Hum Nat (2017) 28:289–322
DOI 10.1007/s12110-017-9294-y

Autonomy, Equality, and Teaching among Aka Foragers and Ngandu Farmers of the Congo Basin

Adam H. Boyette[1] · **Barry S. Hewlett**[2]

Published online: 31 May 2017

Abstract The significance of teaching to the evolution of human culture is under debate. We contribute to the discussion by using a quantitative, cross-cultural comparative approach to investigate the role of teaching in the lives of children in two small-scale societies: Aka foragers and Ngandu farmers of the Central African Republic. Focal follows with behavior coding were used to record social learning experiences of children aged 4 to 16 during daily life. "Teaching" was coded based on a functional definition from evolutionary biology. Frequencies, contexts, and subtypes of teaching as well as the identity of teachers were analyzed. Teaching was rare compared to observational learning, although both forms of social learning were negatively correlated with age. Children received teaching from a variety of individuals, and they also engaged in teaching. Several teaching types were observed, including instruction, negative feedback, and commands. Statistical differences in the distribution of teaching types and the identity of teachers corresponded with contrasting forager vs. farmer foundational cultural schema. For example, Aka children received less instruction, which empirically limits autonomous learning, and were as likely to receive instruction and negative feedback from other children as they were from adults. Commands, however, exhibited a different pattern suggesting a more complex role for this teaching type. Although consistent with claims that teaching is relatively rare in small-scale societies, this evidence supports the conclusion that teaching is a universal, early emerging cognitive ability in humans. However, culture (e.g., values for autonomy and egalitarianism) structures the nature of teaching.

Keywords Teaching · Foragers · Childhood · Cultural evolution · Autonomy · Egalitarianism

✉ Adam H. Boyette
adam.boyette@duke.edu

[1] Duke University, Box 90025, Durham, NC 27708, USA

[2] Washington State University, 14204 NE Salmon Creek Avenue, Vancouver, WA 98686, USA

The role of teaching in the evolution of human culture is currently the subject of great interdisciplinary interest and debate (Byrne and Rapaport 2011; Castro and Toro 2014; Csibra and Gergely 2011; Dean et al. 2014; Lancy 2016; Morgan et al. 2015; Thornton and McAuliffe 2012). Some suggest that teaching is at least in part responsible for the evolution of cumulative culture and humanity's adaptation to environments across the globe (Boyd and Richerson 1985; Gergely and Csibra 2006; Sterelny 2012; Whiten and Erdal 2012). However, others dispute the importance of teaching to human success. Rather, they contend that teaching is extremely rare and of little or no importance in children's cultural learning outside of Western cultures with formal schooling (Fiske n.d.; Gaskins and Paradise 2010; Lancy 2010, 2016; Rogoff 2011; Rogoff et al. 2003). Based on ethnographic work among small-scale societies and peoples of non-Western backgrounds, this latter group of researchers concludes that teaching is not a universal human behavior that is essential to successful child development and the transmission of culture between generations but a cultural construction of Western industrialized societies. Indeed, Lancy (2016) believes research into the relationship between teaching and human cognitive and cultural evolution is ethnocentric and propelled by the Western cultural emphasis on academic achievement. While his claim is debatable, Lancy and others have exposed important gaps in our knowledge of the evolution, development, and cultural diversity of teaching in humans. The nature of variability in human teaching—and its significance in relation to other forms of social learning, such as observation—remains open to empirical investigation. In this paper we conduct such an investigation of teaching using systematic observations of social learning in the daily lives of children in middle childhood through early adolescence from two small-scale societies—Aka foragers and Ngandu farmers of the Central African Republic.

Background

Defining "Teaching"

The claim that teaching is rare or absent in small-scale, non-Western societies is not new (Hewlett and Roulette 2016). Since Margaret Mead (1942), the dichotomy between Western, politically and economically stratified societies and small-scale traditional societies has been used to explore very real differences in the ways children learn and culture is reproduced in these two settings. For example, Rogoff et al. (2003) trace the educational tradition in the United States back to industrialization and the concomitant reduction in opportunities for children to participate in work and social life at home. Starting in the early 1800s, schools became a specialized, child-focused environment where learning was organized according to a "factory model" in which participants had fixed roles—a specialized teacher transmits information to learners whose job it is to respect the teacher's authority and retain the information. As characterized by Rogoff and colleagues, this tradition of teaching as "assembly line instruction" involves a hierarchical relationship between the teacher and learners in which learning is extrinsically motivated by rewards or threats, communication is entirely verbal, the context of learning is outside that in which skills or knowledge are to be applied (e.g., reading and mathematics will not be practically applied until adulthood), and retention of information is tested through regular quizzing.

This model is contrasted with how learning typically occurs in small-scale societies, where the home and work domains are not as clearly defined and there are few if any boundaries between learners and those from whom they may learn (Lancy 2012b; Morelli et al. 2003; Rogoff et al. 2003). In these contexts (and those in the US until the mid-1800s) learning occurs through "intent participation" (Rogoff et al. 2003), or situated learning (Lave and Wenger 1991), whereby children acquire the skills and knowledge needed to be successful in their culture by careful observation and increasing amounts of participation in daily life—that is, without "teaching." The "intent participation" tradition is characterized as collaborative, nonhierarchical, and intrinsically motived by a clear association between learning and application (e.g., children use what they learn very early on to contribute to the family economy or perform culturally valued practices). Lancy's reviews of the literature support this general view of how learning is conducted in small-scale societies, referring to the process as "the chore curriculum" (Lancy 2012b). In his words, "the academic or core curriculum found in schools is formal and imposed on students in a top-down process, the chore curriculum is informal and emerges in the interaction of children's need to fit in and emulate those older, their developing cognitive and sensorimotor capacity, the division of labour within the family and the nature of the tasks (chores) themselves" (2012b:24).

Together, these authors echo Mead's (1942) critique of "teaching cultures" such as those of the West, whose education systems she claimed were derived from institutions of conversion, indoctrination, and colonization. It remains an important critique as formal, Western-style schooling continues to be a focal point of international development policy without regard for cultural variation (Cole 2005). Furthermore, the ethnographic research on which they have based their claims is valuable because it demonstrates the diverse ways human societies organize the training and enculturation of children, making it clear how easily children can learn complex knowledge and skills without classroom instruction. However, the concept of "teaching" in intent-participation societies is too narrowly defined to be useful beyond contrasting "the West" with "the rest." Treating teaching only as it is defined within the context of Western formal education overlooks the possibility that rare or more subtle forms of teaching are important components of social learning in specific social or ecological contexts among small-scale societies—or in the West, for that matter. Other approaches offer a view of teaching with clearer parameters that better facilitate empirical investigation.

Tomasello et al. (1993; Kruger and Tomasello 1996) argue that teaching is part of human nature and essential to the evolution of cumulative culture. In their view, children incrementally acquire better abilities to read the intentions of others and understand that others can do the same. This shared intentionality facilitates receptiveness to teaching such that teachers can better scaffold complex skills and knowledge in young learners. Thus, they define teaching as a behavior in which one intends that another learn information, knowledge, or a skill they did not have before. For Tomasello et al., what makes humans unique from other primates is that adults can expect children, as they gain better mind-reading skills, to recognize the intention to teach. Similarly, Strauss et al. (2002; Strauss and Ziv 2012) argue that teaching is a naturally developing cognitive capacity in humans that develops alongside theory of mind (i.e., the attribution of false beliefs). According to their definition of teaching, a teacher intends to increase the knowledge of another whom they recognize lacks that

knowledge (or possesses a false belief). Their work has therefore focused on the development of teaching abilities in children, rather than the ability of children to learn from adult teachers. Recent experimental evidence supports their view, showing that preschoolers' abilities to teach are associated with their development of theory of mind (Ziv et al. 2016).

Gergely and Csibra (2006) also view teaching as a human adaptation, but they do not believe it requires intent or theory of mind. Rather, they hypothesize that humans possess an innate type of teaching they call "natural pedagogy." Natural pedagogy involves a specialized set of explicit signals (e.g., pointing, child-directed speech, eye gaze, motherese) with which a teacher conveys generalizable knowledge to a learner who has an evolved ability to read and interpret the signals' content. These authors argue that natural pedagogy evolved to solve the problem of faithfully communicating opaque knowledge about tool use. Observation and participation, they argue, are not sufficient to learn opaque information. Evidence for natural pedagogy comes from experiments that demonstrate infants are more likely to imitate and learn about novel objects when their caregivers give "ostensive" signals (Király et al. 2013; Marno and Csibra 2015). Twelve-month-old infants also point at an object more often when a caregiver provides information about it than when they simply share attention with the child, suggesting that the early production of communicative signals in our species is also tied to seeking pedagogy (Kovács et al. 2014).

These cognitive approaches permit the generation and testing of specific hypotheses about the function of teaching and whether certain observable behaviors (e.g., pointing, child-directed language) are uniquely constitutive of teaching as an evolved cognitive ability for cultural transmission. However, like the "cultural approach" reviewed above, cognitive definitions are restrictive. The development of shared intentionality or theory of mind cannot be confirmed through observation in the field, even if certain hypothesized behaviors are observed. The behaviors associated with natural pedagogy may be visible during systematic observation, but they represent a set of behaviors derived from laboratory-based experiments with Western parents and infants. The fact that subjects of cognitive research on teaching are entirely from Western populations, where particular cultural practices around teaching are present and influential from birth (Lancy 2010, 2014), including the use of infant-directed speech and motherese (Hewlett and Roulette 2016), limits the generalizability of inferences that can be made. In this study, our aims are to integrate across approaches and investigate observable uniformity and variation in teaching during the course of daily life in two cultures; therefore we use a definition of teaching based on the functionalist approach taken by evolutionary biologists.

Because the functionalist approach has its roots in the systematic study of teaching in nonhuman animals, its practitioners define teaching in an inclusive but rigorous way in an effort to understand the distinctive nature of teaching as a solution to adaptive challenges faced by any species (Franks and Richardson 2006; Leadbeater et al. 2006; Raihani and Ridley 2008; Thornton and McAuliffe 2006). Therefore, according to Caro and Hauser (1992), teaching requires a teacher modify her or his behavior in the presence of a learner in order for the learner to acquire information more easily than they would without teaching, or access information otherwise inaccessible by learning individually via trial and error. To clearly identify behaviors that were representative of a teaching adaptation, this definition was further refined to include the criteria that (1)

teaching is not a by-product of some other behavior and (2) it involves some level of coordination between an information donor and an information receiver (Thornton and Raihani 2008). Using this functional definition of teaching, we address several outstanding questions.

Teaching in Foragers

Systematic studies of teaching in small-scale societies are few in number (Hewlett and Roulette 2016; Kline et al. 2013; Maynard 2002). This work is needed to clarify the nature of teaching in contexts outside of post-industrialized, Western societies, where the majority of research on teaching is conducted. However, most studies of teaching in small-scale societies have been done with subsistence farmers—less is known about teaching in foragers (Hewlett et al. 2011). Contemporary foragers are unique among human societies in many ways. For example, they share a seemingly paradoxical cultural emphasis on individual autonomy and cooperation (e.g., Endicott 2011) that we hypothesize affects how teaching is given and received. Comparing social learning between foragers and farmers will expand our knowledge of diversity *among* non-Western groups. Moreover, the study of foragers is of substantial theoretical interest because of the similarity of the subsistence strategy and social organization of contemporary foragers to those of the majority of all human groups before the advent of agriculture (Marlowe 2005). Understanding the nature of teaching among foragers may provide unique insights into the evolution of teaching in humans and teaching's role in the evolution of cumulative culture.

