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Research

Social learning among Congo Basin hunter–gatherers

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This paper explores childhood social learning among Aka and Bofi hunter–gatherers in Central Africa. Existing literature suggests that hunter–gatherer social learning is primarily vertical (parent-to-child) and that teaching is rare. We use behavioural observations, open-ended and semi-structured interviews, and informal and anecdotal observations to examine the modes (e.g. vertical versus horizontal/oblique) and processes (e.g. teaching versus observation and imitation) of cultural transmission. Cultural and demographic contexts of social learning associated with the modes and processes of cultural transmission are described. Hunter–gatherer social learning occurred early, was relatively rapid, primarily vertical under age 5 and oblique and horizontal between the ages of 6 and 12. Pedagogy and other forms of teaching existed as early as 12 months of age, but were relatively infrequent by comparison to other processes of social learning such as observation and imitation.

Keywords: hunter–gatherers; social learning; cultural transmission; Africa

1. INTRODUCTION

Anthropologists have long been interested in social learning [1,2], and several excellent monographs exist on social learning in small-scale cultures [3–5]. However, the majority of research in social anthropology and developmental psychology has been conducted with horticultural or intensive farming cultures, where craft specialization and various forms of hierarchy, such as gender or age inequality, exist. Characterizations of social learning in ‘traditional’ cultures are largely limited to these contexts. According to Harris [6], common features of learning in traditional societies are that physical punishment is commonly used to help children learn, infants are taught little because parents consider infants to be incapable of learning, older siblings and children have the right to dominate younger children to show them how to do tasks, and parents are not the friends or playmates of their children. These may be common features of social learning in farming communities but not necessarily in hunter–gatherer communities.

Studies of hunter–gatherer social learning are essential to a comprehensive understanding of how culture evolves, because this way of life characterized 99 per cent of human history and constituted

the environment(s) of evolutionary adaptation. While contemporary hunter–gatherers are not Stone Age relics of the past, they can provide insights into a way of life that was characterized by mobility, small population size (25–35 individuals), minimal gender and age hierarchy, and lack of both storage and strong political leaders. Given the potential importance of hunter–gatherers for understanding social learning in humans, it is ironic that more books and other publications exist on chimpanzee social learning than that on hunter–gatherer social learning.

Here we assemble what we currently know about social learning among the most intensively studied hunter–gatherer juveniles—the Aka and Bofi ‘Pygmy’ children of the Central African Republic and Republic of Congo. We have conducted several years of qualitative and quantitative research with these children, each of us covering a different age range. Not all of our research directly addressed social learning, but our systematic observational and interview data from infancy through adolescence enable us to begin to quantitatively address social learning questions and hypotheses.

This section of the paper introduces two prominent social learning questions, while §2 summarizes the methods we used to answer the questions. Section 3 examines modes of thought, patterns of daily life and demographic features of Congo Basin hunter–gatherers and farmers. These two modes of production and thought are too often grouped together and characterized as traditional, small-scale, tribal or non-Western societies. Instead, we highlight the distinctive features of hunter–gatherers by comparing

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One contribution of 26 to a Discussion Meeting Issue ‘Culture evolves’.

them with their farming neighbours. The two groups live in the same natural environment, the tropical forest, and interact on a regular basis. The relatively distinct hunter–gatherer modes of thought, patterns of daily life and demography are essential for contextualizing our results. Section 4 presents data to address social learning questions, and §5 summarizes and discusses what we currently know about hunter–gatherer social learning.

The paper distinguishes modes of cultural transmission from processes of social learning. Modes of transmission refer to individuals from whom children learn and include vertical, horizontal, oblique, conformist and prestige-bias. Processes of social learning include teaching, emulation, imitation and collaborative learning. The different modes of transmission may involve different processes of social learning: for example, vertical transmission may take place by emulation or teaching. We do not examine all modes of transmission and processes of social learning. Two questions are examined: (i) do hunter–gatherers learn primarily from parents (vertical) or others (horizontal or oblique)? (ii) does teaching exist in hunter–gatherers? We define teaching as modification of one's behaviour to facilitate learning of information, knowledge or skills in another. Our studies do not distinguish imitation from emulation as defined in other papers in this volume [7] because the differences were difficult to capture in our naturalistic behavioural observations. Consequently, from this point forward, 'imitation' can be emulation or imitation as defined in other papers in this volume, unless otherwise noted.

(a) Modes of transmission: from whom do children learn?

Harris's [8] critical review of the child development literature addresses one of the issues in this paper— from whom do children learn? Her review concluded that peers, friends and other adults contributed substantially more to social learning than did parents. Her conclusion was also supported by her literature review of learning in 'traditional' cultures [6], unsurprisingly, because most socialization studies in small-scale cultures were conducted in farming cultures where older siblings and children have key roles in child rearing [9,10].

