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Toys as Teachers: A Cross-Cultural Analysis of Object Use and Enskillment in Hunter–Gatherer Societies

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Abstract

Studies of cultural transmission—whether approached by archaeological or ethnographic means—have made great strides in identifying formal teaching and learning arrangements, which in turn can be closely aligned with models of social learning. While novices and apprentices are often in focus in such studies, younger children and their engagement with material culture have received less attention. Against the backdrop of a cross-cultural database of ethnographically documented object use and play in 54 globally distributed foraging communities, we here discuss the ways in which children make and use tools and toys. We provide a cross-cultural inventory of objects made for and by hunter–gatherer children and adolescents. We find that child and adolescent objects are linked to adult material culture, albeit not exclusively so. Toys and tools were primarily handled outside of explicit pedagogical contexts, and there is little evidence for formalised apprenticeships. Our data suggests that children's self-directed interactions with objects, especially during play, has a critical role in early-age enskillment. Placed within a niche construction framework, we combine ethnographic perspectives on object play with archaeological evidence for play objects to offer an improved cross-cultural frame of reference for how social learning varies across early human life history and what role material culture may play in this process. While our analysis improves the systematic understanding of the role and relevance of play objects among hunter–gatherer societies, we also make the case for more detailed studies of play objects in the context of ethnographic, archival and archaeological cultural transmission research.

Keywords Cultural transmission · Cross-cultural analysis · Niche construction · Innovation · Toys · Object play

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Introduction

The extensive use of tools and material culture is a key characteristic of the hominin lineage, and of *Homo sapiens* in particular. Yet, exactly when and how social learning and the high-fidelity transmission of cultural knowledge replaced genetically determined or largely ad hoc uses of material culture remains controversial (Corbey et al., 2016; Högberg et al., 2015; Tennie et al., 2017). Since the emergence of formal models of cultural transmission (Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981), researchers have sought to characterise the psychological and social conditions under which cultural traits are maintained and elaborated. Understanding the emergence of experts within certain technological domains—acting as teachers, role models and innovators—has been central to this endeavour (Henrich, 2004; Kline et al., 2013).

In parallel to the development of cultural transmission studies, anthropologists and archaeologists have elaborated ways to decode past technological processes (e.g. Eerkens & Lipo, 2007; O'Brien, 2008; O'Brien & Lyman, 2003; Shennan, 1989, 2008). Often summarised under labels such as operational chain analysis (Bleed, 2001), dynamic technological analysis (Schild, 1980) or *chaine operatoire* analysis (Lemonnier, 1992; Sellet, 1993), researchers have reverse-engineered ancient technologies using a combination of ethnoarchaeology, experimental replication and assemblage analyses. While not without their shortcomings (see Bar-Yosef & Van Peer, 2009; Darmark & Apel, 2008; Tostevin, 2011 for cogent critiques), these approaches have provided insights compatible with formal models of cultural transmission (e.g., Jordan & Mace, 2008; Manem, 2020; Riede, 2008; Stout, 2002; Tostevin, 2019). Inherent to these approaches to prehistoric technologies is a focus on identifying skill level progressions towards mastery, mostly in the context of apprenticeship relations (Arnold, 2012; Klaric, 2018; Pigeot, 1990; Rivero, 2016). These analyses have culminated in the viewpoint that formal teaching-and-learning arrangements are necessary to the stability of material culture lineages that characterise much of the archaeological record (Tehrani & Riede, 2008).

In a recent review of the structure and socio-political role of apprenticeship in ethnographic contexts, however, Dallos (2021) points out that apprenticeships serve many purposes other than turning novices into masters. Notably, true formal apprenticeships are rare if not entirely absent in foraging societies. Indeed, many ethnographers working with hunter–gatherers point out that youngsters instead learn mostly by doing, observing and—most pertinent to the present study—playing (Boyette & Hewlett, 2017b; Garfield et al., 2016; Lancy, 2010, 2017; Lew-Levy et al., 2017; MacDonald, 2007). In this context, children's material culture broadly reflects the economic and social structures of its parent culture (e.g. Ember & Cunnar, 2015) and toys play an important role in socialisation by allowing youngsters to explore and practice prevalent norms and activities (Hardenberg, 2010; Kenyon & Arnold, 1985). Early exposure to play objects such as functional miniatures of complex adult artefacts may also contribute to the development of expertise (Lancy, 2016, 2017). These ethnographic observations may not apply wholesale to prehistoric hunter–gatherer societies (cf. Wobst, 1978) but their cross-cultural prevalence challenges the notion that becoming an expert in a given technology requires formal learning arrangements (Harris et al., 2021).

Recent research within developmental psychology further shows that play is a highly efficient strategy that children utilise to learn new skills and motoric proficiency and to gain understandings of abstract causal relationships (Andersen et al., 2022; Bateson & Martin, 2013; Bonawitz et al., 2012; Cook et al., 2011; Gopnik & Wellman, 2012). For example, a recent experimental cross-cultural study found suggestive support for how early-age exposure to certain technologies improves its creative use (Lew-Levy et al., 2021). In the context of cultural transmission, provisioning children with functional miniatures of adult technologies through play may help children learn the functional affordances of cognitively opaque technologies such as stored energy propulsion (i.e. the bow-and-arrow), composite adhesives or wheeled transport (Riede et al., 2018, 2021), and to practise the physical routines associated with each technology (cf. Warnier, 2001). In other words, play is widely believed to be an adaptive feature of childhood that promotes exploration and allows youngsters to experiment with their bodies, their minds and their environments. This early-age experimentation, in turn, may be a crucial component in learning and innovation (e.g., Bjorklund & Brown, 1998; Bloch & Pellegrini, 1989; Briggs, 1991; Gopnik, 2020; Lancy, 1980). Despite these insights, our ability to relate children's material culture and play to later mastery in prehistory remains incomplete.

In the following, we present results from an exploratory descriptive study on tool and toy use in children from hunter–gatherer ethnographic contexts worldwide. Unless otherwise noted, we use the term 'child' and its plural 'children' throughout the text to refer to pre-reproduction youngsters from all developmental stages, i.e., infancy, early childhood, middle childhood and adolescence. In focusing strictly on objects made for or by children, we seek to improve our frame of reference in terms of (i) how objects are embedded in age and gender structures within each society, (ii) what role they play in recognised social learning arrangements, (iii) how such objects might survive the vagaries of preservation once abandoned and (iv) what sorts of objects we would associate with object play archaeologically. We focus on ethnographic hunter–gatherers not because they offer direct analogues to the communities of the distant past, but because they offer the best available reference frame for approaching the human deep past. The great diversity in terms of social organisation, technological systems and economic strategies observed ethnographically mirrors and supplements the diversity observed archaeologically (see, for instance, Finlayson & Warren 2017). As part of this diversity, records from around the world also often highlight the central importance of self-directed learning in these and some other small-scale societies (Lancy, 2016, 2017). These observations—further supported by the results presented here—offer an opportunity to rethink learning processes in prehistory by highlighting the prevalence of playful expertise–acquisition that is not conditioned by apprenticeship but rather by playful peer-led interaction with material culture.

Materials and Methods

Initial Search

We sourced data on child and adolescent toys and tools from the electronic Human Relations Area Files (eHRAF; https://ehrafworldcultures.yale.edu/ehrafe/). The

eHRAF is a searchable database of ethnographies for over 300 societies worldwide. Each paragraph is indexed using the Outline of Cultural Materials or OCM (Murdock et al., 2008). Developed in the 1940s by Murdock, OCM is a classification system aimed at capturing human behaviour, social life and customs, material culture and human–ecological environments as described in ehtnographies worldwide (see https://hraf.yale.edu/resources/reference/outline-of-cultural-materials), albeit with a bias, for foraging societies at least, towards North America. For the present study, we performed two searches. In a first search, we paired Technology and Material Culture (code 005) with Infancy and childhood (850) OR socialisation (860) OR Puberty and initiation (881) OR Status of adolescents (882) OR adolescent activities (883). In a second search, we paired Games (524) with Infancy and childhood (850) OR socialisation (860) OR Puberty and initiation (881) OR Status of adolescents (882) OR adolescent activities (883). Definitions for each of these OCM codes can be found in Table 1.

