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Social Learning and Innovation in Adolescence

A Comparative Study of Aka and Chabu Hunter-Gatherers of Central and Eastern Africa

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Abstract
This paper examines how innovative skills and knowledge are transmitted and acquired among adolescents in two hunter-gatherer communities, the Aka of southern Central African Republic and the Chabu of southwestern Ethiopia. Modes of transmission and processes of social learning are addressed. Innovation as well as social learning have been hypothesized to be key features of human cumulative culture, enhancing the fitness and survival of individuals in diverse environments. The *innovation* literature indicates adult males are more innovative than children and female adults and therefore predicts that adolescents will seek out adult males. Further, the mode of transmission should be oblique (i.e., learning from adults other than parents). Thus, learning of innovations should be oblique or horizontal rather than vertical, with adolescents paying particular attention to "successful" innovative individuals (prestige bias). The *social learning* literature indicates that complex skills or knowledge is likely to be learned through *teaching,* and therefore that teaching will be an important process in the transmission of innovations. In-depth and semi-structured interviews, informal observations, and systematic free-listing were used to evaluate these hypotheses. The study found that (1) cultural context patterned whether or not adolescents sought out adult male or female innovators; (2) oblique modes of transmission were mentioned with greater frequency than horizontal or vertical modes; (3) knowledge and skill bias was notable and explicitly linked by the adolescents to reproductive effort; and (4) teaching was biased toward same-sex individuals and was an important but not an exclusive means of transmitting complex skills and social knowledge.

Keywords Hunter-gatherers · Adolescence · Social learning · Cultural transmission · Innovation · Africa

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Researchers from a variety of disciplines often turn to studies of contemporary hunter-gatherers to understand the nature of human cultural evolution stemming from the realization that for 99% of hominid evolutionary history, a hunting-gathering way of life prevailed. Hunting and gathering, transitional or forager-farming subsistence economies are not relics of the distant past but pertain to contemporary peoples living in contemporary times. Studying these small-scale societies[1] can broaden our understanding of the diverse cultural contexts within which social learning, cultural transmission, and cultural evolution occur. Framing human social cognitive processes (e.g., teaching, verbal instruction, demonstration, imitation) as arising from a long and critical stage in the emergence of our human species increases an understanding of how the accurate transmission and acquisition of cultural traits, including innovations, provided opportunities for culture to be developed and conserved over time (Henrich, 2004, 2010; Lewis & Laland, 2012; Tennie et al., 2009; Tomasello et al., 1993).

Forms of social learning, cultural transmission, and innovation have been hypothesized to be key features of human cumulative culture, enhancing the fitness and survival of individuals in diverse environments. However, little is known about the acquisition of innovative traits among existing hunter-gatherers. Further, what motivates particular individuals to innovate, and others to seek out and learn the new behavior, as well as the requisite qualities for promoting innovation by some individuals in particular contexts, remain inadequately explored and understood (Thornton & Samson, 2012). This study assesses hypotheses regarding how, and from whom, innovative skills and knowledge are transmitted to adolescents in two hunter-gatherer communities, the Aka of southern Central African Republic and the Chabu of southwestern Ethiopia.

Cultural Transmission

Throughout the life course, individual choices and interests in different social and natural environments may vary, but generally, humans learn in a multiplicity of ways (e.g., observation, emulation, imitation, teaching, play), and from a host of people—fathers, mothers, siblings, and peers (Garfield et al., 2016; Hewlett et al., 2011, 2016; Lew-Levy et al., 2017). Humans not only learn in a variety of ways but additionally have developed different mechanisms, with specific properties, to transmit cultural skills and knowledge. Mechanisms of transmission refer to those from whom the individual is learning. Thus, *vertical transmission* refers to learning from parents, *oblique transmission* occurs when one learns from older individuals (e.g., adolescents teaching younger children, or non-parental adults teaching children, and/or adolescents and young adults), and *horizontal transmission* which generally denotes learning from similarly aged friends/peers.

[1] "Small scale" refers to societies generally lacking significant market integration, having limited interaction with state-based entities, and being strongly influenced by long-standing social norms that minimize social stratification and inequality (Garfield et al., 2019; Reyes-García et al., 2017).

Further distinctions can be made in terms of the numbers of learners, such as in *concerted transmission*, where a group of older individuals passes on special knowledge (e.g., during initiation rituals), or one-to-many (e.g., an individual telling a story to many individuals), or one-to-one, as often occurs in a hunter-gatherer society. Different biases impact cultural transmission, including *indirect/prestige bias* in which an individual(s) is learning traits or knowledge that may increase status, and *conformist bias*, which is the propensity to copy the majority (Chudek et al., 2012; Hewlett & Cavalli-Sforza, 1986; Hewlett & Lamb, 2002; Hewlett et al., 2011; Mesoudi, 2011; Richerson & Boyd, 2005:164).

Certain mechanisms can lead to the conservation of culture (vertical, concerted, and conformist), whereas other mechanisms (horizontal and oblique) can, depending on frequency of contact, lead to rapid culture change. Studies suggest that some cultural beliefs and practices, especially those associated with family and kinship, are seldom linked to adaptations to the natural environment and are highly conserved by the mechanisms of cultural transmission (Hewlett & Cavalli-Sforza, 1986; Hewlett & Lamb, 2002; Hewlett et al., 2011). The accuracy of social transmission, in conjunction with the refinement and conservation of cultural traits, favors the emergence of cumulative culture over time (Aoki, 2013; Dean et al., 2012; Enquist et al., 2010, 2011; Kendal et al., 2005; Lehmann et al., 2010; Tennie et al., 2009). High-fidelity transmission increases not only the endurance, evolution, and complexity of cultural systems through time, but the probability of innovation, especially through modification or combination of traits within a population (Boyd & Richerson, 1985; Carr et al., 2016; Henrich, 2010:99; O'Brien & Shennan, 2010a, b). *Fidelity of transmission*, as Lewis and Laland (2012) argue, is key to cumulative culture. In summary, cultural traits not faithfully reproduced between individuals will not exist long enough within the population for modification or combination (innovation) to occur, thus impacting the development of cumulative culture.