The importance of parents versus other children and adults is also a contentious issue in evolutionary studies of cultural transmission. Early social anthropologists interested in learning and education used the term 'cultural transmission' [11] to refer to this issue, but the term took on a different meaning when Cavalli Sforza & Feldman [12] published *Cultural transmission and evolution*. They used the term to refer to an innovative evolutionary approach to culture that used analogies from population genetics and epidemiology to mathematically model several modes of cultural transmission. Mendel revolutionized genetics by identifying mechanisms of genetic transmission, and Cavalli Sforza and Feldman aimed to revolutionize cultural anthropology by identifying specific mechanisms of cultural transmission. Paralleling Mendel's early studies in genetic transmission, Cavalli

Sforza and Feldman's models focused on who transmitted culture. Vertical or parent-to-child transmission was modelled after genetic transmission so that a cultural belief or practice transmitted vertically was predicted to be highly conserved and contributes to intracultural diversity (i.e. each parent transmitting a cultural variant). Horizontal (friends and peers) and oblique (other adults) transmissions were based on disease transmission models in epidemiology and were hypothesized to contribute to the rapid spread of a belief or practice if contact with friends, neighbours or other adults was frequent.

Early tests of Cavalli Sforza and Feldman's models suggested that vertical transmission was particularly important. Stanford University undergraduate students were reported to acquire their religious and political beliefs vertically 50–70% of the time [13]. Aka hunter–gatherer adults, adolescents and children were asked how they learned a list of 50 skills and indicated that about 80 per cent of their knowledge about subsistence, childcare, sharing and other skills was transmitted from their parents, generally from the same sex parent [14]. Other interview-based studies with active [15,16] or former [17] hunter–gatherers also identified parents as primary transmitters of knowledge or skills. Hewlett's ethnographic survey of cultural transmission among 40 hunting–gathering cultures from the Standard Cross-Cultural Sample was consistent with these field studies; parents were primary transmitters of culture to boys in 70 per cent and to girls in 80 per cent of the cultures. Other categories of individuals, such as uncles, aunts or peers, trained boys and girls in the remaining 20–30% of cultures. Vertical transmission is also reported to be a primary mode of transmission in farming communities with craft specialization [18,19].

Boyd & Richerson [20,21] expanded this field, mathematically modelling two relatively new non-vertical transmission mechanisms, conformist transmission (copy the beliefs or practices of the majority) and prestige bias (copy the successful). The emerging fields of human behavioural ecology and life-history theory influenced their cultural transmission theories, and unlike their predecessors, they evaluated the efficiency and tradeoffs of different transmission mechanisms. Henrich & McElreath [22] refined these models and continued to emphasize the importance of non-vertical transmission mechanisms, and simulations by McElreath & Strimling [23] showed that vertical transmission was only adaptive in relatively stable environments. Harris's [6,8] review of the developmental psychology literature, social anthropologists' descriptions of the importance of sibling care in farming cultures [10] and MacDonald's [24] review of the hunter–gatherer ethnographic literature on how children learn hunting skills supported Boyd, Richerson, Henrich & McElreath's emphasis on the importance of horizontal and other non-vertical forms of cultural transmission.

(b) Processes of social learning: does teaching exist in hunter–gatherers?

Social anthropologists suggest that teaching is absent or rare in small-scale cultures, whereas developmental

psychologists tend to assume that it is part of human nature. The first section of a recent review of children's social learning by social anthropologists Lancy & Grove [25] is titled 'The absence of teaching'. Like many social anthropologists, they indicate that teaching seldom occurs in small-scale cultures and emphasize the importance of observational [26] and informal learning [27]. MacDonald's [24] hunter–gatherer study also concluded that 'teaching is unimportant'.

Mead [28] characterized many small-scale cultures as 'learning cultures' because children in these cultures acquired culture easily and quickly without teaching. Social anthropologists past [29] and present [26] used the term 'osmosis' to refer how easy it was for children in small-scale cultures to acquire a wide variety of knowledge and skills without teaching; it was automatic, without effort and nobody failed. Among hunter–gatherer researchers, Lewis [30] concluded that explicit teaching did not exist among hunter–gatherers because it was inconsistent with an egalitarian ethos; 'pedagogic action' (education) took place through practices, changes in physical maturity such as menstruation, and the natural curiosity and motivation of individuals.

The conclusion of Lancy & Grove and other social anthropologists that teaching does not exist in small-scale cultures may be exaggerated. Mead's classic work [24] concluded 'Manus teach very young children things which they consider most important such as physical skill, prudery and respect for property. They [parents, others] teach them these things firmly, unrelentingly, often severely.' Kruger & Tomasello [31] provide several examples of teaching in small-scale cultures, but the vast majority of examples come from horticultural societies, such as the Manus, or intensive farmers where craft specialization is common.

The view that teaching is rare in small-scale cultures contrasts dramatically with the recent proposition by cognitive psychologists that teaching or pedagogy is an innate and relatively unique feature of human cognition [32–34]. Pedagogy is defined by them as when one individual (teacher) provides explicit signals of generalizable (to other situations or individuals) knowledge to another individual (learner) who can read and interpret the content of the signals. They hypothesize that pedagogy evolved to solve the recurring problem of faithfully transmitting opaque knowledge (e.g. tool functions) to the learner. Learners evolved to pay attention to particular cues such as eye and body movements, and teachers evolved the skills to convey important information to learners such as pointing, looking or making sounds. It is hypothesized that other learning processes such as observation, imitation and emulation were not sufficient for learning tasks and behaviours that were opaque to the learner. They concede that others have pointed out the importance of teaching in human evolution [31,35], but suggest that their hypothesis is distinct from previous ones because it does not require the coevolution of cognitive abilities to read the intentions of others or language. However, Csibra and Gergely point out that effective learning is more likely to take place if the learner trusts (reads the intentions of) the teacher.