We then restricted our search to societies categorised as hunter–gatherers or primarily hunter–gatherers, defined by eHRAF as societies that "depend almost entirely (86% or more) on hunting, fishing, and gathering for subsistence" and "depend mostly (56% or more) on hunting, fishing and gathering for subsistence," respectively. In total, 2285 unique paragraphs met our search criteria.

Developing the Coding Scheme

Our goal was to develop a reproducible and replicable coding scheme that could generalise beyond data from hunter–gatherers, and eventually, beyond eHRAF to other sources of data (e.g., observational reports and museum collection entries). To do so, we took multiple iterative steps that broadly involved (1) the research team reading a subset of paragraphs to develop preliminary codes, (2) two student coders coding a subset of paragraphs using these codes, (3) assessing the external consistency of our codes, (4) a single student coder coding all remaining paragraphs and (5) revisiting each code to further refine it. In the following, this procedure is referred to as our 'five-step coding procedure'.

In order to assess intercoder reliability, we used Gwet's AC1 (Wongpakaran et al., 2013). AC1 is preferable over traditional assessments of intercoder reliability such as Cohen's kappa when some codes are particularly rare in a dataset, since Kappa is affected by a skewed distribution of categories (Eugenio & Glass, 2004; Feinstein & Cicchetti, 1990). Assessments of interobserver variability is common in, for instance, osteoarchaeology but remains notably rare in most branches of material culture studies. The data found in eHRAF have not been collated with specific study design and their requirements in mind. Assessing interobserver variability is therefore essential; the values we report here grant confidence to our transcription. In what follows, we describe in detail how we developed our coding scheme.

Table 1 Definitions of OCM codes used in the present study, from the electronic Human Relations Area Files (https://ehrafworldcultures.yale.edu/ehrafe/)

Subject (OCM code)	Definition
Technology and Material Culture (005)	Includes Building and construction (330), Capital goods industries (390), Chemical industries (380), Clothing (290), Energy and Power (370), Equipment and Maintenance of Buildings (350), Land Transport (490), Leather, Textiles, and Fabrics (280), Machines (400), Military Technology (710), Processing of Basic Materials (320), Structures (340), Tools and Appliances (410), Travel and Transportation (480), Water, Air, and Space Transport (500)
Games (524)	Playthings (e.g., dolls, blocks and mechanical toys), games of dexterity (e.g., string figures, tops, juggling, kite flying and billiards), problem games (e.g., riddles, charades and puzzles), games of calculation (e.g., chess, checkers and card games), special children's games, occasions for playing games, participants and spectators, special equipment, rules, organizers and sponsors of games (e.g., cliques, clubs, churches, communities and business organisations), etc
Infancy and Childhood (850)	General statements dealing with several aspects of the care, physical development, activities and status progression of children from birth to puberty. Includes ceremonial during infancy and childhood, child care, childhood activities, development and maturation, infant care, infant feeding, social placement and status of children
Socialisation (860)	General statements dealing with several aspects of the basic mechanisms of cultural transmission, especially the socialisation of impulses and the more informal educational processes. Includes aggression training cleanliness training, independence training, sex training, techniques of socialisation, transmission of beliefs, transmission of cultural norms, transmission of skills, weaning and food training
Puberty and Initiation (881)	Ideas, beliefs and practices associated with first *emissio seminis* and first menstruation, rites of passage at or near puberty, prevalence of special initiation rites for each gender, ceremonial sponsors, function and purpose of ceremonial, mystery and seclusion, taboos, ordeals and tests, teaching secret lore, special instruction in sex life, ideas of death and rebirth, etc
Status of Adolescents (882)	Cultural definition of adolescence (e.g., age limits), beliefs and attitudes about adolescents, prerogatives and disabilities of adolescents, relaxing or tightening of social control for each gender, residence shifts at puberty (e.g., removal of boys to men's house or to home of grandparent or maternal uncle), readjustment of social relationships, etc
Adolescent Activities (883)	Behaviour patterns and attitudes characteristic of adolescents (e.g., dating and loitering), economic activities expected of adolescents, adolescent organisations (e.g., work groups, cliques and bachelors' clubs), adolescent recreation (e.g., expeditions and picnics), adolescent problems (e.g., reactions to social pressures for adult behaviour), etc

Object Identification and Categorization

The paragraphs retrieved during our eHRAF search referred to objects and children. However, it was not necessarily the case that the objects described in the paragraphs were made *for* or *by* children. Thus, our first step was to read each paragraph and identify the objects used or manufactured by children in each one. To do this, we adhered to our 'five-step coding procedure'. First, our team reads 60 paragraphs and flagged any objects made for or by children, with multiple objects possible per paragraph. Any disagreements or inconsistencies were discussed and resolved by consensus. Second, two coders read these same 60 paragraphs and examined the objects listed by the research team. Third, the student coders practised by independently coding objects for 85 new paragraphs. Unless noted otherwise, this preliminary coding alignment preceded the final coding of the variable discussed below. They then compared their object lists, discussed any disagreements, and resolved them by consensus, or by consulting the senior research team. Finally, the student coders independently coded 422 (~18%) paragraphs for objects. The number of objects identified by each coder in each paragraph was highly correlated ($r = 0.79$, $p < 0.001$). Once reliability was achieved, one student coder went on to code all remaining paragraphs.

After reviewing the object list produced by the coders, we decided to further refine our focus of inquiry to tools and toys made for and used by children. Here, we define *tools* as devices or implements used to carry out specific instrumental functions, usually held in the hand, in the context of domestic activities that contribute to food-getting, somatic maintenance or the like. We define *toys* as objects that children play with, i.e., objects that may have a function similar to tools but that are used in non-instrumental or pretense settings. We thus excluded adornments, clothing, and children's bedding from the study. We also excluded items used solely in ceremonial settings because these are difficult to compare across cultures. Finally, we excluded factory-made objects (e.g., pens, paper, and tricycles), as these do not correspond to material culture in the deep past.

FR categorised each remaining toy and tool into one of twelve categories (see Table 2). SLL reviewed each code, and any disagreement was resolved by consensus. Because of low frequencies, animal and human figures, games and physical games and tended and untended facilities were combined into figures, games and facilities, respectively, in the analysis. Whenever available, images (photographs or drawings) of the objects in question were extracted and redrawn for consistency (Fig. 1).

