Not wasted on the young: Childhood, trait complexes & human behavioral ecology. *Studies in History and Philosophy of Science*, *109*, 12–20.
Morgan, T. J. H., Uomini, N. T., Rendell, L. E., Chouinard-Thuly, L., Street, S. E., Lewis, H. M., Cross, C. P., Evans, C., Kearney, R., de la Torre, I., Whiten, A., & Laland, K. N. (2015). Experimental evidence for the co-evolution of hominin tool-making teaching and language. *Nature Communications*, *6*(1), 6029.
Nowell, A. (2021). *Growing up in the ice age. Fossil and archaeological evidence of the lived lives of Plio-Pleistocene children*. Oxbow Books.
Paige, J., & Perreault, C. (2024). 3.3 million years of stone tool complexity suggests that cumulative culture began during the middle Pleistocene. *Proceedings of the National Academy of Sciences of the United States of America*, *121*(26), e2319175121.
Pargeter, J., Khreisheh, N., & Stout, D. (2019). Understanding stone tool-making skill acquisition: Experimental methods and evolutionary implications. *Journal of Human Evolution*, *133*, 146–166.
Pargeter, J., Liu, C., Kilgore, M. B., Majoe, A., & Stout, D. (2023). Testing the effect of learning conditions and individual motor/cognitive differences on knapping skill acquisition. *Journal of Archaeological Method and Theory*, *30*, 127–171.
Perreault, C. (2019). *The quality of the archaeological record*. University of Chicago Press.
Putt, S. S., Woods, A. D., & Franciscus, R. G. (2014). The role of verbal interaction during experimental bifacial stone tool manufacture. *Lithic Technology*, *39*(2), 96–112.
Riede, F., Walsh, M. J., Nowell, A., Langley, M. C., & Johannsen, N. N. (2021). Children and innovation: Play, play objects and object play in cultural evolution. *Evolutionary Human Sciences*, *3*, e11.
Schick, K. D., & Toth, N. (1994). *Making silent stones speak: Human evolution and the dawn of technology*. Simon & Schuster.
Shipton, C., Clarkson, C., Bernal, M. A., Boivin, N., Finlayson, C., Finlayson, G., Fa, D., Pacheco, F. G., & Petraglia, M. (2013). Variation in lithic technological strategies among the Neanderthals of Gibraltar. *PLoS ONE*, *8*(6), e65185.
Snyder, W. D., Reeves, J. S., & Tennie, C. (2022). Early knapping techniques do not necessitate cultural transmission. *Science Advances*, *8*(27), eabo2894.
Snyder, W. D., Boysen, D., Orellana-Figueroa, J. D., Tennoe, C., & Reeves, J. S. (2025). Trade-offs in standardizing raw materials: Experimental control in live knapping studies. *Advances in Archaeological Practice*, *12*(4), 390–415.
Sternke, F., & Sørensen, M. (2009). The identification of children's flint knapping products in Mesolithic Scandinavia. In S. McCartan, R. Schulting, G. Warren, P. C. Woodman, (Eds.) *Mesolithic horizons. papers presented at the seventh international conference on the mesolithic in europe, belfast 2005* (pp. 722–729). Oxbow Books.
Stout, D., Toth, N., Schick, K., & Chaminade, T. (2008). Neural correlates of early stone age toolmaking: Technology, language and cognition in human evolution. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1499), 1939–1949.
Stout, D., Rogers, M. J., Jaeggi, A. V., & Semaw, S. (2019). Archaeology and the origins of human cumulative culture: A case study from the earliest Oldowan at Gona, Ethiopia. *Current Anthropology*, *60*(3), 309–340.
Tennie, C., Premo, L. S., Braun, D. R., & McPherron, S. P. (2017). Early stone tools and cultural transmission: Resetting the null hypothesis. *Current Anthropology*, *58*(5), 652–672.
Tennie, C., Bandini, E., van Schaik, C. P., & Hopper, L. M. (2020). The zone of latent solutions and its relevance to understanding ape cultures. *Biology & Philosophy*, *35*(5), 55.
Toth, N., & Schick, K. (2018). An overview of the cognitive implications of the Oldowan industrial complex. *Azania: Archaeological Research in Africa*, *53*(1), 3–39.
Toth, N., Schick, K. D., Savage-Rumbaugh, E. S., Sevcik, R. A., & Rumbaugh, D. M. (1993). Pan the Tool-Maker: Investigations into the stone tool-making and tool-using capabilities of a bonobo (*Pan paniscus*). *Journal of Archaeological Science*, *20*(1), 81–91.
van Schaik, C. P., Pradhan, G. R., & Tennie, C. (2019). Teaching and curiosity: Sequential drivers of cumulative cultural evolution in the hominin lineage. *Behavioral Ecology and Sociobiology*, *73*, 2.

Animal infants as agents of cultural adaptation

Cédric Sueur[a]*, Marie Pelé[b] and Michael A. Huffman[c,d]

[a]IPHC, UMR7178, Université de Strasbourg, Strasbourg, France; [b]ETHICS EA 7446, Université Catholique de Lille, France; [c]Institute of Tropical Medicine, Nagasaki University, Nagasaki, Japan and [d]Deptartment of Anthropology, University of Sri Jayewardenepura, Gangodawila, Sri Lanka
cedric.sueur@iphc.cnrs.fr
marie.pele@univ-catholille.fr
huffman.michael.8n@kyoto-u.jp
https://sites.google.com/site/cedricsueuranimalbehaviour/
https://www.anthropo-lab.com/membre/marie-pele/
https://www.wrc.kyoto-u.ac.jp/en/members/HuffmanMA.html

*Corresponding author.

doi:10.1017/S0140525X25102070, e249

Abstract

The young across animal species act as learners and innovators of cultural behaviors. Early engagement with their social and ecological environment often leads to the emergence of new behaviors that spread within groups. These juvenile-driven innovations play a central role in developing and transmitting animal cultures, which should be recognized and protected as essential components of biodiversity.

Lew-Levy & Amir compellingly argue for the critical role of human children in cultural adaptation. We agree, but pushing the argument further back in evolutionary time, we propose that cultural innovation and transmission among infants are not uniquely human. Twentieth-century studies challenge the idea that culture is exclusive to humans (Galef, 1992; Laland & Hoppitt, 2003; Whiten, 2021). Animal culture, shaped by species-specific traits and ecological contexts, has emerged as a field of study (Huffman & Hirata, 2003). Our commentary extends this discussion by highlighting that nonhuman animals also exhibit culture. In these species groups as well, the young often act as key cultural agents, as innovators and early adopters of new behaviors.

The discovery of animal culture was first made in Japanese macaques, notably Imo, a juvenile female observed washing sweet

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

potatoes on the beach of Koshima Island, an innovation later adopted by many in her group (Hirata, Watanabe, & Masao, 2001; Kawai, 1965; Matsuzawa, 2015b). This behavior, along with wheat washing, marked early evidence of social transmission. Other cultural behaviors include stone handling, initiated by a juvenile female, and transmitted horizontally among peers, then vertically from mothers to offspring (Huffman, 1996; Leca, Gunst, & Huffman, 2007; Nahallage & Huffman, 2007), and hot spring bathing, which reduces stress and enhances thermoregulation (Matsuzawa, 2018; Suzuki, 1965; Takeshita et al., 2018). These behaviors reveal culture-like processes across macaque populations. This is now extended to many animal species, even insects. Animal culture refers to socially learned behaviors transmitted horizontally and vertically within species (Galef, 1992; Laland & Hoppitt, 2003; Whiten, 2021), the direction being dependent in part by the nature of the behavior itself (Huffman & Hirata, 2003). These behaviors, not genetically inherited, vary across populations and are shaped by social transmission rather than environmental factors alone (Hoppitt & Laland, 2013; Whiten, 2000). However, similar behaviors found in isolated populations, and indeed phylogenetically related taxa suggest a complex interplay between genetic predispositions and learning (Huffman & Hirata, 2003). Transmission mechanisms include local enhancement, imitation, and even teaching (Galef & Heyes, 2004; Zentall, 2022). Cultural diversity, as seen in chimpanzee tool use (Whiten, Horner, & de Waal, 1999, 2005), challenges the human exclusivity of culture and enriches our understanding of evolutionary processes. Researchers distinguish between preculture, protoculture, and culture to reflect varying levels of behavioral complexity in animals (Laland, 1998; McGrew, 1998; Tonutti, 2011). Preculture includes early-stage, inconsistently transmitted behaviors, often arising from imitation or trial-and-error. Protoculture involves socially learned behaviors, like tool use in chimpanzees or sweet potato washing in macaques, transmitted across generations but lacking symbolic and cumulative features (Asquith, 2003; Matsuzawa, 2015a, 2015b). In contrast, human culture is cumulative and symbolic, enabled by language, abstract thought, and teaching (Dean et al., 2014; Mesoudi & Thornton, 2018). It even includes externalized cognition through tools like smartphones (Clark & Chalmers, 1998; Henrich, 2017).

However, in many animal species, we can observe infants as learners and innovators in cultural transmission. What about learning? In chimpanzees, nut-cracking, a behavior requiring the selection and use of stones or wood to open hard-shelled nuts, is socially learned through prolonged observation and practice (about ten years) during infancy (Biro, Sousa, & Matsuzawa, 2006; McGrew et al., 1997). Young individuals often imitate skilled adults, especially their mothers, in both technique and tool choice. Killer whale caves also spend years learning particularly complex hunting strategies like intentional stranding or coordinated attacks on seals by shadowing their matrilineal group, where mothers and grandmothers act as cultural guides and teachers (Lopez & Lopez, 1985; Visser et al., 2008). In meerkats, adults gradually introduce pups to prey by initially providing incapacitated scorpions, adjusting the level of difficulty of the task as the young mature (Thornton & McAuliffe, 2006). Similarly, juvenile New Caledonian crows acquire complex tool-making skills, such as crafting hooked twigs, by observing experienced adults, with population-level variation indicating local cultural traditions (Hunt, 1996; Hunt & Gray, 2003; Rutz, Hunt, & Clair, 2018). These examples highlight the significance of an early age in acquiring survival skills and sustaining cultural continuity across generations.

Animal young are not only learners but also powerful innovators in the emergence of animal culture. A striking example is Imo, a juvenile female Japanese macaque who, in 1953, initiated sweet potato washing on Koshima Island, a behavior never observed before (Hirata et al., 2001; Matsuzawa, 2015b). Her innovation quickly spread among peers, especially juveniles, before being adopted by some adults (Kawai, 1965). Imo also contributed to wheat washing behavior, demonstrating creative problem-solving to separate wheat grains from sand. In other macaque populations, stone handling (SH) – a complex and nonfunctional behavior comprising dozens of distinct manipulations – also originated with a juvenile and spread horizontally to peers before being passed vertically from SH mothers to offspring when they began to raise their own offspring (Huffman, 1996; Leca et al., 2007; Nahallage & Huffman, 2007), showing the importance of peer culture. In orangutans and capuchins, young individuals experiment with tools and materials, occasionally inventing new foraging techniques (Fox, Sitompul, & Van Schaik, 1999; Fragaszy et al., 2004). Juvenile dolphins have been observed to initiate playful or tool-based foraging strategies, such as sponge-carrying, later adopted by others (Mann et al., 2008). Even in birds like New Caledonian crows, young individuals display exploratory behavior that can lead to innovations in tool manufacture (Hunt, 1996). Across taxa, young individuals emerge as essential drivers of cultural novelty and transmission.

Recognizing the agency (Sueur, Zanaz, & Pelé, 2023) of young animals in cultural transmission has practical implications for research and conservation. Infants naturally observe their mothers and peers from birth, eliminating the need for artificial training in experimental tasks. This offers a unique window into spontaneous cultural learning and supports the integration of co-culture approaches in human-animal interactions (Sueur & Huffman, 2024). As Lew-Levy & Amir emphasize for humans, acknowledging juvenile roles enriches our understanding of cultural dynamics. Preserving animal cultures, as forms of biodiversity and adaptive knowledge, thus becomes essential for both scientific insight and conservation ethics (Sueur, 2022; Sueur, Fourneret, & Espinosa, 2024).

Acknowledgements. None.

Financial support. This research was funded by the Institut Universitaire de France and the International Research Project (IRP Comp^{2}A), which is supported by CNRS and Kyoto University.

Competing interests. The authors declare no competing interests.

References

Asquith, P. J. (2003). *Culture, Protoculture and the Biosocial Divide : Japanese Perspectives on the Study*.

Biro, D., Sousa, C., & Matsuzawa, T. (2006). Ontogeny and cultural propagation of tool use by wild chimpanzees at Bossou, Guinea : Case studies in nut cracking and leaf folding. In *Cognitive development in chimpanzees* (p. 476–508). Springer.

Clark, A., & Chalmers, D. (1998). The extended mind. *Analysis*, *58*(1), 7–19. https://doi.org/10.1093/analys/58.1.7

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

Fox, E. A., Sitompul, A. F., & Van Schaik, C. P. (1999). Intelligent tool use in wild Sumatran orangutans. *The mentality of gorillas and orangutans*, *480*, 99–116. https://doi.org/10.1017/CBO9780511542305.005

Fragaszy, D., Izar, P., Visalberghi, E., Ottoni, E. B., & de Oliveira, M. G. (2004). Wild capuchin monkeys (Cebus libidinosus) use anvils and stone pounding tools. *American Journal of Primatology*, *64*(4), 359–366. https://doi.org/10.1002/ajp.20085

Galef, B. G. (1992). The question of animal culture. *Human Nature*, *3*(2), 157–178. https://doi.org/10.1007/BF02692251

Galef Jr, B. G., & Heyes, C. (2004). Social learning and imitation. *Learning and Behavior*, *32*(1), 267–296.

Henrich, J. (2017). *The secret of our success : How culture is driving human evolution, domesticating our species, and making us smarter*. Princeton University Press.

Hirata, S., Watanabe, K., & Masao, K. (2001). Sweet-potato washing Revisited. In T. Matsuzawa (Éd.), *Primate origins of human cognition and behavior* (p. 487–508). Springer Japan. https://doi.org/10.1007/978-4-431-09423-4_24

Hoppitt, W., & Laland, K. N. (2013). *Social learning : An introduction to mechanisms, methods, and models*. Princeton University Press.

Huffman, M. A. (1996). Acquisition of innovative cultural behaviors in non-human primates : A case study of stone handling, a socially transmitted behavior in Japanese macaques. In *Social learning in animals : The roots of culture* (p. 267–289). Academic Press. https://doi.org/10.1016/B978-012273965-1/50014-5

Huffman, M. A., & Hirata, S. (2003). Biological and ecological foundations of primate behavioral tradition. In Dorothy M. Fragaszy and Susan Perry (Eds.), *The biology of traditions: Models and evidence*, (pp. 267–296). Cambridge University Press. https://doi.org/10.1017/CBO9780511584022.011

Hunt, G. R. (1996). Manufacture and use of hook-tools by new Caledonian crows. *Nature*, *379*, 249–251. https://doi.org/10.1038/379249a0

Hunt, G. R., & Gray, R. D. (2003). Diversification and cumulative evolution in new Caledonian crow tool manufacture. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *270*(1517), 867–874. https://doi.org/10.1098/rspb.2002.2302

Kawai, M. (1965). Newly-acquired pre-cultural behavior of the natural troop of Japanese monkeys on Koshima Islet. *Primates*, *6*, 1–30.

Laland, K. N. (1998). The evolution of culture. In T. Akazawa, K. Aoki, & O. Bar-Yosef (Éds.), *Neandertals and modern humans in Western Asia* (p. 427–438). Springer US. https://doi.org/10.1007/0-306-47153-1_27

Laland, K. N., & Hoppitt, W. (2003). Do animals have culture? *Evolutionary Anthropology: Issues, News, and Reviews*, *12*(3), 150–159. https://doi.org/10.1002/evan.10111

Leca, J.-B., Gunst, N., & Huffman, M. A. (2007). Japanese macaque cultures : Inter-and intra-troop behavioural variability of stone handling patterns across 10 troops. *Behaviour*, *144*(3), 251–281. https://doi.org/10.1163/156853907780425712

Lopez, J. C., & Lopez, D. (1985). Killer whales (Orcinus orca) of Patagonia, and their behavior of intentional stranding while hunting Nearshore. *Journal of Mammalogy*, *66*(1), 181–183. https://doi.org/10.2307/1380981

Mann, J., Sargeant, B. L., Watson-Capps, J. J., Gibson, Q. A., Heithaus, M. R., Connor, R. C., & Patterson, E. (2008). Why do dolphins carry sponges? *PLOS ONE*, *3*(12), e3868. https://doi.org/10.1371/journal.pone.0003868

Matsuzawa, T. (2015a). Seventy years after the end of World War II. *Primates*, *56*(2), 105–106. https://doi.org/10.1007/s10329-015-0464-4

Matsuzawa, T. (2015b). Sweet-potato washing revisited : 50th anniversary of the Primates article. *Primates*, *56*(4), 285–287.

Matsuzawa, T. (2018). Hot-spring bathing of wild monkeys in Shiga-Heights : Origin and propagation of a cultural behavior. *Primates*, *59*(3), 209–213. https://doi.org/10.1007/s10329-018-0661-z

McGrew, W. C. (1998). Culture in nonhuman primates? *Annual Review of Anthropology*, *27*(1998), 301–328. https://doi.org/10.1146/annurev.anthro.27.1.301

McGrew, W. C., Ham, R. M., White, L. J. T., Tutin, C. E. G., & Fernandez, M. (1997). Why don't chimpanzees in gabon crack nuts? *International Journal of Primatology*, *18*(3), 353–374. https://doi.org/10.1023/A:1026382316131

Mesoudi, A., & Thornton, A. (2018). What is cumulative cultural evolution? *Proceedings of the Royal Society B: Biological Sciences*, *285*(1880), 20180712. https://doi.org/10.1098/rspb.2018.0712

Nahallage, C., & Huffman, M. (2007). Acquisition and development of stone handling behavior in infant Japanese macaques. *Behaviour*, *144*(10), 1193–1215.