Much is unknown about the developmental trajectory of teaching across childhood in foragers. Hewlett and Roulette (2016) show infants receive teaching relatively frequently and across a range of domains. Later in childhood, only certain domains have been described, and not always systematically. Social skills such as sharing practices (Wiessner 1982) and kinship terminology (Guemple 1988) have been reported to involve deliberate teaching of toddlers, and hunting is the subject of teaching during adolescence (Dira and Hewlett 2016; MacDonald 2007). However, many questions remain: Is there variation in frequency of teaching across childhood? A range of types of teaching is noted in previous studies—from extensive demonstration early in life to verbal explanation in adolescence. Does this pattern hold throughout childhood? Is the pattern particular to a foraging economy, or does it characterize traditional informal teaching more widely?

Our knowledge of who teaches forager children is also limited. Researchers have argued that parents, followed by other close kin, would be the most important teachers among ancestral foragers because they share a high degree of relatedness, are readily available, and are close attachment figures (Shennan and Steele 1999). However, a synthesis of contemporary forager kinship data finds a relatively low level of biological relatedness within these communities (Hill et al. 2011). Rather, co-residing siblings bring together a high proportion of affinal kin, suggesting more opportunities for teaching by unrelated individuals. Is teaching kin-based throughout childhood? Are parents their children's first teachers early in life and others more important later, as demonstrated among subsistence farmers (Kline et al. 2013)?

There has also been an assumption that cultural transmission occurs via sex-biased social learning processes. When asked, foragers tend to report having learned most of

what they know from same-sex parents (Hewlett and Cavalli-Sforza 1986). While this may hold true of skills or knowledge consistent with the sexual division of labor, forager gender norms are highly flexible and skillsets and knowledge bases overlap extensively across the sexes. Is teaching sex-biased across childhood?

Finally, there are no studies of forager children *teaching*. Do differences exist between how children teach other children versus how adults teach? Educational psychologists have argued that teaching is a naturally emerging cognitive ability in humans (Strauss and Ziv 2012; Strauss et al. 2002), but empirical work on this subject is largely restricted to Western samples and to the study of tutoring in the context of formal educational contexts.

As a social learning process, teaching has been specifically implicated as essential to the transmission of human-specific cultural traits such as complex tools and arbitrary ritual behavior (Gergely and Csibra 2006). Only two studies have investigated the domains in which teaching was actually used among foragers. Both find tool use to be one of the major domains, but Hewlett and Roulette (2016) specifically found certain types of teaching were more likely to be used to transmit other domains of culture to Aka infants, such as using negative feedback to teach social norms. Furthermore, Garfield et al.'s (2016) cross-cultural survey found ethnographers tended to report different domains as being taught to children depending on their age, but cultural values and kinship were taught across childhood. In this study, we bridge the findings of these two studies by studying teaching using observational measures across childhood among the Aka and the Ngandu.

The Field Site

The Aka and the Ngandu inhabit the southwestern Central African Republic and northern Republic of the Congo in the tropical forests of the Congo Basin. The current study was conducted in the Central African village of Bagandou and in the forest south of the village (Fig. 1). The learning environment for Aka and Ngandu children is highly conducive to intent participation and situated learning. Traditional ritual, exchange, and fictive kinship relations tie the Aka and Ngandu of Bagandou together in complex and multifaceted ways (Bahuchet and Guillaume 1982). However, each group's social structure and built environment influence the development of cultural models of learning.

The Aka live in fluid communities of 25–50 people who move about four times per year depending on resource seasonality and abundance—especially honey, wild game, caterpillars, and agricultural labor. They subsist from collecting wild foods, supplementing their diet with agricultural goods procured through trade. As much as 80% of food procured is shared with other camp members (Kitanishi 1998). Community life is open and intimate. Aka houses are used only for sleeping, are placed .3 to 1.22 m apart on average, and have enough room for a hearth fire and a bed (Hewlett et al. 1998). Aka foundational schemas include respect for autonomy, egalitarianism, and cooperation. No one can coerce others in Aka society, and all individuals, including children, do as they please. Aka practice prestige avoidance and try not to draw attention to themselves. Cooperation in all activities is tacit and ubiquitous. Foundational schemas are learned early in life because social sanctions exist to reinforce them. Threats (e.g., withholding food) and rough joking curb infringement

Fig. 1 Map of the Central African Republic. The small box indicates the approximate extent of fieldwork

on others' autonomy, promote cooperation and sharing, and minimize status differences between people, including between older and younger individuals (Hewlett 1991).

The Ngandu are Western Bantu subsistence farmers who live in sedentary, roadside communities along the periphery of the tropical forest throughout the region (Vansina 1990). They grow manioc, plantains, corn, peanuts, and other minor crops, and they also sell excess produce, market goods, or specialized services (e.g., tailor, blacksmith, carpenter). Ngandu men and women are highly entrepreneurial and are increasingly integrated into regional markets, though most daily commerce is local. The Ngandu built environment is less intimate than that of the Aka and provides for more societal segmentation. Houses are larger and more permanent in construction. On average, Ngandu houses are 12.19 by 6.10 m and are separated from each other by about 12.19 m (Hewlett et al. 1998). However, there are no fences between houses and people, especially children, move freely throughout the neighborhoods and, after the age of about seven, the village. Ngandu foundational schemas include age and gender hierarchy, communalism, and status competition. Deference to elder males or those of higher status is expected, and children's adherence to these norms is enforced through harsh verbal rebukes. Corporal punishment is not uncommon. Children are expected to perform communal subsistence labor and childcare and are obliged, and highly motivated, to do as they are told in order to enhance the social success of their patrilineage in relation to their neighbors'.

In Bagandou, both the Aka and the Ngandu state that learning to read and write provides their children with valuable opportunities for socioeconomic advancement. Furthermore, they see formal schooling as the pathway to these skills. In general, however, traditional subsistence practices are regarded as more valuable to learn than skills acquired at school (Boyette and Lew-Levy n.d.).

Teaching and Foundational Schemas

As noted above, one approach to teaching has been to contrast Western teaching with learning in small-scale societies. Specifically, sociocultural anthropologists draw attention to the emphasis on hierarchy between teacher and learner in the Western formal schooling context and the lesser degree of autonomy children are given.

Although this observation generally holds, it does not adequately account for the variation between small-scale societies. For instance, different values regarding autonomy or hierarchy may determine how people behave in contexts of inequality—including the unequal access to information that is at the core of the teacher-learner relationship. Often, cultural values of hierarchy versus equality are nested in more general cultural models—ways of thinking that organize and motivate behavior (D'Andrade 1992; Shore 1996). As we have described elsewhere (Hewlett et al. 2011), egalitarianism and autonomy are such general-purpose cultural models—or foundational schemas—among the Aka and other mobile foraging groups, whereas hierarchy and obedience are found among the Ngandu and other small-scale farmers. We expect that these contrasting schemas would determine the nature of teaching in these groups.

Indeed, ethnographic work has shown that teaching traditions are not restricted to one setting (the classroom), role relationship (teacher-student), or developmental period, suggesting they are tied to foundational schemas that guide interactions between those with cultural knowledge and those without across contexts (Greenfield 2004). For example, the "transmit-and-test format" that structures learning in mainstream Euroamerican classrooms dominates middle-class American family adult-child conversations across a variety of contexts (Heath 1983; Schieffelin and Ochs 1986; Scribner and Cole 1973). Foundational schemas are formed early in life and affect thinking across the life course (Hewlett et al. 2000). For example, indigenous children tend to maintain a collaborative learning style in mainstream classrooms despite discouragement from teachers (Philips 1983; Wolcott 1997). Likewise, indigenous heritage teachers often structure learning in a style more conducive to collaborative engagement, as is characteristic of intent participation traditions (Lipka 1994; Paradise et al. 2014).

In particular, the role of direct instruction, in which the "correct" information is given to a learner, is expected to vary according to cultural emphasis on children's autonomy to learn and the authority of others to convey information to children. Experimental work with Western samples has shown a trade-off between the amount of instruction given to children in performing a task and their autonomous exploration (Bonawitz et al. 2011). Although children among both the Aka and Ngandu are given substantially more autonomy than is typical for Western children, the Aka, and forager children more generally, are never obliged to conform to the wishes of others.

Age and Receiving Teaching

The developmental trajectory of teaching as a component of "informal" education is not well understood. The intent-participation model emphasizes learner-driven learning, which naturally is integrated with a child's own cognitive and socioemotional development as they engage with and closely observe their social world (Gaskins and Paradise 2010; Rogoff et al. 2003). In intent participation, the social and physical settings support children performing culturally meaningful activities, either through imitation in play or through true participation; as they improve their aptitude through performance, the expectation is that the time they invest in observing will decrease and less input from others is required (Greenfield 2004).

The same prediction has been derived from evolutionary models of trade-offs between social learning (e.g., observation and teaching) and individual learning. According to modeling studies, because maladaptive behavior can be learned through social learning (Rogers 1988; Boyd and Richerson 1985), a strategy of social learning first followed by individual learning out-competes one involving only social learning (Borenstein et al. 2008; Aoki et al. 2012). A child implementing what she sees others do may be important in vetting maladaptive socially learned behavior (Enquist et al. 2007). Boyette (2016a) shows that Aka and Ngandu children steadily increase their participation in subsistence work across childhood; we therefore expect a negative relationship between social learning and age.

Theoretically, teaching is different from social learning via observing others for at least two reasons: it requires (1) the cognitive capacity for coordination between the teacher and learner and (2) the willingness of a teacher to change their own behavior. These attributes would make teaching more costly, and therefore more rare, than observation or individual learning (Fogarty et al. 2011). Therefore, we expect teaching to be observable (i.e., not absent, contrary to Lancy 2010; Rogoff 2011), but relatively less common than learning by observing others.

Who Teaches Children at What Ages?

There are few studies of children's teachers across childhood, but the general pattern is that parents are important early in life and others become important during middle childhood and adolescence as children's social networks widen and they become interested in learning a broader range of skills, or become better aware of variation in skill levels (Hewlett and Cavalli-Sforza 1986; Hewlett et al. 2011; Kline et al. 2013). This research also indicates teachers tend to be of the same sex as the child across childhood. A recent cross-cultural study of social learning among hunter-gatherers using the eHRAF found that teaching was described in the ethnographic record as predominately by parents and other adults, confirming the general developmental pattern (Garfield et al. 2016). The sex of teachers was not examined, although they note that many instances of social learning were sex-specific in terms of who was taught, implying a sexual division of teaching labor corresponding to that of the domains being taught.

Maynard's (2002) work also demonstrates the role older siblings can play in teaching younger children. Though siblings may be effective teachers because they are emotionally close and know each other well, Strauss et al. (2002) suggest the role is

generalizable across children independent of relatedness. Therefore, in general, we expected children to teach those less experienced than themselves, which will tend to be those who are younger than them given the relatively equal access to learning opportunities in the ethnographic contexts of this study.

These contexts are not equal in the relative status of peers versus adults as authorities over knowledge, though. Rather, we expect the Aka foundational schema of egalitarianism to attenuate the difference in frequency that adults versus other children teach Aka children relative to the Ngandu, for whom age hierarchy and adult authority are foundational schemas.