Object Users and Manufacturers

While reading object descriptions, we asked coders to keep track of the gender of the object user (*boys*, *girls, both boys and girls* or *gender unknown*). Reliability was estimated on the basis of 185 objects (~21% of objects including those subsequently excluded), after which only one of the coders worked through all remaining paragraphs. There was adequate agreement (82.7%) among the codes, and AC1 values were moderate (AC1 = 0.62). Investigating the data further, the coders generally

Table 2 Categories of play objects, their definitions and examples used in this study

Category	Definition	Examples
Animal figure	A model of an animal, typically used as a toy	Willow horse, stuffed skin
Human figure	A model of a human figure	Dolls, rag babies
Games	Organized play which is structured by rules, and/or during which players coordinate their activities. These games are typically played sitting down	Tops, marbles, string figures
Physical games	Play that involves exercise and/or involves feats of strength or skill	Games with balls, monkey bars, jungle gyms, swings, skipping rope, kites, stilts, darts
Musical instrument	A device created or adapted to make musical sound	Whistles, rattles, buzz disk, bullroarer, flutes
Container	An object for holding or transporting something	Pots, bags, baskets, packs, vessels, bowls
Instrument	Hand manipulated objects used in subsistence to collect relatively non-mobile or harmless food resources OR hand manipulated objects used in the manufacture of other objects	Knives, axes, ladder, spindle, chisel, scissors, crimper
Tended facility	A facility is a form that controls the movement of a species or protects it so that it can be collected. When the presence of one or more people is essential, this is a *tended* facility	Hunting nets, fish trap, bird trap, fishing rod, fence for corralling animals, lasso, cow-milking stand, torches to clear plots of land, fish poison
Untended facility	A facility is a form that controls the movement of a species or protects it so that it can be collected. When the facility functions in the absence of people, this is an *untended* facility	Snares, traps, bells for grazing animals, scare crows, protective barriers for plants, substances to repel predators
Shelter	A constructed place giving permanent or temporary protection from the elements	Wickiup, hammock, hut lodge, tent, tipi, camp
Transport	An object which conveys people or goods from one place to another	Canoe, sled, kayak, saddle, paddle
Weapon	An object designed or used for inflicting bodily harm or physical damage during hunting and/or interpersonal conflict	Bows and arrows, bolas, spears, throwing boards, blowgun, riffle, sling

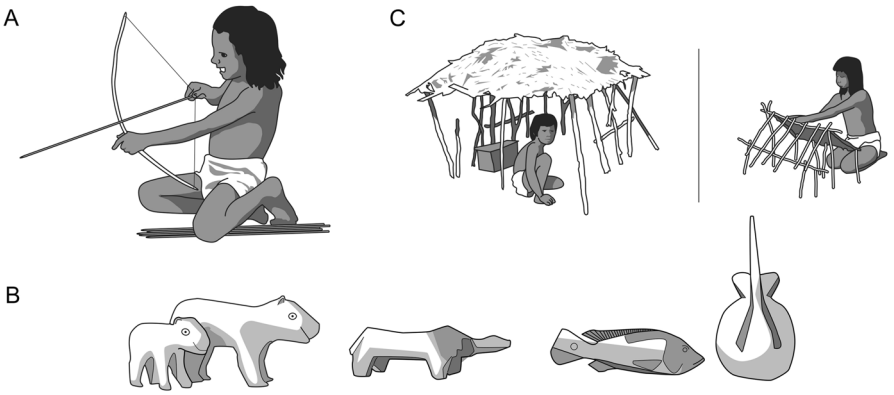

Fig. 1 Examples of artefact images that reflect the range of play objects addressed here, extracted and re-drawn by Ea Rasmussen (Moesgaard Museum) from eHRAF. **A** Canela (South America) boy playing with a scaled-down bow (Crocker, 1990). **B** Ticuna (South America) figurines of (from left to right) a capybara with young; dolls made of muirapiranga wood, a small bench in the form of a tortoise, and a fish and ray (Nimuendajú, 1952). **C** Canela (South America) children's playhouse made of old mats, and girls making a toy house/play shelter just outside village circle of houses (Crocker, 1990). Image elements are not to scale

agreed on objects made for either boys or girls. The main source of coder disagreement was as to whether the ethnographer described objects being used by both boys and girls. SLL reviewed all user gender category entries considering these disagreements, and the training manual was updated to include more information for future coding beyond this study.

We asked the coders to record how the ethnographer described the age of the user when such information was available. Because these descriptions were qualitative, we did not calculate intercoder reliability for user age. Based on these descriptions, user age was then coded ordinally as *infancy and early childhood* (approx. 6 years or younger), *middle childhood and adolescence* (approx. 7 years or older), or *age unknown*. These categories are based in part on cross-cultural developmental theory, which show that substantial changes in skill, social responsibility, and community recognition occur during the transition from early to middle childhood (Lancy & Grove, 2011). These categories also reflect pragmatic issues related to the few observations available for age (see Results), limiting our ability to account for more nuanced age categories. Age category was coded by SLL and reviewed by MMA with disagreements resolved by consensus. Many accounts are woefully unspecific in regard to user age; for example, some ethnographers report child object users as *little* or *of early age*. In such cases, we classified age using our best judgement based on additional information available in the paragraph. In some cases, ethnographers reported an age range (e.g., *six to nine years)*. When these age ranges spanned our designated boundary between early childhood and middle childhood, we systematically recorded the child user as belonging to the younger age category.

We also asked the coders to record how the ethnographer described the object manufacturer when such information was available. SLL then coded these descriptions for manufacturer age category (*child*, *adult* or *both child and adult*) and gender

(*girls/women, boys/men* or *both girls/women and boys/men*). MMA reviewed these codes, and any disagreements were resolved by consensus.

Object Materials

One of the central goals of our study was to examine the types of materials children's toys and tools were made from. Using the 'five-step coding procedure' our team, after reading 60 paragraphs, developed a set of codes with which to identify such materials. Each object was first coded according to whether the ethnographer *described the materials* (yes/no) with which the object was manufactured. For all objects for which material was described, each object was then binarily coded (yes/no) as being manufactured from any one of six non-mutually exclusive material types: *metal, wood/plants (excluding cordage), stone, bone, antler* or *other materials*. Following initial coding alignment, both coders independently coded material availability for 185 objects. Intercoder reliability was relatively high (85.4% agreement; AC1 = 0.71).

For the 81 objects in which both coders agreed that the materials were described, intercoder reliability was high for metal (98.8% agreement; AC1 = 0.99), wood/plant (91.4% agreement; AC1 = 0.85), stone (98.8% agreement; AC1 = 0.99) and bone (100% agreement; AC1 = 0.92). No objects were described as being made with antler. There was strong agreement between coders (86.4%), for 'other materials' and AC1 was high (AC1 = 0.82). Once reliability had been achieved, one student coder went on to code materials for all remaining objects.

After reviewing materials included as 'other', we realised that we had not adequately trained our coders to identify material types. For example, tin or copper was sometimes coded as other because we had not specified the types of metal coders should consider. If plants were referred to by their species name (e.g. willow, birch), these were sometimes also categorised as other materials. SLL revisited all objects coded as including other materials, and recategorised them appropriately. FR then reviewed this recategorization, and any disagreement was resolved by consensus. We also reworked our coding manual to provide more explicit detail regarding material for future coding. We used these material descriptions to estimate the likelihood that objects would be preserved in the archaeological record. We considered preservation to be *low* if objects were made of organic material only (i.e., no metal or stone) or *high* if these included an inorganic component.

Categorising Object Functionality and Complexity

To give further detail regarding the toys and tools used by children, we conducted three additional rounds of coding. Codes for play were developed by MMA after reading the paragraphs. MMA coded each object, which SLL reviewed. All disagreements were resolved by consensus. Objects were considered to be used in *play* if "the ethnographer explicitly mentioned play; if the activity clearly involved music, pretense, or games; if the child was using an object in a non-instrumental way; or if the child engaged in the manipulation of an object with the aim of discovering the objects' properties and attributes such as in target practice" (Lew-Levy et al., 2022).

Objects were considered to be used *instrumentally only* if "objects were exclusively described as being used in service of a goal, to access resources, or to manufacture/repair an object" (Lew-Levy et al., 2022).

Codes for scale and complexity were developed by FR, after reading through the paragraphs, materials and manufacturing descriptions. FR then coded each object, which SLL reviewed. All disagreements were resolved by consensus. Each toy and tool was coded according to scale. *Miniatures* were defined as objects that are scaled down (i.e. small) versions of adult tools. We operationalized this definition by looking for ethnographer descriptions which included terms such as 'miniature', 'small' or as a 'toy' or 'imitation' version of an adult tool. *Adult Versions* were defined as objects that belong to adults that children use in a similar way to adults. We operationalized this definition by looking for reference to children borrowing these objects from their parents, parents giving their objects to their children, or children and adults using the object together. Objects used by *children only* were defined as objects that children use that have no adult equivalent. We operationalized this definition by looking for references to children's toys, games, or child-only activities.