Innovation

Lehmann et al. (2010) suggest that innovation is as critical to cultural evolution as genetic mutation is to biological evolution. The transmission and diffusion of novel information, behaviors, and/or artifacts, along with the receptivity of a society to inventions, are keys to innovation. The role of innovation as an adaptive response to highly variable climatic or social conditions provides solutions to new problems and serves to reduce uncertainty and risk in populations (Richerson & Boyd, 2005). Cultural innovations can lead to lasting physiological and species-typical changes. For example, postmarital residence rules, subsistence practices, and technological innovations have been implicated in impacting population genetic diversity (Arias et al., 2018 and references therein). Innovations, however, are not necessarily direct responses to environmental adversity and instability, nor are they necessarily developed to meet specific needs (Diamond, 1999; Henrich, 2010; O'Brien and Shennan, 2010a, b).

Adopting a broad definition of "innovation," beyond innovations in material culture, can reveal the importance of social and cultural innovations during hominid evolution.

Social and cultural innovations across hominid evolution were likely strong contributors to most traits associated with human uniqueness and adaptations (Coward & Grove, 2011; Elias, 2012; Muthukrishna et al., 2018). Innovative behavior is not unique to humans; it has been documented in meerkats, fish, birds, and some primates (see Biondi et al., 2010; Cole & Quinn, 2012; Goodall, 1986; Katzir, 1982; Laland & Reader, 1999; Morand-Ferron et al., 2011; Reader & Laland, 2001, 2002, 2003; Thornton & Samson, 2012). As with social learning, innovative behavior often occurs in a variety of ways and ecologies (Boesch, 1995, 2003; Galef, 1992; Kameda & Nakanishi, 2002; Laland & Reader, 2010; Nishida, 1987; Tomasello et al., 1993).

Studies assessing the relation between innovation and competitive abilities among nonhuman primates, birds, and fish have provided some insight into the drive behind innovative behavior. For example, low-ranking individuals in some species, unable to physically outcompete higher-ranking individuals, show innovative propensities or engage in risk-taking, innovative behavior (Biondi et al., 2010; Cole & Quinn, 2012; Katzir, 1982; Laland & Reader, 1999; Morand-Ferron et al., 2011; Reader & Laland, 2003; Thornton & Samson, 2012). Species such as *Pan troglodytes* (Goodall, 1986) can achieve high social rank by a display of innovative behavior. In an extensive survey of the literature on primate behavior, Reader and Laland (2001:802) found a higher incidence of innovation in adult male primates than in subadults and females. They also suggest adults may innovate more than young individuals because innovation arises from a foundation of experience and skill more often found in adults than in younger primates (see also Nielsen et al., 2014 for a study of forager children and low rates of tool innovation). Further, the authors suggest that adult males may innovate more than females because of lowered risk aversion driven by sexual selection (Dean et al., 2012; Hewlett, 2013; Reader & Laland, 2001).

Among human primates, adult males from contemporary foraging societies tend to explore and travel greater distances than females and adolescents and take greater risks (e.g., Cashdan & Gaulin, 2016; Kurland & Gaulin, 1984; MacDonald & Hewlett, 1999). Exploration not only increases mating chances, it also increases exposure to new innovations, offering opportunities to observe and learn new traits and behaviors through contact with higher numbers of individuals and broader social-economic networks (Hewlett, 2013; Hill et al., 2011). It has also been suggested that innovations may be less costly and have a greater "fitness payoff" for males than for females (Hewlett & Cavalli-Sforza, 1986; MacDonald and Hewlett, 1999; Reader & Laland, 2001). Indeed, in a previous study, adult Aka males were more often identified as innovators than adult females (Hewlett, 2013). Exploratory and risk-taking behavior are important features in the discussion of social learning, innovation, and cumulative culture. These behaviors "facilitate cumulative knowledge" by increasing the number of people with whom a person will come into contact and increasing the desirability of seeking out and learning from those possessing this cumulated knowledge—in other words, adult males (Lewis & Laland, 2012:2175; Reader & Laland, 2001).

Although adolescents in egalitarian societies, such as the foragers of central Africa, are typically not considered "low-ranking individuals," they likely are highly motivated to pay attention to and learn from successful others, particularly those

who display greater skills, health, reproductive success, and knowledge (Henrich, 2010; Hewlett & Hewlett, 2013; see also Chudek et al., 2012 for further discussion of model-biased learning, and Henrich & Gil-White, 2001). Selective social learning, copying, or choosing to learn from prestigious individuals (prestige bias) potentially confers status and high social rank on the chosen competent, "admired" individual/ "teacher." Furthermore, this type of learning provides the learner with the opportunity to acquire fitness-enhancing "superior" knowledge and skills (Henrich & Gil-White, 2001; Jiménez & Mesoudi, 2019).

The Henrich and Gil-White prestige bias model (2001) predicts older individuals possess more experience in domains that are valued, and therefore younger individuals will be more inclined to copy older, more successful adults who provide higher-quality information. Using age as a good cue of better-than-average knowledge/skills holds true within particular contexts—for example, when the social and ecological environments are stable (or changing slowly), older individuals are sought. However, when the environment is rapidly changing, peers (i.e., horizontal transmission) are predicted to be copied to obtain updated information (Jiménez & Mesoudi, 2019:2–3; Spisak et al., 2014). Likewise, Little et al. (2015) found the use of prestige-biased social learning to be more frequent in younger people or those who lacked experience.

In a review by Jiménez and Mesoudi (2019), prestigious individuals were found to be copied when the skill/knowledge was difficult and relevant, as opposed to when the task was easy and irrelevant. Further, and contrary to Little et al.'s predictions, the authors found evidence that with a *two-stage social learning model,* greater use of prestige bias occurs with age and experience (Henrich, 2010; Henrich & Broesch, 2011; Kline et al., 2013; Reyes-García et al., 2009, 2016, 2017). Social learners, they predicted, should first learn from easily accessible individuals such as neighbors, friends, or family. They later build upon their knowledge and skill by copying prestigious/successful individuals to further improve their abilities. Mathematical models show that if members of each generation seek out and learn from successful individuals (e.g., prestige/success bias), in combination with some form of oblique and vertical transmission, fitness-enhancing knowledge and skills will be distributed in a population over subsequent generations, thereby increasing the probability of cultural adaptation (Boyd & Richerson, 1985; Henrich, 2004; Powell et al., 2009).