Children as Teachers

Strauss et al. (2002) claim teaching is a natural cognitive ability in humans. Based on studies in Western laboratory settings they argue that the ability of children to teach others emerges reliably in universal developmental stages correlated with development of theory of mind. When children are asked to teach another child a game, 3-year-olds will recognize when a peer does not know how to play and will demonstrate for them what to do, typically with minimal explanation. By age five, children rely predominately on explanation and are more responsive teachers in this scenario. They recognize learner progress and adjust their teaching accordingly. At age seven, children engage in "systematic contingent teaching" in which they carefully scaffold the learner's knowledge acquisition, demonstrating a complex understanding of progressive changes in their knowledge state (Strauss and Ziv 2012).

Maynard (2002) has demonstrated a relatively similar pattern in her observations of the teaching strategies of Zinacantec Mayan siblings in natural settings. In her sample of child teachers aged 3 to 11, the children did not vary in the amount of teaching they performed, but children between 8 and 11 years old gave more explanations and more verbal instruction with demonstration. It is an empirical question whether or not Aka and Ngandu children teach and what it might look like in the natural course of their daily lives; however, Maynard's study provides the best basis for general expectations: children may or may not teach more frequently as they get older, but the forms of teaching used are expected to reflect children's cognitive development if teaching is a natural cognitive ability in humans. Furthermore, we expect children to teach in culturally specific ways as they internalize the cultural norms of their communities. Thus, it is expected that Aka children will teach less frequently than Ngandu children, independent of age.

Hypotheses

In review, we test the following predictions:

1. Ngandu will receive teaching more frequently than Aka children because Aka foundational schemas emphasize respect for autonomy and egalitarianism, and teaching limits autonomous exploration (Bonawitz et al. 2011) and emphasizes hierarchy of knowledge (Lewis 2016).

2. Teaching will be less common than social learning through observation across childhood independent of ethnicity because of its relatively higher cost (Fogarty et al. 2011).
3. Teaching and observation (i.e., social learning) will be negatively correlated with children's age independent of ethnicity as they trade-off with independent learning (i.e., performance of learned behavior).
4. Younger children's teachers will tend to be parents, who are replaced by adults and peers later in childhood, as indicated by past research.
5. The relative frequency of adults versus children as teachers will be more similar among the Aka than the Ngandu as a result of the greater age-based egalitarianism.
6. Teachers will be predominately of the same sex as the focal children receiving teaching.
7. Teaching by focal children will be positively correlated with age, as their capacity for intersubjectivity develops (Strauss and Ziv 2012).
8. The focal children will tend to teach younger children, consistent with a sensitivity to the knowledge level of others (Strauss and Ziv 2012).
9. Teaching by focal children will reflect the foundational schemas of their respective cultures and follow the patterns exhibited by adults such that Aka children will teach less frequently than Ngandu children.

Methods

Data Collection and Analysis

Focal follow observations (Altmann 1974) were used to systematically record children's behavior and interactions, including receiving and providing teaching. Children from eight Aka forest-dwelling communities and three Ngandu neighborhoods were included in the sample. To recruit participants, censuses were conducted and a random sample of available children meeting the study criteria were approached for parental consent and child assent. Informed consent was obtained from all parents and assent from all children who participated in the study. When a child or parent refused participation, another child from the census was randomly chosen to replace them. Using a random assignment procedure, focal children were assigned three two-hour sampling periods between 6 AM and 6 PM across a series of days such that each was observed during one morning, one midday, and one afternoon period. If a child was not available during the assigned period, another participating child was chosen or the observation was omitted. Behavior was coded each minute using a 30-s-observe, 30-s-record procedure. If the child was not visible during the observation interval, they were coded as out of sight and the data were not used. A 15-min break was taken every 45 min of observation. The final sample characteristics are presented in Table 1.

The observed age range includes the typical ages of school attendance and encompasses the transitions around middle childhood, the developmental stage between roughly seven and twelve years of age (Bogin 1990). Children are nutritionally independent at this time, and a number of social cognitive abilities emerge (White 1996), including the ability to internalize cultural knowledge conveyed through teaching (Strauss and Ziv 2012; Tomasello et al. 1993). Also, across cultures, children seek

Table 1 Sample characteristics

Ethnicity	*N*	% Female	No. of 2-h Focal Follows	Average No. of Minutes Observed (*SD*)	Total Minutes of Observation
Aka	50	52	135	238.6 (53.5)	11,931
Ngandu	48	50	126	228.4 (59.5)	10,965
Overall	98	51	261	233.6 (56.5)	22,896

out a wider social world and become more independently involved in subsistence work during this period (Lancy and Grove 2011; Rogoff et al. 1975). Of course, if children are attending formal schools, their opportunity to observe and imitate subsistence work is necessarily reduced (Morelli et al. 2003). Additionally, they may become more used to the "assembly line" tradition of formal instruction used in schools, and this may influence how they respond to different types of teaching during daily life.

Although some formal schooling was available to both ethnic groups, neither the Aka nor the Ngandu children involved in the study attended school during fieldwork. Most Ngandu children over five years old did attend elementary school in the village when it was in session. There were one state-funded and two Catholic mission schools. The public school was the more affordable option, but the state did not pay the public schoolteachers regularly, so the school year was cut short during the previous few years before fieldwork. In addition, Ngandu families are large, and parents were strategic about which children went to school and when, such that if a child was needed for work on any one day, they would be asked to stay home. No attempt was made to estimate the relative years of school each Ngandu child had received. For the Aka, the two Catholic mission schools accepted Aka students if Ngandu patrons paid their tuition (Aka did not have regular access to cash), and anthropologists had established an additional nondenominational free public school for the Aka. A few of the Aka children who participated in this study spent one or two months at mission school, and a few others had attended the anthropologists' school for approximately the entire school year. Aka children tended not to be regular attendees, however, because they would often choose to do other activities and, as noted, it is against Aka foundational schemas to attempt to coerce children. As with the Ngandu, no attempt was made to measure history of school attendance. We acknowledge that this is a weakness of the study.

Negative binomial regression was used to model the relationship between frequency of observation and age, and frequency of teaching and age, in each case controlling for Aka versus Ngandu ethnicity. This method is preferred for count data that are overdispersed with high variance (Cohen et al. 2003). The natural log of the total minutes each child was observed was included in the models to account for variation in observation counts (Long and Freese 2006).

Behavioral Variables

Eight social learning variables were recorded for the current study. These included seven types of teaching: *Verbal Instruction*, *Nonverbal Instruction*, *Verbal-Nonverbal Combined*, *Positive Feedback*, *Negative Feedback*, *Teasing*, and *Commands*. Teaching was coded if it occurred at any point in the 30-s observation interval. *Concerted*

observation of the activities of one or more individuals was recorded as a measure of social learning that does not involve teaching. An instance of *observation* was recorded if the focal child held their gaze on the person(s) for at least half of the 30-s observation interval.

Table 2 describes each teaching type recorded. We see instruction, feedback, and teasing as relatively unambiguously meeting our definition of teaching. However, commands are more theoretically challenging because learning by following commands could be a by-product of meeting the teachers' needs. Additionally, the value of what may be learned from different commands may vary substantially depending on the task and the child who receives the command. For example, directing a 4- or 5-year-old child to dance like *dzengi* (a forest spirit often associated with elephant hunts; Hewlett 1991:30) or bring food to an aunt is different in learning value for the child than directing a 14-year-old to fetch water because they have already been doing that for years. Accepting this limitation, we chose to record all instances of commanding children because of the difficulty of disentangling whether each observation represented the former example or the latter. Commanding children to perform tasks, such as running simple errands, is ethnographically very common and is a potentially important learning opportunity that otherwise meets the functional definition of teaching. Such behavior would be teaching according to Kline's (2015) definition as well and was included as teaching by Hewlett and Roulette (2016). Moreover, in egalitarian foraging societies such as the Aka where coercing others is inappropriate but cooperation is highly valued (i.e., autonomy and sharing are foundational schemas), commands may serve an important function. As with the practice of "demand sharing" (Peterson 1993), where it is both expected and appropriate for people to demand goods from others, we see teaching via commands as a type of normative "demand cooperation." Demand sharing serves to reinforce the circulation of material resources whereas opportunities for learning may be circulated by demand cooperation.

Results

Types of Teaching and Contexts

The majority of focal children received teaching of at least one type at least once during observation. Forty-three out of 50 (86%) Aka children and 45 out of 48 (94%) Ngandu children were taught at least once. Female children received teaching more frequently than did males among the Ngandu but not among the Aka ($z = 2.10$, $p = .04$, Wilcoxon rank-sum test). Most teaching was observed in the domestic centers of daily life for both groups. For the Ngandu, 95% of teaching was done around the family concession in the village. The remaining 5% of teaching was observed in the forested areas at the periphery of the village (3%), elsewhere in the village (1.5%), or in a family garden (.5%). For the Aka, 78% of teaching was done around camp, but 13% was observed in the forest away from camp, and 17 instances (9%) were observed in an Ngandu garden during the course of two successive focal follows of two girls aged 7 and 8 years. These girls, two cousins, were from the one camp in the sample that lived close to the village during observations, and their family routinely performed garden labor for the Ngandu. Overall,

Table 2 Types of teaching observed and primary domains

Type of Teaching	Description	Major Domains	Examples (Quotes are direct from field notes)
Verbal Instruction	Verbal explanation of how a behavior is done or what something is, sometimes accompanied by nonverbal instruction	Subsistence work (Aka and Ngandu); traditional ecological knowledge (Aka); health (Aka)	"Ndami points up in a tree, refers to the bees (*banjuee*)" [indicating potential source of honey] – Aka adult male to 8-year-old male, 3/29/10, 9:11 "How to use corn husks to pick up hot pot." – Ngandu adult female to 4-year-old male, 7/13/10, 11:28 "Ok, one more splash of water in the pot, that's enough." – Ngandu adult female to 11-year-old female, 7/15/10, 17:01
Nonverbal Instruction	Nonverbal explanation of how a behavior is done (i.e. demonstration)	Subsistence work	"M shows her which cinder to bring T." – Aka adult male to 13-year-old female, 8/22/10, 17:05
Positive Feedback	Encouragement of a behavior through verbal or nonverbal expression of approval (e.g., praising tone of voice)	Subsistence work	"[Mother yells praise as] she's trying to stack a lot of wood in her small basket. She stuffed it full and now is looking for cord to tie it." Aka female adult to 8-year-old girl, 3/24/10, 9:14
Negative Feedback	Discouragement of a behavior through verbal or nonverbal expression of disapproval (e.g., shaming tone of voice)	Social norms (Aka and Ngandu); subsistence work (Ngandu); game play (Ngandu)	"[Negative feedback] for taking some manioc he wasn't supposed to" – Aka female adult to 7-year-old male, 5/10/10, 16:39 "[Negative feedback] about a wrong game move" – Ngandu male child to 7-year-old girl, 6/15/10, 10:28 "Mom said: 'You don't know how to work, you're the sister of the chimpanzee!'" – Ngandu female adult to 7-year-old girl, 7/11/10, 14:11
Teasing	Verbal play intended to draw attention to and/or shame learner for improper behavior.	Social norms	"Esakala still makes fun of what she said…" –Aka female child to 8-year-old female who had mispronounced or misspoken another child's nickname, 3/27/10, 12:33

Table 2 (continued)

Type of Teaching	Description	Major Domains	Examples (Quotes are direct from field notes)
			"Kata dwa na kumba!" – Aka male child to 13-year-old female, drawing attention to her running away (*dwa na kumba*) without waiting for me, 7/30/10, 17:02
Commands	Use of directive language to encourage a specific behavior to be performed.	Task assignment; sharing (Aka); subsistence work; to come join social activity (Aka); game play (Aka and Ngandu)	"Bring me fire" – Aka adult male to 5-year-old female, 8/15/10, 8:07
			"[Commanded] to give banana to 2, after which B gave her another" – Aka adult female to 5-year-old female, 4/21/10, 16:30
			"Clothes to carry back to house: 'Carry them with care, okay?'" – Ngandu adult male to 5-year-old male, 6/26/10, 16:17
			"Help me with these vegetables" – Ngandu adult female to 7-year-old female, 6/18/10, 16:36

children were taught across contexts in frequencies proportional to where they spent their time, such that teaching was not overrepresented in any particular context.