This is a provocative new hypothesis, but the data used to support it come entirely from infant and child development studies of parent–infant eye contact, gaze and infant-directed speech in urban-industrial cultures, where these types of parent–infant interactions and formal, institutionalized teaching are common. Studies of parent–infant interactions in small scale, particularly hunter–gatherer groups, are needed. It is also important to point out that pedagogy is one type of teaching. Positive reinforcement and other simple modifications of one's behaviour to facilitate learning of information, knowledge or skill in another are not necessarily pedagogy as defined by Gergely and Csibra.

(c) *Connections between modes and processes of transmission*

Theoretical and conceptual connections exist between the modes and processes of cultural transmission. Gergely & Csibra [32], Shennan & Steele [18] and Tehrani & Collard [19] assume that teaching is an important component of vertical transmission. Teaching entails costs to the teacher because he or she has to spend time and energy to accommodate the learner, and other processes of social learning (imitation and emulation) are not as efficient as teaching. Gergely & Csibra [32] and Shennan & Steele [18] hypothesize that teaching is more efficient than other processes of learning and that parents (vertical transmission) are more likely to invest in training of their children than are others; the potential roles of older brothers, sisters or cousins (horizontal transmission) are not mentioned. Shennan and Steele also hypothesize that learning should be early rather than late so as to free up parent's time to have another child and that learners should demand more than teachers are willing to give (based on parent–offspring conflict theory).

Researchers who emphasize horizontal transmission tend to downplay the role of teaching. Other processes, such as observation and interactions with older children, copying what the majority are doing or acquiring traits of successful adults, are more likely to be emphasized by researchers who model horizontal transmission.

Given this overview, if teaching is part of human nature it should be common at a relatively young age in hunter–gatherers. If teaching is a product of cultural structures, such as increasing inequality associated with farming cultures [30], specialization or institutional developments, it should be absent or rare in hunter–gatherers.

2. METHODS

Our data come primarily from Aka and Bofi hunter–gatherers and Ngandu and Bofi farmers in the southern forests of the Central African Republic. About 20 000 Aka and 3000 Bofi hunter–gatherers occupy the area; the number of Ngandu and Bofi farmers is substantially greater, but we do not have reliable estimates. The Aka have economic, ritual and kinship relationships with several different farming groups, including the Ngandu. The Bofi hunter–gatherers are neighbours of the Aka and were Aka

until about 70 years ago when they started to affiliate with Bofi farmers and speak the Bofi language. From this point on, whenever we use the term ‘hunter–gatherers’ or ‘foragers’, we are referring to the Aka or Bofi foragers, unless otherwise noted, and when we say ‘farmers’ we are referring to the Ngandu or Bofi farmers, unless otherwise noted. We do not want to diminish the dramatic diversity that exists among Congo Basin hunter–gatherer and farmer groups but want to simplify the paper to reduce potential confusion between groups.

Focal follows of individuals from infancy through adolescence provide key data used to answer the two social learning questions. Each child was followed for 6–12 h over several randomly selected days. Anywhere from 20 to 30 behaviours were coded every 30 s. The data have been collected over the past 15 years. The coded behaviours for infancy and early childhood were similar, whereas the coded behaviours for children 4–18 years of age were similar in some domains (e.g. who is proximal to focal child) but different in others (e.g. codes for teaching and imitation). Electronic supplementary material provides greater detail on the samples from each age group and the procedures and behavioural codes used in each study. Qualitative methods such as participant observation, open-ended and semi-structured interviews and structured questionnaires were also used to understand cultural perceptions of social learning, which individuals said they learned from and how they learned particular skills and knowledge. Each of the authors has spent at least two field seasons with Congo Basin foragers.

3. CULTURAL AND DEMOGRAPHIC CONTEXTS OF CONGO BASIN HUNTER–GATHERER SOCIAL LEARNING

This section describes foundational schema (cultural values and ways of thinking and feeling that pervade several domains of life), features of daily life and demographic contexts essential to understanding forager social learning. Comparisons with neighbouring farmer groups are used to help identify distinctive features of hunter–gatherer social learning.

(a) *Foundational schema*

Three foundational schemas pervade hunter–gatherer life: egalitarianism, autonomy and sharing. An egalitarian way of thinking means others are respected for what they are and it is not appropriate to draw attention to oneself or judge others to be better or worse than others. Men and women, young and old, are viewed as relatively equal and have similar access to resources. Respect for an individual’s autonomy is also a core cultural value. One does not coerce others, including children. Men and women, young and old, are generally free to do what they want. If an infant wants to play with a machete, she is allowed to do so. A giving or sharing way of thinking also pervades hunter–gatherer life; hunter–gatherers share 50–80% of what is acquired by hunting and gathering, Aka share with everyone in camp, every day.

The farmers cultivate manioc, corn, plantains and peanuts. They exchange some of their crops for meat and other forest products of hunter–gatherers. Women plant, maintain and harvest the fields and provide the majority of the dietary calories, whereas men fish, hunt and trade. Foundational schemas among the farmers include: gender and age hierarchy, communalism and material/economic dimensions to social relations. Women are expected to defer to the requests of men and the young should be respectful of elders, be they older siblings or parents. Communalism refers to the cultural value placed on putting the needs of the group, generally clan members or the extended family, over the needs of an individual. The third foundational schema refers to the thoughts and feelings that interpersonal relations have economic or material components. Material and economic dimensions of relationships are embedded within the social and emotional aspects of relationships.