Social Learning and Adolescence

A "functional" definition of teaching (Caro & Hauser, 1992; Lew-Levy et al., 2017) includes the following criteria: (1) a knowledgeable individual modifies their behavior only in the presence of a naive individual, (2) the knowledgeable individual incurs some cost or derives no immediate benefits by modifying their behavior, and (3) the naive individual acquires knowledge or skills more rapidly or efficiently than they would otherwise, or would not have learned at all, as a result of the knowledgeable individual's behavior (Caro & Hauser, 1992). Teaching is one of many forms across diverse taxa of social learning (Garfield et al., 2016). This study also draws upon an understanding of the characteristics of teaching as outlined by Thornton

and Raihani (2008:1825–26). The authors conclude that teaching is a cooperative behavior with response-dependent fitness payoffs (often with related individuals); an individual modifies their behavior to facilitate learning in others, not for some other purpose (i.e., not an incidental by-product of other activity); and teaching involves the coordinated, bidirectional interaction between a donor and a receiver of information, each sensitive to the other's actions.

Garfield et al. (2016) studied the relationship between the age of the learner and the teaching processes of cultural transmission in 982 ethnographic texts from 23 diverse hunter-gatherer societies in the online Human Relations Area Files World Cultures (eHRAF). They found that 16% of all instances of teaching occurred in adolescence, the second highest frequency across all age groups. Observation, imitation, collaborative learning, local enhancement, and individual learning exhibited few to no occurrences in adolescence (for evaluations of male/female patterns of social learning patterns see Garfield et al., 2016). For the purposes of this study, the definitions used for the processes of transmission are listed in Table 1 (modified from Garfield et al., 2016:25, Table 2.1).

Having undergone a surge of biological, cognitive, and evolutionary changes, the brains of adolescents are no doubt capable of abstract and innovative thought, able to use concepts skillfully, and successively relate concepts to each other in more complex ways (Bogin, 2009, 2013; Gogtay et al., 2004). The ethnographic record of hunter-gatherers suggests social learning of complex and abstract concepts, such as religious beliefs, cosmology, cultural values, and kinship, frequently occurs during adolescence (Fig. 1). Classic work by Margaret Mead (1930) in Manus showed that children generally have naturalistic explanations for illnesses, whereas adults are much more likely to invoke supernatural causation. Beliefs in the supernatural are a characteristic feature of humanity, and it seems reasonable to hypothesize that these

Table 1 Operational definitions of teaching processes

Observation and imitation	The learner directly observes some tasks, skill or behavior and attempts to replicate the observed actions
Teaching	An individual modifies their behavior intentionally to impart knowledge, skills or behaviors to a learner
Teaching-demonstration-direct physical proximity	Type of teaching where an individual demonstrates knowledge, skills or behaviors to a learner and has learner stand or sit next (close to) 'teacher' who may take hand or touch learner to guide movements and may give feedback and examples during the process
Teaching-demonstration	Type of teaching where an individual demonstrates knowledge, skills or behaviors to a learner and may give feedback and examples during the process
Teaching-verbal correction	Type of teaching where an individual demonstrates knowledge, skills or behaviors to a learner and gives corrective feedback and examples during the process
Teaching-storytelling/song	Type of teaching where an individual imparts specific knowledge, skills or behaviors to a learner by verbal (including song) communication of stories, or metaphors
Individual learning	Individual exhibits repeated attempts to learn a skill or develop new skills on his/her own. This includes trial and error and individual practice

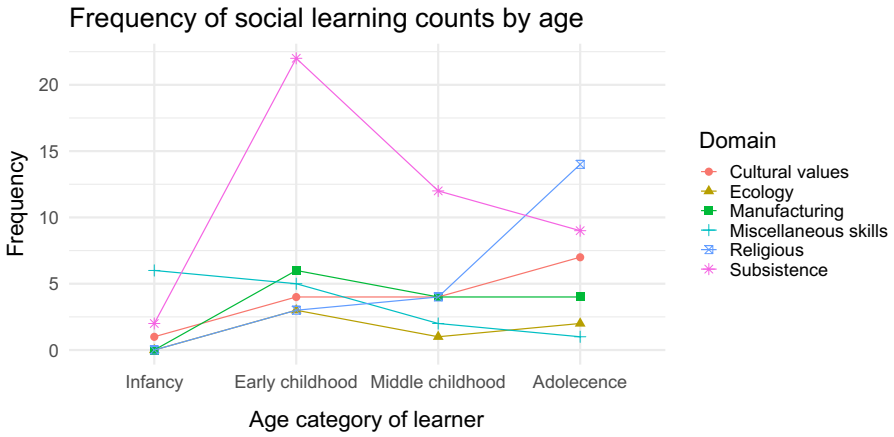

Fig. 1 Frequency of ethnographic instances of social learning by domain across age categories. (Adapted from Garfield et al., 2016:28, Table 2.4)

beliefs are fully integrated into young people's belief systems during adolescence (Hewlett & Hewlett, 2013; Lewis, 2008). As Fig. 1 indicates, adolescence is indeed a time in which learning about cultural values and the supernatural world intensifies. This is, in part, due to the adolescent's enhanced cognitive abilities to hypothesize, generalize, and imagine. But adolescents are also influenced dramatically by new experiences, such as initiation, by the physical changes of puberty, and by the desire to learn more about the adult world. Puberty and menstrual blood, for instance, are associated with many taboos and are often entry points for learning more about the supernatural (Lewis, 2008).

Learning of other complex skills and material culture production, such as basket or tool making (spears, cross bows, traps), house building, big game hunting, and intensive gathering, often occurs during adolescence. Among the Chabu, researchers Dira and Hewlett (2016) found adolescent individuals received direct instruction (including verbal explanation and demonstration) of complex spear hunting techniques and innovations. In a meta-ethnographic review, Lew-Levy et al. (2017) found reports of direct instruction in late childhood and early adolescence. This is the age when they began learning the production of more complex material culture skills, with transmission occurring both vertically and obliquely, and generally with sex-biased knowledge acquisition and transfer.