Rutz, C., Hunt, G. R., & Clair, J. J. H. S. (2018). Corvid technologies : How do new Caledonian crows get their tool designs? *Current Biology*, *28*(18), R1109–R1111. https://doi.org/10.1016/j.cub.2018.08.031

Sueur, C. (2022). Non-human animal cultures, co-cultures and conservation. *Cultural Science*, *14*(1), 93–102. https://doi.org/10.2478/csj-2022-0013

Sueur, C., Fourneret, É., & Espinosa, R. (2024). Animal capital : A new way to define human-animal bond in view of global changes and food insecurity. *Npj Sustainable Agriculture*, *2*(1), 1–5. https://doi.org/10.1038/s44264-024-00030-4

Sueur, C., & Huffman, M. A. (2024). Co-cultures : Exploring interspecies culture among humans and other animals. *Trends in Ecology & Evolution*, *39*(9), 821–829. https://doi.org/10.1016/j.tree.2024.05.011

Sueur, C., Zanaz, S., & Pelé, M. (2023). Incorporating animal agency into research design could improve behavioral and neuroscience research. *Journal of Comparative Psychology*, *137*(2), 129–143. https://doi.org/10.1037/com0000335

Suzuki, A. (1965). An ecological study of wild Japanese monkeys in snowy areas. *Primates*, *6*(1), 31–72. https://doi.org/10.1007/BF01794458

Takeshita, R. S. C., Bercovitch, F. B., Kinoshita, K., & Huffman, M. A. (2018). Beneficial effect of hot spring bathing on stress levels in Japanese macaques. *Primates*, *59*(3), 215–225. https://doi.org/10.1007/s10329-018-0655-x

Thornton, A., & McAuliffe, K. (2006). Teaching in wild meerkats. *Science*, *313*(5784), 227–229.

Tonutti, S. (2011). *Anthropocentrism and the definition of 'culture' as a marker of the human/animal divide*. Brill. https://brill.com/display/book/edcoll/9789004214941/Bej.9789004187948.i-348_010.xml

Visser, I. N., Smith, T. G., Bullock, I. D., Green, G. D., Carlsson, O. G. L., & Imberti, S. (2008). Antarctic peninsula killer whales (Orcinus orca) hunt seals and a penguin on floating ice. *Marine Mammal Science*, *24*(1), 225–234. https://doi.org/10.1111/j.1748-7692.2007.00163.x

Whiten, A. (2000). Primate culture and social learning. *Cognitive Science*, *24*(3), 477–508.

Whiten, A. (2021). The burgeoning reach of animal culture. *Science*, *372*(6537), eabe6514. https://doi.org/10.1126/science.abe6514

Whiten, A., Goodall, J., McGrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., Tutin, C. E., Wrangham, R. W., & Boesch, C. (1999). Cultures in chimpanzees. *Nature*, *399*(6737), 682–685.

Whiten, A., Horner, V., & de Waal, F. B. M. (2005). Conformity to cultural norms of tool use in chimpanzees. *Nature*, *437*(7059), 737–740. https://doi.org/10.1038/nature04047

Zentall, T. R. (2022). Mechanisms of copying, social learning, and imitation in animals. *Learning and Motivation*, *80*, 101844. https://doi.org/10.1016/j.lmot.2022.101844

Structure of peer cultures and social changes

Akira Takada*

Graduate School of Asian and African Area Studies, Kyoto University, Kyoto, Japan
takada.akira.2z@kyoto-u.ac.jp

*Corresponding author.

doi:10.1017/S0140525X25101830, e250

Abstract

Through the extensive literature review that examines the importance of children's peer cultures, Lew-Levy and Amir's

paper not only succeeded in elaborating on the existing evolutionary theory of cultural learning but also contributed to the development of adjacent research domains. I would like the authors to further discuss the issues of age differences, transformation and resilience, and social justice.

Highlighting the importance of children's peer cultures, Lew-Levy and Amir's paper advocates that "(i) children are independent producers and maintainers of autonomous cultures, (ii) peer cultures are a source of community knowledge diversity, and (iii) peer cultures may be called upon to help communities adapt to episodes of social and/or ecological change (sect.1, para. 1)."

As mentioned in this paper, a long childhood is said to be a species' characteristic of *Homo sapiens* and a major factor in the evolutionary and ecological prosperity (Nielsen, 2012; Thompson & Nelson, 2016). This paper argues that in addition to each individual child learning about existing adult culture in that long childhood, groups of children actively and collectively shape their cultures, which leads to the success of the whole society. With these arguments, the core of the authors' interest seems to lie in reconsidering evolutionary theory so far. Through the extensive literature review that examines the importance of children's peer cultures, however, this paper not only succeeded in elaborating existing evolutionary theory but also contributed to the development of adjacent research domains as well.

In this commentary, I would like to consider the importance of this research, especially in the context of my expertise, namely, ethnographic research on children's socialization and social changes. In many societies, it has been shown that high levels of teaching and learning occur while children engage in peer-to-peer interactions (Lancy, Bock, & Gaskins, 2010). Such peer-to-peer interactions play a major role not only in the transmission and development of "traditional" knowledge but also in its disappearance and replacement. Thus, socialization and social changes sometimes go hand in hand.

This is also true for the case of hunter-gatherer societies in contact with agropastoral societies. In the history of research on hunter-gatherer societies, many researchers have focused on subsistence activities mainly conducted among adults for considering the foundations of human sociality. As a result, many excellent studies have demonstrated how hunter-gatherer societies incorporate non-hunting and gathering activities, including agricultural and pastoral activities (e.g., Lee, 2014; Tanaka, 2014).

However, not only in such subsistence activities among adults but also in play activities, such as singing and dancing among children, hunter-gatherer societies have been shown to actively incorporate activities and cultural elements of agropastoral societies and reorganize their own peer cultures (e.g., Takada, 2020).

As Takada (2020) showed, even seemingly unrelated activities, such as hunting-and-gathering and singing-and-dancing activities, are deeply connected to the underlying social structure. In addition, through the abundance of playful activities in childhood, children cultivate lifelong social relationships with each other. Structural changes that have gone into the deeper structure over a long period of time can bring about irreversible changes in the whole society, unlike knowledge and skills that have been adopted on the surface.

Play, therefore, is not an activity that can be positioned on the periphery, either for the individual members or for the whole group. Rather, it is a core activity that characterizes both. And it is in peer cultures, which children collectively generate, maintain, and innovate, that play is most active. Lew-Levy and Amir's paper thus provides valuable empirical and theoretical support for this. The points (i), (ii), and (iii) shown at the beginning of this commentary are important for developing such arguments in a more analytical way.

These arguments also inspire new questions. Below are three interesting issues that I would like the authors to discuss further.

(1) The issue of age differences in peer cultures: Although large age differences, such as those between adults and children, often inhibit a playful atmosphere and reinforce authoritative relationships, a certain age range can also motivate activating interactions between them. As also discussed in this paper, forming multi-aged child groups is a key feature of childhood in hunter-gatherer societies (Konner, 1976, 2016). The desire to act like older children is the primary driving force that activates imitation and group activities of children. How do the roles of children with age differences and children of the same age differ and relate in peer cultures?

(2) The issue of transformation and resilience in peer cultures: Children's peer cultures are often very flexible and open to new elements. Whether they are considered archaic elements (e.g., traditional hunting-gathering methods) or new elements (e.g., singing-dancing of agropastoral people's origin) to the adult culture, these distinctions do not necessarily work the same way for the children. Children encounter them in their own contexts, and whether they are interesting is often more important for the children to adopt them. At the same time, children's peer cultures often show commonalities across time and place (e.g., similar games found in faraway places and times). How can such flexibility and resilience be compatible?

(3) The issue of social justice suggested from peer cultures: As referenced in this paper, Malinowski noted the members' determination among child groups and made the famous phrase "small republic of children" (Malinowski, 1929). Lew-Levy and Amir's paper further suggests that the members' decisions based on their active discussion, which is the goal of the current political system, are in a way rooted in peer cultures. The contemporary republican form of government has shown serious social problems, such as the lack of minority recognition and fair distribution (Honneth, 1995; Takada, 2022). To solve them and achieve better social justice, what can the characteristics of peer cultures presented in this paper suggest?

Acknowledgements. N/A

Financial support. This study was financially supported by the Grant-in-Aid for Scientific Research (S) "Ecological future making of childrearing in contact zones between hunter-gatherers and agro-pastoralists in Africa."

Competing interests. N/A.

References

Honneth, A. (1995). *The struggle for recognition: The moral grammar of social conflicts*. Polity Press. (Originally published in German in 1992).

Konner, M. J. (1976). Maternal care, infant behavior and development among the !Kung. In R. B. Lee, & I. DeVore (Eds.), *Kalahari hunter-gatherers: Studies of the !Kung San and their neighbors* (pp.218–245). Harvard University Press.

Konner, M. J. (2016). Hunter-gatherer infancy and childhood in the context of human evolution. In C. L. Meehan, & A. N. Crittenden (Eds.), *Childhood: Origins, evolution, and implications* (pp.123–154). University of New Mexico Press.

Lancy, D. F., Bock, J., & Gaskins, S. (2010). *The anthropology of learning in childhood*. Rowman Altamira.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Lee, R. (2014). *The Dobe Ju/'hoansi*. (4th ed.) Wadsworth Cengage Learning.
Malinowski, B. (1929). *The sexual life of savages in northwestern Melanesia*. Liveright.
Nielsen, M. (2012). Imitation, pretend play, and childhood: Essential elements in the evolution of human culture?. *Journal of Comparative Psychology*, *126*(2), 170–181. https://doi.org/10.1037/a0025168
Takada, A. (2020). *The ecology of playful childhood: The diversity and resilience of caregiver-child interactions among the San of southern Africa*. Palgrave Macmillan.
Takada, A. (2022). *Hunters among farmers: The !Xun of Ekoka*. University of Namibia Press.
Tanaka, J. (2014). *The Bushmen: A half-century chronicle of transformations in hunter-gatherer life and ecology*. Kyoto University Press and Trans Pacific Press.
Thompson, J. L., & Nelson, A. J. (2016). Childhood and patterns of growth in the genus Homo. In C. L. Meehan, & A. N. Crittenden (Eds.), *Childhood: Origins, evolution, and implications* (pp.75–101). University of New Mexico Press.

Coordinating with Peers vs. Adults

Michael Tomasello*

Duke University & Max Planck Institute for Evolutionary Anthropology, Durham, NC, USA
michael.tomasello@duke.edu

*Corresponding author.

doi:10.1017/S0140525X25102045, e251

Abstract

Within their peer cultures, children not only teach and socially learn from one another, but they also prompt one another to confront and adapt to different, coequal perspectives in a way that superintending adults cannot do.

In most classic ethnographies, children are almost invisible. In the past few decades, however, children's important role in the functioning and evolution of culture has become much more well-documented and widely recognized. Lew-Levy and Amir bring all this work together in a very helpful way.

I would like to draw attention to a phenomenon mentioned but not highlighted in the target article. In keeping with the article's focus on various kinds of cultural transmission, the claim is that "Peer interaction can be generative, leading to the discovery of information not initially possessed by either child" (sect, 3.4, para 2). But calling the outcome "discovery of information" undersells the unique structure and function of peer interaction within human cultures.

As compared with the social groups of other animal species, human culture has two unique dimensions. First is transmission. Although developing children learn important things from peers (as documented in the target article), becoming a competent and mature member of a culture still depends mostly on interactions with adults who already possess mature cultural skills and knowledge. Second is coordination. In this case, the issue is not so much acquiring mature skills and knowledge but learning to coordinate one's cognition and action with others who are no more knowledgeable or skillful than oneself, which is of course what occurs during adulthood when everyone has more-or-less equivalent knowledge and skills. For this, it is not adults but peers who represent the key partners.

The outcome of coordinating with coequal peers is an understanding of others and their perspectives as fundamentally equivalent to the self and its perspective (Tomasello, 2019). This understanding is of critical importance in two domains. First, Piaget (1932/1997) stressed that children do not – indeed cannot – become moral beings through interactions with adults. Adults already know the right and wrong ways to behave, and they transmit these to children. But following a moral rule because an adult insists is not a moral act; it must be done for the right reason. Sharing a toy is not a moral act if it is done merely to please an adult; it must be done by considering the perspective and interests of affected parties as determined, for example, in moral discourse with them. Developmental research has found that children's moral discussions with adults are markedly asymmetrical, as the moral expert impresses upon the child the "correct" perspective, with the child being relatively passive. In contrast, children's moral discussions with peers are more symmetrical and active, involving more sophisticated argumentation with a need for reason-giving and justification for assertions (Kruger, 1992; Mammen, Koymen, & Tomasello, 2018, 2019).

Second, collaborative problem solving and decision making with coequal others – an important skill in adulthood – also rely on argumentation in discourse. In this case, there are not studies comparing children's interactions with adults and peers, but much research shows that in interactions with peers, even preschool children employ sophisticated skills of justificatory reasoning, relying on judgments of common ground with the interlocutor (Koymen, Mammen, & Tomasello, 2016) and giving meta-reasons for why one justification is better than another (Koymen et al., 2020; see Koymen & Tomasello, 2020, for a review). Examining the literature on collaborative learning in school-age children, Kuhn (2015) documents that peer interaction is especially important for problems that require individuals to take and respect different perspectives – whereas adult experts are best for transmitting facts.

One might think that processes of collaborative moral reasoning and joint decision making with peers should be the same across all cultures, and at some general level, this must be true. But children in different cultures possess different common ground knowledge acquired from others in the culture, as well as different valuings of various forms of evidence and reasons (perhaps modeled on adults). And in some cultures, children have more opportunities to engage in unsupervised interactions with peers, during which they make truly joint decisions. For all of these reasons, peer interactions may contribute to the development of moral and rational reasoning skills somewhat differently in different cultural settings.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. None.

References

Koymen, B., Mammen,M., & Tomasello, M. (2016). Preschoolers use common ground in their justificatory reasoning with peers. *Developmental Psychology*, *52*, 423–429.
Koymen, B., O'Madagain, C., Domberg, A., & Tomasello, M. (2020). Young children's ability to produce valid and relevant counterarguments. *Child Development*, *91*, 685–93.
Koymen, B., & Tomasello, M. (2020). The early ontogeny of reason-giving. *Child Development Perspectives*, *14*, 215–220.

Kruger, A. C. (1992). The effect of peer and adult-child transactive discussions on moral reasoning. *Merrill-Palmer Quarterly*, *38*(2), 191–211.
Kuhn, D. (2015). Thinking together and alone. *Educational Researcher*, *44*, 46–53.
Mammen, M., Koymen, B., & Tomasello, M. (2018). The reasons young children give to peers when explaining their judgments of moral and conventional rules. *Developmental Psychology*, *54*, 254–262.
Mammen, M., Koymen, B., & Tomasello, M. (2019). Children's reasoning with peers and parents about moral dilemmas. *Developmental Psychology*, *55*, 2324–233.
Piaget, J. (1932/1997). *The moral judgment of the child*. The Free Press.
Tomasello, M. (2019). *Becoming human: A theory of ontogeny*. Harvard University Press

Children (and adults) need status to disseminate their innovations

Katie Vasquez*

Department of Psychology, University of Chicago, Chicago, IL, USA
kvasquez@uchicago.edu
https://katievasq.github.io/

*Corresponding author.

doi:10.1017/S0140525X2510188X, e252

Abstract

Children have creative, innovative minds. But not all innovations become cultural touchstones. I propose that innovations are more widely adopted when spearheaded by a high-status member of a social hierarchy. This works because people want to emulate high-status others (including some children), thus facilitating the mainstreaming of high-status people's cultural innovations.

Developmental psychologists tend to endorse a conventional narrative that children are acquirers of cultural knowledge, as taught by adults. Lew-Levy and Amir challenge this narrative by providing several examples of children creating cultural innovations. I agree that children can be quite inventive, but it is unclear how far-reaching children's innovations are. Their paper leaves an important question unanswered: Whose innovations are adopted widely? I propose that the cultural innovations of a select few, high-status individuals are the ones that are most likely to catch on. This is true for both adults and children. Turning our research toward high-status children and their contributions could clarify how children's innovations become widespread.

Higher-status people have tons of advantages that could make them better equipped to introduce cultural innovations. Compared to their lower-status counterparts, higher-status adults receive more attention (Dalmaso et al., 2012) and are more influential (Cheng et al., 2013). High-status children may have similar sway (Lansu & Cillessen, 2015). For example, children copy what high-status people do. Children even engage in "high-fidelity imitation" of high-status people, meaning children imitate many, if not all, of their actions, including those that seem irrelevant to a given task (McGuigan, 2013). This work suggests that when high-status people deviate from the norm and try something new, others are more willing to adopt their ways. Note that Lew-Levy and Amir allude to these ideas. They say that cultural evolution relies on "high-fidelity transmission" (Legare & Nielsen, 2015). I am extending this argument—it is not all (or even many) who can achieve this high-fidelity transmission. It is primarily high-status people who wield the special power and influence that prompts high-fidelity imitation.

One may be cautious that this selective copying of a small group of high-status agents is merely a quirk of W.E.I.R.D. (Western, Educated, Industrialized, Rich, and Democratic) societies (Henrich, Heine, & Norenzayan, 2010). To this concern, Henrich and Gil-White (2001) would offer a hard no. They surveyed several ethnographies and found that this copying of high-status others based on "prestige" occurs in numerous large-scale and small-scale societies. Prestigious agents are respected and admired, often due to their skills. Therefore, people orient their attention toward them and feel compelled to copy and learn from them.

Do children wield high social status that functions like prestige, and leverage it to spread innovations? At least one of the case studies offered by Lew-Levy and Amir provides preliminary evidence for, I posit, the selective uptake of prestigious children's innovations. Older Zinacantec Mayan girls teach younger girls to weave textiles (Greenfield, Maynard, & Childs, 2000). These girls not only transmit existing knowledge but they also generate new knowledge (i.e., novel weaving patterns). I would argue, these new designs become widely embraced by other girls, and even adult women, because they perceive these girls as skilled weavers worth learning from.

This one example provides a proof of concept. But it would be especially compelling if developmental researchers could identify other kinds of high-status children who innovate and whose innovations are widely accepted. There is a growing body of research favoring this latter point. Specific kinds of high social status children are in a position to have their innovations adopted. They are targets of both imitation and learning more broadly.