When sufficient information was available, we also coded objects according to their complexity. Objects were considered *simple* if they were made from a single material, with no movable parts. Objects were coded as *composite* if they were made from multiple materials, involved complex transformations, or obtained a function not related directly to its constituent parts. In practice, coding for complexity was complex. We considered various types of information, based on availability. We accounted for the material description coded following the steps above, and reread the material description by the ethnographer. If the object was necessarily made with multiple materials (e.g., a doll made with *both* a wooden body and a stone head) rather than objects which could be made with various single materials (e.g., a doll made of *either* wood or stone), we considered this a composite object. We also read ethnographers' descriptions of the manufacturing process for hints as to whether multiple materials may be involved even if they were not explicitly listed. We considered the object themselves: did they involve multiple parts, such as a bow and arrow, or a whip and top? If, after reviewing the steps, we were still unsure as to whether it was simple or composite, we coded this object as *information not available.*

Learning

The student coders were asked to binarily identify any objects which were described as embedded within a learning experience (yes/no). As part of the 'five-step coding procedure', reliability was achieved on 185 objects, after which one student went on to code all remaining objects. Agreement and AC1 was high (agreement; 92.4%, AC1 = 0.92).

For objects embedded in learning (i.e., learn = yes), we coded learning mechanisms (i.e., how children learned) and pathways (i.e., whom children learned from). When objects were embedded in multiple learning instances, we coded only the first one listed. Due to limited data, we categorised mechanisms as either (1) *teaching*: "An individual modifies his or her behaviour specifically to impart knowledge, skills,

or behaviours, to a learner", (2) *collaborative*: "Individuals of approximately equal age, skill, knowledge, and cognitive ability collectively contribute to the learning of a specific skill or knowledge" or (3) *observation/imitation*: "The learner directly observes some skill or behaviour and attempts to replicate the observed actions or behaviours" (Garfield et al., 2016, p. 25, see also Boyette & Hewlett, 2018; Kline, 2015). Following Cavalli-Sforza and Feldman (1981), we categorised pathways as either (1) *vertical:* learning from parents and/or grandparents, (2) *horizontal:* learning from peers or (3) *oblique:* learning from non-parental individuals from the paternal generation.

Importance of Coding Scheme Development

While seemingly menial, the interactive and iterative design of our coding scheme has been essential not only in ensuring consistency and replicability but also in aligning the variable disciplinary perspectives from which we approach the topic of play objects. Finding traits and trait states that are appropriately motivated by cognitive and developmental theories and hold archaeological relevance is essential for better articulating cross-cultural ethnographic and archaeological perspectives that have the potential of mutual enrichment. Applying the coding scheme to other data sources (e.g., museum collections and ethnographer reports) and additional eHRAF content relating to societies following non-foraging subsistence strategies may entail further expansion of categories within the scheme.

Statistical Analysis

The dataset resulting from the above coding steps is hierarchical in structure. Each row in the dataset contains information about an object. Objects are nested within paragraphs, publications, societies and continents. Thus, to estimate the percent of objects within each category while also accounting for the uncertainty arising from variation in observations across these levels, we followed other recent eHRAF studies (Garfield et al., 2021; Lightner et al., 2021) in exploring our data using binary logistic or multinomial multilevel regressions. Each model included a random effect for paragraph, publication, society, and continent, which adjusts estimates for sampling imbalances. Analyses were conducted in R Version 4.0.5 (R Core Team, 2020). Models were fit in Rstan (Stan Development Team, 2016) via brms version 2.16.1 (Bürkner, 2017). Each model was fit on four chains of 5000 iterations each, half of which were warm-up iterations. We specified weakly informative priors. R-hats were smaller than 1.01, suggesting good mixing across the models. Unless otherwise noted (i.e., instances where we report raw frequencies due to sparse observations), all percentages reflect posterior means and 89% percentile intervals (PI).

Results

Sample Description

A total of 272 paragraphs contained information relating to 434 objects from 54 societies (mean object count per society = 8.04, SD = 8.07, range = 1–38; Table S1). Paragraphs were sourced from 124 publications (mean publication count per society = 2.30, SD = 1.78, range = 1–9) published between 1854 and 2019. There were more observations for children's toys and tools in earlier ethnographies (see Supplementary Information for analysis and discussion). This likely reflects a broader ethnographic trend of describing material culture more generally at the turn of the twentieth century. Reflecting eHRAF regional biases, 60% of objects in our dataset and 52% of surveyed societies came from North America (Fig. 2). The inclusion of a random effect for 'Continent' helps adjust for the overrepresentation of North American societies within the dataset.

The detail with which children's toys and tools were described varied considerably by ethnographer and surveyed community. For example, Pearsall (1950, p. 343) describes the materials, transmission and developmental processes by which Klamath boys learn to make and use bows:

> *At first they play with a tiny bow of willow, little more than a toy, which they learn to make from an older boy or from their father. But by the time a boy is six or seven his father presents him with a real bow made from juniper. It is smaller than the large yew war and hunting bows of the men, and the arrows are blunt. The boys practice shooting at targets around the camp. They will not begin to do any hunting for several years, but groups of boys imitate the shooting contests of their elders.*

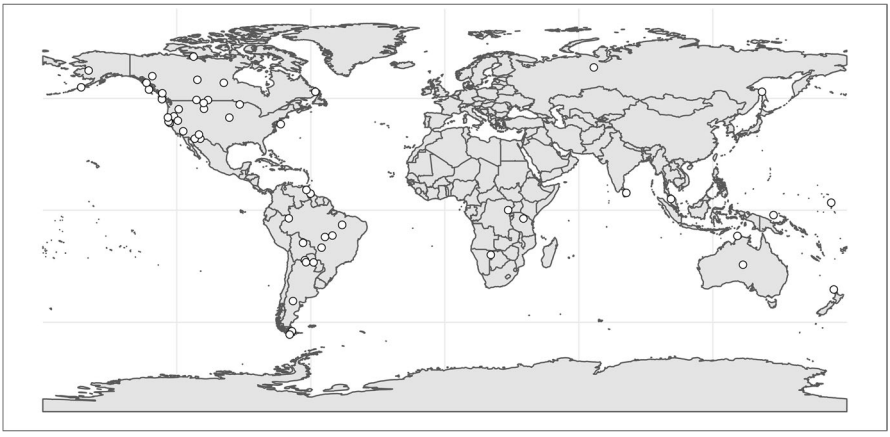

Fig. 2 Map showing the location of the 54 societies for which data on children's tools and toys were available. Note that 60% of objects and 52% of societies were from North America

Seligman et al., (1931, pp. 91–92) describe how Vedda children manufacture ladders while emulating honey collecting during play, and how community members participated in this game:

> *One thing is taught the lads systematically, that is the method of collecting honey from the combs of the rock bee. Whenever the caves are conveniently situated a ladder of creepers is suspended from a tree in the jungle above and hangs over the end of the face of rock which forms the cave. On this the youths play at "honey getting." At Pihilegodagalge the lads were quite willing to demonstrate to us how it was done, and the elder men showed clearly that this was a game which they encouraged. A lad of about thirteen collected some green leaves and tied them together with creeper, then taking an arrow, a toy masliya, and a broken gourd tied with creeper, which hung over his arm, for a maludema [a deer-skin vessel for honey-collecting], he set fire to the leaves and climbed the ladder. While lowering the smoker and letting the smoke blow into the crevice in the rock where the comb was supposed to be, he pretended to cut round its sides with an arrow and thrust at it with his masliya [a four-pronged implement used in honey-collecting], from which he transferred the honey into the gourd. As he descended from the ladder he beat his chest and sides as though driving off the bees, and directly he reached the ground rushed into the jungle to escape from them, all the smaller children imitating him with great glee. Obviously this was a well-known and favourite game, for even the elders took part in it, throwing their clothes over their heads and running into the jungle.*

At the other end of the spectrum, ethnographers simply list the objects children played with. For example, Nimuendajú (1948, p. 718) states of Ticana children:

> *They play with dolls carved of muirapiranga, figures of animals, little canoes, small bows and arrows, and buzz-disks of gourd shells.*

Many ethnographers allude to how objects feature in children's knowledge acquisition, without providing further detail about how and from whom children received the objects. Among the Tlingit, Emmons and De Laguna (1991, p. 101) state that:

> *[Children] were taught to pack by carrying a light pack about every day for an hour or so.*

A total of 40% of the objects in our sample were used by boys, 13% were used by girls, and 11% were used by both girls and boys; the gender of object users was unknown for the remaining 36% (Fig. 3A). 10% of the objects in our dataset were reportedly used by infants and children in early childhood (i.e., six years of age and under), and 16% of objects were used by children in middle childhood and adolescence (i.e., seven years of age and over); the age category for object users was unknown for the remaining 74% of our database (Fig. 3B).