Interactions take place between biology (e.g., onset of puberty, risk-taking behaviors), ecology (e.g., settlement size, political-economic setting), development (e.g., cognitive and physical changes with age), and culture (e.g., ideas, cultural models about adolescence). These interactions enable adolescents to gather information about the "social aspects of reproductive maturity"—cooperation, competition, risk-taking, and reputation building—skills necessary for reproductive success and survival (Bogin, 2009, 2013; Ellis, 2013; Hewlett, 2013; Hewlett & Lamb, 2002). Human adolescents are actively experimenting with, protesting, interpreting, and selecting which cultural skills and knowledge to incorporate into their lives. As they

do so, they are reshaping (and conserving) their cultures (Anderson-Fye, 2004). And while adults may be "innovators"—since they possess experience, wisdom, advanced knowledge, and physical skill/fitness—adolescents may be more driven to learn new innovations and/or engage in innovative behavior, as they have the most to "gain" in terms of reproductive fitness (Liebenberg, 1990; Walker et al., 2002).

However, underlying motivation, at least in some contexts, may be interindividual variation in capacities such as knowledge, experience, skills, cognition, and physical endowments or limitations. For instance, particular individuals may be highly motivated to innovate in tool production but lack sufficient experience to accomplish this. Or an individual may be highly motivated to innovate within a social/cultural ritual but lack the social capital required to initiate new traditions. However, for individuals with the prerequisite skills, innovation can then become a viable option (assuming the motivation is also present). Forager adolescents may take the lead and invest in exploratory risk-taking, especially adolescent males (see MacDonald & Hewlett, 1999). This typically happens in the context of increased cognitive abilities, reputation building, lack of subsistence obligations, substantial leisure time (the "spare time hypothesis"; Kummer & Goodall, 1985 as cited in Thornton & Samson, 2012:1460), forager values and social structures, and enhanced physical health. This leads to innovative acquisition and dissemination of new innovations through horizontal transmission (Bogin, 2013; Ellis, 2013; Hewlett & Cavalli-Sforza, 1986; Reader & Laland, 2001; Reyes-García et al., 2016).

Study Aims

This study explores social learning of innovations among Aka forest foragers of central Africa and Chabu adolescents in southwestern Ethiopia, a transitional hunter-gatherer society (Hewlett, 2013, 2016). The study was framed around the adoption and transmission of innovative behaviors, knowledge, and/or technologies. Indigenous terms and understandings (i.e., cultural models) of innovation, motivations for teaching and learning, characteristics of innovators, processes of social learning, and modes of cultural transmission were considered. Specifically, the study addressed (*a*) from whom did adolescents learn (parents, other adults, peers); (*b*) how did learning occur (e.g., observations, emulation, teaching, play); and (c) what innovative skills and knowledge did Aka and Chabu adolescents learn?

Based on the limited literature review above, the following were predicted:

1. Adult males should show more innovation than adult women and children. The literature indicates adult males engage in more risk-taking and exploratory behaviors than adult females and adolescents. And they are more likely to travel greater distances, where they may have a greater likelihood of exposure to innovations than females, children, and adolescents (Hewlett & Cavalli-Sforza, 1986; Hill et al., 2011, 2014; MacDonald & Hewlett, 1999; see also Reader & Laland, 2001).
2. Contrary to this, adolescents are highly motivated to learn for a variety of reasons mentioned below. They may want to learn successful innovations quickly

and easily and therefore may try to learn them from other local, easily accessible adolescents (horizontal transmission) who have already acquired this knowledge.

3. Adolescents should seek out adults who are more knowledgeable than their parents to learn complex innovative skills and knowledge. The "successful" innovations (skills or knowledge that others pay attention to and try to learn) should act as a good cue of better-than-average knowledge/skills. Therefore, older adults would be more likely to be sought out and copied, depending on the social and natural context (Jiménez & Mesoudi, 2019:2–3; Spisak et al., 2014). This suggests the mode of transmission of innovations should be oblique, assuming that fathers and mothers have average skills/knowledge and are not innovators (in which case vertical transmission would be more advantageous). Adolescents are, at this life stage, transitioning their investment from somatic to reproductive interests. They are particularly interested in finding a marriageable partner and establishing new corollary social networks prior to adult sexual and social roles (e.g., significant contribution to subsistence, parenting, and marriage). As adolescents selectively choose to learn from adults other than their parents, they are effectively increasing the pool of successful others from whom to learn innovative skills, enabling the accumulation of more complex skill sets (Henrich, 2010:114).
4. Adolescents want to learn new skills and knowledge efficiently and will therefore seek out innovators with the most successful innovations. They look for innovators who are generous, known for being good teachers, and willing to share skills and knowledge (Henrich & Gil-White, 2001; Jiménez & Mesoudi, 2019:2–3).
5. Acquisition of knowledge of innovations will tend to be same-sex-biased—that is, both Aka and Chabu adolescent males are predicted to choose adult males to learn from. Likewise, adolescent females will choose specific adult females from whom to learn. This is somewhat inconsistent with hypothesis number 1 (but see Henrich & Broesch, 2011; Hewlett & Cavalli-Sforza, 1986; Reyes-García et al., 2009, 2016).
6. Teaching has been hypothesized to be more efficient for learning complex skills and knowledge than observation and imitation. Consequently, teaching complex innovative skills and knowledge should be common (Gergely & Csibra, 2006; Lew-Levy et al. 2017; Shennan & Steele, 1999).

Ethnographic Context

The Aka

Fieldwork for this study was initially conducted in September–October 2010 and in February–March 2012 among the Aka, one of at least fifteen ethnolinguistic groups of forest foragers, sometimes referred to as "Pygmies," located throughout the southwestern Central African Republic (CAR) and the northeastern part of the Republic of Congo (ROC). They have an approximate population of 30,000 and population density of less than one person per square mile. Their fertility rate is high (about five to six live births per woman) and their infant and child mortality rate is high (approximately 50% for children under the age of 15). Aka bands are associated with

a village clan, and each band has a trail from the village to forest camps. Increasingly, Aka spend less time in forest camps and more time in large camps closer to logging roads, their village farms, schools, and missions (Hewlett, 1991, 2014).