Some of this research is from hunter-gatherer societies where older children teach younger children about foraging and hunting (Boyette & Hewlett, 2018; Imamura, 2016; Lew-Levy et al., 2020). Of course, in these societies, it could be that older children are treated as younger adults. But one study by Dira and Hewlett (2016) calls this into question by asking: What do children look for in a role model? They asked Chabu children (of Southwest Ethiopia) who they would prefer to learn to hunt with. Even when children could have selected trusted adults or same-age friends, the most common response was someone who was skilled and knowledgeable. This study supports the notion that, at least Chabu children, may seek out other children as teachers. But they do so selectively, and they prioritize skilled teachers. So, it is clear that some children gain influence in these networks, perhaps because of their skills. But are these children cultural innovators or cultural transmitters? Do they create new knowledge or teach what they have been taught? Future work should explore how specific child innovations (many of them outlined in the target article) spread in these kinds of social networks.

Another kind of status worth looking at is popularity. At least in Western industrialized societies, so-called "popular kids" are influential (Sandstrom, 2011). Many peer relations researchers describe popularity as an early-emerging form of prestige (Cillessen, 2011; Kwon & Lease, 2014; Zhou & McLellan, 2021). Popular kids do share many features with prestigious leaders: Their peers pay more attention to them (Lansu & Cillessen, 2015) and copy them (Choukas-Bradley et al., 2015; Gommans et al., 2017). But what kinds of things are they influencing? We know that children copy trends set by popular kids (Kwon & Lease, 2014). They also adopt

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

their social attitudes (Cohen & Prinstein, 2006). But are popular kids innovative, and how? Do popular kids only decide what norms come and go, or do they invent new social rituals, new styles, and new language (i.e., slang)? It would be exciting to explore if any innovations are generated from these children's minds and if they are propagated from popular kids to the larger society.

In conclusion, I agree with Lew-Levy and Amir. Children are not merely passive sponges absorbing the adult culture. They can be innovators of culture in their own right. But I qualify their argument by suggesting that specifically high-status children can lead cultural change (as is the case with cultural change introduced by adults). Even with this qualifier, we do not know the extent to which these children actually carry out cultural innovations that become widely recognized. Thus, future work will need to pinpoint how much high-status children spread new artifacts and ideas, as opposed to how much they spread existing ones.

Acknowledgments. I would like to thank Alex Shaw and Rodney Tompkins for their feedback on these ideas. I would also like to thank Anderson Lynch and Lena Tran for copy-editing.

Financial support. None.

Competing interests. None.

References

Boyette, A. H., & Hewlett, B. S. (2018). Teaching in hunter-gatherers. *Review of Philosophy and Psychology*, *9*, 771–797. https://doi.org/10.1007/s13164-017-0347-2

Cheng, J. T., Tracy, J. L., Foulsham, T., Kingstone, A., & Henrich, J. (2013). Two ways to the top: evidence that dominance and prestige are distinct yet viable avenues to social rank and influence. *Journal of Personality and Social Psychology*, *104*(1), 103. https://doi.org/10.1037/a0030398

Cillessen, A. (2011). Toward a theory of popularity. In *Popularity in the peer system* (pp. 273–299). The Guilford Press.

Choukas-Bradley, S., Giletta, M., Cohen, G. L., & Prinstein, M. J. (2015). Peer influence, peer status, and prosocial behavior: An experimental investigation of peer socialization of adolescents' intentions to volunteer. *Journal of Youth and Adolescence*, *44*, 2197–2210. https://doi.org/10.1007/s10964-015-0373-2

Cohen, G. L., & Prinstein, M. J. (2006). Peer contagion of aggression and health risk behavior among adolescent males: An experimental investigation of effects on public conduct and private attitudes. *Child Development*, *77*(4), 967–983. https://doi.org/10.1111/j.1467-8624.2006.00913.x

Dalmaso, M., Pavan, G., Castelli, L., & Galfano, G. (2012). Social status gates social attention in humans. *Biology Letters*, *8*(3), 450–452. https://doi.org/10.1098/rsbl.2011.0881

Dira, S. J., & Hewlett, B. S. (2016). Learning to spear hunt among Ethiopian Chabu adolescent hunter-gatherers. In *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and Ethnographic perspectives* (pp. 71–81). Springer. https://doi.org/10.1007/978-4-431-55997-9_6

Gommans, R., Sandstrom, M. J., Stevens, G. W., Ter Bogt, T. F., & Cillessen, A. H. (2017). Popularity, likeability, and peer conformity: Four field experiments. *Journal of Experimental Social Psychology*, *73*, 279–289. https://doi.org/10.1016/j.jesp.2017.10.001

Greenfield, P. M., Maynard, A. E., & Childs, C. P. (2000). History, culture, learning, and development. *Cross-Cultural Research*, *34*(4), 351–374. https://doi.org/10.1177/106939710003400404

Henrich, J., & Gil-White, F. J. (2001). The evolution of prestige: Freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior*, *22*(3), 165–196. https://doi.org/10.1016/S1090-5138(00)00071-4

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world?. *Behavioral and Brain Sciences*, *33*(2–3), 61–83. https://doi.org/10.1017/S0140525X0999152X

Imamura, K. (2016). Hunting play among the San children: Imitation, learning, and play. In *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 179–186). Springer. https://doi.org/10.1007/978-4-431-55997-9_15

Kwon, K., & Lease, A. M. (2014). Perceived influence of close friends, well-liked peers, and popular peers: Reputational or personal influence?. *Journal of Social and Personal Relationships*, *31*(8), 1116–1133. https://doi.org/10.1177/0265407514522887

Lansu, T. A., & Cillessen, A. H. (2015). Associations of group level popularity with observed behavior and influence in a dyadic context. *Journal of Experimental Child Psychology*, *140*, 92–104. https://doi.org/10.1016/j.jecp.2015.06.016

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

Lew-Levy, S., Kissler, S. M., Boyette, A. H., Crittenden, A. N., Mabulla, I. A., & Hewlett, B. S. (2020). Who teaches children to forage? Exploring the primacy of child-to-child teaching among Hadza and BaYaka Hunter-Gatherers of Tanzania and Congo. *Evolution and Human Behavior*, *41*(1), 12–22. https://doi.org/10.1016/j.evolhumbehav.2019.07.003

McGuigan, N. (2013). The influence of model status on the tendency of young children to over- imitate. *Journal of Experimental Child Psychology*, *116*(4), 962–969. https://doi.org/10.1016/j.jecp.2013.05.004

Sandstrom, M. J. (2011). The power of popularity: Influence processes in childhood and adolescence. In *Popularity in the peer system* (pp. 219–244). The Guilford Press.

Zhou, W., & McLellan, R. (2021). Examining social status profiles with gender, school attended, SES, academic achievement and wellbeing in urban China. *Journal of Youth and Adolescence*, *50*(7), 1464–1477. https://doi.org/10.1007/s10964-021-01454-8

The adaptive role of peer culture is shaped by risk landscapes

Alejandro Pérez Velilla[a]* and Paul E. Smaldino[b]

[a]University of California, Merced (APV and PES), Merced, CA, USA and [b]Santa Fe Institute (PES), Santa Fe, NM, USA
aperezvelilla@ucmerced.edu
psmaldino@ucmerced.edu
https://anthrocult.org
https://smaldino.com/wp/

*Corresponding author.

doi:10.1017/S0140525X25102008, e253

Abstract

Peer cultures can contribute adaptive innovations, but their capacity for contribution depends on the environmental risk landscape. High-risk environments promote conservative cultural transmission, suppressing contributions from peer-driven exploration, while low-risk conditions allow peer cultures to thrive, generating, and spreading novel solutions. Socioeconomic stratification also influences these dynamics, creating cultural divides in how peer cultures operate.

Peer cultures undeniably contribute important adaptive information to the larger cultural landscape, as Lew-Levy and Amir convincingly argue in their target article. Early developmental stages have long been acknowledged as making important

contributions to evolutionary fitness (Gould, 1977), including the evolution of social behaviors (Toth & Robinson, 2007), and it should be similar for cultural evolution. We agree that the innovation and rapid knowledge dissemination facilitated by children's peer cultures are important engines of cultural adaptation, especially when environments are subject to swift changes. Indeed, this claim is consistent with recent modeling of the role of "peripheral" groups in collective innovation and adaptation (Milzman & Moser, 2023; Turner et al., 2023). Here, we wish to highlight an important and overlooked factor in explaining differences in the potential for innovation within peer cultures within and between cultures. This is the nature of the relevant risk landscape for the social and physical environment in which a community resides.

The *risk landscape* refers broadly to the degree of uncertainty individuals face regarding the outcomes of their decisions, and to the affordances and constraints for engaging with that uncertainty. Three major dimensions define this landscape: *wealth buffers*, which characterizes how much individuals can lose without ruinous outcomes (such as crippling health problems, bankruptcy, or death); *aggregate uncertainty*, which characterizes peoples' expectations of community-wide correlated environmental changes (such as climate events or economic downturns); and *idiosyncratic uncertainty*, which characterizes individuals' unique expectations of changes to their local conditions (including the possibility of personal accidents, health issues, or job loss).

In environments characterized by high-risk conditions – where wealth buffers are small and aggregate or idiosyncratic uncertainty is high – the potential costs of experimentation and innovation may be too much to bear. In such environments, unsuccessful experiments can lead not only to personal setbacks but to catastrophic consequences that can ripple through entire social groups, as when the closing of a factory decimates an entire town's economy. When uncertainty is primarily idiosyncratic, learning from peers who might be experiencing very different local conditions can lead to suboptimal or ruinous outcomes (Smaldino & Pérez Velilla, In press), as when two pastoralists share herd management strategies, but differences in the local predator populations result in significant livestock loss for one despite successful herds for the other.

Lew-Levy and Amir emphasize that peer cultures often provide innovative, diverse, and potentially adaptive solutions due to their exploratory nature. In high-risk environments, however, cultural innovation – especially from peer cultures – faces considerable barriers. Such environments create a premium on conservative cultural strategies, characterized by a reliance on tried-and-true methods transmitted by older generational cohorts. This conservatism arises from a selective pressure to minimize potential losses rather than maximize potential gains, thereby limiting the viability and attractiveness of exploratory strategies.

Our recent modeling research (Pérez Velilla, Beheim, & Smaldino, In press) indicates that conservative learning strategies, which focus on the preservation of intergenerational knowledge, tend to dominate in environments where errors carry severe penalties. It seems likely that this sort of conservative cultural inertia will often extend into peer cultures. When the stakes are high, children may internalize risk-averse norms, and mixed-age peer cohorts could serve as chains of high-fidelity conservative cultural transmission rather than as sources of innovation. Consequently, peer cultures in high-risk settings may function less as hotbeds of cultural innovation and more as vectors for conservative transmission, reinforcing rather than challenging existing cultural practices.

However, under lower-risk conditions – where wealth buffers, social safety nets, or ecological stability reduce the consequences of failure – peer cultures are likely to flourish, particularly when any environmental changes are correlated across the community. These more forgiving environments afford the luxury of trial-and-error learning, allowing peer groups to experiment and rapidly disseminate novel solutions without existential threat. Our models (Pérez Velilla, Beheim, & Smaldino, In press) predict exactly this pattern: exploratory learning strategies, which leverage peer influence and youthful experimentation, thrive in low-risk, affluent settings and are bolstered by the presence of aggregate uncertainty. Thus, the influence of peer cultures on community resilience and adaptability is conditional, fundamentally tied to the surrounding risk landscape.

An additional dimension to consider is how socioeconomic stratification within communities interacts with these risk conditions. Wealthier strata typically enjoy lower effective risk levels due to their greater capacity to buffer against potential losses. This insulation allows them to engage more freely in exploratory learning, leading to more innovative peer cultures. Conversely, disadvantaged groups face intensified risks and thus are compelled toward greater conservatism, and the peer cultures in these scenarios might serve as vectors of conservative cultural transmission. This divergence exacerbates inequalities in innovation and adaptability across strata, influencing long-term community dynamics and potentially perpetuating systemic disparities (Pérez Velilla, Beheim, & Smaldino, In press).

In summary, we emphasize that while peer cultures undoubtedly contribute valuable adaptive innovations, their capacity to do so is significantly modulated by the risk landscapes in which their communities are embedded. Recognizing this constraint highlights the necessity of integrating analyses of environmental uncertainty and risk management strategies into studies of peer cultural contributions. By doing so, we can better understand the nuanced roles that children's peer cultures play – not merely as generators of cultural diversity and innovation, but as integral components deeply embedded within cultural systems shaped by risk and uncertainty.

Financial support. This work was supported by grants from the John Templeton Foundation (#63336) and the National Science Foundation (BCS-2241874) to PES.

Competing interests. The authors declare no competing interests.

References

Gould, S. J. (1977). *Ontogeny and phylogeny*. Belknap Press.

Milzman, J., & Moser, C. (2023). Decentralized core-periphery structure in social networks accelerates cultural innovation in agent-based modeling. In *Proceedings of the 2023 International Conference on Autonomous Agents and Multiagent Systems*, 2213–222.

Pérez Velilla, A., Beheim, B., & Smaldino, P. E. (In press). The development of risk behaviors and their cultural transmission. *Psychological Review*. American Psychological Association.

Smaldino, P. E., & Pérez Velilla, A. (2025). The evolution of similarity-biased social learning. *Evolutionary Human Sciences*, *7*, e4.

Toth, A. L., & Robinson, G. E. (2007). Evo-devo and the evolution of social behavior. *Trends in Genetics*, *23*(7), 334–341.

Turner, M. A., Singleton, A. L., Harris, M. J., Harryman, I., Lopez, C. A., Arthur, R. F., Muraida, C., & Jones, J. H. (2023). Minority-group incubators and majority-group reservoirs support the diffusion of climate change adaptations. *Philosophical Transactions of the Royal Society B*, *378*(1889), 20220401.

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

The cognitive foundations of children's culture

Annie E. Wertz[a]* and Connair Russell-Wilks[b]

[a]Department of Psychological & Brain Sciences, University of California, Santa Barbara, Santa Barbara, CA, 93106-9660, USA and [b]School of History, Anthropology, Philosophy & Politics, Queen's University Belfast, 25 University Square, Belfast, Northern Ireland, BT7 1NN, UK
wertz@ucsb.edu
c.russell@qub.ac.uk

*Corresponding author.

doi:10.1017/S0140525X25101908, e254

Abstract

Lew-Levy and Amir clearly articulate the importance of children's peer cultures in broader human culture and evolution. However, peer cultures are juxtaposed against a relatively narrow definition of adult culture, which risks overlooking potential similarities. We argue that a more comprehensive analysis of the underlying psychological mechanisms will be required to elucidate whether children's peer cultures are truly distinct.

Lew-Levy and Amir paint a vivid and well-evidenced picture of the rich peer cultures that exist cross-culturally in humans. This compelling exposition of the nature of cultural transmission in children adds an important piece to the puzzle of human childhood and how it contributes to human cultural evolution. We agree that the role of children in building and transmitting cultures has been undervalued. However, it is not yet clear that peer culture is a qualitatively different kind of culture from any other type of culture. For the purposes of their argument, Lew-Levy and Amir introduce a distinction between "peer culture" and "adult culture." This dichotomization risks oversimplifying the richness in variation across "adult cultures" and obscuring similarities to peer culture in children. To more cleanly arbitrate potential differences between cultures in childhood and adulthood, it will be essential to articulate the structure of the underlying psychology involved and describe whether it changes across development. This approach can elucidate whether peer culture is truly distinct from adult cultures or one of several cultural variants within the broader scope of cultural evolution.

A first step is to situate peer cultures within the variability of adult cultures. Lew-Levy and Amir's portrayal of a unitary adult culture tied to formal institutions risks glossing over the myriad subcultures and countercultures that exist outside of formal institutions (e.g., punk music counterculture, regional or ethnic subcultures; Lieske, 1993; Fox, 1987), or societies with few formal institutions in general. It also overlooks adult cultures that may emerge at other points in the lifespan, such as dating, parenting, and possibly elderly cultures (e.g., Lin et al., 2023). If one considers a broader view of culture among adults, it becomes harder to view peer culture as necessarily distinct from adult culture, but rather one of myriad kinds of culture that humans can create in different conditions and stages of life. While they describe some of the characteristics of peer culture, it is not clear from the target article whether these would emerge from distinct psychological or cultural-evolutionary processes, and if they do not, then what precisely distinguishes peer cultures from other subsets of human culture?

Therefore, a second essential step is to map the psychology of underwriting peer cultures. If the cognitive systems that build and maintain cultures undergo fundamental changes from childhood to adulthood, it stands to reason that they may produce peer cultures that are qualitatively different from adult cultures. The question then becomes: What are the cognitive differences between children and adults underpinning the creation and transmission of distinct cultures? Although Lew-Levy and Amir briefly discuss relevant aspects of cognitive development (section 7.3), this section is cursory and broad. While it is undoubtedly true that increased abilities for joint attention, self-regulation, social interactions, exploration, and language play important roles, the target article leaves the details implicit, and it is unclear whether developmental changes in those abilities would constitute a difference in kind or merely a difference in degree.

One key cognitive capacity to investigate is social learning, the driving force of human cumulative culture (e.g., Boyd & Richerson, 1995; Henrich & McElreath, 2003; Tomasello, Kruger, & Ratner, 1993). Infants and children readily engage in social learning, imitating others' actions in ways that vary in their fidelity to the model and selectivity for the models they imitate (see e.g., Gweon, 2021; Over & Carpenter, 2012) and, in some cases, the content they learn (e.g., Barrett & Broesch, 2012; Wertz, 2019). These social learning "biases" reflect the complex underlying structure of social learning systems. Social learning biases are also present in adulthood and show similar selectivity for certain types of content (e.g., information pertinent to survival; Stubbersfield, Tehrani, & Flynn, 2015) and for learning from certain models (e.g., favoring information from prestigious individuals; Jiménez & Mesoudi, 2019; conforming to the majority/plurality; Morgan, et al., 2012).