Table 3 shows the frequencies of each type observed by ethnic group. Commanding using the imperative mode was by far the most common type of teaching observed and usually involved assigning the child a small task, often fetching something for the "teacher." Among the Aka, discernably more commands involved food sharing (e.g., "Give this manioc to so-and-so," "Go retrieve our family's portion") or calls of "Come" or "Let's go," indicating that the teacher (usually a child) wants the focal child to join in an activity.

The only significant difference between ethnic groups was in the frequency focal children received instruction. Although relatively rare, on average, Ngandu children received three times as much instruction as Aka children ($z = -3.16$, $p = .002$, Wilcoxon rank-sum test), in support of our first hypothesis. The domain of household or subsistence work was a common subject of instruction among the Ngandu. In one instance, an 11-year-old girl was observed being told how much water to put in a stew pot. In another, a 4-year-old boy was told how to use cornhusks to pick up a hot pot. In contrast, instruction among the Aka often pertained to ecological knowledge. An 8-year-old boy's adult male companion pointed out the location of bees along a trail, for

Table 3 Frequencies of teaching received by focal children

	Mean	*SD*	Max	Total	Wilcoxon Rank Sum Test
All Teaching					$z = -.37$
Aka	3.9	3.4	20	194	
Ngandu	4.0	3.0	14	193	
Verbal Instruction					$z = -3.16$***
Aka	.3	.8	4	17	
Ngandu	.9	1.1	4	41	
Nonverbal Instruction					$z = -.02$
Aka	.02	.1	1	1	
Ngandu	.02	.1	1	1	
Positive Feedback					$z = .98$
Aka	.04	.3	2	2	
Ngandu	0	0	0	0	
Negative Feedback					$z = -.41$
Aka	.5	1.0	4	25	
Ngandu	.4	.6	2	18	
Teasing					$z = 1.3$
Aka	.1	.5	3	7	
Ngandu	.04	.3	2	2	
Commands					$z = .83$
Aka	3.3	3.0	17	163	
Ngandu	2.8	2.3	9	131	

***$p = .002$

example; in another instance, a 13-year-old girl received the instruction from her peer that it was time to finish their foraging because it was going to rain. Although this latter instance contained an imperative (i.e., a command), it was coded as instruction because of the additional informational content (i.e., the rain was her rationale for saying they should leave). In that instance, the girls were digging for wild yams, and it can be difficult to know how much more time to commit to digging or searching since the payoff for each dig is highly variable. Therefore, the instruction indicated the more experienced girl's judgment that they would not find more yams before the rain came.

Positive feedback was only observed twice and only among the Aka. Negative feedback and teasing were about as frequently observed as verbal and nonverbal instruction (12% vs. 14% of all teaching) and tended to be directed at discouraging improper social behavior, such as failing to share food, being aggressive, or disrupting the flow of work. The majority of Aka negative feedback consisted of a terse interjection—sometimes the offender's name or simply, "Oh"—typically voiced with a sing-song pitch drop or a pitch drop and rise. On a few occasions a child received a mild tap from an adult. Among the Ngandu, tapping was not uncommon between children, and verbal negative feedback was occasionally harsh, such as when a mother angrily told her 7-year-old daughter, "You don't know how to work, you're the sister of the chimpanzee!" Teasing, a more complex type of negative feedback, constituted a much smaller proportion of the teaching observed. Teasing was typically in response to selfishness, fearfulness, or failures of physical or social skill. For instance, Boyette was with three siblings around the ages of 16, 13, and 10 returning home from a net hunt on a muddy trail. The 10-year-old slipped and almost fell. Subsequently, his brother and sister joked about the misstep continuously throughout the rest of our 30-min walk home. The younger brother only smiled and laughed at himself during this episode, but the example illustrates the way teasing may facilitate recognition of mistakes and challenge learners to change their behavior.

Children's Age and Teaching

In support of our second hypothesis, teaching was less frequent than social learning via observation throughout childhood. On average, children spent approximately 4% of their time in concerted observation of others (SD = 3.5%), whereas they were taught during approximately 2% of observations (SD = 1.5%). There was a clear developmental trajectory of both social learning behaviors. Negative binomial regression models indicate that both variables are negatively correlated with age independent of ethnicity, in support of our third hypothesis (Table 4). According to these data, with each year of age Aka and Ngandu children receive about 8% less teaching (b = −.08, β = .92, p < .001) and observe others' behavior about 8% less frequently (b = −.08, β = .92, p < .001). Figure 2 displays these results graphically. Additionally, the significant negative effect of Ngandu ethnicity on observation (b = −.42, β = .66, p = .007) indicates Ngandu children observe others about 34% less often than Aka children. A quadratic relationship between social learning and age as well as interaction effects between age, age-squared, and ethnicity on social learning were explored, and no meaningful relationships were found. A significant interaction effect exists between age-squared and ethnicity on observation, but there are no significant main-effects in the model. The result was deemed uninterpretable.

Table 4 Negative binomial regression model results of age and ethnicity on frequency of observing others (Model 1) and being taught (Model 2)

	Variable	*B*	*SE B*	β	*z*	*p*	95% CI of *B*
Model 1[a]	Age	−.08	.02	.92	−3.61	<.001	[−.12, −.04]
	Ethnicity	−.42	.16	.66	−2.69	.007	[−.73, −.11]
Model 2[b]	Age	−.08	.02	.92	−4.11	<.001	[−.12, −.04]
	Ethnicity	.04	.14	1.05	.31	.755	[−.23, .33]

$N = 98$. For Ethnicity, Aka = 0, Ngandu = 1. Age units are years. The *ln* of the total minutes of observation per child is included in each model and held at zero.

[a] Model LR $r^2 = 17.31$, $p < .001$

[b] Model LR $r^2 = 16.74$, $p < .001$

Identity of Teachers across Childhood

Focal children's ages were estimated as precisely as possible, but exact ages of all children were not precisely known and age categories are more likely to correspond to level of cultural knowledge than exact age in years. Therefore, both focal children and child teachers were coded as either being in early childhood (~4–6 years), middle childhood (~7–12), or adolescence (~13–16). Figure 3 shows the distribution of teaching by parents, other adults, and children across these three stages of childhood represented in the sample. In both the Aka and Ngandu, parents continuously represented between roughly 25% and 50% of teaching across childhood, contrary to Hypothesis 4. Among the Aka, the proportion of teaching given by parents was highest in adolescence, whereas it was highest during middle childhood among the Ngandu.

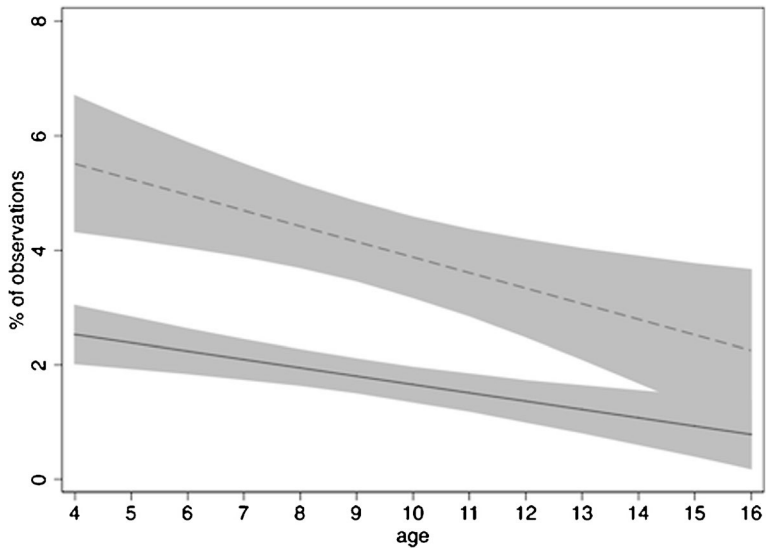

Fig. 2 Linear-fit lines of the frequency focal children were taught (*solid line*) in comparison to observing others (*dashed line*) shown as percentages of all observations. Shaded regions are 95% confidence intervals. Both types of social learning have a significant, negative relationship with learner age independent of ethnicity

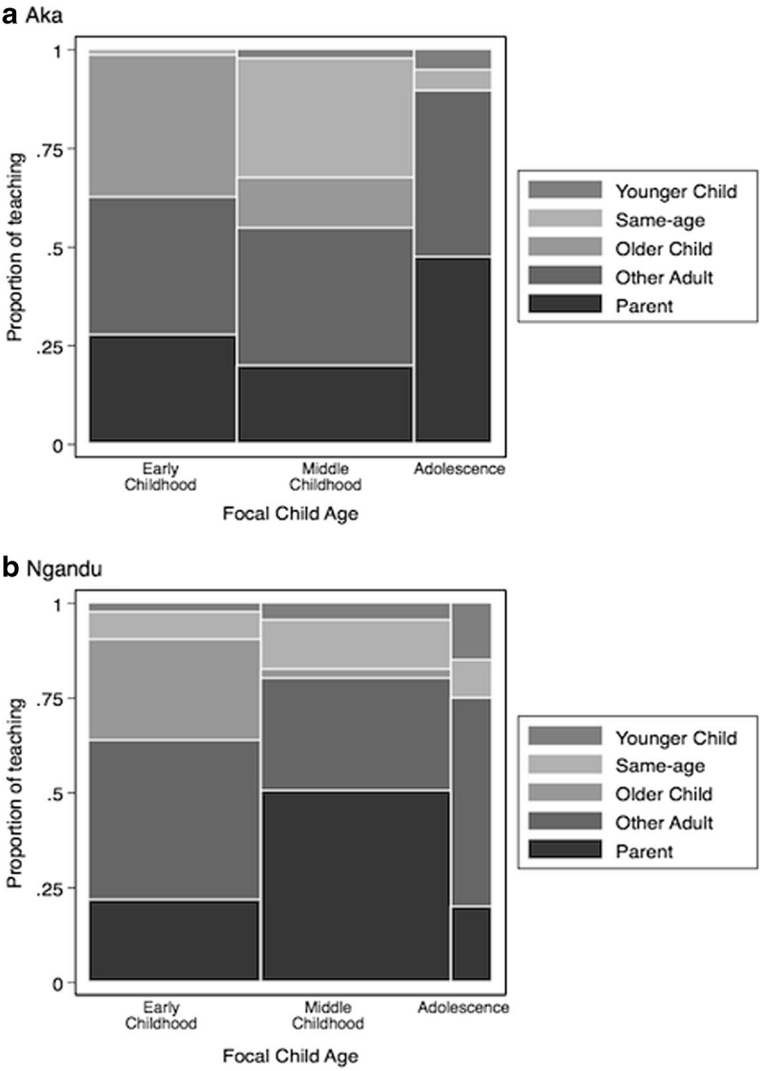

Fig. 3 Mosaic plots representing the proportion of teaching giving to (**a**) Aka and (**b**) Ngandu focal children by different children and adults across childhood

In both groups, the majority of child teachers were in an older age category than the focal child receiving teaching. Among child teachers, 85% were older, 13% were the same age, and 3% were younger than the focal child. As seen in Fig. 3, the greatest proportion of teaching given by other children was highest in middle childhood among the Aka and during early childhood among the Ngandu. Same-aged peers represented a particularly high proportion (about 25%) of teaching among the Aka during middle childhood.