Foundational schemas are learned early in life because sanctions exist for them. If a forager child does not share, others gesture, comment or tease the child. Young children often hear stories about how people who do not share properly face sanctions (e.g. illness, death, death of a child). Among farmers, sanctions tend to be harsh. Corporal punishment is not an uncommon response for young farmer children who do not listen to or respect their parents or older siblings [36].

(b) *Habitus and demographic contexts of hunter–gatherer social learning*

This section describes relatively distinct features of forager *habitus* [37]—daily, lived experiences—and demography that are important for understanding social learning. The *habitus* is shaped by the foundational schema and is also the means by which children learn the foundational schema and other cultural knowledge. Forager *habitus* and demography are again contrasted with those of neighbouring farmers to highlight forager patterns.

(i) *Physical and emotional intimacy*

Physical and emotional proximity is particularly important to hunter–gatherers [38]. Forager camps are generally very dense, often occupying a space the size of a large dining and living room in the USA or the space of one or two farmer houses. When hunter–gatherers sit down in the camp, they are usually touching somebody. At night, foragers sleep very close together and usually sleep with someone; our study of co-sleeping found that forager children and adolescents never slept alone, whereas farmer children over 7 years old slept alone 30–40% of the time. In terms of holding during infancy and early childhood, forager three to four month old infants were held 91 per cent of the day while farmer infants were held 54 per cent of the day [39]. Forager 2-, 3- and 4-year-olds were held 44, 27 and 8 per cent of daylight hours, whereas farmer children of the same age were held 18, 2 and 0 per cent of the day [40].

The importance of emotional proximity to others is illustrated in two studies. In a study of conflicts

between toddlers and older juveniles among hunter–gatherers and farmers, Fouts & Lamb [41] found that hunter–gatherer toddlers were substantially more likely to have conflicts over staying close to juveniles (38% of conflicts among forager toddlers versus 2% of conflicts among farmer toddlers), whereas farmer toddlers were more likely to have conflicts with juveniles over competition for objects (48% of farmer toddler conflicts versus 14% of forager toddler conflicts) or over the juvenile hitting the toddler, which never occurred among the hunter–gatherer toddlers. This study illustrates early acquisition and manifestation of cultural values—emotional proximity to others among the hunter–gatherers and the economic-material dimensions of social relations among the farmers.

In another study, hunter–gatherer and farmer adolescents were asked about their experiences and feelings about the death and loss of friends and relatives [42]. Forager expressions of grief emphasized their love and emotional connections to the person, whereas farmer expressions of grief focused on materials objects the lost relative gave or provided.

(ii) *Self-motivated and directed learning*

Hunter–gatherer children are granted autonomy during the day, whereas farmer children are subject to the control of parents and older children. For instance, Hewlett found that forager three to four month old infants took the breast on their own to nurse during 58 per cent of feeding bouts by comparison to only 2 per cent of feeding bouts among farmers. Farmer mothers directed infant nursing while it was infant-directed among foragers. At weaning, hunter–gatherer mothers said that the child decided when he or she wanted to wean, whereas farmer mothers said they decided. The hunter–gatherer mothers said that if they initiated the weaning it would cause the child to get sick, whereas the farmers said nursing too long causes the child to become lazy [43]. In the co-sleeping study, forager parents indicated that their children slept wherever they wanted, whereas the farmer parents said that they told their children where to sleep. Recent studies in social anthropology on informal learning emphasize self-motivation [27], but hunter–gatherer children probably initiate learning and discovery more often than children in other modes of production. Forager children's high motivation to learn occurs early and often. Infants climb into their parents' laps to watch them cook, play an instrument or make a net. Children want to learn more than what parents and others want to give, but forager parents seldom refuse the intrusions of a child, because of their egalitarian and autonomy ethos.

(iii) *Trust of others*

The development of trust of others is important to some degree in all cultures, but the socialization for trust of several others is particularly pronounced in hunter–gatherers, which relates to their extensive sharing and giving. Hunter–gatherer infants and young children were breastfed on demand, averaging about 4 bouts per hour, whereas farmers averaged

about 2 bouts per hour. Young forager infants were often breastfed by other women, generally aunts and grandmothers (sometimes even fathers offered their breast), whereas among farmers, breastfeeding by other women was thought to cause infant sickness and was not practised except under unusual circumstances. Forager caregivers were significantly more likely than farmer caregivers to respond to infant crying, and farmer infants cried significantly longer and more frequently than did forager infants [39,44]. Hunter–gatherer infants and young children were held twice as often as neighbouring farmers, and this additional holding came from many different individuals—fathers, grandmothers, siblings and others. In early infancy, mothers provided the most care, but all others together provided more holding than did mothers [38]. Likewise, hunter–gatherer toddlers received most plates of food from mother, but all other categories of providers together (grandmothers, aunts, etc.) provided more plates of food to children than did mothers [45].