Is the psychology of social learning meaningfully different in children and adults? Pursuing this question can clarify whether children's peer cultures are fundamentally different from adult cultures. One possibility is that the social learning psychology itself differs between children and adults. For example, perhaps there are biases present in childhood that are absent in adulthood (or vice versa). Alternatively, perhaps the social learning psychology remains qualitatively the same across development, but other related cognitive mechanisms differ, particularly capacities that would facilitate innovation. A potential candidate is artifact reasoning, which seems to undergo a shift during childhood such that younger children do not show functional fixedness when reasoning about artifacts, while older children and adults have difficulty overlooking the intended function of an artifact in order to use it in a novel way (German & Defeyter, 2000). Another candidate is developing linguistic abilities, which famously narrow and become less flexible with age (e.g., Hakuta, Bialystok, & Wiley, 2003). Finally, it may also be the case that the same learning biases are at play in both child and adult cultural transmission, but operate differently owing to their interaction with cultural norms. For example, the tendency to copy prestigious individuals is well established, yet understandings of who exactly is prestigious and worth copying may vary with age. Prestige can be determined by direct observation of someone's success or by learning which cues are important for signaling success (Jiménez & Mesoudi, 2019), but our degree of exposure to these cues will vary with age, as will what our cultural group or subgroup deems as success. As a result, Peppa Pig may seem prestigious to a 5-year-old, but not to his mother.

Lew-Levy and Amir make a convincing case for the importance of child peer cultures in human cultural evolution; however, what

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

looks prima facie to be distinct may simply be one among the broad suite of subcultures in the human cultural tapestry. In order to make a clearer argument for the distinctness of child peer cultures, we argue that further elucidation of the distinct (or not) psychology underlying peer cultures is required.

Acknowledgements. N/A.

Financial support. This research received no specific grant from any funding agency, commercial, or not-for-profit sectors.

Competing interests. None.

References

Barrett, H. C., & Broesch, J. (2012). Prepared social learning about dangerous animals in children. *Evolution and Human Behavior*, *33*, 499–508.

Boyd, R., & Richerson, P. J. (1995). Why does culture increase human adaptability?. *Ethology and Sociobiology*, *16*(2), 125–143.

Fox, K. J. (1987). Real punks and pretenders: The social organization of a counterculture. *Journal of Contemporary Ethnography*, *16*(3), 344–370.

German, T., & Defeyter, M. A. (2000). Immunity to functional fixedness in young children. *Psychonomic Bulletin & Review*, *7*, 707–712.

Gweon, H. (2021). Inferential social learning: Cognitive foundations of human social learning and teaching. *Trends in Cognitive Sciences*, *25*(10), 896–910.

Hakuta, K., Bialystok, E., & Wiley, E. (2003). Critical evidence: A test of the critical-period hypothesis for second-language acquisition. *Psychological Science*, *14*(1), 31–38.

Henrich, J., & McElreath, R. (2003). The evolution of cultural evolution. *Evolutionary Anthropology: Issues, News, and Reviews: Issues, News, and Reviews*, *12*(3), 123–135.

Jiménez, Á. V., & Mesoudi, A. (2019). Prestige-biased social learning: Current evidence and outstanding questions. *Palgrave Communications*, *5*, 20.

Lieske, J. (1993). Regional subcultures of the United States. *The Journal of Politics*, *55*(4), 888–913.

Lin, G. X., Mikolajczak, M., Keller, H., Akgun, E., Arikan, G., Aunola, K., … & Roskam, I. (2023). Parenting culture(s): Ideal-parent beliefs across 37 countries. *Journal of Cross-Cultural Psychology*, *54*(1), 4–24.

Morgan, T. J., Rendell, L. E., Ehn, M., Hoppitt, W., & Laland, K. N. (2012). The evolutionary basis of human social learning. *Proceedings of the Royal Society B: Biological Sciences*, *279*(1729), 653–662.

Over, H., & Carpenter, M. (2012). Putting the social into social learning: Explaining both selectivity and fidelity in children's copying behavior. *Journal of Comparative Psychology*, *126*(2), 182–192.

Stubbersfield, J. M., Tehrani, J. J., & Flynn, E. G. (2015). Serial killers, spiders and cybersex: Social and survival information bias in the transmission of urban legends. *British Journal of Psychology*, *106*(2), 288–307.

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural learning. *Behavioral and Brain Sciences*, *16*(3), 495–511.

Wertz, A. E. (2019). How plants shape the mind. *Trends in Cognitive Sciences*, *23*(7), 528–531.

Understanding how peer culture is transmitted requires an understanding of peer teaching

Kathleen H. Corriveau[a]*, Nina N. Ye[a] and Samuel Ronfard[b]

[a]Boston University, Wheelock College of Education and Human Development, Boston, MA, USA and [b]University of Toronto, Mississauga, Ontario, Canada

kcorriv@bu.edu
ninayeni@bu.edu
samuel.ronfard@utoronto.ca
www.bulearnlab.com
www.utmchildlab.com

*Corresponding author.

doi:10.1017/S0140525X25101842, e255

Abstract

Lew-Levy and Amir emphasize the importance of peer cultures in understanding children's active roles in preserving and transforming cultural knowledge. We review research highlighting peer teaching as a specific mechanism through which peer culture is maintained and transmitted. We argue that understanding peer teaching is essential to the broader understanding of cultural continuity and change.

Lew-Levy and Amir emphasize peer cultures as central to understanding cultural evolution and human life history, suggesting peer cultures as a key feature allowing for children's active participation in cultural preservation and transformation. Challenging the adult-centric view of cultural evolution, the authors highlight children's role in innovation and peer culture transmission and provide an overview of how social norms are largely learned from peers. However, the specific mechanism of the transmission process remains largely unexplored by the authors. Although Lew-Levy and Amir acknowledge horizontal transmission as supporting the spread of peer culture, it is important to emphasize that young children are equipped with the cognitive and social skills to disseminate and preserve cultural knowledge through peer teaching. We highlight some recent support for how selective information transmission and cultural variability impact children's peer-teaching practices within and across societies. We argue that a deeper understanding of peer teaching is essential to understanding the transmission of peer culture.

Young children engage in spontaneous teaching without explicit instruction and respond to their learners' performance to teach selectively (Strauss, Ziv, & Stein, 2002). Not only do they consider their learners' knowledge, goals, and competence, but they also adjust their teaching based on their learners' knowledge states (e.g., Baer & Friedman, 2018; Bridgers, Jara-Ettinger, & Gweon, 2020; Davis-Unger and Carlson, 2008; Gweon & Schulz, 2019; Ronfard & Corriveau, 2016; Qiu et al., 2024; Qiu et al., 2025) and the extent to which the to-be-learned information could be acquired first-hand (Ronfard, Was, & Harris, 2016; Ronfard & Harris, 2018). This adaptability ensures that cultural knowledge and social norms are transmitted effectively by allowing children to modify their explanations and the level of guidance they provide to peers. By the age of 4, children consistently choose and convey information that aligns with their learners' needs (Bridgers et al., 2020; Gweon & Schulz, 2019; Pueschel et al., 2023).

Children's ability to effectively transmit cultural knowledge through peer teaching necessitates that they engage in mental state reasoning to infer the appropriate amount and specific content of the information provided to support effective learning of others (Bass et al., 2019; Corriveau, Ronfard, & Cui, 2018; Jeong & Frye, 2025; Strauss & Ziv, 2012; Strauss et al., 2002; Ye, Heyman, & Ding, 2020). By tailoring their teaching based on their learners' needs, children demonstrate an early capacity for perspective-taking and

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

pedagogical sensitivity – skills that are essential for effective knowledge transmission. Beyond considering their learners' epistemic states when making decisions about what and how much information to transmit to others, peer teaching behaviors may also be shaped by interpersonal relationships and social alliances. For instance, children may strategically withhold information when teaching outgroup members to maintain ingroup loyalty (e.g., Liberman & Shaw, 2018; Misch, Over, & Carpenter, 2016). They may also be more motivated to elaborate, scaffold, or repeat explanations when interacting with friends or familiar peers than competitors or peers outside their social group (e.g., Over, 2016). Selective peer teaching fosters an environment where knowledge is not only passed down but also actively reshaped and reinforced within the peer group, allowing peer culture to remain dynamic and responsive to new social and environmental contexts.

Moreover, children's peer-teaching practices are marked by within- and between-culture variability. For example, 6-year-old Japanese children are more likely than their German peers to choose to teach an ignorant learner (Kim et al., 2018). Similarly, the type of teaching practices impacts US and Chinese children's approach to their engagement in their own teaching. Three- to 7-year-old Chinese children differed in their teaching practices depending on whether they were exposed to "traditional" or "Westernized" teaching practices at school (Ye et al., 2025). One contributing factor to these cultural differences is the pedagogical beliefs and practices children encounter at home and in school: often referred to as ethnotheories (Harkness & Super, 2015). Such exposure likely shapes children's understanding of the basic process of teaching and the specific strategies they employ when engaging in peer teaching (e.g., LeVine et al., 2012; Visscher, 2010).

These findings suggest that one reason peer cultures vary according to the social environment in which children are situated is because peer teaching is deeply embedded in children's sociocultural contexts. Specifically, the children's approach to peer teaching and interaction reflects the broader values emphasized in their communities. As just one example, collectivist cultures that value social harmony may encourage teaching that supports group cohesion (Liu & Elicker, 2005; Paine, 1990; Pang & Richey, 2007), whereas individualist cultures may emphasize autonomy and performance (Pang & Richey, 2007; Qi, 2022). Investigating such cultural differences in peer teaching offers a more nuanced understanding of peer culture as a dynamic and socially constructed system rather than a uniform developmental phenomenon.

In sum, understanding peer teaching is crucial for understanding the transmission of peer culture and cultural evolution. Prior research has provided valuable insights into how children teach, but much of this work has focused on structured or experimental settings. What remains underexplored are the ways in which children engage in teaching within naturalistic peer interactions – an important gap that the authors highlight, which future research would benefit to address. Although the authors offer a compelling argument for recognizing children as active participants in cultural transmission, their discussion largely overlooks the specific mechanisms through which peer culture is maintained and evolves. Peer teaching offers a clear lens to examine these processes. Through peer teaching, children not only transmit information but also reinforce and reshape peer culture in ways that align with their broader cultural context. Incorporating peer teaching into the study of peer cultures can enhance our understanding of the types of information children transmit and the specific strategies they use for cultural transmission – revealing the strategic and adaptive nature of peer culture. Recognizing this process of peer teaching is essential to capturing the complex role of children in actively sustaining and transforming culture. Future research should aim to investigate peer teaching as a key mechanism in the transmission and evolution of peer cultures.

Financial support. This work is supported by The John Templeton Foundation Grant (61542) to Kathleen H. Corriveau.

Competing interests. The authors have no known conflicts of interest to disclose.

References

Baer, C., & Friedman, O. (2018). Fitting the message to the listener: Children selectively mention general and specific facts. *Child Development*, *89*(2), 461–475. https://doi.org/10.1111/cdev.12751

Bass, I., Gopnik, A., Hanson, M., Ramarajan, D., Shafto, P., Wellman, H., & Bonawitz, E. (2019). Children's developing theory of mind and pedagogical evidence selection. *Developmental Psychology*, *55*(2), 286–302. https://doi.org/10.1037/dev0000642

Bridgers, S., Jara-Ettinger, J., & Gweon, H. (2020). Young children consider the expected utility of others' learning to decide what to teach. *Nature Human Behaviour*, *4*(2), 144–152. https://doi.org/10.1038/s41562-019-0748-6

Corriveau, K. H., Ronfard, S., & Cui, Y. K. (2018). Cognitive mechanisms associated with children's selective teaching. *Review of Philosophy and Psychology*, *9*, 831–848. https://doi.org/10.1007/s13164-017-0343-6

Davis-Unger, A. C., & Carlson, S. M. (2008). Development of teaching skills and relations to theory of mind in preschoolers. *Journal of Cognitive Development*, *9*, 26–45. https://oi.org/10.1080/15248370701836584

Gweon, H., & Schulz, L. (2019). From exploration to instruction: Children learn from exploration and tailor their demonstrations to observers' goals and competence. *Child Development*, *90*(1), 148–164. https://doi.org/10.1111/cdev.13059

Jeong, J., & Frye, D. A. (2025). Approximating the ZPD? Young children's judgements of appropriate task level for learning. *The British Journal of Developmental psychology*, *43*(1), 37–65. https://doi.org/10.1111/bjdp.12519

Harkness, S., Mavridis, C. J., Liu, J. J., & Super, C. M. (2015). Parental ethnotheories and the development of family relationships in early and middle childhood. In L. A. Jensen (Ed.), *The Oxford handbook of human development and culture: An interdisciplinary perspective* (pp. 271–291). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199948550.013.17

Kim, S., Paulus, M., Sodian, B., Itakura, S., Ueno, M., Senju, A., & Proust, J. (2018). Selective learning and teaching among Japanese and German children. *Developmental Psychology*, *54*(3), 536–542. https://doi.org/10.1037/dev0000441

LeVine, R. A., LeVine, S., Schnell-Anzola, B., Rowe, M. L., & Dexter, E. (2012). *Literacy and mothering: How women's schooling changes the lives of the world's children*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195309829.001.0001

Liberman, Z., & Shaw, A. (2018). Secret to friendship: Children make inferences about friendship based on secret sharing. *Developmental Psychology*, *54*(11), 2139–2151. https://doi.org/10.1037/dev0000603

Liu, J., & Elicker, J. (2005). Teacher-child interaction in Chinese kindergartens: An observational analysis. *International Journal of Early Years Education*, *13*(2), 129–143. https://doi.org/10.1080/09669760500171139

Misch, A., Over, H., & Carpenter, M. (2016). I won't tell: Young children show loyalty to their group by keeping group secrets. *Journal of Experimental Child Psychology*, *142*, 92–106. https://doi.org/10.1016/j.jecp.2015.09.016

Over H. (2016). The origins of belonging: Social motivation in infants and young children. *Philosophical Transactions of the Royal Society of London. Series B, Biological sciences*, *371*(1686), 20150072. https://doi.org/10.1098/rstb.2015.0072

Paine, L. (1990). The teacher as virtuoso: A Chinese model for teaching. *Teachers College Record*, *92*(1), 49–81. https://doi.org/10.1177/016146819009200105

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

Pang, Y., & Richey, D. (2007). Preschool education in China and the United States: A personal perspective. *Early Child Development and Care*, *177*(1), 1–13. https://doi.org/10.1080/14797580500252712

Pueschel, E. B., Ibrahim, A., Franklin, T., Skinner, S., & Moll, H. (2023). Four-year-olds selectively transmit true information. *PLoS One*, *18*(4), e0284694. https://doi.org/10.1371/journal.pone.0284694

Qi, Y. (2022). *Teachers' practices in preschool science education: A comparison study between USA and China (Publication No. 29253267)* (doctoral dissertation). University of California, Los Angeles, CA, United States; ProQuest Dissertations and Theses Global. Available at: https://www.proquest.com/docview/2684619814? sourcetype=Dissertations%20and%20Theses (accessed April 16, 2025).

Qiu, F. W., Ipek, C., Gottesman, E., & Moll, H. (2024). Know thy audience: Children teach basic or complex facts depending on the learner's maturity. *Child Development*, *95*, 1406–1415. https://doi.org/10.1111/cdev.14077

Qiu, F. W., Park, J., Vite, A., Patall, E., & Moll, H. (2025). Children's selective teaching and informing: A meta-analysis. *Developmental Science*, *28*, e13576. https://doi.org/10.1111/desc.13576

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

Ronfard, S., Was, A. M., & Harris, P. L. (2016). Children teach methods they could not discover for themselves. *Journal of Experimental Child Psychology*, *142*, 107–117. https://doi.org/10.1016/j.jecp.2015.09.032

Ronfard, S., & Harris, P. L. (2018). Children's decision to transmit information is guided by their evaluation of the nature of that information. *Review of Philosophy and Psychology*, *9*(4), 849–861. https://doi.org/10.1007/s13164-017-0344-5

Strauss, S., & Ziv, M. (2012). Teaching is a natural cognitive ability for humans. *Mind, Brain, and Education*, *6*, 186–196. https://doi.org/10.1111/j.1751-228x.2012.01156.x

Strauss, S., Ziv, M., & Stein, A. (2002). Teaching as a natural cognition and its relations to preschoolers' developing theory of mind. *Cognitive Development*, *17*, 1473–1487. https://doi.org/10.1016/s0885-2014(02)00128-4

Visscher, P. (2010). *Learning a new way of teaching? The impact of schooling on the teaching approach of Quechua parents and older siblings* (Unpublished doctoral dissertation). Harvard University.

Ye, N. N., Cui, Y. K., Ronfard, S., & Corriveau, K. (2025). The development of children's teaching varies by cultural input: Evidence from China and the U.S. *Frontiers in Developmental Psychology*, *3*, 1511224. https://doi.org/10.3389/fdpys.2025.1511224

Ye, N. N., Heyman, G., & Ding, X. P. (2020). Linking young children's teaching to their reasoning of mental states: Evidence from Singapore. *Journal of Experimental Child Psychology*, *209*, 105175. https://doi.org/10.1016/j.jecp.2021.105175

From protest to gossip: the developmental roots of norm enforcement in peer culture

Meltem Yucel[a,b]*

[a]Duke University, Department of Psychology and Neuroscience, Durham, NC and [b]Michigan State University, Department of Psychology, East Lansing, MI, USA,
nazlimeltemyucel@gmail.com
yucel@msu.edu

*Corresponding author.

doi:10.1017/S0140525X25102082, e256

Abstract

Lew-Levy and Amir propose that children's peer culture plays a bidirectional role in cultural evolution. Here, I propose (1) that norm enforcement strategies deserve a more central role and (2) that these strategies emerge earlier in development than suggested. Recognizing these early behaviors offers a deeper understanding of how peer cultures develop and how even young children actively shape their cultural landscape.

Lew-Levy and Amir present a compelling argument that children's peer culture plays a bidirectional role in cultural evolution, acting both as a product of cultural forces and as a driving influence on them. Their target article effectively highlights the role of adolescents in mediating between peer and adult cultures and acknowledges mechanisms such as gossip and storytelling in the transmission of peer norms. Although the authors touch on these strategies briefly, emerging work suggests it is important to more fully consider the developmental trajectory and foundational importance of norm enforcement mechanisms (e.g., gossip) as tools that even young children use to negotiate, reinforce, and shape group norms. In this commentary, I expand upon their framework by proposing an additional two key points. First, norm enforcement strategies emerge far earlier in childhood than the target article suggests. And second, these strategies deserve a more central role in understanding how peer culture is formed, sustained, and transmitted.