Although a linear developmental shift in teaching from parents to others was not evident in either group, Aka and Ngandu children differed in the proportions of teaching received from adults versus children overall. Results of a comparison of teaching by all adults versus all children are shown in Fig. 4.

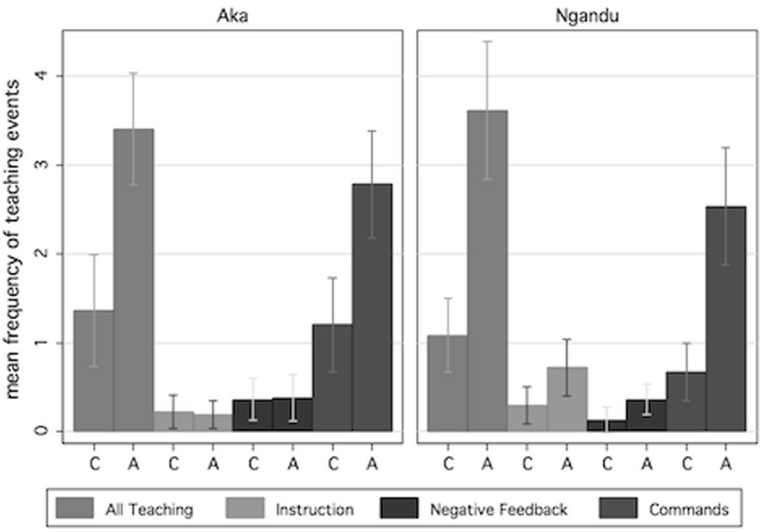

Fig. 4 Means and standard deviations of frequencies that Aka and Ngandu children (C) and adults (A) taught focal children

For this analysis, verbal and nonverbal instructions were combined into a single variable, "instruction," as were negative feedback and teasing, into "negative feedback." In both groups, children were given commands by adults significantly more frequently than by other children (Aka: $z = -4.17$, $p < .001$; Ngandu: $z = -5.33$, $p < .001$; Wilcoxon rank-sum test). However, the same pattern was present for instruction and negative feedback only for the Ngandu (negative feedback: $z = -2.84$, $p = .005$; instruction: $z = -2.77$, $p = .006$). In other words, other Aka children gave the focal children instruction and negative feedback no less frequently than did adults, in partial support of Hypothesis 5.

Although teasing was combined with negative feedback in this analysis, it is worth noting that teasing was done almost exclusively by children in both groups (2 of 2 instances among the Ngandu and 6 of 7 among the Aka). However, the rarity of this type of teaching does not permit greater statistical inference regarding its association with adults or children across the groups.

Table 5 shows the sex of adult and child teachers by the sex and ethnicity of the focal children. Adult women performed more than half of all teaching in both groups, and four to five times as much as adult men. Female and male children taught at roughly equal frequencies in both groups. Despite the relatively greater proportion of teaching received from adult women, teacher sex was associated with the sex of the focal child for the Aka ($\chi^2 = 10.04$, $p = .002$) and the Ngandu ($\chi^2 = 30.09$, $p < .001$), in support of Hypothesis 6.

The kinship relations between focal children and teachers were also examined. Table 6 summarizes the results of the analysis. Mothers were by far the most significant individual contributor of teaching to focal children, providing about one-quarter of all teaching. However, outside of the immediate family, close kin ($.0625 < r < .5$) provide approximately an equal proportion of teaching as mothers, and distant or non-kin ($r \leq .0625$) more than both categories of individuals—about one-third. Fathers and full siblings provided relatively negligible teaching.

Table 5 Age and sex of individuals who taught focal children

Teacher		% of Teaching received			
		Aka		Ngandu	
		Female	Male	Female	Male
Adult	Female	55	44	62	32
	Male	10	21	14	36
Child	Female	21	10	17	8
	Male	14	25	7	24
		100	100	100	100

Teaching by Children

Most focal children in both groups were observed to teach others in addition to having received teaching. Sixty-four percent of Aka and 66% of Ngandu focal children taught others at least once. Table 7 displays the frequencies of teaching by focal children by teaching form. Similar to frequency of teaching received, giving commands was the most common form of teaching, followed by negative feedback, instruction, and, lastly, positive feedback. In contrast to the pattern seen for teaching received, there were no significant differences between the two ethnicities in frequency of any teaching process.

It is noteworthy that the one instance of positive feedback was given by an 11-year-old Aka boy who was the most active teacher in the sample, having performed a teaching behavior 17 times. The particular instance was in the context of an all-child group gathering *Gnetum africanum* leaves from some young trees on the periphery of camp. He praised two other children for their work climbing the trees, tying up bunches of the edible leaves, and dropping them to the ground. He was observed to teach the other children five times in this one activity, and he is one of five Aka children who directed their teaching at two others simultaneously, and the only one to have directed teaching at three other children (one instance of instruction and two commands). Of those who taught more than one other at a time, he is the only Aka child to have done

Table 6 Relatedness of teachers to focal children

Teacher	% of Teaching	
	Aka	Ngandu
Mother	24	29
Father	6	11
Sibling	14	11
Close Kin	28	24
Distant or non-kin	28	25
	100	100

Table 7 Frequencies of teaching by focal children

	Mean	*SD*	Max	Total	Wilcoxon Rank Sum Test
All Teaching					$z = .29$
Aka	2.1	2.9	17	106	
Ngandu	1.4	1.5	7	69	
Instruction					$z = -.32$
Aka	.4	1.0	6	19	
Ngandu	.3	.5	2	13	
Positive Feedback					$z = .98$
Aka	.02	.1	1	1	
Ngandu	0	0	0	0	
Negative Feedback					$z = -.72$
Aka	.5	1.0	4	25	
Ngandu	.5	.7	3	23	
Commands					$z = -.01$
Aka	1.2	2.1	9	61	
Ngandu	.7	1.0	4	33	

so more than once, and did eight times in total. Three Ngandu children also directed teaching at two others (three instances of negative feedback and two of instruction between the three children).

Although this Aka boy was by far the most active teacher in the sample, an analysis of teaching by focal children's age suggests middle childhood in general is a peak time for teaching by the Aka children but not for the Ngandu. Table 8 shows the results of negative binomial regression modeling of age, age-squared, and ethnicity on age. The positive main effect of age suggests an overall increase with age throughout the ages observed. However, a significant interaction effect between age-squared and ethnicity suggests that this relationship is a concave quadratic one for the Aka, and that the difference between the Aka and Ngandu children's frequency of teaching is significant

Table 8 Negative binomial regression model results of age (centered), ethnicity, and age-squared on frequency that focal children taught others

Variable	*B*	*SE B*	β	*z*	*p*	95% CI of *B*
Age	.17	.04	1.18	4.75	<.001	[.10, .24]
Ethnicity	−.79	.36	.37	−2.21	.027	[−1.48, −.09]
Age^2	−.03	.01	.96	−2.41	.016	[−.05, −.01]
Ethnicity * Age^2	.04	.02	1.05	2.09	.037	[.002, .08]

$N = 98$. For Ethnicity, Aka = 0, Ngandu = 1. Age was centered by subtracting the mean before calculated Age^2 and running the model. The *ln* of the total minutes of observation per child is included in model and held at zero.

[a] Model LR $r^2 = 25.06$, $p < .001$

at this age only. Figure 5 displays this graphically. As can be seen, when teaching is divided into its component processes, among the Aka, only giving commands increases steadily with age, whereas both instruction and negative feedback peak in middle childhood. For the Ngandu, each curve shows a steady increase with age. Note that this result holds true when the most active Aka teacher is omitted from the model as well.

As for whom the focal children taught, the pattern was consistent with a perspective that children scaffold knowledge and also that teaching is sex-biased. Roughly two-thirds (59% for Aka, 64% for Ngandu) of all instances of teaching were directed at children younger than the focal child. Similarly, two-thirds of the teaching was directed towards others of the same sex (Table 9).

Discussion

In this study, we have answered the call for integration across major approaches to the study of teaching. Using a definition of teaching from evolutionary biology, we have demonstrated that patterns of teaching received and given by Aka and Ngandu children correspond in large part to cultural differences in values concerning hierarchy and autonomy in children's social learning in ways described by cultural anthropologists to distinguish teaching in large-scale Western societies from teaching in non-Western, small-scale societies. Additionally, by examining teaching in children from early through late childhood, we have observed in two naturalistic contexts developmental patterns corresponding to previous evolutionary and ethnographic accounts of human social learning, and a unique interaction between culture and development in teaching

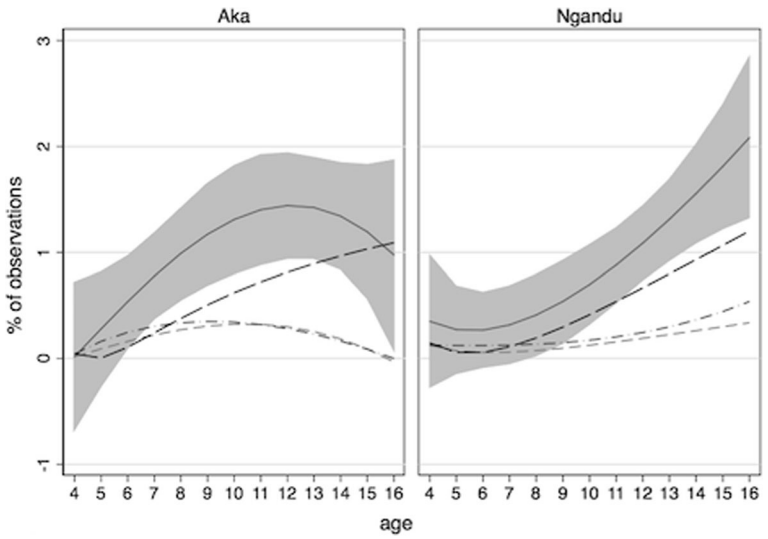

Fig. 5 Fractional polynomial fit curves of the frequency of all teaching by focal children (*solid line* with shaded 95% confidence intervals), instruction only (*light gray dashed line*), negative feedback only (*dark gray dash-dot*), and commands only (*black dashed line*) by ethnicity shown as percentages of all observations. The Aka show a distinct teaching peak in middle childhood, largely attributable to peaks in giving instruction and negative feedback

Table 9 Relative age and sex of children receiving teaching from focal children

Pupil	% of Teaching	
	Aka	Ngandu
Younger	59	64
Same Age	33	30
Older	7	6
	100	100
Same Sex	61	67
Other Sex	39	33
	100	100

by forager children. Overall, the account of Aka forager and Ngandu farmer children's teaching presented here supports the claim that teaching is a natural cognitive ability in humans, but one deeply integrated with the cultural norms it likely evolved to transmit.

Teaching and Cultural Learning

We hypothesized (Hypothesis 1) that teaching would be more frequent among the Ngandu. Because teaching limits the scope for autonomous exploration, we predicted it would be relatively deemphasized among the Aka, for whom respecting autonomy and egalitarianism are foundational schemas. We found partial support for this hypothesis. The frequency of verbal instruction received by Ngandu children was significantly greater than that received by the Aka children. Instruction, the type of teaching most typical of Western social learning, limits the opportunity for autonomous exploration (Bonawitz et al. 2011) and makes a claim of authority over the correct way something should be done, or the reason why (Lewis 2009). As Lewis (2016) argues, for foragers, knowledge can be distributed widely and integrated in other cultural ideas that provide alternative routes to deeper understandings of opaque cultural knowledge without any specific individual claiming authority over that knowledge. In contrast, teasing and negative feedback more generally do not provide the learner with an alternative course of action; they only draw attention to incorrect behavior. In other forager cultures, teasing even seems to be intentionally ambiguous in order to promote *individual* learning through reflection (e.g., Omura 2016).