(iv) *Mixed adult–child groups*

Konner [46] indicates that after weaning, hunter–gatherer children move from a relationship with mother to relationships with children in mixed aged playgroups. Our data question his representation of hunter–gatherers and indicate that parents and other adults are frequently around children and even adolescents. Time with parents and other adults, generally grandparents, gradually declines with age, but by comparison to farmers, foragers spend considerably less time in child-only groups. Table 1 summarizes Fouts's data on who is proximal (i.e. within arm's reach) to hunter–gatherer and farmer young children; hunter–gatherer children were much more likely to be proximal to more categories of people and parents and other adults than were farmers. By age 4–5, hunter–gatherers are still proximal to parents and adults 33 per cent of the time, whereas farmer children are proximal to them only 6 per cent of the day. Farmer children at this age spent 59 per cent of their day in child-only groups, whereas hunter–gatherer children spent only 18 per cent of their day in proximity to child-only groups. Boyette found that 4- to 12-year-old forager children spent more time in mixed aged groups, but they were still within visual range of an adult 77 per cent of the day, and parents and other adults were among their nearest neighbours (defined as those equally close to the child) 33.1 per cent of the day.

Another behavioural study found that forager children in late childhood spent 40 per cent of their day in mixed adult–child proximity groups (defined as three closest individuals to child) and 30 per cent of their day in child-only proximity groups while in a camp setting [47]. Outside of the camp, these children spent 70 per cent of their time with an adult social or work group and 30 per cent of their time with a child-only social or work group. This is consistent with Boyette's recent finding that children were more likely to spend time with adults in the forest and less likely to spend time with younger children in camp,

Table 1. Percentage of observation intervals hunter-gatherer and farmer children were within arm's reach of adults and children.

proximity	age					
	2-years-old		3-years-old		4-years-old	
	hunter-gatherers	farmers	hunter-gatherers	farmers	hunter-gatherers	farmers
adults only	63.5	34.5	47.5	23.4	33.1	5.6
children only	7.0	28.3	18.7	29.2	18.5	59.2
adults and children	21.6	13.5	23.0	9.5	28.9	2.7

as they got older. Neuwelt-Truntzer [47] found that this pattern continued into adolescence.

At night, the co-sleeping study found that forager children and adolescents were three times more likely than farmer children of similar age to sleep with parents or other adults.

(v) Play

Play is an important learning context. Several researchers have reported that hunter-gatherer children spend most of the day playing and are not expected to contribute much to subsistence or maintenance [46,48]. By comparison, children in farming communities are more likely to be given responsibilities for childcare and other tasks [49]. Boyette found that forager 4- to 12-year-old children spent a considerable amount of time playing (31.4% of day) and laying around (idle, 37.9% of day). Unfortunately, comparative data on farmers are not available. Forager play is relatively equally divided between solitary play, social play and work play (children imitating/emulating adult tasks). Kamei's [50] study of types of play among 7- to 15-year-old Baka hunter-gatherers, Cameroonian neighbours of the Aka, identifies 85 different types of games, the majority (61%) dealing with hunting-gathering, camp life (cooking and childcare) and singing-dancing. All of this play takes place in child-only groups, and most of the play involves learning about making a living as a hunter-gatherer.

It is essential to understand the cultural and demographic contexts of forager social learning. Foragers value autonomy and egalitarianism, so parents, older children or other adults are not likely to think and feel that they know what is best or better for a child and are generally unlikely to initiate, direct or intervene in a child's social learning. This is consistent with our finding that forager social learning is self-motivated and directed, but it also suggests that teaching and explicit instruction should be rare or absent. Sharing and giving are also forager core values, so what an individual knows is open and available to everyone; if a child wants to learn something, others are obliged to share the knowledge or skill. If forager children regularly asked questions, teaching could be common, but forager children seldom ask questions about how to do things. The mixed adult-child demographic data on where children are at different ages suggest that parents are proximal and very available for social learning, especially before age 5, but that after age 5 children are more likely

to be around children and other adults. Vertical transmission is likely at younger ages and horizontal and oblique transmissions more likely in middle and late childhood. Forager children also play much with other children, creating opportunities for horizontal transmission. Since learning is self-motivated and directed and takes place in intimate and trusting contexts, hunter-gatherer children are generally very confident and self-assured learners. Finally, intimacy and socialization for trust with many individuals suggest that social learning may be rapid in foragers, as developmental psychologists [32] showed that trust facilitates social learning.

4. MODES AND PROCESSES OF SOCIAL LEARNING

(a) Modes of transmission: from whom do hunter-gatherer children learn?

(i) The case for vertical transmission

Vertical transmission should be important in hunter-gatherers given our great ape phylogenetic heritage of mother-to-offspring transmission [51] and parents' potential inclusive fitness benefits from taking the time to transmit knowledge or skills [18]. Theoretically, one can make the case, but this is also what hunter-gatherers say when asked how they learned a wide range of skills and knowledge [14,17,52]. In a recent study, Hattori [16] found that Baka hunter-gatherer women said that they learned about the uses of 90 plants from their mothers 80 per cent of time, fathers 15 per cent of time and others 5 per cent of time; Baka men said that they learned about the plants from their mothers 10 per cent of the time, fathers 65 per cent of the time, siblings 11 per cent of the time and others 13 per cent of the time. An interview-based qualitative study of forager adolescents [53] is replete with expressions of vertical transmission. One adolescent boy explained 'father showed me how to care for younger brothers and sisters and to have a good character. He showed me how to hunt and find honey. (My mother) showed me how to guard the baby and how to wash and comfort the babies'. Often the same sex parent was identified as the person transmitting knowledge, such as when a forager adolescent male stated 'I love my father because he shows me everything', but this is not always the case in hunter-gatherers where gender flexibility is pervasive; an adolescent female stated 'father showed me how to care for the *moanna* (baby) and to give her food and to wash her'.