Norm enforcement strategies – such as protest, tattling, and gossip – emerge early in childhood and serve as foundational tools for regulating social behavior and maintaining group cohesion. Protest involves directly confronting peers about norm violations, often expressing disapproval of unfair or inappropriate behavior. While effective, protest can carry social risks, especially when directed at more dominant individuals (Ingram, 2014). Tattling, by contrast, is a less confrontational strategy in which children report transgressions to authority figures or other peers, thereby enforcing group norms without direct conflict (Vaish et al., 2011; Yucel & Vaish, 2018). Gossip, evaluative communication about others, represents a more sophisticated and decentralized form of norm enforcement (Engelmann, Herrmann, & Tomasello, 2016; Fine, 1977; Köymen & Engelmann, 2022). By circulating evaluative information within the peer group, gossip allows children to shape reputations, influence alliances, and regulate behavior – all without direct confrontation or adult oversight. Taken together, these distinct strategies reflect peer-driven mechanisms for norm learning and enforcement, with particular relevance for understanding how children participate in the cultural innovation and transmission that Lew-Levy and Amir emphasize.

A growing body of research demonstrates that children engage in these norm-relevant behaviors and language well before adolescence. Protest, tattling, and gossip are not only fundamental to early peer culture but are also observable between ages three and five (Engelmann et al., 2016; Hardecker et al., 2016; Schmidt & Tomasello, 2012; Vaish, Missana, & Tomasello, 2011; Yucel & Vaish, 2018). These behaviors are argued to serve multiple social functions, including regulating peer behavior, articulating implicit group expectations, and reinforcing shared values (Tomasello, 2016, 2019; Yucel & Moulder, 2024). While Lew-Levy and Amir rightly emphasize the role of adolescents in language-based innovation and cultural mediation, such a focus may underplay the significance of early peer interactions in laying the groundwork for these later dynamics. As gossip becomes increasingly central in

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

early to middle childhood, it represents another form of *horizontal transmission* – the peer-to-peer dissemination of cultural knowledge and social norms – that occurs largely outside the purview of adult authority. In this way, norm enforcement is not merely a reactive response to violations but a formative process through which children co-construct and sustain their cultural environments.

Protest, tattling, and gossip form a dynamic and developmentally unfolding toolbox of strategies through which children enforce, internalize, and transmit group norms. Protest enacts immediate correction, tattling delegates enforcement to external agents, and gossip sustains broader cultural cohesion by influencing reputations and social affiliations. These strategies do not simply reflect cultural norms; they actively construct and shape them. By participating in these practices from a young age, children can contribute meaningfully to the evolution and maintenance of peer culture, thereby participating in the broader processes of cultural transmission and transformation. Future research would benefit from examining how these strategies unfold across developmental stages and vary across sociocultural contexts, such as differences in the value placed on individual assertiveness versus group harmony, or in adult involvement in peer conflict, to better understand how children's norm enforcement behaviors both reflect and shape local peer and adult cultural practices. Doing so would further illuminate the deeply embedded role even young children play in the ongoing process of cultural evolution.

Recognizing the developmental trajectory of norm enforcement strategies allows for a richer understanding of how peer cultures emerge and evolve and how children, long before adolescence, serve as active contributors to the cultural landscape.

Acknowledgments. The author would like to thank Kaitlyn Werner, Mia Radovanovic, and Alexis Smith-Flores for their feedback.

Financial support. The preparation of this article was supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health under Award Numbers F32HD108861. The opinions expressed are those of the authors and do not represent the views of the Institutes.

Competing interests. None.

References

Engelmann, J. M., Herrmann, E., & Tomasello, M. (2016). Preschoolers affect others' reputations through prosocial gossip. *British Journal of Developmental Psychology*, *34*(3), 447–460. https://doi.org/10.1111/bjdp.12143

Fine, G. A. (1977). Social components of children's gossip. *Journal of Communication*, *27*, 181–185.

Hardecker, S., Schmidt, M. F. H., Roden, M., & Tomasello, M. (2016). Young children's behavioral and emotional responses to different social norm violations. *Journal of Experimental Child Psychology*, *150*, 364–379. https://doi.org/10.1016/j.jecp.2016.06.012

Ingram, G. P. D. (2014). From hitting to tattling to gossip: An evolutionary rationale for the development of indirect aggression. *Evolutionary Psychology*, *12*(2), 343–363. https://doi.org/10.1177/147470491401200205

Köymen, B., & Engelmann, J. M. (2022). Young children rely on gossip when jointly reasoning about whom to believe. *Developmental Psychology*, *58*(6), 1091–1102. https://doi.org/10.1037/dev0001066

Schmidt, M. F. H., & Tomasello, M. (2012). Young children enforce social norms. *Current Directions in Psychological Science*, *21*(4), 232–236. https://doi.org/10.1177/0963721412448659

Tomasello, M. (2016). *A natural history of human morality*. Harvard University Press.

Tomasello, M. (2019). *Becoming human*. Harvard University Press. https://doi.org/10.1016/S0262-4079(20)30691-6

Vaish, A., Missana, M., & Tomasello, M. (2011). Three-year-old children intervene in third-party moral transgressions. *The British Journal of Developmental Psychology*, *29*(Pt 1), 124–130. https://doi.org/10.1348/026151010X532888

Yucel, M., & Moulder, R. G. (2024). Gossiping for a reason: Revised Gossip Functions Questionnaire (RGFQ). *Psychological Test Adaptation and Development*, *5*, 216–228.

Yucel, M., & Vaish, A. (2018). Young children tattle to enforce moral norms. *Social Development*, *27*(4), 924–936. https://doi.org/10.1111/sode.12290

Authors' Response

Toward an integrated study of peer cultures

Sheina Lew-Levy[a] and Dorsa Amir[b]*

[a]Department of Psychology, Durham University, Durham, UK and [b]Department of Psychology & Neuroscience, Duke University, Durham, NC, USA
sheina.lew-levy@durham.ac.uk
dorsa.amir@duke.edu

*Corresponding author.

doi: 10.1017/S0140525X2510424X, e257

Abstract

In our target article, we proposed that children are not merely recipients of adult culture but actively produce and maintain their own peer cultures, which may help communities navigate rare yet pivotal episodes of social and ecological change. Commentaries from across the social and biological sciences expanded this framework, situating peer cultures within developmental, evolutionary, and comparative contexts. They emphasized the diversity of peer cultures, the communicative systems and transmission mechanisms that sustain them, and introduced new approaches for identifying them – from formal evolutionary models to research in non-human species and the archaeological record. In this response, we synthesize and build on these contributions by addressing questions about the scope and influence of peer cultures within the broader processes of cultural evolution and by outlining future directions for a more unified, cross-disciplinary science of peer cultures.

R1. Introduction

We thank all of the commentators for their thoughtful and wide-ranging responses. The breadth of engagement across diverse disciplines – spanning anthropology, archaeology, psychology, folklore studies, animal behavior, and formal modeling – reflects the broad relevance of peer culture to numerous lines of inquiry and underscores the merits of greater cross-talk and integration across fields. If every commentary here inspired even one study, we would be well on our way to establishing the cultural evolution of peer cultures as a subfield in its own right.

Taken together, the commentaries reflect a diverse range of perspectives on the role of children and peer cultures in the human story – some extending and endorsing our central argument, others interrogating its function and limits. In our reply, we first highlight and engage with proposed extensions across two levels of analysis. Specifically, in Section 2, we address ontogenetic extensions, exploring how peer cultures may vary across societies and the mechanisms that regulate them. In Section 3, we address phylogenetic extensions, linking our arguments to formal evolutionary modeling, comparative non-human animal work, and archaeology. Finally, in Section 4, Open Questions, we address comments about the definition, scope, and plausibility of peer cultures as explanatory constructs, as well as the conditions under which children may (or may not) contribute to cultural innovation.

R2. Ontogenetic extensions

R2.1. Contextual variability and peer culture responsiveness

Commentators highlighted that peer cultures are far more pervasive, contextually diverse, and culturally variable than we initially emphasized. Children construct peer cultures within the varied social, economic, and ecological landscapes they inhabit, responding to the specific affordances and constraints of each. A comprehensive study of children's peer cultures should thus include a wide range of cultural settings, industrialized societies among them.

Greenfield draws attention to the contextual features that contribute to children's cultural innovations. Her long-term research among Zinacantec Maya communities suggests that children's creative expression in weaving, once highly constrained by traditional conformity in textile design, expanded dramatically with increased schooling and participation in market economies. She argues that, rather than emerging in all environments, children's innovative capacities are culturally variable. We agree that not all environments are conducive (or tolerant of) cultural innovations, and indeed that in some contexts, innovations may be actively discouraged, such as among the Maya, where in the early 1970s, to be "different" was to be "bad." We see this not as a recession of peer culture, but as a reflection of its responsiveness to socioecological variables. Just like adult cultures, peer cultures mirror the affordances and constraints of their environments.

It's also possible that, in settings where conformity is highly valued, children experiment with alternative practices and ideas within the safety of their peer groups, even if those differences remain invisible or undervalued by adults. These small departures can persist within peer cultures until broader conditions make them legible to the wider community. In the Mayan example, we wonder whether, prior to market integration and schooling changes, children developed novel weaving designs during play activities outside of the purview of adults, even if these were not integrated into formal textile production. If they did, this would provide evidence that peer cultures not only mirror the present but also anticipate future shifts, preserving and refining emergent forms of behavior that may later be recognized as innovations. Importantly, Greenfield points out that it was Mayan adolescents who were the first to use the term "different" in a positive way. We note that across cultures, adolescents often seem most open to adopting market-based innovations. For example, Bolivian Tsimané acquire a majority of their market-based skills in adolescence (Schniter et al., 2015). Further, in a recent study, Lew-Levy and colleagues found that Congolese BaYaka and Bantu adolescents showed shifting norms regarding the sharing of money with increased market integration. Together, these findings suggest that adolescents and their peer cultures may play a disproportionate role in adapting to market integration, a pattern that would benefit from further study.

Kong and Ding further suggest that, in contexts where conformity is prized, children's innovations may take on more subtle forms, expressed through style, language, or humor rather than overt departures from adult norms. Specifically, in East Asian peer cultures with high parental and institutional control, children frequently develop more covert and coded forms of peer culture, shifting their creativity into digital and semi-private "third spaces." These hidden forms of play and communication demonstrate that even in constrained settings, peer cultures still emerge. We would like to point out another example of peer culture emergence in the face of high institutional control. From the 1880s until World War II, Navajo children were forcibly sent to boarding schools where English was compulsory, and children who spoke Navajo among themselves were punished (Schaengold, 2004; Velupillai, 2015). Yet, as linguist Schaengold demonstrates (2004), in secret, children at these boarding schools continued to speak Navajo with each other, preserving their language to the best of their abilities in the face of severe pressure. Having been sent to boarding school from a young age, most children's knowledge of Navajo was incomplete. So, they often substituted unknown Navajo words with English ones, creating a "code" – a mix of Navajo and English – which also became a means of communicating back home with other boarding school survivors. Between the 1950s and 1970s, Bilingual Navajo stabilized as a language distinct from Standard Navajo and is now the main Navajo language spoken by many. Here, peer cultures helped retain and even refine a huge swath of cultural knowledge despite grave threats from adults. Understanding how children manufacture physical or virtual third spaces and how peer cultures covertly arise, adapt, and are transmitted within these spaces offers a promising direction for future research.

Lancy complements this discussion through an assessment of street children's cultures, offering a case study where children's autonomy is not restricted but instead expanded by necessity. Without adult or institutional oversight, these groups teach one another through apprenticeship, building shared repertoires of skill and moral understanding. Far from marginal exceptions, such groups reveal children's impressive organizational and pedagogical capacities when completely unregulated by adults, demonstrating how peer cultures can generate complex cultural forms related to education, cooperation, and creativity even under extreme constraints. Further, through their migration patterns, street children transport with them new ideas and material culture between urban and rural settings. Future research should investigate how children's migration – in the presence and absence of adult caretakers – shapes the circulation and adoption of novel peer culture forms.

Drawing on their work with Ethiopian Koygu transitional hunter-gatherers, Nyangatom pastoralists, and Central African Aka hunter-gatherers, Bira and Hewlett describe how culturally constructed niches shape peer culture diversity. Where cultural schemas reflect hierarchical social values, such as among the Nyangatom, teaching from adults is more widespread. In contrast, among the egalitarian Koygu, adults minimize their interventions into children's learning. These conditions may suppress peer group transmission among the former and amplify it among the latter. Echoing the example of high-control East Asian communities above, we would like to note that even in the face of non-supportive

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

cultural schema, peer cultures can covertly emerge. For example, among Masai pastoralists, Tian (2025) reports that community elders regarded play as an unworthy topic of inquiry, with some noting that they themselves had not engaged in play during childhood. Nonetheless, Masai children guided Tian in observing how and when they played away from adult supervision. Thus, while we agree that cultural schemas contribute to diversity in peer cultures, we propose that they also influence the extent to which peer cultures are overt or concealed, thereby shaping their visibility and our capacity to study them.

Bira and Hewlett also argue that the size of settlement patterns shapes who children can interact with. They show that larger settlements among the Koygu offer more opportunities for peer group interaction. We additionally note that, in larger settlements, children have more opportunities to assort with same-aged peers, allowing them to play competitive games, which are rarer in mixed-aged groups due to large variations in skill level (Draper, 1976; Edwards & Whiting, 1988; Lancy, 1984). Further, in larger settlements children are more likely to segregate into same-gender playgroups (Lew-Levy et al., 2020). As demographic shifts occur, it's possible that in some communities, children's social experiences diverge quite dramatically from their parents. In these cases, it could be that children's peer group play becomes the site of novel social norms (such as a trend toward hierarchy or gendered segregation), which may have downstream effects for the next generation's societal schema (Cannon, 2023). Takada adds to this discussion, arguing that mixed-age groups also allow for younger children to observe and imitate older children. He asks: What happens when same-aged groups begin to outnumber mixed-aged ones? This is an important question for the study of both peer culture and cultural evolution more broadly, especially in the face of increasingly formalized institutions that segregate children almost exclusively into same-aged peer groups. Future work should examine how these demographic and institutional shifts reshape the cultural ecology of childhood, influence the balance between cooperation, competition, and hierarchy in peer groups, and how peer cultures are produced and transmitted in these contexts.

Finally, Burdett and Fong point out that our target article primarily focused on children in small-scale societies and that not enough attention was paid to children in urban settings (a point also echoed by Miu et al.). Our rationale for this choice was to highlight instances of peer cultures in communities understudied in child development (Amir & McAuliffe, 2020; Henrich et al., 2010; Nielsen et al., 2017). We acknowledge, however, that this emphasis underrepresents how peer cultures manifest in industrialized environments and, as Burdett and Fong observe, may inadvertently give the impression that peer cultures are less prevalent there. A more holistic study of children's peer cultures should sample broadly across cultural settings, including industrialized ones. The commentaries addressed above go some way in correcting this bias.

R2.2. Communication, social regulation, and cognitive development

Several commentaries focused on distinct communication and social regulation systems at the heart of peer culture, which function to enforce norms, generate knowledge, and negotiate meaning. In turn, such peer interaction shapes children's developing social cognition and moral reasoning. Together, these commentaries highlight peer groups not merely as sites of cultural transmission and innovation, but as developmental engines in which cognition and culture evolve together.

Yucel highlights norm enforcement strategies – such as protest, tattling, and gossip – as key mechanisms of moral regulation and identity formation in peer cultures. In her view, these strategies do more than police behavior – they also construct the moral landscape of the group, signaling what kinds of actions, alliances, and identities are valued. We agree that this rich social ecosystem deserves closer empirical attention, especially the study of how peer groups influence children's developing moral reasoning capacities and emerging sense of identity. An informative study, for instance, could consider how the content of peer gossip varies across cultures and ages, revealing which underlying social values are most salient in peer cultures at different stages of development.

Building on the idea that social dynamics shape what and how children learn, Langenhoff et al. highlight disagreement as a productive communicative mechanism within peer cultures. Rather than undermining cohesion, disagreements invite children to articulate reasons, defend positions, and co-construct new understandings. We add that these sorts of interactions are likely even *more* useful in peer settings where adults are not actively present and unable to intervene to resolve disagreements by providing correct answers. Langenhoff et al. further point out that research has overwhelmingly focused on domains of knowledge that are "already known" and that are typically taught by adults. Open-ended domains, where children can co-construct new knowledge with peers, remain understudied, even though they likely offer rich ground for peer cultural innovation.

Tomasello extends this point, arguing that social interactions among peers differ fundamentally from those between children and adults. Within peer settings, authority is flattened, and children must negotiate meaning, coordinate perspectives, and reach consensus without relying on deference to expertise. These dynamics, which rely on argumentation (and often disagreement, as Langenhoff et al. point out), are critical social experiences that are formative in children's emerging understanding of morality and of collaboration. One could even make the stronger claim, *à la* Piaget (1948), that peer interactions are not only helpful for internalizing and understanding the moral world but are actually *necessary*. Further, through their peer negotiations, children can develop novel moral norms and reasoning skills that do not exist in adult cultures. The ways in which children collaboratively engage in moral reasoning in peer interactions and the mutual development of culture and cognition in early life are a fruitful avenue for future research.

Similarly, Burdett and Fong argue that peer interactions provide unique social learning opportunities. They cite experimental work showing that through peer interactions, 3-4-year-olds can innovate complex tools that were not achieved when working alone or when working dyadically with an adult (McGuigan et al., 2017). The authors suggest that a greater emphasis on the bidirectionality of peer interaction and cognitive development would add an important dimension to the study of peer cultures. We agree that the relationship between peer interaction and cognitive development is reciprocal: peer interactions not only depend on social-cognitive capacities, such as theory of mind and perspective-taking, but also serve as the very context in which these capacities are refined. The ability to interpret others' intentions, manage disagreement, and coordinate shared goals is both a prerequisite and a product of peer cultures.

Gabora and Beckage's commentary offers a novel lens on how peer interaction shapes cognition, emphasizing mental rather than

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

social networks. They argue that cognitive development can be modeled as an *autocatalytic process* in which children's ideas – once linked and exchanged within peer groups – mutually reinforce one another, producing self-sustaining cycles of conceptual growth. This framework elegantly formalizes what many developmental theorists have described qualitatively: collaboration among children allows them to reconfigure shared understandings and, in doing so, reshape their own epistemic architecture, enabling "each new generation to escape the mental ruts of the previous." Peer cultures, then, function as collective engines of conceptual reorganization, where children's interactions not only generate new cultural forms but also catalyze the emergence of increasingly integrated cognitive systems.