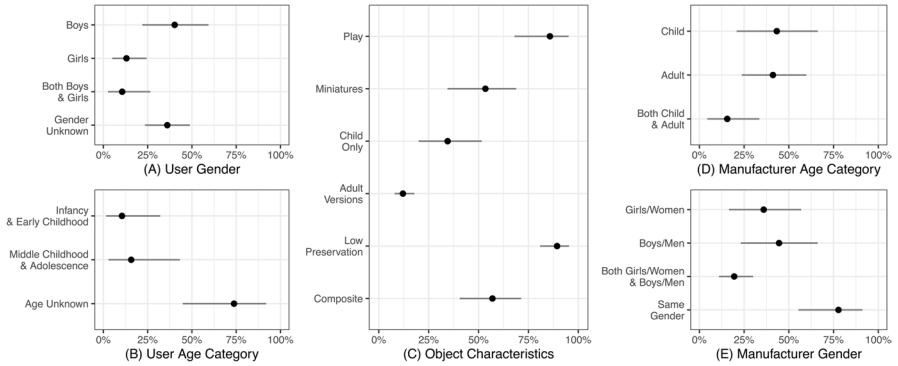

Fig. 3 Distribution of objects within the dataset estimated from intercept-only binary logistic or multinomial multilevel models. Points reflect percentages computed from the posterior mean estimates. Error bars indicate 89% percentile intervals, reflecting uncertainty in the percentage estimates. Please see the main text for information regarding available sample sizes for each coded category

What Types of Objects Do Children Use?

Table 3 shows the raw frequencies for all object types identified in our dataset. The objects most frequently described were weapons ($n = 117$), games ($n = 80$) and animal and human figures ($n = 76$). Boys were exclusively reported to use weapons, while girls were the main users of figures. For example, among the Kaska, seven- to eight-year-old boys (Honingmann & Bennett, 1949, p. 188)…

> *…make their own slingshots, to use in shooting at trees and birds.*

Among the Maori, stilts were used by children and young men during play and games, as reported by Buck (1952, p. 246):

> *Stilts (pou toti, pou turu, pou koki, pou tokorangi) consisted of the shaft (pou) with a projecting foot-rest (teka) at varying heights above the lower end. The simplest stilts were made of a straight branch with a cut-off side branch to form the foot-rest. Others were made of a straight shaft to which a short piece was lashed at right angles to form the foot-rest and a cord attached to its outer end was carried obliquely upwards to the shaft about a foot or so above the lashing of the foot-rest to the shaft. Stilts were used by children simply to walk about, to run races, or to cross streams. Young men had so-called wrestling matches in which tripping with the stilts was effective.*

Among the Aranda, dolls are usually according to Basedow (1925, p. 80),

> *…just a plain stick or stone, with perhaps some distinguishing feature upon it, like a knob at one end which represents the head. Occasionally it is painted with red ochre.*

Table 3 Raw frequency table showing object types broken down by the gender of user, activity, scale, preservation likelihood and complexity

		User gender $n=434$				Activity $n=416$		Scale $n=434$		Preservation likelihood $n=202$			Complexity $n=330$	
Type	Total	Boys	Girls	Both	Unknown	Play	Instrumental Only	Adult Version	Child Only	Miniature	High	Low	Composite	Simple
Weapons	117	98	0	0	19	82	30	7	0	110	7	26	103	3
Games	80	30	9	16	25	79	1	0	79	1	7	36	25	37
	76	3	41	5	27	61	12	0	72	4	3	52	27	34
Transport	57	18	4	8	27	32	18	11	0	46	1	17	13	14
Container	30	2	17	1	10	14	16	5	1	24	3	12	1	16
Subsistence	27	14	6	2	5	13	12	16	0	11	2	7	10	7
Shelter	24	0	16	4	4	16	7	1	0	23	0	13	10	9
Musical Instruments	23	6	0	2	15	22	1	2	18	3	1	15	17	4

Information on play was available for 416 objects from 53 societies (Fig. 3C). 86% of objects were reportedly used in play. Information on scale was available for all objects in the dataset. Half of the objects (54%) were reportedly miniature versions of adult objects. Miniatures were most commonly containers, shelter, transport, and weapons (Table 3). For example, among the Kiribati (Koch, 1986, pp. 229–230):

> *Boys (and sometimes girls, too) from about six to twelve years old play at sailing small toy canoes on large puddles in the vicinity of the settlement after heavy rain or they do so on ponds in the bush or make use of unplanted taro pits. The simpler type is made from a pinnule of a coconut frond. The boys make the more refined kind (wa te bani kaina) (sometimes with the help of an elder brother of their father) out of a piece of pandanus leaf, some pandanus leaf fibre and a piece from the midrib of the pinnule of a coconut frond. The children have a competition (kauaia) with from two to about ten of them sailing their canoes in the wind. The owner of the victorious canoe receives no prize. The small craft are usable only for a single day's games.*

Many objects (34%) were reportedly for children only, in the sense that no adult versions existed. Child-only objects were most commonly figures, games, and musical instruments (Table 3). Among the Deg Hit'an (Ingalik), Osgood (1958, p. 257) reports:

> *The bark whistle is an example of a child's toy and one which may be used by a boy alone if only because whistling is regarded by the Indians as unpleasantly suggestive. First of all, the whistling is associated with the supernatural figure known as the Nakani, or bad Indian, who is reasonably feared. Therefore, whistling at night by a child will cause him to be punished. Even in the daytime, whistling is not enjoyed by adults as it is believed that such sounds will cause winds to rise and winds may create difficulties or even danger for a man paddling his canoe in the summer, the only season in which willow bark whistles can be made.*

A minority of objects (12%) were reportedly adult versions of objects used by children. Most subsistence objects were reported to be adult versions (Table 3). For example, to encourage children to help their parents, Turnbull (1962, p. 128) reports that a father…

> *…may also give [his son] a strip of hunting net.*

What Are Children's Objects Made of?