Aka live in small intimate camps of 25–35 individuals. The number of people in the camp varies almost daily as adolescents (and others) travel to other camps or relatives and friends come to visit. Their homes are small, at most 3 m in diameter and 2 m high. Inside the home is a bed of animal skins, tree bark, and leaves or twigs fashioned into a bedframe where the family sleeps together. The huts of the *ngondo* (adolescent females) are smaller and only have room for one or at most two inhabitants. The bachelors' lean-tos, built by the *bokala* (adolescent males), are usually larger, rectangular structures, able to house four to six young males. But it is not unusual for adolescents, particularly on cold nights, to return to the family bed of their parents or grandparents. Aka have relatively high intergenerational and gender egalitarianism, values of sharing, flexibility of social roles, trust of others, and an "immediate return" pattern of subsistence. Gender egalitarianism among the Aka shapes cultural models regarding the sexual division of labor in subsistence and childcare activities, access to resources, and religious beliefs. Consistent with their egalitarian schema, the Aka avoid drawing attention to themselves, avoid ranking one another, share extensively, and highly respect the autonomy of individuals, including children (Hewlett et al., 2011).

The social context of learning, such as to whom Aka children are in proximity most of the time (and at what ages), is important in understanding from whom learning occurs, the way in which learning occurs, and what Aka children are learning. Aka children learn cultural values, beliefs, and practices through a variety of mechanisms (e.g., play, dancing, singing, exploration) in specific and differing social and physical contexts. A good proportion of Aka social learning is early, rapid, and mostly vertical up to age four or five (see Hewlett et al., 2011, 2016; Hewlett & Roulette, 2016 for more detailed descriptions of social learning in Aka infants and children).

From early infancy onward, Aka children learn to be autonomous. Babies not only have many caregivers and allonurses (other than the mother), but also nurse on demand (self-directed nursing, as the mother's breast is usually bare and easily accessed). But by the third or fourth year of life, children self-wean when they choose to stop breastfeeding. Weaning may also be directed by the pregnant mother as she prepares for the birth of the next child (Fouts et al., 2012; Meehan, 2005). Once weaned, 3- to 4-year-olds are carried when their parents go gathering or on net hunts, or they are left in camp. If they stay behind, a grandparent, other adults, or older children and siblings will watch over them.

The Aka cultural value of autonomy is clear not only in self-directed breastfeeding and weaning, but in self-directed play and learning. "I don't like it when our children play with machetes, but if the baby decides to play, I leave it. And if the baby cuts themselves and if they see the blood, they themselves will decide not to play with the machete" (Aka mother). Parents rarely correct their children, and when they do, discipline generally involves teasing or chastising. Although adults may request help or ask the child to do some activity, they do not punish the child if their request is ignored. Hitting a child can be cause for divorce (Hewlett, 1991, 2012).

Even into adolescence, there are no expectations from others in terms of work or behavior, save for the expectation surrounding sharing, with social sanctions for any unwillingness to share (Boyette & Hewlett, 2017; Hewlett, 2013).

The autonomous young Aka children, *moanna,* play, take part in, or initiate subsistence activities, and they spend a lot of their time into late childhood in the company of their parents, other adults, and play groups of children of both genders and various ages. Children are thus learning from other children, often through play (Boyette, 2013, 2016a, b; Crittenden, 2016; Lew-Levy & Boyette, 2018; see also Smith, 1982).

From six to eight years or thereafter, boys are called *mona bokala* and girls, *mona ngondo*. The children's activities and interests expand beyond their parents' hut. By this age, they are able to keep up with adults and often choose to accompany them as they gather forest fruits and vegetables or when the family goes on a net hunt (Fig. 2) (Boyette, 2013; Hewlett, 1991; Hewlett et al., 2011; Meehan, 2005). Generally, the children learn from their same-sex parent (Hewlett & Cavalli-Sforza, 1986). With autonomy paramount, however, knowledge acquisition is often self-directed, and the children decide which adult to spend time with and to learn from. Children at this age are taught about social relations, subsistence skills, and the fluidity of Aka gender tasks and roles. The foundational schema of egalitarianism, autonomy, sharing/trust, and an "immediate return" system provides a learning environment in which there are tolerant adults and self-directed, highly motivated children.[2] Children learn to trust a variety of people in their lives; likewise, those surrounding the child trust in the child's abilities to engage with, and learn from, the social and natural environment. Additionally, as those individuals intimately know and are socially/emotionally attached to the child, they are willing to invest in and support the child throughout the process of exploration, maturation, and cultural acquisition. Thus, learning is rapid and early (Hewlett et al., 2011).

By 10 years of age, Aka children have acquired 80–90% of basic subsistence and social skills (Hewlett & Cavalli-Sforza, 1986). More complex skills (elephant hunting, how to make a crossbow) and in-depth knowledge are acquired in adolescence, when they are more physically mature, have greater strength and more time to experience these different activities. Mating skills, how to hunt large game, special medicine, and knowledge about the supernatural are taught during adolescence (Hewlett, 2012; Hewlett & Cavalli-Sforza, 1986).

Respect for autonomy and self-directed knowledge acquisition continues during Aka adolescence as the children choose when and what to learn, and from whom to learn. Learning occurs in a context of continued close physical and emotional contact, in an environment where trust and social-emotional security are pervasive. While emotional and physical closeness are such that parents continue to be key facilitators of cultural transmission, adults other than parents (being more numerous) also play important roles in adolescents' daily lives. They provide the potential for both horizontal (friends and peers) and oblique (other adults) cultural transmission (Hewlett, 2012; Hewlett & Cavalli-Sforza, 1986; Hewlett et al., 2011).

[2] "Foundational schema" refers to modes of thought that pervade life, from subsistence activities to who sleeps together to how to organize a dance.

Fig. 2 Young Aka boy on net hunt (Photo courtesy of Barry Hewlett)

The Chabu

Fieldwork among the Chabu was conducted in February–March 2013 and January–February 2014. The Chabu are transitional forager-horticulturalists with an approximate population of 2,000 people, located in the highland forest areas of three administrative states of southwestern Ethiopia (Oromo, Southern Nations Nationalities and Peoples Region [SNNPR], and Gambela). Genetic and linguistic work suggests the Chabu are genetically distinct from their nearest neighbors and are linguistic isolates (Dira & Hewlett, 2018a, b; Garfield & Hagen, 2019; Scheinfeldt et al., 2019; Schnoebelen, 2009; Taye, 2015).[3] The Chabu are not officially recognized as a distinct ethnic group at the national governmental level. However, the Chabu say three factors differentiate them from other people around them: music, language, and their acknowledgment as the first inhabitants of the area.