The Ngandu may be more likely to use instruction because of their relatively greater exposure to Western education. That we did not explicitly control for exposure to formal schooling is a weakness of this study. However, the general cultural emphasis on hierarchy among the Ngandu existed prior to any exposure to Western schools (Vansina 1990), and instruction was still very rare among the Ngandu, consistent with other ethnographic accounts of small-scale, intent-participation farming cultures.

The influence of Aka egalitarian foundational schema is also apparent in who provided instruction and negative feedback in that there was no significant difference in the frequency Aka children and adults used instruction or negative feedback to teach the focal children. This result partially supports Hypothesis 5. However, the pattern found for teaching by commands requires greater explanation. Contrary to Hypothesis 5, the Aka were like the Ngandu in that adults issued commands more often than

children. For the Ngandu, this pattern is consistent with that of the other teaching types and reflects a normative hierarchy by age consistent with Ngandu foundational schemas. In contrast, the greater use of commands by Aka adults seems contrary to the foundational schema of egalitarianism. Similarly, focal Aka children also *gave* commands more often with age whereas negative feedback and instruction were both less frequent among the oldest children.

While surprising, we do not believe these results are inconsistent with Aka foundational schemas. Rather, they illustrate the constant tension between autonomy and egalitarianism that is at the heart of social life among the Aka and other foragers. For example, Woodburn (1982) points out that egalitarian social relations among the Hadza are maintained by constant assertions of autonomy. Other authors describe the persistent demands to share typical of forager social relations, and the concomitant acceptance—to a point—of attempts to refuse (Bird-David 1990; Lee 2013; Peterson 1993; Omura 2016). Endicott (2011) refers to this behavior pattern as "cooperative autonomy." For the Batek, cooperative autonomy "was based on a combination of obligations to the group and protections for individuals against coercion by others" (Endicott 2011:81). Commands as a form of teaching among foragers must be seen from within this context. Adults or older children may alter their behavior in order to offer a learning opportunity to someone less experienced by asking them to do an errand or participate in an activity, as observed during this study. However, whether or not to cooperate is at the discretion of the learner, and there are no consequences for refusal. Future work will measure the frequency of compliance to commands, but our impression is that cooperation is more common than refusal. The evolutionary implications of teaching by commands are discussed further below, but we believe this form of teaching is central to scaffolding cooperation in daily life and, more than other types of teaching, maintains the egalitarian distribution of knowledge common to foragers.

One set of results reported here is notably inconsistent with past research on cultural transmission among the Aka (Hewlett and Cavalli-Sforza 1986). Here, we found that adults consistently represented only between 25% and 50% of children's teachers during daily social learning (Fig. 3a); most teaching by adults was by females (Table 5); and, although mothers performed four times as much teaching as fathers (24% vs. 6%), most teaching was done by other close kin or unrelated individuals. These findings contrast with those of Hewlett and Cavalli-Sforza (1986), who surveyed Aka adults and found that 81% of 50 cultural traits were learned from parents and most often from the same-sex parent. We attribute the contrast in results to several factors. Hewlett and Cavalli-Sforza (1986) used an interview methodology so their informants may have been remembering the first or most salient instance of learning, which may have occurred earlier in childhood than represented by the ages studied here. As infants and toddlers, Aka children spend more time close to their mothers and fathers than later in childhood, and more often travel with them when they work in the forest (Hewlett et al. 2011). During this time children have ample opportunities to observe their parents perform most of the skills surveyed by Hewlett and Cavalli-Sforza. It is also possible that people simply remembered incorrectly and attributed their learning to their parents because they are emotionally close to them and probably did learn many things from them. Aunger (2002) found evidence for such overattribution. Working in the eastern Congo Basin, he found that people tended to report learning about food avoidances

from their parents, but the actual pattern of shared avoidances showed a greater influence of non-parents than was reported.

Another possible explanation for the contrasting views of parents' contributions to learning presented by Hewlett and Cavalli-Sforza (1986) and the current study is that learning for most cultural knowledge and skills is cumulative. Children may receive teaching across multiple learning occasions, and it may be difficult to identify who, in such cases, is the ultimate "teacher" (Lancy 2012a). When the first author asked Aka children who taught them how to share, most said their parents at first but readily mentioned other individuals who contributed to their learning when probed further (Boyette 2013, n.d.). In the current study, the focal follow methodology demonstrates that teaching, while rare, is situated in the rich social lives of Aka and Ngandu children and involves a variety of people—whether they are introducing information or reinforcing it. Similarly, Chabu forager adolescents reported to Dira and Hewlett (2016) that they first learned about spear hunting from hearing their fathers tell stories. However, Dira's focal follows with these same adolescent males showed that many men were involved in teaching during the course of actual hunts.

This is the first study of teaching *by* forager children of which we are aware, and several findings stand out. First, contrary to Hypothesis 9, there were no differences between the Aka and Ngandu children in frequencies of teaching that they gave to others. This was surprising but may be explainable in relation to the distinctive developmental trajectories of teaching for the two sets of children growing up in contrasting culturally constructed niches. For the Ngandu, instruction, commands, and negative feedback all followed the same trajectory, gradually increasing to a peak in adolescence, in partial support of Hypothesis 7. For the Aka, however, teaching was most frequent during middle childhood. When the frequency of each major teaching type across the ages represented in the sample is examined (Fig. 4), it can be seen that instruction and negative feedback were observed less frequently during adolescence among the Aka, whereas commands continued to increase in frequency, as noted above. In a general sense, both patterns replicate the results reported by Maynard (2002), who observed children up to 11 years of age: increases in commands, explanation (i.e., instruction), and feedback with age at least through middle childhood. Middle childhood is associated with the development of "recursive intersubjectivity"—a level of reflecting on others' minds that theoretically makes human cultural learning possible (Tomasello et al. 1993). Thus more teaching by children of this age fits the model of teaching being a reliably developing cognitive ability in humans (Strauss and Ziv 2012). However, why Aka adolescents performed less teaching (except via commands) suggests a more complex picture, one plausibly related to the nature of situated learning in these two contexts.

For the Aka and Ngandu, teaching and learning are embedded in everyday experience. As described in Boyette (2016a), for both groups, participation in the subsistence economy increases steadily with age, while time spent in play decreases. However, the organization of Ngandu children's work and play is strictly hierarchical. Ngandu children gain more status with age and thereby more control over—and responsibility to transmit—cultural knowledge and practice. These results are consistent with that pattern. For the Aka, because adults do not enforce participation in work, children become involved when they feel prepared, and in the meantime they explore their natural ecology and practice subsistence skills in social play (Boyette 2016a). Play

provides opportunities for collaborative learning (e.g., of subsistence practices; Boyette 2016b) during middle childhood that are traded for legitimate participation in work during adolescence.

For example, on one occasion, the first author accompanied a group of women, adolescent girls, and younger children on a bail-fishing trip. While the women and adolescents dug the streambed and grabbed fish, one child, an 11-year-old boy (the most active teacher in the sample, noted above) picked up a caught fish. As his younger siblings and cousins watched, he opened the fish and exposed its eggs, exclaiming to the other children that it was a female (an instance coded as "Instruction"). Three minutes later, he found a water snail and showed it to his toddler cousin, repeating its name. He then demonstrated how to crack it open (i.e., "Instruction").

The evidence here suggests that teaching those who are less experienced, suggesting acknowledgment of gaps in others' knowledge, is a universal aspect of human teaching. Aka and Ngandu children tended to direct their teaching toward younger children, in support of Hypothesis 8. However, we did not see the emergence of more elaborate forms of teaching as observed by Strauss et al. (2002). Nor did we see the "talk with demonstration" as often as Maynard (2002) did among the older Mayan children. A similar category of behavior, "verbal with nonverbal instruction" was coded but lumped with "Instruction" because of its rarity (~1% of all teaching) and theoretical similarity. This variation is likely due to both the social learning contexts in which teaching was observed in each study and the contrasting cultural models of knowledge transmission. First, the game that Strauss and colleagues utilized in their teaching procedure—an unfamiliar game—would be highly unusual in the contexts of Aka and Ngandu childhood. The Ngandu do play a variety of ruled games, but novel ones—where children do not have the opportunity to learn by observation for some time before playing—are rarer than they are in Western settings and were not encountered during this study. Additionally, teaching was observed during play among both the Aka and Ngandu, but theoretical explanations of the type described by Strauss and colleagues are not culturally normative in either culture. Maynard observed indigenous Mayan children who participated in backstrap-loom weaving. Although formal instruction is not as common in the traditional Mayan context as in Western cultures, this culturally valued craft industry is more cognitively demanding and occupied more of the children's time than anything observed among the Aka or Ngandu during the course of fieldwork for this study.

That being said, it is possible that different forms of teaching might have been observed during the course of other activities not witnessed during the study period. For example, cracking of a variety of forest nuts is a laborious and highly skilled activity that could result in injury if not done correctly. Nut trees vary greatly in their distribution throughout the forest and were not a major resource for the Aka during the time of this study. However, in subsequent fieldwork, Boyette observed very careful demonstration and explanation given by women to preadolescent and adolescent girls of how to crack open *Irvingia gabonensis* nuts (Boesch et al. 2017).

Evolutionary Implications

Theoretically, teaching is more costly than observing others because it requires the participation of a teacher and coordination between the teacher and learner, and the

cognitive prerequisites for this coordination (Fogarty et al. 2011). Additionally, in order to vet maladaptive learned behaviors, social learning is argued to trade off with individual learning over the life course (Aoki et al. 2012; Borenstein et al. 2008). We tested these two hypothesis and found support for both. Children were observed in concerted observation of others more frequently than they were taught; however, both forms of social learning decreased with age. The picture of teaching that emerges is consistent with the expectations of an evolutionary perspective and with the ethnographic record: teaching is relatively rare in small-scale societies with intent-participation traditions favoring children's access to adult economic, social, and ritual life. However, teaching supplements observational learning as children build skills and knowledge, which they later refine through legitimate participation.

Mothers were important teachers, partly in line with our expectation of teaching being largely done by kin and especially parents. However, fathers were rarely teachers, and adult women, independent of kinship, performed half of the teaching received by focal children. This suggests an important role for women in cultural transmission during the age range examined here. Men may play more of a role, particularly with sons, later in a child's life—for example, in learning to hunt (Dira and Hewlett 2016). At the same time, most teaching both received (Table 5) and given (Table 9) by focal children was directed to others of the same sex, consistent with past research (Hewlett and Cavalli-Sforza 1986). Girls also received more teaching, which might explain the prominence of adult women teachers.

The categories of teaching observed here were consistent with many of those in other studies (Hewlett and Roulette 2016; Kline 2015; Maynard 2002) and can shed light on the evolutionary history of teaching as a mechanism of human cultural transmission and a component of human evolution. For one, feedback is likely an early form of teaching because it does not require complex language, nor does it necessarily require advanced theory of mind (Castro and Toro 2004). Although others (Gergely and Csibra 2006) have suggested teaching evolved for the transmission of tool use or other subsistence skills, in this study, negative feedback was used primarily in response to improper social behavior (Table 2), especially sharing or non-aggression among the Aka, suggesting early teaching was related to the transmission of social norms rather than tool use (see also Hewlett and Roulette 2016).