Materials were described for 202 objects from 46 societies. Objects were made with a mean count of 1.29 materials (SD = 0.51, range = 1–3). Figure 4 details the percentage breakdown of objects by materials as calculated from raw frequencies. Materials coded as other include horn, cloth, animal skins, rope, ochre, shells, clay, pitch, fibre, rags, leather, quills, silk, feathers and wool. Consisting of mainly or only

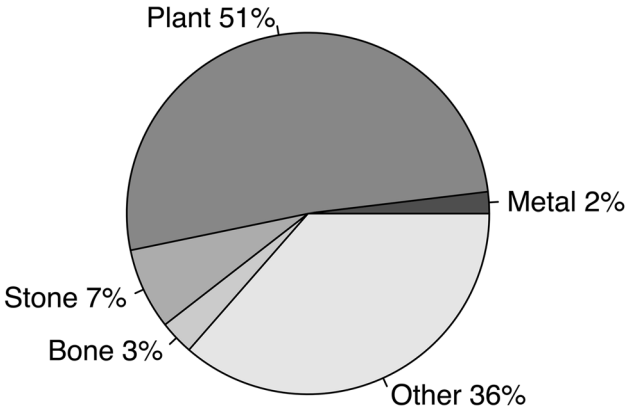

Fig. 4 Pie chart showing the percentage of 261 materials reportedly used in the manufacture of 202 objects, as calculated from raw frequencies. Materials coded as other include horn, cloth, animal skins, rope, ochre, shells, clay, pitch, fibre, rags, leather, quills, silk, feathers and wool

organic materials, 89% of objects would be unlikely to preserve well in archaeological contexts, irrespective of object type (Table 3; Fig. 3C). Even when at least one durable material was used, identifying a play object—for instance, the pellet belonging to a child's sling—would be challenging albeit not impossible archaeologically.

We were able to determine the complexity of 330 objects for all 54 societies. Of these, most were composite (57%), in the sense that they were manufactured using two or more materials (Fig. 3C). Weapons and musical instruments especially were reportedly proportionally more likely to be composite objects (Table 3). For example, among the Ona (Gusinde, 1931, pp. 568–569):

> *Every boy is no less inseparably attached to his sling. This resembles the one for a man exactly, in spite of its smaller dimensions; it is also handled in the same way. Among the most popular targets are counted the small birds, as well as fungi on tree trunks and a small puddle. The rascals engage in all kinds of pranks with their slings, unobserved if possible, precisely as among us. For example, they will make a stone suddenly strike in front of the feet of a girl; a dog is shot at, in order to confuse it; a heavy stone is made to fly against a hut, in order to knock for a friend. If their activity becomes too disorderly, because small children might be endangered by their careless stone-throwing, a few scolding words from an adult will chase the imps away.*

Among the Deg Hit'an (Ingalik) (Osgood, 1970, pp. 257–258)…

> *…the bull roarer, an even more simple contraption made from a narrow strip of spruce wood about a foot long. This piece, like the buzz, has the edges serrated. To a hole in one end, a six-foot babiche line is fastened which enables the boy to whip the bull roarer around his head and produce a loud burr.*

Who Makes Objects for Children?

Information regarding object manufacturer age category was available for 99 objects from 32 societies. Children manufactured about as many objects as adults (43% children, 41% adult and 15% both children and adults; Fig. 3D), for example, among Ojibwa (Jenness, 1935, p. 95):

> *Their parents often made them toy boats by coiling a bulrush spirally, pegging the coils together, and setting up a mast in the centre. The children themselves strung berries into necklaces, made necklaces and bandoliers of pine needles, modelled animal figures from clay, and filled with berries the leaves of the "owl's socks" or pitcher plant. Boys and girls often played camp together; the boys caught fish and birds for the girls to cook, and the girls made little mats and birch-bark baskets for their tiny wigwams.*

Turnbull (1962, pp. 128–129) describes similar dynamics among the Mbuti:

> *A mother will delight herself and her daughter by weaving a miniature carrying basket. At an early age boys and girls are "playing house." They solemnly collect the sticks and leaves, and while the girl is building a miniature house the boy prowls around with his bow and arrow. He will eventually find a stray plantain or an ear of corn which he will shoot at and proudly carry back.*

Information regarding object manufacturer gender was available for 98 objects from 32 societies. Girls/women and boys/men manufactured a comparable number of objects (36% girls/women, 45% boys/men, 20% both girls/women and boys/men; Fig. 3E). When examining cases in which the gender of the object user and the gender of the object manufacturer were known (79 objects from 30 societies), 78% were made by and for individuals of the same gender (i.e., girls/women manufacturers and users, boys/men manufacturers and users and both boys/men and girls/women manufacturers and users).

How Are Objects Embedded in Learning Experiences?

We found 35 objects which were embedded within explicit pedagogical contexts in 16 societies, as recognised by the ethnographer. For example, among Nuu-chah-nulth, small trap sets were made to liven stories (Drucker, 1951, p. 135):

> *MP related how he and his playmates clustered about the Muchalat war chief, tuckai'il̓am, then an old man, who regaled them with tales of his hunting and trapping adventures and made small sets to illustrate his yarns. Such useful information he interspersed between stories of catching wolves and land otters with his bare hands, which contributed but little to the boys' store of useful information, but enthralled them considerably.*

Among the Manus, children learn to paddle in the company of peers (Mead, 1930, p. 28):

As soon as the children can swim a little, in a rough and tumble overhand stroke which has no style but great speed, they are given small canoes of their own. These little canoes are five or six feet long, most of them without outriggers, mere hollow troughs, difficult to steer and easy to upset. In the company of children a year or so older, the young initiates play all day in shallow water, paddling, punting, racing, making tandems of their small craft, upsetting their canoes, bailing them out again, shrieking with delight and high spirits.

Because learning objects were infrequently reported, we only examined the nature of the pedagogical events in which they were embedded using raw frequency statistics. Most pedagogical events ($n = 19$) involved vertical transmission (i.e., parents to offspring), and most ($n = 27$) also involved teaching (by encouragement, storytelling, instruction, or opportunity provisioning). Figure 5 shows that a majority of teaching with objects was vertical and oblique, with some peer (i.e., horizontal) teaching with

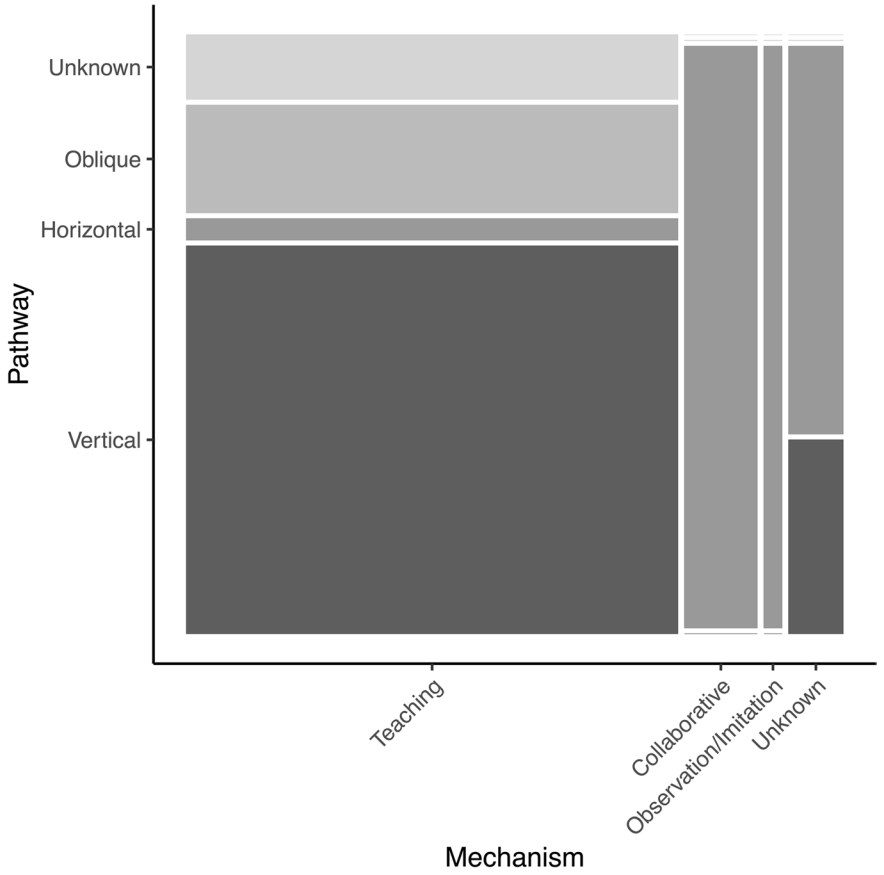

Fig. 5 Mosaic plot showing the distribution of objects embedded in pedagogical events by learning pathway and mechanism. The width of each bar is proportional to the frequency of each mechanism. The height of each bar is proportional to the frequency of each pathway within each mechanism

objects also evidenced. In other words, learning with objects via teaching occurred across all pathways. In contrast, using objects in collaborative learning and during observation/imitation only occurred horizontally.