In a more quantitative study, Boyette asked 39 5- to 18-year-old forager children to list anyone who taught them to share food. On average, 60 per cent of the Aka children said that their mothers taught them to share food, 27 per cent listed their fathers, 20 per cent other kin and 3 per cent mentioned a non-family member (children could list more than one individual). Learning to share was often attributed to the same sex parent. Girls mentioned mothers 84 per cent of the time and boys mentioned fathers 65 per cent of the time.

The habitus and demographic contexts of social learning also contribute to patterns of vertical transmission. In terms of intimacy, hunter–gatherer infants were held most of the day and parents provided over 80 per cent of the holding [37]. Fathers and others provided more holding than mothers while in the camp setting in early infancy, but outside of camp and by late infancy, mothers and fathers provided most of the holding. Fouts found that in early childhood, hunter–gatherer children were within an arm's reach of a parent 40–50% of the day. Mothers and fathers continued to do most of the holding until age 4.

At night, hunter–gatherer infants and children up to the age of 12 slept with their parents. In late childhood and adolescence, hunter–gatherer children spent less time with parents, but they continued to regularly interact with, eat and sleep with them.

(ii) *The case for horizontal and oblique transmission*

While our phylogenetic history suggests that vertical transmission should be important, humans are distinct from great apes in that cooperative breeding is part of human nature. Allomaternal care is pronounced in hunter–gatherers [39], and it would be surprising to find that individuals other than parents did not influence cultural transmission.

Hattori's [16] study with Baka foragers examined the degree of agreement between informants in how plants were used. Plants used for food or material culture showed 80–95% agreement between informants, but plants used for medicine showed only 25–30% agreement and considerable intracultural variability. The intracultural diversity of medicinal plant use is consistent with the theoretical expectations of vertical transmission, but the uniformity found in food and material culture suggests that other modes of transmission, possibly conformist bias, influence social learning. Hattori suggests that plants used for food and material culture are public and open to observation, whereas medicinal plant use is relatively private.

Forager parents are more accessible to their young children than parents are among farmers, but other adults and juveniles play significant roles in forager children's daily lives and probably stimulate horizontal and oblique transmission. In infancy, parents are most likely to hold the baby but many others are nearby and interact with the child. If a parent sits down with their infant, they place the infant in their lap facing away from them and towards other camp members. Other adults and children were more likely than mothers or fathers to engage infants in any type of play, but especially in face-to-face play during early infancy [38].

Table 2. Frequency (percentage of intervals observed) hunter–gatherer parents and others provided caregiving (e.g. clean and wash), showed affection or vocalized to the child during daylight hours.

	2-year olds	3-year olds	4-year olds
parents	6.7	3.1	4.3
others	2.8	3.9	3.7

In early childhood, parents, especially mothers, were proximal and provided most of the holding, but other caregivers interacted with toddlers just as often as did parents. Table 2 shows that hunter–gatherer parents were more interactive with their 2-year-old than were others, but by 3 and 4 years of age, children were interacting with others just as frequently as parents.

By middle and late childhood, adults are often nearby, but children spend most of the day in multi-aged child groups. Boyette found that forager children at this age spent most of their day with other children and that children frequently observed and imitated/emulated other children's behaviour. All the types of play he described occurred with other children. The potential for oblique transmission also increases at this time as the chances of children living in step-parent households increase; 42.4 per cent of 11- to 15 year olds do not live with both biological parents [38].

Hunter–gatherer parents are important contributors to cultural transmission, especially by comparison to farmer parents. Foragers say that parents as a category provide more cultural transmission than any other similar category, such as siblings, cousins, aunt/uncles, grandparents or friends. Behavioural observations also indicate that children spend substantial parts of the day near parents up until age 5. However, other adults and juveniles also spend considerable time with children, especially after age 5. The roles of 'others' in hunter–gatherers (i.e. all friends, cousins, etc.) are poorly understood and probably underestimated, and more systematic studies are needed to evaluate the nature and impact of their contributions to social learning.

(b) *Processes of social learning: does teaching exist in hunter–gatherers?*

Evolutionary approaches to culture identify several processes of social learning [51], but we focus here on teaching because anthropological literature [25] says that it is rare or does not exist in hunter–gatherers, whereas other recent literature [32–34] indicates that it is part of human nature. We define teaching as modification of one's behaviour to facilitate learning of information, knowledge or skill in another. Pedagogy as defined by Gergely and Csibra is one type of teaching. Qualitative and quantitative data suggest that pedagogy and other forms of teaching exist in hunter–gatherers.

Parents make small axes, digging sticks, baskets and spears for infants and young children. These are small-sized artefacts that reflect the size of the infant or child and are not toys. Mothers place these implements in

their baskets and while resting on a net hunt or other subsistence activity, they will be given to infants. The infants chop, dig, etc., and the parents watch, laugh, make sounds and sometimes physically take the infants' hands to show them how to use the implement. Hewlett made 1 h naturalistic video recordings of 10- to 12-month olds, and preliminary analysis indicates that parents in at least three of the videos exhibited pedagogy; parents moved the arm of the infant to show her how to dig or use a knife, or pointed to objects or actions that helped the infant obtain oblique information about a tool or a particular task (e.g. build a house). Parents in half of the videos gave their infants a knife or machete to play with during the 1 h video. All co-authors have observed parents place fabric slings on toddlers, sometimes placing a bottle or corncob in it to represent an infant. Young children are also frequently asked to deliver food to other houses and parents use eye contact and gestures to indicate where to take the food.