Today the Chabu live in more than ten settlements or camps in the forest of the Majang zone of Gambela and the Sheka zone of SNNPR. Several settlements are near coffee plantations. Demographic data collected from 51 households in two villages (with a total of 127 persons, 68 males and 49 females) suggests that fertility is high and infertility infrequent. The total fertility rate is estimated to be 5.3 live births per woman (Dira & Hewlett, 2016, Dira & Hewlett, 2018a, b). Women generally are married by age 18–20 and have their first child two years after marriage. Men marry two to four years later than women. Polygyny is practiced and divorce is reported to be fairly common and, as has been found with other hunter-gatherer groups, typically occurs early in the marriage, before children are born (e.g., Hewlett, 1991). The social unit includes the family, the settlement or village, and the regional community. The conjugal family is the most significant social unit of production and reproduction. More research is needed to further understand the nature of Chabu social units, particularly in terms of clan ties and regional community ranges.

[3] The publications by Scheinfeldt et al. (2019) and Schnoebelen (2009) use the Majang word Sabue, or Shabu, rather than the ethnonym Chabu.

Although little is known about Chabu history and culture, the Chabu recount that traditionally they were hunter-gatherers and beekeepers. A small population of Chabu still live some distance from the settled villages in nuclear family groups, subsisting primarily by hunting and gathering from the surrounding forests. In the twenty-first century, most of the Chabu have shifted from a primarily hunting-gathering way of life to foraging-farming. An increased involvement in the local economy, including selling and trading honey, pottery, meat, and land, was also found.

There is a sexual division of labor. Chabu men fish and hunt in the forest, often daily, for wild pigs, duikers, and antelope, as well as maintaining traps and a large number of beehives (some men may own as many as 200 beehives). The Chabu women tend small fields of maize and coffee and grow taro, bananas, squash, some enset, and other vegetables in gardens close to their homes and fields. The women also regularly gather forest foods, depending on the availability of produce from their gardens and the season. Summer, for example, is considered a "hungry season," and women may go daily into the forest to gather (S. J. Dira, personal communication 2014). Many of the women and adolescent females also make pottery to sell in the local markets; a few men, known to be "specialists," construct spears or baskets to sell or trade.

Terms designating the life cycle begin with the *sesele* or newborn, *cho* for a crawling baby, and *sara* for a toddler. At this toddling stage, the young boys and girls begin learning and practicing specific, gendered tasks from their mothers and fathers (Fig. 3). Middle childhood is designated by the term *oofa*. At around 6 years of age, young boys learn to hunt and check traps with their fathers and will start to make little "practice" beehives, traps, and houses. At this time, they may use a small spear, without a metal tip, to practice killing rodents and birds. At around age 10, with help from older brothers and/or their fathers, they are able to build and begin to sleep in their own small *dhipo* (house). They generally have at least one beehive they

Fig. 3 Young Chabu girl, "making pottery" with her mother

have built and maintained, and by the time they have reached puberty may own up to 10 beehives.

In middle childhood, young girls are mainly helping their mothers, learning and practicing domestic chores, cooking, planting corn, fetching water, washing clothes, caring for younger siblings, and gathering wild forest plants (yams, mushrooms, leaves). They also may begin to make pottery, both to furnish their own future dhipos and to sell at the local market. Both boys and girls learn many skills when they are very young, practicing and perfecting them as they mature. It takes years of practice to become good at complex tasks and skills.

Once children reach puberty, young adolescent boys (*attines*) are often with their fathers, hunting, checking traps and beehives, or clearing the fields and forest. By this age, as noted, they may own eight to ten beehives and are setting up their own traps. At around fifteen, adolescent males will also have their first iron-tip adult spear to use when hunting with their father or with a group of friends (Dira & Hewlett, 2016). The adolescent males will already have built their own small house, where they will live alone, although they continue to eat with their family and/or friends, "The family insists we build our own homes so we will learn to be responsible for our own lives" (Chabu adolescent male).

Chabu girls, or *kota* (adolescent females), have a little house constructed for them by their older brothers or father and will live in these homes when menstruating or when a visitor comes to the family house. It is rare that they live alone as they generally choose to live in their family home or with a friend in their small home when menstruating. The young girls "work to learn" and practice "keeping house and cooking" at their dhipos, demonstrating to potential mates their "wife capacity," or readiness and desirability as a mate. If interested, a young man will send lotions, perfume, clothes, and perhaps food to the young woman and her family. If his gifts are accepted, the couple will be considered "engaged." The young man then begins building a marriage house in his natal village and collecting the bridewealth payment. Upon marriage, the young couple lives in the newly built home and establishes a garden in the man's "ancestral" village, where they will live with their future children.

Methods

Sample

Since little is known about social learning in transitional hunter-gatherers, most of the research was inductive and descriptive. In addition, at the time of the Chabu studies, the Chabu had not been systematically studied ethnographically, and basic demographic data needed to be collected prior to the research. Aka adolescents and adults were recruited from five camps along trails into the forest from a village in the Central African Republic. The Chabu sample consisted of a majority of the adults and adolescents from a highland forest village with a population of about 25 in southwest Ethiopia. For both the Aka and Chabu, the sample size was small.

Consent for conducting the study was obtained from Aka and Chabu village elders, and recruitment of participants was initiated at the time of the initial field trips. Individual consent was obtained from the parents of the Aka and Chabu adolescents, and assent from the adolescents was obtained independently. All unmarried Aka and Chabu adolescents between the ages of 12 and 19 were eligible. Generally speaking, both Aka and Chabu adolescents were identified by the use of indigenous terms and understandings designating a life-stage beginning with puberty and ending with marriage. Adulthood begins when adolescents show evidence of "adult knowledge" and the ability to hunt or keep a house and have and care for children. All Aka and Chabu adults in the villages at the time of the field study were eligible to participate. Informed consent was obtained from all parents, other adults, and adolescents who participated in the study. Approval for this study and data collection was obtained from the institutional review board of Washington State University (IRB #12972) and Hawassa University College of Social Sciences and Humanities.