R2.3. Mechanisms of transmission

A rich set of commentaries focused on modes of transmission within peer groups, exploring how factors such as peer teaching and social status help maintain and regulate peer cultures. Together, these commentaries reveal that the transmission of peer cultures is shaped by a complex interplay of hierarchy, teaching, and motivation. They collectively push the study of cultural evolution beyond simple models of imitation and toward a richer account that recognizes children as active teachers, selective learners, and self-motivated innovators.

Vasquez brings attention to the social hierarchy of peer groups, suggesting that social rank plays an important role in which cultural products are retained and transmitted. That is, just as children are attentive to social factors such as prestige when deciding which adults to learn from, they are almost certainly applying these same judgments to their own peer groups, with implications for how peer cultures change and spread. We endorse Vasquez's suggestion that social learning biases (e.g., as reviewed in Kendal et al., 2018) are likely highly influential in peer cultures and second the call for more work on this topic. Importantly, we would like to add that peer cultures may have their own prestige valences, which are distinct from those of adults. For example, "class clowns" – students known for using disruptive humor or comical behavior in school settings – have been shown to score highly in leadership as well as peer-conferred social status (Damico & Purkey, 1978; Ruch et al., 2014; Wagner, 2019). Class clowns are also considered rule breakers who challenge adult-dominated power structures overtly and covertly, signaling allegiance to the peer group rather than to institutional authority, and their comic talent is directly related to perceived leadership (Ruch et al., 2014; Wagner, 2019). Taken together, this evidence suggests that different social characteristics can be leveraged into prestige within peer cultures and that these may differ from dimensions of prestige valued by adults in the same communities. We believe there are rich research questions to pursue in this arena, using, for instance, longitudinal or network-based methods to trace how innovations move through peer groups and how social factors like prestige amplify or suppress them.

Corriveau et al. also underscore the importance of social status, highlighting not just social rank but also group membership as a key determinant of how and among whom cultural transmission takes place. But for Corriveau et al., these dynamics affect not just peer learning but also *peer teaching*. They draw from a rich literature documenting the sophisticated ways in which children (spontaneously) teach one another, facultatively adjusting their teaching based on the learner's knowledge states. This point is reinforced by Bira and Hewlett's observational data among children in small-scale societies – which suggest that child-to-child teaching occurs in nearly half of all learning events – and by Qiu and Moll's commentary, which highlights the sophisticated nature of children's teaching capacities. Corriveau et al. further suggest that "children may strategically withhold information when teaching outgroup members to maintain ingroup loyalty." This is a compelling example of the in-group psychology we discuss in the target article (Section 7.3), which begins to emerge around age three and is further expressed through selective teaching – deciding who to teach and who to ignore. We fully agree with the authors that peer teaching is an overlooked but critical component of children's cultures and that naturalistic studies of peer teaching are lacking (but see Boyette & Hewlett, 2017; Lew-Levy et al., 2020; Maynard, 2002). Studies that focus on the nuances of how culture is taught and negotiated between children can help us better understand the active role that children play in cultural evolution.

In addition to questions of *who* peer cultures are learned from, an open question concerns *which* cultural products are most likely to spread. Perez et al. argue that, as children are cared for and provisioned by adults, the necessity of engaging in extrinsically motivated activities is reduced, allowing individuals to rely more on intrinsic motivational systems – those that are inherently satisfying, as opposed to those driven by external rewards or pressures. This motivational landscape shapes which peer cultural products emerge and endure: practices that are intrinsically engaging, for example, that are playful, challenging, or socially rewarding, are more likely to crop up. This perspective offers a useful complement to models of cultural transmission that emphasize efficiency or utility, suggesting instead that the persistence of peer-created culture may depend as much (or even more) on its motivational appeal as on its functional value.

Further, we found great value in Perez et al.'s argument that as children age, their intrinsic motivations also mature, leading to downstream changes in peer cultural products. Specifically, they recontextualized the Matses case study from the target article, arguing that fishing proficiency may have been a byproduct of intrinsic motivation to explore the river. This interpretation underscores how intrinsic motivations in childhood can seed behaviors that later acquire extrinsic utility. It further highlights a developmental continuity between play and production and suggests that peer cultures may serve as incubators of future adaptive skills, where exploration today becomes expertise tomorrow. In other words, practices that originate as intrinsically motivated play, experimentation, or collective problem-solving may later crystallize into enduring adult traditions, skills, or institutions.

Lastly, Bira and Hewlett extend our discussion of transmission mechanisms to highlight two forms of group transmission: *concerted* transmission, in which multiple group members communicate the same skill or knowledge to an individual, and *cumulative* transmission, in which children acquire skills or knowledge through repeated, multimodal interactions with several group members over time, each encounter building on prior experience and progressively scaffolding mastery. They argue that these forms of transmission are key for maintaining the stability of peer culture over time, drawing from rich observational data of Koygu, Nyangatom, and Aka children's lives to illustrate these differing modes. These understudied transmission pathways represent new conceptual tools for understanding how learning is socially

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

distributed and how peer cultures sustain coherence across generations.

R3. Phylogenetic extensions

R3.1. Formal modeling of peer cultures

Several commentators extended our framework into the realm of formal modeling, outlining new approaches that could help specify how peer cultures emerge, stabilize, and evolve. Across these contributions, there is a consensus that models of cultural evolution should not treat children merely as noise or passive transmitters in cultural systems but as dynamic agents whose age-structured interactions shape the tempo and trajectory of cultural change.

Perez Velilla and Smaldino argue that the influence of children's cultural experimentation is not constant across settings but modulated by the surrounding "risk landscape." In low-risk, buffered environments – where the cost of failure is minimal – exploratory peer-driven learning strategies can flourish, generating and spreading novel solutions. Conversely, in high-risk contexts where mistakes are costly, conservative social learning and vertical transmission tend to dominate, constraining the space for peer innovation. This framework provides an elegant way to formalize the ecological conditions under which peer cultures are most likely to act as engines of adaptation, offering a bridge between developmental plasticity and population-level cultural dynamics (Frankenhuis & Amir, 2022). Their commentary also converges with Greenfield's argument that shifting socioecological conditions, such as transitions from subsistence to market economies, systematically alter the cultural value of innovation itself. Both perspectives emphasize that the expression and transmission of peer cultures are context-dependent, varying with the risks, affordances, and incentives present in children's social and ecological environments. We'd further like to note – as Perez Vellila, Smaldino, and colleagues also recently posited (2025) – that the risk landscape itself changes across development, as children are provisioned by adults and alloparents, the latter of whose care is increased in harsher environments (Martin et al., 2020). Similarly, in our recent work, we evaluated the role of climatic variability in shaping children's activities across twelve forager and mixed-subsistence populations (Lew-Levy et al., 2022). We found that localized risks, such as water availability and predation, did relate to how children participated in activities such as domestic work and childcare, but we found no relationship between localized risks and food production. This may be because children's social groups – including foraging with peers – offer a way to buffer food production risks through collective risk pooling. These findings support the notion that the risk environment itself varies across the lifespan and that social mechanisms can help buffer those risks.

Deffner et al. argue that bridging theoretical models and real-world data is essential for evaluating how peer cultures influence cultural change. They propose the rise of plant-based diets as a case study for modelers to explore, noting that youth have driven these diets as a form of climate activism. In Germany, for instance, adolescents are 2.5 times more likely than adults to be vegan or vegetarian. This case study highlights an important mechanism through which children and adolescents may shape the trajectory of cultural evolution: not necessarily by inventing new domains of culture, but by reorganizing existing ones around new values or practices that can influence broader society. Deffner et al. also emphasize that studying culture change requires attention to factors such as population size and age structure. To this latter point, we would like to offer another relevant case study: In the 1950s, Canadian children born in the post-WWII baby boom were raised in relative affluence in a political climate that emphasized freedom in opposition to the Cold War (Owram, 1997). Under these conditions, peer cultures thrived. By the 1960s, the generational identity such peer cultures cultivated "was sufficiently forceful [. . .] to challenge the credibility of the adult world" (Owram, 1997, p. 217), leading to the radical politics of the era (e.g., nuclear disarmament, anti-war, feminism).

Deffner et al. further argue that, while accounting for population size and age structure necessarily increases model complexity, it also allows for a more accurate representation of how cultures evolve. The authors outline clear steps for modeling the transmission of norms (including diffusion from young innovators through homophilic networks), estimating parameters from longitudinal or historical data, and simulating interventions to promote climate-friendly behaviors. We support this approach and hope that the case studies in our target article, and those offered by commentators, provide a foundation for such generative models.

Morin offers a conceptual complement to these modeling efforts through the notion of *selection for proliferation*. He argues that peer cultural forms often spread not because they are necessarily efficient or adaptive, but because they are easily reproduced – through repetition, visibility, or emotional resonance. Combined with the high turnover of peer groups, this creates a distinct cultural milieu: many traditions are short-lived and disappear quickly, but some are so good at spreading, they are retained for very long periods of time. In other words, high turnover increases the variance in how long traditions last. The overall result is a small set of highly "proliferative" children's traditions (like certain playground games, songs, or jokes) that can endure just as long as some adult cultural traditions, even though the population of children is constantly changing. This mechanism offers a powerful way to reconcile the apparent instability of peer cultures with their surprising continuity over time – an open question also raised by Takada. Rather than viewing rapid turnover as a liability, Morin's account reframes it as a selective environment that privileges transmissibility over function, producing a form of cultural evolution optimized for engagement rather than efficiency. Echoing Perez et al. and Takada's argument that intrinsic motivations are key for peer cultural engagement, Morin's framework invites cultural evolutionary models to move beyond utility-based assumptions and to consider affect and play as central selective forces in children's cultural systems.

R3.2. Peer cultures among non-human animals

Several commenters extend the presence and function of peer cultures to non-human animals. This perspective reinforces our view that the developmental features of juvenility uniquely foster cultural experimentation and that these dynamics are not limited to humans.

Sueur et al. present a particularly comprehensive and vivid account of non-human animal peer cultures, drawing on a wide range of animal studies to argue that juvenile animals are not merely passive learners but active agents of cultural innovation. They document numerous cases where young individuals generate behavioral novelties – from object play to tool use – that subsequently diffuse through their groups. For example, juvenile macaques have been observed initiating practices such as stone

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

handling and sweet potato washing, behaviors later adopted by older members (Hirata et al., 2008). Altogether, their review makes a compelling case that peer cultures are not uniquely human.

Gray similarly underscores the role of juvenile play as a crucible for cultural innovation. He highlights another case study among macaques (Tan, 2017), in which young macaques playfully began to smash rocks together, perhaps just to enjoy the sound (led by intrinsic motivations, as Perez et al. point out). At some point, the rock-smashing among juveniles – and seemingly only juveniles – gained instrumentality as a way to crack open shellfish, allowing access to a nutrient-rich resource. When these juveniles matured into adults, their behavioral repertoires matured with them and were subsequently learned by new generations through imitation. We agree with Gray that there may be rich avenues for research in this domain, examining the role of play in downstream cultural innovations.

McAuliffe and Thornton extend this comparative argument by focusing on the mechanisms through which juvenile-led innovations are transmitted within animal societies. They highlight three possible routes: (1) juveniles may retain their learned behaviors as they age, allowing those innovations to persist and eventually diffuse through the group once the innovators reach adulthood; (2) other individuals, regardless of age, may selectively adopt successful juvenile practices, indicating that competence rather than dominance can guide social learning; and (3) some species can flexibly adjust their information-use strategies, with adults temporarily relaxing age-based learning biases to acquire knowledge from younger individuals when circumstances favor it. Together, these pathways demonstrate that juvenile innovations need not terminate within the peer domain but can, under the right social conditions, permeate the broader cultural system of the group, even in non-human species.

McAuliffe and Thornton also point out an interesting feature of juvenility that may contribute to innovation: juveniles are often of low rank and may therefore need to find creative ways to secure resources that higher-ranking members need not seek. This social positioning may in fact create ideal conditions for experimentation; with less to lose and fewer expectations to conform to, juveniles may exploit niches of opportunity overlooked by more dominant individuals. Such innovation from the margins mirrors patterns seen in human peer cultures, where reduced oversight and marginal status can likewise foster creativity and variation. For example, in many hunter-gatherer societies, children develop specialized foraging tools adapted to their smaller size and lesser strength, allowing them to target food resources usually ignored by adults (see Pretelli et al., 2024 for review). Framing juvenility in this way – as both a socially and developmentally privileged context for exploration – reinforces the idea that peer cultures, across species, function as engines of adaptive novelty within broader cultural systems.

R3.3. Identifying peer cultures in the archaeological record

Several commentators turned to archaeology to examine how children's cultural contributions might appear – or fail to appear – in the deep past. They noted that while identifying peer cultures and children's innovations in the archaeological record is difficult, the study of contemporary children and their material culture can provide new insights and help clarify how children contributed to cultural evolution in human history.

Sugiyama argues that *Homo* tool industries show little evidence of innovation, challenging the idea that children serve as agents of cultural adaptation. She points to the strong, apparent conservatism of Acheulean tool industries produced by other members of our genus, including *H. erectus* and *H. heidelbergensis*. Sugiyama also cites research showing a gradual technological transition from the Middle Stone Age to the Late Stone Age in the African archaeological record. She concludes that, until the European Upper Paleolithic, the cultural products of our ancestors reflected continuity rather than innovation. Only in the Upper Paleolithic, Sugiyama contends, do we see a sustained shift toward novel developments in technology and symbolic expression – including art, music, and personal ornamentation. She further argues that this period coincides with longer lifespans and larger social groups, which enabled cumulative knowledge transfer across generations, particularly from grandparents.

The discontinuous view of behavioral modernity suggested by Sugiyama's commentary – emerging relatively abruptly in *H. sapiens* rather than gradually across *Homo* – is challenged by recent archaeological discoveries. Among Neanderthals, recent findings suggest comparability of behavioral and cognitive capacities (Maida, 2025) as reflected in evidence of technological diversity and complexity in the lithic and organic record (Florindi et al., 2024; Leder et al., 2024), creation of large structures (Jaubert et al., 2016), and symbolic expression including engravings (Leder et al., 2021). With regard to the Acheulean record and the contention that there is little evidence of innovation among *H. erectus* and *H. heidelbergensis* populations, Hopkinson et al. (2013, p. 63) argue that this view "does not withstand scrutiny." The authors review considerable evidence for variability in the Acheulean tool industry, including in handaxe morphology, regional and temporal variation in early appearances of prepared core reduction technology prior to the Middle Paleolithic, and variability in the primary reduction of large cutting tools. Hopkinson et al. further argue that local short-term variability paired with long-term global stasis in Acheulian populations may be explained by (1) relatively short *childhoods* in comparison to later *Homo*, limiting opportunities for innovation on local scales, and (2) small group sizes and limited network interconnectivity, reducing the likelihood that innovations would spread between groups. While the exact timing for the evolution of childhood remains uncertain, through greater network connectivity and longer pre-reproductive periods, innovations produced by *H. sapiens* children could have been disseminated into the wider regional social ecology of the Upper Paleolithic.

Further, our contention was not that peer cultures are the *only* mechanisms by which communities adjust to change, and there is undoubtedly an important role for grandparents in the human story. However, dissociating the emergence of these two life history stages is complicated, as the evolution of extended childhood and postreproductive longevity likely co-occurred (Kaplan et al., 2000), mutually reinforcing each other and creating new social and cognitive conditions for cumulative culture. Where there were grandparents, there were also children. A longer juvenile period potentially afforded more time for exploration and horizontal learning among peers, while longer post-reproductive lifespans expanded opportunities for vertical and oblique transmission from elders. Together, these life history shifts may have forged a developmental bridge between innovation and retention – with children introducing variation through play and experimentation, and grandparents stabilizing and transmitting those successful innovations across generations.

Sugiyama also draws on ethnographic evidence to argue that children in diverse societies display respect and deference toward adult authority. However, we note that such observations are

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

typically made by adult ethnographers usually focused on adult interlocutors. As Barker and colleagues observe, outside the purview of adults, children can be strikingly irreverent toward adult norms and cultural forms. Similarly, Coffey and Scaff demonstrate that the presence of adults can obscure the full complexity of children's cultural production. We should not assume that children always defer to adults or adult-generated culture when beyond adult supervision.

Finally, we note that the absence of clear evidence for children's technological innovations does not necessarily imply their absence from the process of cultural evolution. Assuming that children were indeed not contributing much to technological innovation, one explanation may lie in, as Mesoudi points out, higher acquisition costs; it's possible that children's contributions to complex technologies may have been hampered and that their contributions are more likely in other domains (a point echoed by Nielsen). However, it's also possible that children *did* contribute to technological innovations, but that these contributions are difficult to recognize. For example, among the Papuan Gidra, children were given finished bows, from which they would learn the manufacturing process through reverse engineering (Nishiaki, 2013). Rather than produce innovative *products,* children may have generated novel manufacturing *processes*, something unlikely to be identified as such in the archaeological record.

Furthering this point, Snyder and Bandini argue that archaeological traces of children's activity may be present but under-recognized. For instance, the small, irregular flakes, or "practice pieces," once dismissed as production debris may, in fact, index moments of learning, imitation, and experimentation within early peer groups. They outline concrete methodological steps for identifying children in the archaeological record, such as experimental knapping studies with contemporary children and fine-grained analyses of artifact variability that might reflect learning or play. Encouragingly, a number of archaeologists have already begun to explore this space (Kilgore et al., 2025). In a recent flintknapping study, for instance, children aged 8–11 took turns learning to knap (Milks and Stileman, personal communication). They were seated side by side, with every other child participating in the first session, then switching places so their neighbors could learn during the second session. The experiment leads, Annemieke Milks and Finn Stileman, observed that during the second session, the children who had already practiced began offering advice and instructions – often unsolicited – to their neighbors, supporting their learning through shared experience. While an adult instructor was sometimes present to provide demonstration and individual guidance, in his absence, children often stepped in to take on that teaching role themselves. These observations vividly illustrate the natural drive for peer teaching and learning, even in apprenticeship contexts traditionally assumed to involve adult-only instruction, such as those described by Fischer (1989) and Takakura (2013).