Instruction, on the other hand, is a relatively more costly form of teaching and tended to be directed toward subsistence work or traditional ecological knowledge (at least among the Aka). This suggests that instruction specifically, rather than teaching more generally, perhaps evolved to improve transmission of the difficult skills associated with extractive foraging.

Lastly, commands were the most common form of teaching observed in this study. Commands most often took the form of a task assignment, such as "bring me that" or "take this to so-and-so." However, Aka children also often commanded others to join them in a shared activity—to initiate or maintain a relation (Bird-David 1999; Naveh 2016). Commands are unique as a form of teaching in that they require as prerequisites both complex language and prosociality (at least on the part of the learner). By issuing a command, the teacher is modifying their behavior to provide a potential learning opportunity to a learner who then can choose to cooperate by modifying their behavior in response. The frequency that commands were issued to focal children and the

fact the developmental trajectory of focal children giving commands to others is different than giving negative feedback or instruction among the Aka (Table 8 and Fig. 5) suggest it plays a particular role in social life and in cultural transmission in human groups. As noted above, among foragers such as the Aka, no one is ever obliged to cooperate. For example, Boyette observed an instance where a 16-year-old Aka boy commanded every younger child in camp to get him water before finally having to get it himself. While fetching water for someone may not be a compelling learning experience, acting as food couriers certainly is, and was one common domain in which commands were used—thereby integrating demand sharing with commands as "demand cooperation." Together, teaching via negative feedback, first, and commands, second, may have contributed to the evolution of human cooperation and egalitarianism in ways similar to—and perhaps concurrent with—demand sharing (Lewis et al. 2014).

This is the first systematic comparative study of teaching in the lives of "school age" forager children, and we believe it is appropriate to discuss potential evolutionary implications. However, we do not claim that the Aka and Ngandu represent all traditional societies, nor are the Aka, in particular, representative of all contemporary or past mobile foraging societies. The patterns described in this paper may be different in foraging groups of other social and natural ecologies with different subsistence patterns and types of social organization. However, the ethnographic contexts of Aka childhood are remarkably similar to those described for other mobile foragers, especially tropical forest foragers (Bird-David 2005; Endicott and Endicott 2014; Morelli et al. 2014). Furthermore, ethnographers consistently emphasize the values of respect for autonomy, sharing, and egalitarianism—what we describe as foundational schemas—as central to forager social life, independent of natural ecology (Woodburn 1998; Guemple 1988; Naveh 2016; Omura 2016; Bird-David 1990; Endicott 2011). Therefore, we believe it is justified to argue many of the patterns we observed here would characterize teaching in other forager contexts. Future research is needed to test this assertion.

Conclusion

In this paper we have furthered the discussion of teaching within the evolutionary and comparative social sciences by examining the case of teaching among foragers and farmers in naturalistic settings across a critical developmental period—from the time postweaning through the development of advanced social cognition, into the earliest stages of adolescence. These are the early "school years" in the West, and most previous research on teaching in small-scale societies has focused on these ages. We have validated their general findings: teaching is rare in comparison to observational learning. However, we have showed that teaching occurs and that we cannot simply contrast "the West" with "the rest" without considering the nuanced implications of culture. Forager foundational schema of autonomy and egalitarianism visibly shape the nature of teaching in the lives of "school-age" foragers. Ngandu farmers share with the West a relatively greater use of top-down verbal instruction, although to a much reduced degree. However, we have argued that where the Aka and the Ngandu are similar is telling: negative

feedback and demand cooperation may be key early forms of teaching that shaped learning in ancestral human groups.

Acknowledgements Funding for this research was provided by the National Science Foundation under grant DGE-0549425 and the Wenner-Gren Foundation under Dissertation Fieldwork Grant GR 8021. Boyette gratefully acknowledges the assistance of Mboulou Aubin and Mboula Edward during fieldwork, and the Aka and Ngandu families who taught us so much.

References

Altmann, J. (1974). Observational study of behavior: sampling methods. *Behaviour, 49*(3/4), 227–267.

Aoki, K., Wakano, J. Y., & Lehmann, L. (2012). Evolutionary stable learning schedules and cumulative culture in discrete generation models. *Theoretical Population Biology, 81*, 300–309.

Aunger, R. (2002). Exposure versus susceptibility in the epidemiology of "everyday" beliefs. *Journal of Cognition and Culture, 2*(2), 113–154.

Bahuchet, S., & Guillaume, H. (1982). Aka-farmer relations in the northwest Congo Basin. (S. M. Van Wyck, trans.). In E. B. Leacock & R. B. Lee (Eds.), *Politics and history in band societies* (pp. 189–212). Cambridge: Cambridge University Press.

Bird-David, N. (1990). The giving environment: another perspective on the economic system of gatherer-hunters. *Current Anthropology, 31*(2), 189–196.

Bird-David, N. (1999). "Animism" revisited: personhood, environment, and relational epistemology. *Current Anthropology, 40*(s1), s67–s91.

Bird-David, N. (2005). Studying children in "hunter-gatherer" societies: reflections and a Nayaka perspective. In B. S. Hewlett & M. E. Lamb (Eds.), *Hunter-gatherer childhoods: evolutionary, developmental, and cultural perspectives* (pp. 92–104). New Brunswick: Aldine Transaction.

Boesch, C., Bombjaková, D., Boyette, A., & Meier, A. (2017). Technical intelligence and culture: nut cracking in humans and chimpanzees. *American Journal of Physical Anthropology.* doi:10.1002/ajpa.23211.

Bogin, B. (1990). The evolution of human childhood. *Bioscience, 40*(1), 16–25.

Bonawitz, E., Shafto, P., Gweon, H., Goodman, N. D., Spelke, E., & Schulz, L. (2011). The double-edged sword of pedagogy: instruction limits spontaneous exploration and discovery. *Cognition, 120*(3), 322–330.

Borenstein, E., Feldman, M. W., & Aoki, K. (2008). Evolution of learning in fluctuating environments: when selection favors both social and exploratory individual learning. *Evolution, 62*(3), 586–602.

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

Boyette, A. H. (2013). *Social learning during middle childhood among Aka forest foragers and Ngandu farmers of the Central African Republic*. PhD dissertation, Washington State University, Pullman.

Boyette, A. H. (2016a). Children's play and culture learning in an egalitarian foraging society. *Child Development, 87*(3), 759–769.

Boyette, A. H. (2016b). Children's play and the integration of social and individual learning: a cultural niche construction perspective. In B. S. Hewlett & H. Terashima (Eds.), *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 159–169). Tokyo: Springer Japan.

Boyette, A.H. (n.d.). Autonomy and the socialization of cooperation in foragers: Aka children's views of sharing and caring. *Hunter Gatherer Research,* in prep.

Boyette, A. H., & Lew-Levy, S. R. (n.d.). Variation in cultural models of resource sharing between Congo Basin foragers and farmers: implications for learning to share. In D. Friesem & N. Lavi (Eds.), *Inter-disciplinary perspectives on sharing among hunter-gatherers in the past and present*. Cambridge: The McDonald Institute in press.

Byrne, R. W., & Rapaport, L. G. (2011). What are we learning from teaching? *Animal Behaviour, 82*(5), 1207–1211.

Caro, T. M., & Hauser, M. D. (1992). Is there teaching in nonhuman animals? *The Quarterly Review of Biology, 67*(2), 151–174.

Castro, L., & Toro, M. A. (2004). The evolution of culture: From primate social learning to human culture. *Proceedings of the National Academy of Sciences (USA), 101*(27), 10235–10240.

Castro, L., & Toro, M. A. (2014). Cumulative cultural evolution: the role of teaching. *Journal of Theoretical Biology, 347*, 74–83.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah: L. Erlbaum Associates.

Cole, M. (2005). Cross-cultural and historical perspectives on the developmental consequences of education. *Human Development, 48*(4), 195–216.

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

D'Andrade, R. G. (1992). Schemas and motivation. In R. G. D'Andrade & C. Strauss (Eds.), *Human motives and cultural models* (pp. 23–44). Cambridge: Cambridge University Press.

Dean, L. G., Vale, G. L., Laland, K. N., Flynn, E., & Kendal, R. L. (2014). Human cumulative culture: a comparative perspective. *Biological Reviews, 89*(2), 284–301.

Dira, S. J., & Hewlett, B. S. (2016). Learning to spear hunt among Ethiopian Chabu adolescent hunter-gatherers. In B. S. Hewlett & H. Terashima (Eds.), *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 71–81). Tokyo: Springer Japan.

Endicott, K. M. (2011). Cooperative autonomy: social solidarity among the Batek of Malaysia. In T. Gibson & K. Sillander (Eds.), *Anarchic solidarity: Autonomy, equality, and fellowship in Southeast Asia* (pp. 62–87). New Haven: Yale University Council on Southeast Asia Studies.

Endicott, K. L., & Endicott, K. M. (2014). Batek childrearing and morality. In D. Narvaez, K. Valentino, A. Fuentes, J. J. McKenna, & P. Gray (Eds.), *Ancestral landscapes in human evolution* (pp. 108–125). Oxford: Oxford University Press.

Enquist, M., Eriksson, K., & Ghirlanda, S. (2007). Critical social learning: a solution to Rogers's paradox of Nonadaptive culture. *American Anthropologist, 109*(4), 727–734.

Fiske, A. (n.d.). Learning culture the way informants do: observing, imitating and anticipating. Unpublished ms., Department of Anthropology, University of California, Los Angeles.

Fogarty, L., Strimling, P., & Laland, K. N. (2011). The evolution of teaching. *Evolution, 65*(10), 2760–2770.

Franks, N. R., & Richardson, T. (2006). Teaching in tandem-running ants. *Nature, 439*(7073), 153.

Garfield, Z., Garfield, M., & Hewlett, B. S. (2016). A cross-cultural analysis of hunter-gatherer social learning. In H. Terashima & B. S. Hewlett (Eds.), *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 19–34). Tokyo: Springer Japan.

Gaskins, S., & Paradise, R. (2010). Learning through observation in daily life. In D. F. Lancy, J. Bock, & S. Gaskins (Eds.), *The anthropology of learning in childhood* (pp. 85–118). Walnut Creek: AltaMira Press.

Gergely, G., & Csibra, G. (2006). Sylvia's receipe: the role of imitation and pedagogy in the transmission of human culture. In N. J. Enfield & S. C. Levenson (Eds.), *Roots of human sociality: Culture, cognition and human interaction* (pp. 229–255). Oxford: Berg Publishers.

Greenfield, P. M. (2004). *Weaving generations together: evolving creativity in the Maya of Chiapas*. Santa Fe: School of American Research Press.

Guemple, L. (1988). Teaching social realtions to Inuit children. In T. Ingold, D. Riches, & J. Woodburn (Eds.), *Hunters and gatherers 2: Property, power, and ideology* (pp. 131–149). Oxford: Berg.

Heath, S. B. (1983). *Ways with words: Language, life, and work in communities and classrooms*. New York: Cambridge University Press.

Hewlett, B. S. (1991). *Intimate fathers: The nature and context of Aka pygmy paternal infant care*. Ann Arbor: University of Michigan Press.

Hewlett, B. S., & Cavalli-Sforza, L. L. (1986). Cultural transmission among Aka pygmies. *American Anthropologist, 88*(4), 922–934.

Hewlett, B. S., Fouts, H. N., Boyette, A. H., & Hewlett, B. L. (2011). Social learning among Congo Basin hunter-gatherers. *Philosophical Transactions of the Royal Society B, 366*, 1168–1178.