In Hewlett's [36] study of women's lives, she asked women to teach her how to 'be an Aka woman'. In order to show her how to make a basket, a woman sat next to her, touching her and never left her side. The woman started the basket, ripped it apart, then asked her to try it on her own. As Hewlett tried to weave, some people laughed and commented; after a short time, a 12-year-old girl came over, sat next to her in the same way and demonstrated again how to do it and then handed it back for her to try. Hewlett was not weaving correctly so the girl took her hand and helped her weave the twine. The mother and 12-year-old spent three weeks, hours at a time, sitting right next to Hewlett until she completed the small children's basket. Both the mother and young girl clearly had pedagogic skills, knew how to scaffold (i.e. build on the knowledge Hewlett was acquiring over time) and promoted learning in a novice.

As part of the same study, Hewlett asked Aka women what were the important lessons they learnt from their mother. Several women indicated that learning edible versus inedible food items was the most important thing they had been taught. Women described how when they were very young their mothers laid out several types of mushrooms or wild yams in front of them and explained how to identify edible versus inedible varieties.

Boyette is conducting the only systematic observational study of hunter–gatherer social learning. In a preliminary study, he observed 35 children aged 4–18 years and coded instances (every 30 s) of the focal child observing others, imitating others (child performs behaviour just observed), receiving instruction from others (child gives verbal or gestural signal intended to change focal child's behaviour) and giving instruction to others (child gives verbal or gestural signal intended to change the behaviour of another child). The last two codes were measures of teaching. Consistent with existing anthropological studies, he found that observation was common, taking place 72 min d^{-1} , but that children received instruction 14 min d^{-1} , gave instruction 5 min d^{-1} and imitated others 3 min d^{-1} . Somewhat surprisingly,

imitation was rare, but this is due, in part, to how it was defined (child tries to replicate behaviour just observed). This definition did not distinguish emulation from imitation because focal techniques were not detailed enough to evaluate the unique qualities of each type of social learning. As expected, amount of time in observation, receiving instruction and imitation declined with age, whereas giving instruction increased with age. Giving instruction was particularly common during child-only productive activities and when children were in play, imitating productive activities. This study is important because it demonstrates that some forms of teaching (not limited to pedagogy as defined by Gergely and Csibra) exist on a daily basis and that horizontal transmission is prevalent at these ages as forager children are learning from other children in a variety of ways (observation, imitation and teaching).

Examples of teaching among other hunter–gatherer groups come primarily from research with the !Kung. Konner [54] described how !Kung taught their infants to sit and walk, while Draper [55] found that 4- to 14-year-old girls received 1.5 'adult interruptions' per hour (a measure of adults 'shaping a child's behaviour') and boys received about 2 per hour. Wiessner [56] described how parents removed beads from infants' necklaces and had them give the beads to appropriate kin relations so they could learn about sharing networks. Konner [51] also indicated that !Kung learn to share early: '!Kung value sharing very highly, and from the time their infants are six months of age mothers and other adults frequently say 'Na' meaning 'Give' when a bit of food is in the infant's hand and on the way to its mouth. The criterion is that they should inhibit the very strong impulse to eat and reliably turn the morsel over to the adult making the demand'.

An example of the early parent–infant social learning hypothesized by Gergely and Csibra comes from Guemple's [57] descriptions of teaching kinship categories to infants among the Inuit foragers. While on the mother's back, a young infant is asked to identify which individual in the room belongs to a kinship category, for instance, *nuak* or paternal aunt. Other individuals in the room look at the person with that kin term and when the infant looks at the correct relative the mother looks approvingly at him or her and others in the room cheer. At 12 months of age, infants are asked to point to particular kin and by 14–18 months a child can identify everyone in the camp by an appropriate kin term.

5. SUMMARY AND DISCUSSION

Existing studies of social learning in small-scale cultures come primarily from farming communities. This paper uses quantitative and qualitative data on Congo Basin hunter–gatherer children and literature on a few other forager groups to examine what we know about social learning in hunter–gatherers. Data are limited, but we propose the following generalizations.

- Social learning occurs early and is relatively rapid. Twelve month olds know core cultural values, kinship terms and have had experience with a broad