The Aka sample (Table 2) consisted of 20 adolescents (10 males and 10 females). Not all individuals participated in all portions of study—15 adolescents free-listed innovators, and 20 participated in informal interviews. Also of interest were the motivations prompting innovators to share their knowledge and skills; therefore, 10 adults, five of whom were identified as innovators, were interviewed. The Aka adults who agreed to participate were approximately 35–40 years of age. The five adults *not* identified by adolescents as "innovators" were included in the study to determine whether identified innovators would also be identified by adults.

The sample of Chabu adolescents who agreed to participate consisted of six females and six males between the ages of 12 and 20 (Table 3). The Chabu adult sample was four adult females (three identified as innovators) and three adult males (one identified as an innovator), all between 30 and 80 years of age. As with the Aka, the innovative adults had been identified by the adolescents as being innovators and were interviewed if they were available and willing.

Data Collection

Informal and Semi-Structured Interviews The ethnographic interviews with each individual from the Aka and Chabu groups included a series of informal and

Table 2 Demographics of Aka sample

		Age (years)			
	n	*Mean*	*SD*	*Min*	*Max*
Adults					
Females	7	37.1	1.6	35	40
Males	3	27.3	6.4	20	30
Adolescents					
Females	10	15.3	1.6	13	18
Males	10	15.4	1.9	11	18

Table 3 Demographics of Chabu sample

		Age (years)			
	n	*Mean*	*SD*	*Min*	*Max*
Adults					
Females	4	38.2	9.2	28	50
Males	3	60.0	26.4	30	80
Adolescents					
Females	6	14.3	2.1	12	17
Males	6	13.1	3.3	10	19

semi-structured interviews detailing indigenous terms for innovation. Definitions of terms corresponding to innovation, and identification and descriptions of innovations, were also included. Questions such as "If there is an old design with a new feature, is that an innovation? Are original songs and dances considered innovations?" were asked. In addition, informal observation of behavioral and technological innovations and teaching occurred during fieldwork. The primary analytic strategy of the informal and semi-structured interviews included content analysis of the interviews, daily informal observations (and participation) of teaching behaviors, and daily entry into field and personal journal notes. Analysis of the interviews began with a simple coding of emergent themes, assessment of the reoccurrence of general patterns, and formation of data-driven categorizations from the interviews. In this way, differences between individuals and the thematic content could be observed.

In-depth informal and semi-structured interviews were further used to understand from whom (mechanisms) and how (processes) adolescents learned specific skills or knowledge. For the interviews with 20 Aka adolescents and 10 adults, a local French-speaking research assistant fluent in Diaka was utilized. Aka adolescents and adults used the same term (*ekeloko*) and description of innovation as being the creation of something novel, that which did not exist in the past. Responses were consistent in terms of indigenous concepts and terms of innovation, identification of innovative behaviors, knowledge, technologies, and features associated with innovations.

Twelve Chabu adolescents and seven adults were interviewed in informal and semi-structured interviews regarding any local terms for innovation, descriptions, definitions of corresponding terms, and examples of innovations (the same questions asked of the Aka). As with the Aka, Chabu informants were consistent in citing the term used (*agadhatta*), and in their descriptions of what innovations were. All informants were interviewed in the Chabu language with a local Chabu research assistant and a local non-Chabu research assistant who spoke Chabu and English.

Free-Listing Finally, informants (both adults and adolescents) were asked to free-list (Quinlan, 2005) individuals they identified as being innovators and then to also free-list characteristic attributes of the innovators. All Aka and Chabu participants were instructed to list as many (or as few) people they perceived as being an innovator. The participants were then asked to provide a separate free-list of the qualities or

attributes of innovators. As much as possible in the Aka and Chabu village setting, each individual was asked to free-list in a private setting to prevent bystander contamination (Quinlan, 2005). Salience scores were computed by finding the salience of identified (listed) innovators and, for the second free-list, attributes of innovators for each Aka and Chabu individual. The innovators (and then attributes) are ranked inversely and then divided by the number of innovators/attributes listed. The composite (or mean) salience value for each individual and attribute was determined by dividing the salience scores by the number of free-listers. The informal and semi-structured interviewing process allowed for cross-checking of emic domains and provided greater depth to the study (Quinlan, 2005).

Results

Cultural Models

Qualitative ethnographic interviews detailed how Aka and Chabu think about and perceive innovation (Quinn, 2018; Shore, 1996). Aka and Chabu adolescents had very specific linguistic terms relating to innovation. Both groups described innovation as the creation of something novel, something that did not exist in the past, was "new for today" (Table 4). For the Aka, the terms associated with innovation were related to the work of creation. *Ekeleko* means "to create"; *Motou wa ekeleko ya bela* speaks of the person who "works to create." "New" can mean a novel or modified feature, song, dance, basket, or even finding a new use for a plant for medicine. Among the Chabu, *fal* refers to "creating or making," and *kina fal* suggests creating/making a thing or matter (which may or may not be an "innovation"), while *kina amb* refers to a new matter or thing. However, the term that the Chabu who were interviewed used most often when referring to innovation was *agadhatta*, variously described as "creating a new feature on an old thing" or "a person who works hard" and "a person who creates new things." Chabu adolescents, and adults as well, used the term to refer to a person who

Table 4 Aka and Chabu terms relating to innovation

Aka		Chabu	
Ekeleko	"To create"	*Fal*	"To do, create" (make something)
Ekeleko wa mbinda	"To create new things"	*Kinna fal*	"Create a thing"
Motou wa ekeleko ya bela	"Person who works to create; i.e., works on creating something new"	*Angadhatta*	"Working to/creating a new feature on an old thing"
Ekeleko ya inda wa kene	"Doing something new"		
Eboko ya elo	"New, [original] for today"	*Kinna amb*	"New matter or thing"

becomes agadhatta through the hard work of creation because that person "brings out something new." As an elderly Chabu man explains:

> *Agadhatta* is everywhere, it is in all things. It is *waytsine ambe ezagen*. This means to do all things. It means to finalize the hard work. It is doing your hard work and observing and thinking about this hard work, and doing it very well. It is all hard work to think of change, to think of new things, but the new thoughts come from hard work. *Agadhatta* has existed for long years, since our ancestors.