Lastly, Miu et al. extend these insights into the domain of formal modeling, offering tools that may eventually allow us to test hypotheses about children's roles in the archaeological record. They argue that incorporating developmental parameters into models of cultural evolution can help generate expectations about what children's cultural contributions might look like in the material record, thus providing a theoretical framework for interpreting the material traces of peer learning and innovation (Miu et al., 2025). We agree that material culture is an ideal focus point for understanding children's contributions to culture change across contemporary cultures, both in the deep past and among our non-human kin. Further, material culture can provide insights into individual variation in behavior: how tools are used, how toys and small tools facilitate learning (Riede et al., 2018), and the role of horizontal and vertical transmission in learning to manufacture tools (Imamura, 2016; Jordan, 2015; Meyer et al., 2025), along with population-level effects on network connectivity (Kline & Boyd, 2010) and environmental variability (Collard et al., 2013; Meyer & Riede, 2025). Current databases, such as the Play-Object-Play database (https://play-object-play.au.dk/), which surveys tools and toys made for and by children in the ethnographic record, offer one avenue for understanding developmental and cross-cultural patterns in children's object manufacturing and use, including within peer cultures. Morin offers another corpus of material culture: he suggests that online language data may now provide a novel and enduring domain for tracking and assessing peer cultures. The digital material record, from forum exchanges to collaborative gaming and social media interactions, can open new empirical terrains for studying how children learn, create, and circulate cultural innovations. This suggestion underscores a potential shift in developmental research – from inferring cognitive processes in the past to directly observing cultural change in real time and at scales previously inaccessible.

R4. Open questions

R4.1. Meta-theoretical considerations: Whose voice is heard, and why does it matter?

Dutra argues that scholarship from the Global South – and scholars based there – must be meaningfully integrated into the study of peer culture evolution. We fully agree. The impetus for our target article was shaped by such cross-contextual encounters: the serendipitous discovery of Morin's article on children's traditions (2010), for instance, recognized by Lew-Levy because of her fluency in French; our reading of Bame Nsamenang's work from Cameroon (1992); and our sustained engagement with the communities we have worked with for many years. Inclusion must extend far beyond linguistic or geographic boundaries, and we are optimistic that technological advances such as those that facilitate long-distance engagement and translation will greatly support these efforts.

Dutra also suggests our focus on autonomy in peer cultures may be representative of hegemonic western thought. To clarify, our usage of "autonomy" is actually most closely related to what hunter-gatherer researchers term *cooperative autonomy*, often defined as "a combination of obligations to the group and protections for individuals against coercion by others" (Endicott, 2011, p. 81). This framing underlies our depiction of overlapping circles in Figure 1 – reflecting our view that adult and peer cultures are not wholly independent – and our argument that children's contributions to domains such as food security illustrate cooperation rather than separation. In upcoming empirical work on peer cultures, we plan to collaborate closely with in-country researchers as co-designers and co-authors, and we encourage others to similarly engage with local knowledge systems regarding the value – or limits – of children's peer groups in their societies.

Takada draws on Malinowski's notion of the "small republic of children" to argue that peer cultures function as political bodies within which children collectively negotiate norms, resolve conflicts, and make decisions that balance individual autonomy with group cohesion. What insights can we gain from children's social regulation mechanisms that could be applied to adult societies

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

today? A few key features of peer cultures may be worth highlighting in this regard. First, peer cultures tend to be less authoritarian, and while some age-based hierarchy does exist, it is much looser than the hierarchy that structures most adult communities. Power is often negotiated through consensus and mutual respect rather than fixed authority. Second, children tend to retain a high degree of individual autonomy, exercising choice within collective frameworks that still value equality and inclusion. This balance between independence and interdependence may offer a useful model for how adult societies can foster cooperation without reproducing rigid hierarchies. Third, children are buffered from many of the risks and time demands encountered by adults, giving them space for exploration and creativity. Economic initiatives that offer social support, such as a universal basic income, can similarly provide a protected environment necessary for adults to explore widely, expand their creativity, and innovate solutions to broader societal issues (RSA, 2016).

R4.2. Are peer cultures distinct from adult cultures?

A number of commentators raised questions about the boundary between peer and adult cultures, challenging how clearly the two can be separated.

Barker and colleagues, writing from a folklorist perspective, offer their views on the distinctiveness of peer and adult culture, suggesting that the lines between these cultural spheres are often blurred. Citing several (delightful) examples from children's folklore studies, they argue that children often directly acquire adult cultural forms but transform them into something that belongs distinctly to their own cultures. Barker et al. suggest that developmental needs play an important role in such hybridization. Further, the authors bring terms and histories from folklore studies, which we believe can enrich evolutionary research on this topic. For instance, we find great utility in the term *"triviality barrier,"* referring to a tendency of scholars to dismiss topics seen as frivolous or trivial, as opposed to treating them as serious subjects of study. We also found it quite stimulating to consider the *protective role* of the triviality barrier as a way to keep meddling adults out of peer cultures. Whether children explicitly recognize this barrier and whether they strategically utilize it to prevent adult incursion is an important avenue for future work.

Bennis similarly argues that children have not been *dismissed* but rather *ignored* in cultural evolution. That is, while adults are unmarked – treated as "natural, normal, or representative examples of a broader category (*people*)" – children are *marked* as a deviation from that category. Bennis further emphasizes that peer cultures are not limited to children. That is, people can form peer groups at different life stages, such as in elderhood, or in different social niches, such as members of a tech start-up. While this is true, we would argue that there is something evolutionarily distinctive about childhood that sets it apart from other life stages. The long, protected period associated with this life stage in humans affords children extended time for exploration, experimentation, and horizontal learning – conditions rarely replicated in adulthood. Further, children's cognition differs markedly from that of adults in ways that make their peer interactions uniquely generative. Compared to adults, children exhibit greater neural plasticity (Fandakova & Hartley, 2020), cognitive flexibility, and exploratory learning tendencies (Gopnik, 2020; Lucas et al., 2014). Their reasoning is often less constrained by prior knowledge or social convention, enabling them to entertain multiple possibilities and learn through experimentation (Gopnik, 2020; Gopnik et al., 2017; Lucas et al., 2014). Gray echoes these points in his commentary, highlighting four dispositional traits that are especially pronounced in childhood and together predispose children toward exploration and innovation. *Curiosity* motivates children to seek out novelty, *playfulness* encourages creative engagement with both ideas and materials, *sociability* facilitates rapid diffusion of new behaviors within peer groups, and *future orientation* directs attention toward emerging or anticipated challenges. These features make peer contexts especially fertile grounds for innovation: in interaction with similarly flexible partners, children can collaboratively generate novel ideas, behaviors, and social practices that adults might overlook or dismiss. Peer interaction thus functions not only as a medium for cultural transmission but also as a potential driver of cultural adaptation and change.

In a related commentary, Dutra argues that the "boundary between childhood and adulthood is permeable, overlapping, and culturally contingent," advising against an "age-based essentialism." Wertz & Russell-Wilks echo this point, suggesting that the dichotomization between child and adult culture risks oversimplifying the story. As stated above, we agree that there is not always a sharp boundary between adult and child cultures, in much the same way that there is no sharp boundary between childhood and adulthood. Further, we agree with Dutra that an outsized focus on age as a discrete category risks obscuring the gradual nature of development. However, the existence of gradual change in development does not preclude us from considering the distinctiveness of childhood as a stage with its own social and cognitive affordances. In much the same way, the existence of overlap and influence between child and adult culture does not undermine the value of treating them as analytically distinct. Rather than drawing sharp boundaries between children's and adults' cultures and risking essentializing by age, our aim is to provide a framework that lends structure to complex variation.

Wertz & Russell-Wilks raise an additional and important point about whether the underlying psychologies that produce peer culture in childhood and adult culture later in life are markedly different, which would help determine whether peer cultures comprise a qualitatively different form of culture than any other type of culture. They bring attention to a number of candidate domains – such as artifact reasoning and language – which may evidence distinct signatures as a function of an individual's age. We find Wertz and Russell-Wilks' question thought-provoking. In their view, if underlying psychological mechanisms are distinct enough, peer cultures would constitute a different *type* of culture altogether. However, would the importance of peer culture be threatened if these differences were not found? We're not so sure. All human cultures – adult or child – likely draw on a shared suite of cognitive capacities but can produce distinct products reflecting specific social and physical needs specific to each life stage. The distinctiveness of peer culture, then, may arise from these contextual differences rather than from fundamentally different psychologies. Still, examining whether the underlying mechanisms differ would offer valuable insight into how and why peer cultures develop their unique forms.

Lastly, Qiu and Moll challenge the idea that children's cultural production arises primarily from peer-generated knowledge. They argue that children's cultural transmission often focuses on content that originates from adults, which children then adapt, refine, and pass on to others – including both peers and adults. In this view, children's contribution to cumulative culture lies less in generating novel content and more in their role as pedagogical agents and *cultural brokers,* transmitting and transforming adult-

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

derived knowledge across social contexts. The authors use as examples children's translation for parents and grandparents in immigrant contexts, the introduction of technologies, and civic education at home. We believe that while these are compelling points, a focus on adult-derived content need not obscure children's own innovative contributions. As outlined in our article, peer cultures also generate distinct cultural forms – novel games, rituals, linguistic practices, and social norms – that arise from children's collective activity rather than direct adult transmission. Further, innovation can occur *through* the process of cultural brokering. For example, children may transform adult-derived cultural knowledge through copying errors, leading to change in these traits. And children may transmit some adult-derived traits and not others, leading to cultural selection. The invention of peer-derived knowledge and the transformation of adult-derived knowledge represent two potential sources of cultural innovation that require further study.

R4.3. How significant are children's contributions to culture change?

While many commenters agreed that children likely have their own distinctive cultures, several commentaries raised important questions about the scope and impact of peer cultures on broader trends in cultural evolution.

Mesoudi points out that two types of innovations exist: those that optimize existing knowledge and those that open a new niche or domain by exploiting a new phenomenon (Derex, 2021). More optimized cultural products tend to be more complex, carry high cultural acquisition costs, and thus involve long learning periods, limiting children's abilities to meaningfully innovate. In post-industrial settings, cultural products generally, and technology specifically, have become increasingly complex over time. The associated acquisition costs may hamper children's abilities to meaningfully innovate. Yet, children may uniquely contribute to the opening of new knowledge niches. Using the example of the computer game industry in the 1980s UK, Mesoudi shows that adolescents mastered programming independently from adults. As computer games advanced, the industry shifted towards trained programmers, eventually excluding adolescents due to the high acquisition costs of game production optimization. But, as the costs of adopting new technology decrease, children and adolescents may again have the opportunity to contribute meaningfully in this space. We agree with Mesoudi that accounting for acquisition costs associated with optimization vs. niche expansion "might help to elucidate exactly when, for what traits, and in what kind of societies, children are likely to contribute to society-wide cultural adaptation."

Similarly, Nielsen argues that children's cultural influence is almost certainly *domain-sensitive*. He notes that while it may be true that children maintain distinctive peer cultures, the claim that these cultures have lasting effects on broader cultural evolution is less certain. Nielsen specifically asks, "If childhood cultures are meaningful, why are children not less inclined to worship the God(s) of those around them (indeed, why don't they develop, and keep as real, their own)?" We agree that some domains – such as religion, ritual, or formal institutions – are likely less open to peer-driven change. Yet, peer-driven gods are not completely absent from the ethnographic record. Among the Mbendjele BaYaka in the Republic of the Congo, for instance, children are the guardians of a forest spirit named *Bolu*, who is respected by children and adults alike (Knight & Lewis, In Press; Lewis, 2002). Like forest spirits guarded by adults, *Bolu* has his own *ndjanga*, or secret path, and specific songs. Unlike forest spirits guarded by adults, however, there is no formal initiation for *Bolu*. *Bolu* is an ancient forest spirit and has likely been maintained and transmitted across many generations of children (Lewis, personal communication). However, we agree that other domains are likely far more permeable. In areas characterized by rapid transformation or weak adult expertise – such as new technologies, social media, and digital communication – Nielsen argues that children may act as early adopters and innovators, guiding how these tools are used and understood. Their fluency in navigating emerging ecological and technological landscapes may give them disproportionate influence precisely where cultural adaptation is happening most quickly.

Kempe and colleagues identify language – particularly phonology, morphosyntax, and the lexicon – as a domain in which young children are unlikely to contribute to innovation. They argue that some of the linguistic innovations we highlighted among young children tend to disappear in later ages, as children conform to adult linguistic conventions with higher fidelity. Here we offer several clarifications. First and foremost, Kempe et al. define children as 10 and under, whereas in our target article childhood was defined more broadly, as between 3 and 17 years. By this definition, much of what Kempe et al. describe as adolescent-driven change would still fall within the scope of our argument. Second, the authors challenge the idea that, although children may not shape established languages, they could nonetheless play a key role in the emergence of new ones. Interestingly, the proposition that children contribute to language emergence aligns with Mesoudi's distinction in the technological domain between niche expansion and optimization: children may drive expansion into new linguistic niches (the creation of novel languages), whereas adults are more likely responsible for optimizing established linguistic systems. Kempe et al. also question whether, in cases such as Nicaraguan Sign Language, innovations arise from children themselves or from their position within an iterated learning chain. They express skepticism toward the former, arguing that children's limited cognitive capacities constrain their ability to "scan the semiotic affordances of referential domains and monitor alignment with an interlocutor." Yet by around age five, children's mentalizing abilities are well developed (Callaghan et al., 2005), and as Wertz and Russel-Wilks note, their language learning capacities far surpass those of adults. It therefore seems plausible that, when interacting without a shared language, children could infer one another's intentions and converge on shared communicative acts – processes that might underlie the emergence of new languages. Importantly, we do not claim that children are the *only* ones to contribute to language emergence, but that, like adults, they *can*.

Kempe et al. also discuss prestige and frequency biases, which would favor learning from adults. However, this assertion may reflect an outsized emphasis on adult language to the exclusion of peer group language and communication more broadly. Indeed, there is ample evidence suggesting that children's learning biases are context sensitive. For example, in two naturalistic studies, children between the ages of 2 and 5 years imitated adults in disciplinary-related domains but peers in affective and play-related domains (Grusec & Abramovitch, 1982; Kuczynski et al., 1987). In experimental contexts, children aged between 3 and 5 years preferred adults as sources of information about nutritious foods but peers for information related to toys (Shutts et al., 2010; VanderBorght & Jaswal, 2009). We also note that several

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

studies from children outside of the post-industrialized West demonstrate that children receive more language input from other children than adults (e.g., Cristia et al., 2019, 2023). Therefore, one possibility is that children contribute to language evolution at the level of the peer group, even if these innovations rarely propagate beyond the peer group. Kempe et al. further argue that "young children require adult scaffolding to reach communicative efficiency." However, the paper by Matthews et al. (2007) cited to support this claim only included adult scaffolding, with no peer condition for comparison. While we agree that scaffolding is necessary for language development, whether peers or adults scaffold more effectively in different contexts and use the same strategies to do so is still an open and interesting empirical question.

To this latter question, Coffey and Scaff provide evidence that, in fact, adult scaffolding is not necessary for communicative efficiency. Specifically, as we noted above, they argue that linguistic input from peers has been systematically overlooked. As the authors point out, researchers themselves are adults, and their very presence can distort children's behaviors – prompting them to speak more performatively or deferentially than they otherwise might. To address this, they advocate for long-form audio-based recording methods that capture children's interactions in real time with minimal adult interference. Long-form recordings show that even in urban western classroom settings, "children talk more amongst each other than they do their teachers and their speech production is better predicted by peer input than adult input." Morin offers another source of naturalistic linguistic data – text exchanges, forum posts, or collaborative platforms – suggesting that these may offer an unprecedented window into how peer-driven linguistic variation propagates and stabilizes. We believe studies adopting such naturalistic methods have the potential to revolutionize our understanding of how children contribute to each other's linguistic, cognitive, and social development within peer group settings.

R5. Concluding thoughts

We would like to sincerely thank the commentators for their exciting contributions to the study of peer cultures from an evolutionary perspective. Collectively, the comments expand the possible cultures, timepoints, and species in which peer cultures and their effect on culture change may be evident. They simultaneously narrow our focus through well-developed theoretical frameworks and by identifying the parameters within which peer cultures can be more or less adaptive. Our interchange has led us to outline the following action points, which we hope will be stimulating for researchers excited to take on the challenge of studying peer cultures and their adaptive benefits.

Cross-cultural and (pre-)historical research. We have learned that peer cultures exist across the world despite severe constraints, such as high adult control settings in East Asia, and among highly autonomous children, such as street children. We need targeted empirical ethnographic research on peer cultures in diverse societies, including in the post-industrialized West, East, and Global south. We need research on urban and rural children to understand how migration between these settings shapes the evolution of peer cultures. We also need to look for evidence of peer cultures deeper in the past, through the use of historical textual documents and through the linkage of contemporary peer groups' material culture with the existing archaeological record. Because they can be hidden to the adult eye, we need new methods for studying peer cultures, which may require involving children themselves as meaningful collaborators and key informants in our approach.

Underlying cognitive mechanisms and their development. We need experimental research elucidating the underlying cognitive mechanisms that give rise to peer cultures. Specifically, we would like to understand whether children possess unique cognitive capacities that shape the peer cultures they produce, or whether social features of childhood can instead explain the rise of peer cultures. In turn, understanding such cognitive mechanisms can also shed light on how (e.g., teaching), from whom (e.g., social learning biases), why (e.g., intrinsic motivation), and what (e.g., selection for proliferation) is transmitted within peer groups. Beyond studying individual children, we advocate for researchers to take seriously how peer interaction and peer cultures shape children's cognitive development, including their moral and rational reasoning skills. While psychologists acknowledge that child development interacts with the specific cultural context in which it takes place (Amir & McAuliffe, 2020; Henrich et al., 2010; Nielsen et al., 2017), we have not yet accounted for the *peer culture* contexts in which children grow and negotiate their social and physical worlds.