- range of subsistence activities. Children know most subsistence, childcare, sharing and essential skills and knowledge to make a living by age 10, if not earlier.
- Vertical transmission is pronounced up to age 4–5. Foragers are frequently around parents in early childhood and this is whom forager adults and children say taught them a wide range of cultural knowledge and skills. Vertical transmission probably occurs after this age because parents continue to be around their children and forager camps are small, living density is high, physical and emotional proximity is valued and co-sleeping with parents continues until early adolescence.
 - Horizontal and oblique transmission are dominant modes of cultural transmission between the ages of 5 and 12. Children in middle and late childhood spend most of their day in multi-aged child groups playing or resting (idle, including visiting). Non-parental adults are also usually within sight and accessible to children. Adolescents spend considerable time in child-only groups, but they begin to spend more time with adults, especially when outside of the camp setting during subsistence activity. Children at this age spend most of their time observing and imitating other children and adults.
 - Pedagogy and other forms of teaching exist in hunter–gatherers. Systematic observational studies suggest that older children and other adults modify their behaviour to help younger children learn, but that this teaching is relatively rare by comparison to observation and imitation. Informal observations and limited video data indicate that pedagogy exists in infancy. Parents used eye contact, pointed and moved infant's arms to help them learn how to use tools, perform tasks such as house building, and learn foundational schema such as how to share. Foragers said parents and others explicitly taught them particular cultural knowledge and had no problem teaching field researchers how to do a variety of tasks. Data are limited and substantially more are needed to evaluate the types and developmental aspects of teaching and other processes of social learning in hunter–gatherers.
 - Learning to trust others is central to forager life and is transmitted early via a variety of modes and processes. It facilitates pedagogy and other forms of teaching, probably contributes to early and rapid learning, and is central to maintaining extensive sharing common to hunter–gatherer cultures.
 - Social learning is usually a self-motivated and guided discovery process. Parental interruptions and sanctions are relatively rare due to limited parental authority, especially by comparison to farmers. Respect for autonomy and an egalitarian ethos promote self-discovery and an intrinsic motivation to learn. Children often want to learn more than what others are willing to provide.
 - Play permeates hunter–gatherer child daily life, but its role in social learning is poorly understood. Lack of parental direction provides more time for play and horizontal transmission.

Our data have several theoretical implications. The data support Shennan and Steele's [18] hypothesis

that hunter–gatherer social learning should be early, rapid, primarily vertical and take place via teaching. Hunter–gatherer infants are given small artefacts, parents sometimes use direct instruction to show infants and young children how to use the tools and parents hold or are within arm's reach of infants and young children most of the day. But the hypothesis underestimates the significance of horizontal and oblique transmission and the roles of observation and imitation. Our data indicate that 5- to 18-year olds teach each other and children are likely to observe and imitate older children. The children who receive or provide instruction are usually siblings and/or cousins so horizontal transmission may enhance their inclusive fitness, but unlike the parents, and a factor that may motivate older children to invest in younger children, is that the younger children will be their future sharing and subsistence partners.

Qualitative and quantitative data also support the Gergely and Csibra [32–34] hypothesis that pedagogy is a human universal. As they suggest, it occurs early in life and is primarily vertical, at least in infancy. Data indicate that various forms of teaching, broadly defined, occur daily, but that other processes of social learning, such as observation and imitation, are more prevalent. The Gergely and Csibra hypothesis also underestimates the importance of teaching by other children and adults. Other children and adults modify their behaviour to enhance the learning of children. Better methods (e.g. videotapes and field experiments) are needed to evaluate pedagogy with older children. Trust may enhance social learning, and this is an essential factor for understanding the effectiveness of hunter–gatherer social learning.

Social anthropologists and others may have overlooked pedagogy and other forms of teaching because of preconceived notions of formal teaching; it is often thought to be explicitly linguistic and involve easily observable self-conscious efforts of teachers. Pedagogy may not be verbal or very explicit. Researchers are unlikely to catch it with scan sampling techniques or participant observation. Pedagogy was captured with videotapes, and other forms of teaching (modifying behaviour to help others learn) were captured with focal follows.

Social anthropologists [25], developmental psychologists [6,8] and several cultural evolution theorists [20,21] emphasize the importance of horizontal transmission, and it occurs regularly among hunter–gatherers, especially after age 5, but it is more likely to be a characteristic feature in farming cultures. Farmer children are weaned relatively early, usually by 18 months, mothers and others stop holding children years before this happens among foragers, farmer infants are often placed in the care of older siblings, and as table 1 indicates, they spend a majority of the day in child-only groups because both mothers and fathers leave the village to work and socialize. These data are consistent with existing studies of farmers. Horizontal transmission has specific features, and it may contribute to more rapid culture change and greater cross-cultural diversity than is observed among hunter–gatherers.

Social learning always takes place in a biology–culture interface. Social anthropologists tend to ignore biology, and evolutionary biologists tend to neglect the role of culture. Hopefully, this paper provides implicit examples of biology–culture interactions. Pedagogy, reading the intentions of others, attachment, cooperative breeding and paying attention to successful individuals all influence social learning and appear to be part of human nature and biology. Cultural niche construction, such as the differences between forager and farmer modes of production, and cultural ideologies, such as the differences between forager and farmer foundational schema, also influence social learning and can amplify or diminish the expression of the biological propensities. Formal educational institutions clearly amplify the role of pedagogy, and Lewis [30] is probably correct that explicit teaching is less likely to occur in hunter–gatherers than in farmers because of their egalitarian ethos and respect for autonomy. In contrast, farmers expect men to tell women what to do and parents and older children will tell younger children what to do and how to do it. Better data are needed to test these hypothesized differences between foragers and farmers.

Finally, this paper has several limitations. We focused on social learning in childhood and used data on tropical forest hunter–gatherers with extensive relationships with farmers. Social learning continues into adulthood, and we have few data on foragers in other natural and social environments. The most pronounced limitation is the lack of systematic data on hunter–gatherer social learning. We assembled what we knew at this point in time and often relied upon indirect methods to evaluate social learning (e.g. who is around and interacting with the child), but there is so much we do not know—who do children watch, how often do children initiate learning, how are vertical and horizontal transmission similar and different, what are the roles of conformist and prestige bias and how early do pedagogy and other forms of teaching occur? We know very little about social learning in hunter–gatherer adolescence. Systematic research on hunter–gatherer social learning is urgently needed. This way of life will not be part of the human landscape for much longer.

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