Hewlett, B. S., Lamb, M. E., Leyendecker, B., & Schölmerich, A. (2000). Internal working models, trust and sharing among foragers. *Current Anthropology, 41*(2), 287–297.

Hewlett, B. S., Lamb, M. E., Shannon, D., Leyendecker, B., & Schölmerich, A. (1998). Culture and early infancy among central African foragers and farmers. *Developmental Psychology, 34*(4), 653–661.

Hewlett, B. S., & Roulette, C. J. (2016). Teaching in hunter-gatherer infancy. *Royal Society Open Science, 3*(1), 150403.

Hill, K. R., Walker, R. S., Bozicevic, M., Eder, J., Headland, T., Hewlett, B., et al. (2011). Co-residence patterns in hunter-gatherer societies show unique human social structure. *Science, 331*(6022), 1286–1289.

Király, I., Csibra, G., & Gergely, G. (2013). Beyond rational imitation: learning arbitrary means actions from communicative demonstrations. *Journal of Experimental Child Psychology, 116*(2), 471–486.

Kitanishi, K. (1998). Food sharing among the Aka hunter-gatherers in northeastern Congo. *African Study Monographs, Supplement, 25*, 3–32.

Kline, M.A. (2015). How to learn about teaching: an evolutionary framework for the study of teaching behavior in humans and other animals. *Behavioral and Brain Sciences,* 38, 1–70.

Kline, M. A., Boyd, R., & Henrich, J. (2013). Teaching and the life history of cultural transmission in Fijian villages. *Human Nature, 24*(4), 351–374.

Kovács, Á. M., Tauzin, T., Téglás, E., Gergely, G., & Csibra, G. (2014). Pointing as epistemic request: 12-month-olds point to receive new information. *Infancy, 19*(6), 543–557.

Kruger, A. C., & Tomasello, M. (1996). Cultural learning and learning culture. In D. Olson & N. Torrance (Eds.), *The handbook of human development and education* (pp. 369–387). Oxford: Blackwell.

Lancy, D. F. (2010). Learning "from nobody": the limited role of teaching in folk models of children's development. *Childhood in the Past, 3*, 79–106.

Lancy, D.F. (2012a). Ethnographic perspectives on cultural transmission/acquisition. Paper prepared for the School of American Research Advanced Seminar on "Multiple Perspectives on the Evolution of Childhood."

Lancy, D. F. (2012b). The chore curriculum. In G. Spittler & M. Bourdillon (Eds.), *African children at work: Working and learning in growing up for life* (pp. 23–56). Berlin: LIT Verlag.

Lancy, D. F. (2014). "Babies aren't persons": a survey of delayed personhood. In H. Otto & H. Keller (Eds.), *Different faces of attachment: Cultural variations on a universal human need* (pp. 66–112). Cambridge: Cambridge University Press.

Lancy, D. F. (2016). Teaching: natural or cultural? In D. Berch & D. Geary (Eds.), *Evolutionary perspectives on education and child development* (pp. 33–65). Heidelberg: Springer.

Lancy, D. F., & Grove, M. A. (2011). Getting noticed. *Human Nature, 22*(3), 281–302.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Leadbeater, E., Raine, N. E., & Chittka, L. (2006). Social learning: ants and the meaning of teaching. *Current Biology, 16*, R323–R325.

Lee, R. B. (2013). *The Dobe Ju/'hoansi* (4th ed., student ed.). Belmont: Wadsworth Cengage Learning.

Lewis, J. (2009). As well as words: Congo pygmy hunting, mimicry, and play. In R. Botha & C. Knight (Eds.), *The cradle of language* (pp. 236–256). Oxford: Oxford University Press.

Lewis, J. (2016). Play music and taboo in the reproduction of an egalitarian society. In B. S. Hewlett & H. Terashima (Eds.), *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 147–158). Tokyo: Springer Japan.

Lewis, H. M., Vinicius, L., Strods, J., Mace, R., & Migliano, A. B. (2014). High mobility explains demand sharing and enforced cooperation in egalitarian hunter-gatherers. *Nature Communications, 5*, 5789. doi:10.1038/ncomms6789.

Lipka, J. (1994). Schools failing minority teachers. *Educational Foundations, 8*(2), 57–80.

Long, S. J., & Freese, J. (2006). *Regression models for categorical dependent variables using stata* (2nd ed.). College Station: Stata Press.

MacDonald, K. (2007). Cross-cultural comparison of learning in human hunting. *Human Nature, 18*(4), 386–402.

Marlowe, F. W. (2005). Hunter-gatherers and human evolution. *Evolutionary Anthropology, 14*(2), 54–67.

Marno, H., & Csibra, G. (2015). Toddlers favor communicatively presented information over statistical reliability in learning about artifacts. *PloS One, 10*(3), e0122129.

Maynard, A. E. (2002). Cultural teaching: the development of teaching skills in Maya sibling interactions. *Child Development, 73*(3), 969–982.

Mead, M. (1942). Educative effects of social environment as disclosed by studies of primitive societies. In E. W. Burgess, W. L. Warner, F. Alexander, & M. Mead (Eds.), *Symposium on environment and education* (pp. 48–61). Chicago: University of Chicago Press.

Morelli, G., Henry, P. I., & Foerster, S. (2014). Relationships and resource uncertainty. In D. Narvaez, K. Valentino, A. Fuentes, J. J. McKenna, & P. Gray (Eds.), *Ancestral landscapes in human evolution* (pp. 69–103). Oxford University Press.

Morelli, G., Rogoff, B., & Angelillo, C. (2003). Cultural variation in young children's access to work or involvement in specialised child-focused activities. *International Journal of Behavioral Development, 27*, 264–274.

Morgan, T. J. H., Uomini, N. T., Rendell, L. E., Chouinard-Thuly, L., Street, S. E., Lewis, H. M., et al. (2015). Experimental evidence for the co-evolution of hominin tool-making teaching and language. *Nature Communications, 6*, 6029. doi:10.1038/ncomms7029.

Naveh, D. (2016). Social and epistemological dimensions of learning among Nayaka hunter-gatherers. In B. S. Hewlett & H. Terashima (Eds.), *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 125–133). Tokyo: Springer Japan.

Omura, K. (2016). Sociocultural cultivation of positive attitudes toward learning: considering differences in learning ability between Neanderthals and modern humans from examining Inuit children's learning process. In B. S. Hewlett & H. Terashima (Eds.), *Social learning and innovation in contemporary hunter-gatherers: Evolutionary and ethnographic perspectives* (pp. 267–284). Tokyo: Springer Japan.

Paradise, R., Mejía-Arauz, R., Silva, K. G., Dexter, A. L., & Rogoff, B. (2014). One, two, three, eyes on me! *Human Development, 57*(2–3), 131–149.

Peterson, N. (1993). Demand sharing: reciprocity and the pressure for generosity among foragers. *American Anthropologist, 95*(4), 860–874.

Philips, S. U. (1983). *The invisible culture: Communication in classroom and community on the Warm Springs Indian Reservation*. Prospect Heights: Waveland Press.

Raihani, N. J., & Ridley, A. R. (2008). Experimental evidence for teaching in wild pied babblers. *Animal Behaviour, 75*, 3–11.

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

Rogoff, B. (2011). Childhood and learning: how do children learn without being taught? One way is by observing and pitching in. *Anthropology of Childhood and Youth Interest Group Newsletter* 3(2, October), 8–10. American Anthropological Association.

Rogoff, B., Paradise, R., Arauz, R. M., Correa-Chávez, M., & Angelillo, C. (2003). Firsthand learning through intent participation. *Annual Review of Psychology, 54*(1), 175–203.

Rogoff, B., Sellers, M. J., Pirrotta, S., Fox, N., & White, S. H. (1975). Age of assignment of roles and responsibilities to children. *Human Development, 18*(5), 353–369.

Schieffelin, B. B., & Ochs, E. (1986). Language socialization. *Annual Review of Anthropology, 15*, 163–191.

Scribner, S., & Cole, M. (1973). Cognitive consequences of formal and informal education: new accommodations are needed between school-based learning and learning experiences of everyday life. *Science, 182*(4112), 553–559.

Shennan, S. J., & Steele, J. (1999). Cultural learning in hominids: a behavioral ecological apporach. In H. O. Box & J. R. Gibson (Eds.), *Mammalian social learning: Comparative and ecological perspectives* (pp. 367–388). Cambridge: Cambridge University Press.

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

Sterelny, K. (2012). *The evolved apprentice: How evolution made humans unique*. Cambridge: MIT Press.

Strauss, S., & Ziv, M. (2012). Teaching is a natural cognitive ability for humans. *Mind, Brain, and Education, 6*(4), 186–196.

Strauss, S., Ziv, M., & Stein, A. (2002). Teaching as a natural cognition and its relations to preschoolers' developing theory of mind. *Cognitive Development, 17*, 1473–1787.

Thornton, A., & McAuliffe, K. (2006). Teaching in wild meerkats. *Science, 313*(5784), 227–229.

Thornton, A., & McAuliffe, K. (2012). Teaching can teach us a lot. *Animal Behaviour, 83*(4), e6–e9. doi:10.1016/j.anbehav.2012.01.029.

Thornton, A., & Raihani, N. J. (2008). The evolution of teaching. *Animal Behaviour, 75*(6), 1823–1836.

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural learning. *Behavioral and Brain Sciences, 16*, 495–552.

Vansina, J. (1990). *Paths in the rainforests: Towards a history of political tradition in equatorial Africa*. Madison: University of Wisconsin Press.

White, S. H. (1996). The child's entry into the "age of reason." In A. J. Sameroff & M. M. Haith (Eds.), *The five- to seven-year shift: The age of reason and responsibility* (pp. 17–30). Chicago: University of Chicago Press.

Whiten, A., & Erdal, D. (2012). The human socio-cognitive niche and its evolutionary origins. *Philosophical Transactions of the Royal Society B: Biological Sciences, 367*(1599), 2119–2129.

Wiessner, P. (1982). Risk, reciprocity, and social influences on !Kung San economics. In E. Leacock & R. B. Lee (Eds.), *Politics and history in band societies* (pp. 61–84). Cambridge: Cambridge University Press.

Wolcott, H. F. (1997). Why have minority groups in North America been disadvantaged by their schools? In G. Spindler (Ed.), *Education and cultural process: Anthropological approaches*. Prospect Heights: Waveland Press.

Woodburn, J. (1982). Egalitarian societies. *Man, 17*(3), 431–451.

Woodburn, J. (1998). "Sharing is not a form of exchange": an analysis of property-sharing in immediate-return hunter-gatherer societies. In *Property relations: Renewing the anthropological tradition* (pp. 48–63). Cambridge: Cambridge University Press.

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

Adam H. Boyette received his PhD in Anthropology from Washington State University in 2013. He studies the anthropology of childhood and parenting, especially among small-scale societies of the Congo Basin. Adam has published on forager children's play and social learning from developmental and evolutionary perspectives, and is generally interested in biocultural approaches to childhood and parenting studies. He is currently a postdoctoral lecturing fellow in the interdisciplinary Thompson Writing Program at Duke University.

Barry S. Hewlett is a professor of anthropology at Washington State University, Vancouver. He received his PhD from the University of California, Santa Barbara in 1987. His research focuses on two general topics: the anthropology of childhood and the anthropology of infectious and parasitic diseases. Barry has written extensively on both topics and has conducted research in several central and eastern African countries, including more than twenty field trips to the Central African Republic.