Discussion

We have provided a cross-cultural ethnographic inventory of objects made for and by hunter–gatherer children as recorded in eHRAF. We found that children's objects are linked to adult material culture (e.g., weapons, containers, boats and figurines), albeit not exclusively so (e.g., games and some musical instruments that are specifically listed as having no grown-up counterparts). Toys and tools were primarily handled outside of explicit pedagogical contexts. Importantly, we found little evidence for formalised apprenticeships. Taken together, our data suggests that children's self-directed interactions with objects, especially during play, has a critical role in early-age enskillment.

Toys and tools are an equal part of boys' and girls' childhood in the dataset. Although overall, boys' objects were more frequently reported than those used by girls, this imbalance is driven by the high prevalence of weapons within our dataset, which were exclusively reported to be used by boys. When discounting weapons, girls' tool use is more prevalent in the dataset. Recent studies in contemporary hunter–gatherer societies either do not find salient gender differences in children's time allocation to object play (Lew-Levy et al., 2020a) or that it is biased towards girls (Boyette, 2016). Weapons may appear frequently in our dataset because they are conspicuous, and because historically, most ethnographers were men. Ethnographer gender may skew ethnographic data in terms of normative social biases as well as in terms of access and proximity to gender-specific activities and their associated objects. Alternatively, miniature weapons may be prevalent in the reports of boys' material culture because they are complex to manufacture and operate, resulting in longer learning periods and thus increased likelihood of being recorded by ethnographers (Kaplan et al., 2000; Walker et al., 2002). This possibility is supported by boys' more frequent use of objects in games in our dataset, many of which were games of skill pertinent to hunting (see Table 3).

Across the board, both forager girls and boys tend to use objects in work and play which emulate the gendered division of labour in their communities (Bock & Johnson, 2004; Gosso, 2010). Girls more frequently played with figures, containers and shelters (see Table 3). Boys/men and girls/women were almost equally likely to manufacture objects, usually for same-gendered children. Both of these findings are consistent with the same-gender transmission across cultures (Boyette & Hewlett, 2017a; Hagen et al., 2016; Hewlett & Cavalli-Sforza, 1986), supporting the view that objects contribute to knowledge and norm transmission (see discussion below).

Many objects made by and for children had full-scale counterparts (e.g., miniature bows) or real-life correlates (e.g., animal figurines). Often made with discarded or less durable materials than full-scale versions, such tools often yet by no means always require limited investment in time and resources to manufacture. Still, the incorporation of scaled-down objects into physical and imaginative play may have provided

children of the past with opportunities to experiment with the emergent functional properties of tools with little associated cost (Riede et al., 2018, 2021), just as it does today. Such learning could contribute to later, tacit mastery while laying the cognitive foundations for innovation, even in the absence of formal apprenticeships.

Both children and adults manufactured toys and tools. These findings reflect the importance of the peer group to skill acquisition in hunter-gatherer societies (cf. Lew-Levy et al., 2019b; Lew-Levy et al., 2020b). Manufacturing objects for children likely serves several functions. Adults and older children may manufacture and give objects to distract children in their care (Bakeman et al., 1990; Lew-Levy et al., 2019a). Children may be given scaled-down tools as a means to transmit knowledge about cultural and subsistence activities (Crittenden, 2016). Furnishing children with objects may give children the opportunity to observe the manufacturing process, and reverse-engineer assembly (Nishiaki, 2013). No matter the cause, such opportunity provisioning has important consequences for transmitting information about tool use, tool construction, subsistence activities, and community identity.

Beyond learning to make and use tools themselves, our data show how tools are often used as props to help children learn about the world. For example, small traps may be set to illustrate the behaviours of prey, or a stone may be placed on a child's back to help her learn to swim. Such pedagogical objects may quite literally represent teaching tools, which accelerate mastery by providing children with opportunities to develop ecological, physical, and cognitive knowledge and skill they may not otherwise have through practice and/or pedagogical cueing. Both adults and children were reported to use tools to transmit information, the former primarily through teaching, and the latter primarily through collaboration, observation, and imitation. These findings echo those of Garfield et al. (2016) who showed that formal teaching usually occurred vertically, and collaborative learning horizontally in hunter-gatherer societies. In sum, our findings suggest that objects themselves hold certain mnemonic properties providing cues and clues to their use (cf. Kelly, 2015): they are the silent teachers whose mere presence scaffolds and guides learning.

The majority of hunter–gatherer children's objects recorded in our database were made from multiple materials. Even those objects coded as 'simple' often displayed variable and complex material properties. Sticks, for example, can be used and worked in numerous ways, their properties depending on species, growth condition and specific place of origin. Playing with such objects may help children learn about material properties (what can it do?). By combining materials during toy construction within the safe context of play, children may learn the transformative properties of these materials (what can I do with it?) (Bjorklund & Gardiner, 2012). And by using objects in normative but also alternative fashion, youngsters also explore, practice and acquire the attendant physical routines associated with particular objects (how do I use it?). Such exploratory learning processes and goal-free tinkering (cf. Bevan et al., 2015) may have been essential in the rapid rise of complex composite technologies after around 300,000 years ago where we see—or infer—the increasing presence of composite items with emergent functional properties, such as mats, traps, projectile technology, glues and poisons (Wadley, 2015).

Most of children's toys and tools were constructed using organic materials, suggesting that they would preserve poorly in the archaeological record (see also

Langley, 2018; Langley & Litster, 2018). Like Crawford (2009), we found that children often played with discarded adult tools, suggesting that objects often entered a 'toy' stage, most commonly at the end of their lifetime. Such uses would be difficult to discern in the archaeological record. Focused use-wear studies aimed at revealing children's particular behavioural traces may step in here. In addition, many small components of composite toys (e.g. the stones of slings) were made from non-organic materials. Knowing to look for such components may help us better recognise play objects in prehistoric contexts.

The degree to which artefact size can confidently be used to infer toys in the archaeological record has been a matter of debate (see Crawford, 2009; Park, 1998, 2005). While we have not systematically investigated adults' use of miniatures in ritual or quotidian contexts, the prominence of miniatures in our dataset lends credence to the interpretation of objects at the lower end of a given size distribution as play-objects, such as the scaled-down spear-thrower handles from the Oregon Coast (100–800 CE) discussed by Losey and Hull (2019) and the small organic spear-tips of the European Late Upper Palaeolithic (18-15 ka BP) presented by Langley (2018) and Pfeifer (2015) respectively (see Milks et al., 2021 for further examples). In addition, the cross-cultural prevalence of human and animal figurines aligns well with interpretations of many Palaeolithic (Farbstein et al., 2012; Lbova, 2021) and post-Palaeolithic (see Langley & Litster, 2018; Sommer & Sommer, 2015) figurines as potential play objects, alongside the more common interpretation of prehistoric figurines as religious/ritual objects. Close attention to specific contexts will help us distinguish toy and religious figurines from each other, as well as the potentially salient interplay between play and religion (Renfrew et al., 2017) in the future.