Domains of innovation. We need a deeper understanding of the domains in which peer culture innovations are likely to contribute to culture change and those in which they are not. The commentators offer three focal domains, which we agree require further targeted research: technology, language, and norms. Luckily, commentators already offer robust approaches for exploring these avenues. Empirically, these include methods such as long-form recording, analyses of online textual sources, and the study of material culture inclusive of the manufacturing processes that give rise to them. Theoretically, this includes frameworks for assessing when peer cultures are likely to contribute to culture change – such as in niche expansion vs. optimization – and simulation-based models that link individual-level cognitive processes and life histories with group-level population sizes and age structures. Collectively, we should no longer accept for children to be excluded from formal cultural evolutionary modeling.

Studies of non-human animals. A growing body of evidence suggests that juvenility is a fertile developmental stage for innovation across species. As the commentaries reviewed, juvenile animals often occupy low-rank niches, exploit overlooked resources, and engage in playful experimentation that can lead to later instrumental behavior. Whether those innovations endure depends on social structure, adult openness to learning from young individuals, and other life history constraints. We need comparative frameworks that map juvenile propensities for innovation and exploration to neural development, social tolerance, and demographic connectivity – much like research on play (e.g., Kerney et al., 2017). Such frameworks will let us test whether the same mechanisms that produce human peer cultures also shape cultural dynamics in other primates and beyond.

We hope that this dialogue serves as a foundation for a sustained, cumulative science of peer cultures – one that integrates developmental, comparative, and evolutionary approaches. We

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press

invite scholars across disciplines to join in shaping this next chapter, advancing our understanding of children as agents of cultural adaptation.

Acknowledgments. Thanks to Annemieke Milks, Aislinn Keogh, Elena Miu, and William Buckner for comments and reading suggestions.

Financial support. SLL was funded by a Starting Grant from the European Research Council (ERC) under the European Union's Horizon Europe research and innovation programme (grant agreement No 101160788).

References

Amir, D., & McAuliffe, K. (2020). Cross-cultural, developmental psychology: Integrating approaches and key insights. *Evolution and Human Behavior*, *41*(5), 430–444. https://doi.org/10.1016/j.evolhumbehav.2020.06.006

Boyette, A. H., & Hewlett, B. S. (2017). Autonomy, equality, and teaching among Aka foragers and Ngandu farmers of the Congo Basin. *Human Nature*, *28*(3), 289–322. https://doi.org/10.1007/s12110-017-9294-y

Callaghan, T., Rochat, P., Lillard, A., Claux, M. L., Odden, H., Itakura, S., Tapanya, S., & Singh, S. (2005). Synchrony in the onset of mental-state reasoning: Evidence from five cultures. *Psychological Science*, *16*(5), 378–384.

Cannon, A. (2023). Social inequality before farming? Multidisciplinary approaches to the study of social organization in prehistoric and ethnographic hunter-gatherer-fisher societies. *American Antiquity*, *88*(1), 108–109. Cambridge Core. https://doi.org/10.1017/aaq.2022.85

Collard, M., Buchanan, B., O'Brien, M. J., & Scholnick, J. (2013). Risk, mobility or population size? Drivers of technological richness among contact-period western North American hunter–gatherers. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *368*(1630), 20120412. https://doi.org/10.1098/rstb.2012.0412

Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (2019). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development*, *90*(3), 759–773. https://doi.org/10.1111/cdev.12974

Cristia, A., Gautheron, L., & Colleran, H. (2023). Vocal input and output among infants in a multilingual context: Evidence from long-form recordings in Vanuatu. *Developmental Science*, *26*(4), e13375. https://doi.org/10.1111/desc.13375

Damico, S. B., & Purkey, W. W. (1978). Class clowns: A study of middle school students. *American Educational Research Journal*, *15*(3), 391–398. https://doi.org/10.3102/00028312015003391

Derex, M. (2021). Human cumulative culture and the exploitation of natural phenomena. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *377*(1843), 20200311. https://doi.org/10.1098/rstb.2020.0311

Draper, P. (1976). Social and economic constraints on child life among the! Kung. *Anthropology Faculty Publications*, *13*, 199–217.

Edwards, C. P., & Whiting, B. B. (1988). *Children of different worlds: The formation of social behavior*. Harvard University Press.

Endicott, K. M. (2011). Cooperative autonomy: Social solidarity among the Batek of Malaysia. In T. Gibson & K. Sillander (Eds.), *Anarchic solidarity: Autonomy, equality, and fellowship in Southeast Asia* (pp. 62–87). Yake University Council on Southeast Asia Studies New Haven.

Fandakova, Y., & Hartley, C. A. (2020). Mechanisms of learning and plasticity in childhood and adolescence. *Developmental Cognitive Neuroscience*, *42*, 100764. https://doi.org/10.1016/j.dcn.2020.100764

Fischer, A. (1989). A late Palaeolithic «school» of Flint-knapping at Trollesgave, Denmark. Results from refitting. *Acta Archaeologica*, *60*, 33–49.

Florindi, S., Santaniello, F., Aranguren, B., Grimaldi, S., Melandri, C., Puzio, D., & Revedin, A. (2024). Wooden hafting technology in the early Neanderthal site of Poggetti Vecchi (Italy). *Quaternary Science Reviews*, *345*, 109014. https://doi.org/10.1016/j.quascirev.2024.109014

Frankenhuis, W. E., & Amir, D. (2022). What is the expected human childhood? Insights from evolutionary anthropology. *Development and Psychopathology*, *34*(2), 473–497. https://doi.org/10.1017/S0954579421001401

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., O'Grady, S., Lucas, C. G., Griffiths, T. L., Wente, A., Bridgers, S., Aboody, R., Fung, H., & Dahl, R. E. (2017). Changes in cognitive flexibility and hypothesis search across human life history from childhood to adolescence to adulthood. *Proceedings of the National Academy of Sciences*, *114*(30), 7892–7899. https://doi.org/10.1073/pnas.1700811114

Grusec, J. E., & Abramovitch, R. (1982). Imitation of peers and adults in a natural setting: A functional analysis. *Child Development*, *53*(3), 636–642. https://doi.org/10.2307/1129374

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world?. *Behavioral Brain Sciences*, *33*(2–3), 61–135. https://doi.org/10.1017/S0140525X0999152X

Hirata, S., Watanabe, K., & Masao, K. (2008). "Sweet-potato washing" revisited. In T. Matsuzawa (Ed.), *Primate origins of human cognition and behavior* (pp. 487–508). Springer Japan. https://doi.org/10.1007/978-4-431-09423-4_24

Hopkinson, T., Nowell, A., & White, M. (2013). Life histories, metapopulation ecology, and innovation in the Acheulian. *PaleoAnthropology*, *2013*, 61–76.

Imamura, K. (2016). Hunting play among the San children: Imitation, learning, and play. In B. Hewlett & H. Terashima (Eds.), *Social learning and innovation in contemporary hunter-gatherers: evolutionary and ethnographic perspectives* (pp. 179–186).

Jaubert, J., Verheyden, S., Genty, D., Soulier, M., Cheng, H., Blamart, D., Burlet, C., Camus, H., Delaby, S., Deldicque, D., Edwards, R. L., Ferrier, C., Lacrampe-Cuyaubère, F., Lévêque, F., Maksud, F., Mora, P., Muth, X., Régnier, É., Rouzaud, J.-N., & Santos, F. (2016). Early Neanderthal constructions deep in Bruniquel Cave in southwestern France. *Nature*, *534*(7605), 111–114. https://doi.org/10.1038/nature18291

Jordan, P. (2015). *Technology as human social tradition: Cultural transmission among hunter-gatherers*. University of California Press.

Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A. M. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology: Issues, News, and Reviews*, *9*(4), 156–185. https://doi.org/10.1002/1520-6505(2000)9:4%253C156::AID-EVAN5%253E3.0.CO;2-7

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

Kerney, M., Smaers, J. B., Schoenemann, P. T., & Dunn, J. C. (2017). The coevolution of play and the cortico-cerebellar system in primates. *Primates*, *58*(4), 485–491. https://doi.org/10.1007/s10329-017-0615-x

Kilgore, M. B., Liu, C., & Stout, D. (2025). What can lithics tell us about the evolution of learning and development?. *Archaeometry*, arcm.70002. https://onlinelibrary.wiley.com/doi/abs/10.1111/arcm.70002

Kline, M. A., & Boyd, R. (2010). Population size predicts technological complexity in Oceania. *Proceedings of the Royal Society B: Biological Sciences*, *277*(1693), 2559–2564. https://doi.org/10.1098/rspb.2010.0452

Knight, C., & Lewis, J. (In Press). *The revolutionary origins of language*. Yale University Press.

Kuczynski, L., Zahn-Waxler, C., & Radke-Yarrow, M. (1987). Development and content of imitation in the second and third years of life: A socialization perspective. *Developmental Psychology*, *23*(2), 276–282. https://doi.org/10.1037/0012-1649.23.2.276

Lancy, D. (1984). Play in anthropological perspective. In P.K. Smith (Ed.), *Play in animals and humans* (pp. 295–303). Basil Blackwell. https://digitalcommons.usu.edu/sswa_facpubs/92

Leder, D., Hermann, R., Hüls, M., Russo, G., Hoelzmann, P., Nielbock, R., Böhner, U., Lehmann, J., Meier, M., Schwalb, A., Tröller-Reimer, A., Koddenberg, T., & Terberger, T. (2021). A 51,000-year-old engraved bone reveals Neanderthals' capacity for symbolic behaviour. *Nature Ecology & Evolution*, *5*(9), 1273–1282. https://doi.org/10.1038/s41559-021-01487-z

Leder, D., Lehmann, J., Milks, A., Koddenberg, T., Sietz, M., Vogel, M., Böhner, U., & Terberger, T. (2024). The wooden artifacts from Schöningen's Spear Horizon and their place in human evolution. *Proceedings of the National Academy of Sciences*, *121*(15), e2320484121. https://doi.org/10.1073/pnas.2320484121

Lewis, J. (2002). *Forest hunter-gatherers and their world: A study of the Mbendjele Yaka pygmies of Congo-Brazzaville and their secular and religious activities and representations*. University of London.

Lew-Levy, S., Boyette, A. H., Crittenden, A. N., Hewlett, B. S., & Lamb, M. E. (2020). Gender-typed and gender-segregated play among Tanzanian Hadza and Congolese BaYaka Hunter-Gatherer children and adolescents. *Child Development*, *91*(4), 1284–1301. https://doi.org/10.1111/cdev.13306

Lew-Levy, S., Kandza, V., Jang, H., Kiabiya Ntamboudila, F., Bihoundou Mouketou, D., Siassia Vindou, C. D., Ngalekandza, E., Koubemba, B., Lendzingoud, A. P. X., Goulou, R., Visine, A., Boyette, A. H., & Gettler, L. T. (2025). BaYaka forager and Bantu fisher-farmer adolescent engagement with intensifying market integration in the Republic of the Congo. *Journal of the Royal Anthropological Institute*, 1467–9655.70006. https://doi.org/10.1111/1467-9655.70006

Lew-Levy, S., Kissler, S. M., Boyette, A. H., Crittenden, A. N., Mabulla, I. A., & Hewlett, B. S. (2020). Who teaches children to forage? Exploring the primacy of child-to-child teaching among Hadza and BaYaka Hunter-Gatherers of Tanzania and Congo. *Evolution and Human Behavior*, *41*(1), 12–22. https://doi.org/10.1016/j.evolhumbehav.2019.07.003

Lew-Levy, S., Reckin, R., Kissler, S. M., Pretelli, I., Boyette, A. H., Crittenden, A. N., Hagen, R. V., Haas, R., Kramer, K. L., & Koster, J. (2022). Socioecology shapes child and adolescent time allocation in twelve hunter-gatherer and mixed-subsistence forager societies. *Scientific Reports*, *12*(1), 8054.

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

Maida, G. D. (2025). Becoming Neanderthal. *EAZ – Ethnographisch-Archaeologische Zeitschrift*, *59*(2). https://doi.org/10.54799/KPOX9368

Martin, J. S., Ringen, E. J., Duda, P., & Jaeggi, A. V. (2020). Harsh environments promote alloparental care across human societies. *Proceedings of the Royal Society B: Biological Sciences*, *287*(1933), 20200758. https://doi.org/10.1098/rspb.2020.0758

Matthews, D., Lieven, E., & Tomasello, M. (2007). How toddlers and preschoolers learn to uniquely identify referents for others: A training study. *Child Development*, *78*(6), 1744–1759. https://doi.org/10.1111/j.1467-8624.2007.01098.x

Maynard, A. E. (2002). Cultural teaching: The development of teaching skills in Maya sibling interactions. *Child Development*, *73*(3), 969–982. https://doi.org/10.1111/1467-8624.00450

McGuigan, N., Burdett, E., Burgess, V., Dean, L., Lucas, A., Vale, G., & Whiten, A. (2017). Innovation and social transmission in experimental micro-societies: Exploring the scope of cumulative culture in young children. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1735), 20160425. https://doi.org/10.1098/rstb.2016.0425

Meyer, M. V., Haidle, M. N., & Riede, F. (2025). Reconstructing situated learning in a community of practice using cognigrams. *Hunter Gatherer Research*, *11*(1), 41–74. https://doi.org/10.3828/hgr.2024.39

Meyer, M. V., & Riede, F. (2025). Playing to survive: Children and innovation during the little ice age in Greenland. *European Journal of Archaeology*, *28*(1), 81–100. https://doi.org/10.1017/eaa.2024.36

Miu, E., Andersen, M. M., Lew-Levy, S., & Riede, F. (2025). Childhood exploration drives population-level innovation in cultural evolution. https://doi.org/10.1101/2025.03.28.645934

Morin, O. (2010). Pourquoi les enfants ont-ils des traditions?. *Terrain. Anthropologie & Sciences Humaines*, *55*, 20–39. Article 55. https://doi.org/10.4000/terrain.14042

Nielsen, M., Haun, D., Kärtner, J., & Legare, C. H. (2017). The persistent sampling bias in developmental psychology: A call to action. *Journal of Experimental Child Psychology*, *162*, 31–38. https://doi.org/10.1016/j.jecp.2017.04.017

Nishiaki, Y. (2013). "Gifting" as a means of cultural transmission: The archaeological implications of bow-and-arrow technology in Papua New Guinea. In T. Akazawa, Y. Nishiaki, & K. Aoki (Eds.), *Dynamics of learning in Neanderthals and modern humans Volume 1* (pp. 173–185). Springer Japan. https://doi.org/10.1007/978-4-431-54511-8_10

Nsamenang, A. B. (1992). *Human development in cultural context: A third world perspective*. SAGE Publications.

Owram, D. (1997). *Born at the right time: A history of the baby boom generation*. University of Toronto Press. https://muse.jhu.edu/pub/50/monograph/book/106870

Pérez Velilla, A., Beheim, B., & Smaldino, P. E. (2025). The development of risk attitudes and their cultural transmission. *Psychological Review*. Advance online publication. https://doi.org/10.1037/rev0000599

Piaget, J. (1948). *The moral judgment of the child* (pp. ix, 418). Free Press.

Pretelli, I., Crittenden, A. N., Dounias, E., Friant, S., Koster, J., Kramer, K. L., Mangola, S. M., Saez, A. M., & Lew-Levy, S. (2024). Child and adolescent foraging: New directions in evolutionary research. *Evolutionary Anthropology*, *33*(2), e22020. https://doi.org/10.1002/evan.22020

Riede, F., Johannsen, N. N., Högberg, A., Nowell, A., & Lombard, M. (2018). The role of play objects and object play in human cognitive evolution and innovation. *Evolutionary Anthropology: Issues, News, and Reviews*, *27*(1), 46–59. https://doi.org/10.1002/evan.21555

RSA, T. (2016). Creative citizen, creative state. *Pathways to Universal Basic Income*. https://medium.com/pathways-to-universal-basic-income/creative-citizen-creative-state-a3cef3f25775

Ruch, W., Platt, T., & Hofmann, J. (2014). The character strengths of class clowns. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.01075

Schaengold, C. C. (2004). *Bilingual navajo: Mixed codes, bilingualism, and language maintenance* [Ph.D., The Ohio State University]. In *proquest Dissertations and Theses (305138822). ProQuest Dissertations & Theses Global; ProQuest One Literature*.

Schniter, E., Gurven, M., Kaplan, H. S., Wilcox, N. T., & Hooper, P. L. (2015). Skill ontogeny among Tsimane forager-horticulturalists. *American Journal of Physical Anthropology*, *158*(1), 3–18. https://doi.org/10.1002/ajpa.22757

Shutts, K., Banaji, M. R., & Spelke, E. S. (2010). Social categories guide young children's preferences for novel objects. *Developmental Science*, *13*(4), 599–610. https://doi.org/10.1111/j.1467-7687.2009.00913.x

Takakura, J. (2013). Using lithic refitting to investigate the skill learning process: Lessons from upper paleolithic assemblages at the shirataki sites in Hokkaido, Northern Japan. In T. Akazawa, Y. Nishiaki, & K. Aoki (Eds.), *Dynamics of Learning in Neanderthals and Modern Humans Volume 1: Cultural Perspectives* (pp. 151–171). Springer Japan. https://doi.org/10.1007/978-4-431-54511-8_9

Tan, A. W. Y. (2017). From play to proficiency: The ontogeny of stone-tool use in coastal-foraging long-tailed macaques (Macaca fascicularis) from a comparative perception-action perspective. *Journal of Comparative Psychology*, *131*(2), 89–114. https://doi.org/10.1037/com0000068

VanderBorght, M., & Jaswal, V. K. (2009). Who knows best? Preschoolers sometimes prefer child informants over adult informants. *Infant and Child Development*, *18*(1), 61–71. https://doi.org/10.1002/icd.591

Velupillai, V. (2015). *Pidgins, creoles and mixed languages*. 1–626. John Benjamins Publishing Company.

Wagner, L. (2019). The Social life of class clowns: Class clown behavior is associated with more friends, but also more aggressive behavior in the classroom. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.00604

Xu, J., Hewlett, B., Rawlings, B., Scaff, C., Abels, M., Tian, X., Badiani, F., Ndlovu, N., Rosun, N., & Oppong, S. (2025). *6. Negotiating fieldwork challenges: Voices from the field*. Open Book Publishers. https://www.openbookpublishers.com/books/10.11647/obp.0440/chapters/10.11647/obp.0440.06

https://doi.org/10.1017/S0140525X24001377 Published online by Cambridge University Press