Clearly, formal practice supports enskillment in, for instance, flintknapping. Yet, much previous research has been embedded in societies characterised by social hierarchies and strong skill differentiation and division (e.g., Roux et al., 1995; Stout, 2005), a situation not readily transferred to the Palaeolithic. Projected into pre-agricultural prehistory, the cross-culturally rarity of formal apprenticeships either suggests that hunter–gatherer 'schools of flintknapping' (cf. Fischer, 1990) were rarer than previously believed, or implies that past hunter-gatherers may, at times, have diverged from their ethnographic counterparts in social learning strategies. Yet the frequency of innovations and of play objects varies, possibly hinting at similarly variable practices of niche provisioning. The perspective offered here thus leads us to argue for the development of study designs that are not so much concerned with demonstrating formal teaching and learning situations, but rather allow us to discriminate between different prevalent learning modes, which in turn would also allow us to more robustly parameterize models addressing how such learning modes shape cultural evolutionary trajectories over generational time scales. Some recent studies have already taken up this challenge (see chapters in Klaric, 2018, for instance) but more work focused on play objects and on linking different modes of social learning to formal models of culture change is needed.

Limitations

The ethnographic record has many biases, as does eHRAF, including unsystematic observations, especially of children, by untrained or biased observers. Given the universality of both play and of material culture in humans, the absence of evidence is unlikely to indicate evidence of absence, but rather a normative bias against the recording of children's activities and materials. Another difficulty we encountered in eHRAF is capturing the objects used by adolescents. Explicit records of such are absent, possibly because ethnographers did not see them different from adults in their material culture use. An eHRAF search pairing vocational training (OCM code 874) defined as 'Institutionalized vocational apprenticeship' with Technology and Material Culture (005) only yielded results regarding formal schooling in North America, suggesting that apprenticeship is indeed rare or else severely underreported for hunter–gatherer societies. The dataset on the whole also suffers from an inherent bias towards North American societies. This is grounded in HRAF beginning as a US-based endeavour as well as the richness of North American ethnographies. A related potential bias concerns the recording by adult ethnographers of cases in which youngsters come up with innovative uses of or modifications to technologies, which are then picked up by adults. Given the prevalence of vertical and oblique transmission from adults to children and adolescents, an interest in these flows of innovation will often be at risk of perceiving these as strictly unidirectional, even in cases when they are not so.

Further, detailed descriptions, photographs or drawings of the toys recorded ethnographically are rare, often lacking specific size measurements, scale bars or listings of raw materials and their transformations. Little attention is paid to manufacturing processes, raw material acquisition, use-life and discard. This low granularity of the directly object-related information does not allow us to derive any classification or guideline for potential prehistoric toys and their constituent parts. Future work with ethnographic or ethno-historic collections may provide such close analyses.

Finally, ethnographic generalisations may not be fully valid for prehistory (M. Ember & Ember, 1995; Wobst, 1978). Indeed, while descriptive generalisations from representative samples are preferable to generalisations from small and unrepresentative samples, they are still problematic if the conditions of life in more contemporary societies differ substantially from the past. Yet, if cross-cultural research establishes that one variable strongly predicts another, and an archaeologist can establish the state of one of those variables, then there is a rationale for making an informed guess about the other variable, even if it is not directly measurable from the archaeological record (Ember & Cunnar, 2015, p. 89).

Conclusion

There are strong reasons to believe that the characteristics of the early-age ontogenetic niche environment of past children influenced their cognitive development (Coward & Howard-Jones, 2021). The systematic cross-cultural study of hunter–gatherers' tool and toy use presented here takes first steps towards a more robust comparative framework for understanding such contexts in the deep past and very specifically with relation to the objects youngsters would have handled and played with. Ethnographically, formal apprenticeships leading to the mastery of specific complex technologies are rare in hunter–gatherer societies (Lancy, 2010; MacDonald, 2007). Further, formal apprenticeships often serve socio-political ends other than enskillment (Dallos, 2021). Finally, because apprenticeships mostly focus on conservation of craft knowledge and production, they may in fact constrain innovation (cf. Greenfield, 2004). In contrast, we have shown that in foragers learning to make and use tools is embedded into everyday experiences including play, peer collaboration, instruction and participation in adult activities rather than formal apprenticeship. Play and object play have a significant role in enskillment but, critically, the early-age handling of play objects would also have facilitated the playful exploration of object and material affordances beyond normative practices (German & Defeyter, 2000). Such non-formalised learning may hence optimally combine cultural conservation and change.

These findings should compel us to rethink how we imagine and formally model cultural transmission and learning at archaeological timescales. The prevalence of object play across many non-human primate species suggests a deep evolutionary history of this behaviour (e.g. Bekoff & Byers, 1998). Yet—and even with due awareness of potential taphonomic biases—the archaeological record currently hints at a relatively late appearance of wide-spread play object provisioning. It is therefore possible in the intersection between *Homo sapiens*' expanded strategic social learning repertoire (Gärdenfors & Högberg, 2017; Heyes, 2017) and the increasing presence of material culture within the human niche (Riede, 2019) that object play may have played a central role as a catalyst of enskillment and innovation.

Considering the limitations outlined above, our study also sounds a clarion call for ethnographers to systematically record play objects. Detailed archaeological and ethnoarchaeological studies of skill acquisition (e.g. Crown, 2001; Gandon et al., 2018, 2021; Harush et al., 2020; Roux et al., 1995) can serve as templates for recording ethnographic play objects and their associated operational chains. Contextualised with wider ethnographic data, such new sources would allow us to better query the relationships between object play, age/kin structure, the transition from play to work and, if studies are conducted longitudinally, the potential effects of object play on innovation propensities later in life. Beyond archaeology, a closer attention to the specific objects with which youngster play may feed into synthetic understandings of how evolved propensities and historically specific contexts interact in both present-day child development (Wynberg et al., 2021) and in the long-term co-evolution of cognition and technology (Stout, 2021). In this spirit, we have recently launched a database project aimed at providing a platform for such efforts: https://

play-object-play.au.dk. This web-based catalogue includes all the information presented in this paper and is open to community-driven contributions beyond hunter-gatherer societies and beyond HRAF. We strongly encourage fieldworkers, museum curators and anyone else concerned with play object to add to this repository.

Going forward, there are several productive ways in which systematic analysis of ethnographic databases can be utilised. First, eHRAF offers rich data on societies other than hunter-gatherers. Extending this data mining exercise to pastoralists, horticulturalists, and agriculturalists will allow researchers to investigate whether changing socio-economic contexts (hierarchy, craft specialisation, etc.) impact object play, toy provisioning, the balance between playful and structured learning, and the role of children and adolescents in innovation. Furthermore, an inventory of play objects in non-human primates will generate insights about object play in these species and provide an improved context for understanding the evolution of object play in the hominin lineage. Detailed technological analyses of toys from the archaeological record using, for instance, cognigrammetry (e.g., Haidle, 2014), traceology and operational chain analysis, may inform us about the cognitive (Tostevin, 2011) and motoric (Warnier, 2001) requirements of handling miniatures. Improved chronological information on toys in archaeological contexts—not commonly the focus of high-resolution dating efforts— may allow us to understand their (potentially) causal role in long-term innovation. Finally, cross-cultural developmental psychological experiments focusing on object play—with due focus on the play objects themselves—will also greatly enhance our ability to understand both past and present cultural diversity as historically contingent product of combined biological and cultural evolutionary processes (cf. Muthukrishna et al., 2021).

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Author Contribution FR contributed to the conceptualization, data curation, funding acquisition, investigation, methodology, project administration, writing—original draft, and writing—review and editing. SLL contributed to the conceptualization, data curation, data analysis, funding acquisition, investigation, methodology, project administration, coder supervision, validation, visualization, writing—original draft, and writing—review and editing. NNJ contributed to the conceptualization and writing—review and editing. NL contributed to the writing—review and editing. MMA contributed to the data curation, funding acquisition, investigation, methodology, project administration, validation, and writing—review and editing;

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Data availability It is available at https://github.com/sheinalewlevy/Toys-As-Teachers.

Declarations

Conflicts of Interest We declare no conflicts of interest.

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