The term encompasses more than innovation, or the creation of something new; it refers as well to the time and effort, the "hard work" from which creative ideas, designs, and technologies emerge. As with the Aka, creating was hard work—that is, innovators work to create. Innovations arise from long-term engagement and mastery of a particular skill. Innovation has to do with talent plus practice and preparation; the innovators, among both the Chabu and Aka, were able to begin practicing from the time they were very young and were able to learn from those who were best at what they do.

The Aka and Chabu adolescents were very specific not only in defining terms for innovation, but in detailing the characteristics of what they perceived as innovations—a behavior, knowledge, design, or technology that was different and "new." An Aka adolescent described what he saw as an innovative basket manufacturing technique, "His baskets are very strong. He goes into the forest and gets vine and then he dries it in the sun to make it strong. Other people don't dry the vine in the sun." Another young Aka adolescent spoke of an older man as being an innovator because "his works are good and strong. His knives and spears are stronger and better than other people's." A young Aka adolescent female explained it this way: "A creative person has good ways of doing something better."

From examples given by the Chabu, it appeared that features considered to be innovative were not only "new" but also those favored by many—enhanced designs or technologies or other modifications to artifacts that became highly sought after (the definition of a "successful" innovation). As a young woman explained, "She (innovator S, named by most people) is a specialist in this new design; not everyone knows these designs. We learned how to make these pots from our ancestors, but she created this new design. Many people come from other villages to learn from her this new design." And when asked about "failed" innovations, another Chabu female identified as a highly skilled pottery maker and innovator explained, "I have never made a design that has failed, that others do not want to learn."

Examples of innovation processes, described among both groups of adolescents, tended to be what could be termed "modification"—enhancement of a trait that existed previously—for example, a pottery design, basket, or drum, or spear made with a new feature or produced in a different, new way. It was unclear if the production of a new medicine, song, or dance could be understood as a process of "modification" or "combination." However, the creation of new traits was seen by the Aka

and Chabu adolescents as innovations (for a discussion of modification, combination, and novel invention, see Lewis & Laland, 2012).

Prediction 1 Adult males should be more innovative than adult women, adolescents, and children.

Aka adult males were more likely to be identified as innovators and sought out by adolescents (Kleibeuker et al., 2013; Tamnes et al., 2010). Along four different trails leading into the rainforest near the village where the study was conducted, with approximately 200 people on each trail, eight Aka adolescent males free-listed 16 innovators, all of whom were adult males. Most of the innovations created by innovators and sought after by male and female adolescents were new songs and dances; of the 16 innovators mentioned, seven were noted to produce songs and dances the Aka adolescents were keen to learn and, at times, pay for (Table 5). There are special songs and dances for specific events, such as for funerals, to attract the attention of a potential mate, for love, seduction, sexuality, and learning of one's role and place within camp life; it is not surprising these forms of cultural transmission are so prevalent (Arom et al., 2008; Fürniss & Joiris, 2010; le Bomin, 2010). Four adult males in particular were frequently listed and had high salience scores. Seven Aka adolescent females identified ten innovators in their free lists; two were females (one adult, one adolescent), two were adolescent males. Adolescent males were less likely to list female innovators than were adolescent females. Adolescent females listed both male and female innovators, listing more males than females.

In two different Chabu villages, with a combined population of approximately 150–200 people, 11 innovators were identified by 12 adolescents interviewed

Table 5 Aka adolescents' free-listing of innovators

Innovator	Sex	Age (est)	Innovation(s)	Σ	Composite salience Σ/*n* (*n* = 16)
1	M	32	Songs/dances	10.90	0.68
2	M	25	Songs/hunt/baskets for men	6.82	0.42
3	M	30	Songs/dances/basket	5.93	0.37
4	M	50	Drums	5.76	0.36
5	M	30	Knife/basket	3.58	0.22
6	M	35	Plant medicine	2.42	0.15
7	M	18	Men's work song/dances	2.42	0.15
8	M	18	Song/dance	1.67	0.10
9	M	25	Songs/dances/baskets	1.20	0.08
10	F	20	Female baskets	1.17	0.08
11	M	50	Men's basket	1.00	0.06
12	M	30	Bag	0.83	0.05
13	M	25	Baskets	0.80	0.05
14	M	40	Organizes big ceremonies	0.33	0.02
15	F	17	Female baskets	0.33	0.02
16	M	30	Drums	0.17	0.01

Table 6 Chabu adolescents' free-listing of innovators

Innovator	Sex	Age (est)	Innovation(s)	Σ	Composite salience Σ/*n* (*n* = 11)
1	F	28	Pottery	5.00	0.45
2	F	40	Pottery	3.42	0.31
3	M	25	Songs/guitar	2.33	0.21
4	M	70	Hunting /light spear	0.67	0.06
5	M	35	Baskets (fishing)	1.25	0.11
6	M	40	Knives/spears	1.33	0.01
7	F	25	Pottery	1.00	0.09
8	F	30	Pottery	1.00	0.09
9	F	35	Baskets	1.00	0.09
10	F	30	Pottery	0.75	0.06
11	F	35	Pottery	0.25	0.02

(Table 6). Contrary to predictions, and to what was found with the Aka, Chabu adult females were somewhat more frequently mentioned as innovators than males. Specifically, four of the innovators were males (ages 23–70 years) and seven were females (ages 28–45). A 28-year-old female in particular had the highest salience score from the free lists of both adults and adolescents. However, female innovators appear to be domain-specific and related to recent integration into a market economy in which new pottery designs ("*gauche*") made by the women has generated a good cash income. The six adults who were also asked to identify innovators were not included in Table 5. However, their free-listing mirrored the adolescent free-listing of innovators—the exception being that the adults did not list M 3, a 25-year-old male known for making guitars and songs, as high as did the adolescents.

Predictions 2 and 3 Adolescents will seek out (2) knowledgeable local adolescents with innovation (horizontal transmission) versus (3) more knowledgeable/skillful adults other than parents (oblique transmission) to learn complex innovations.

Innovators and those seen as most skilled or knowledgeable were adults other than parents; most initial transmission of new knowledge or invention occurred obliquely. For instance, interviews with the Chabu adolescents revealed that in *all* cases in the free-listing data sets, adolescents sought out skilled or knowledgeable adults other than parents from whom to learn. Adults (mostly young adults) were more prone to be sought out for their "better-than-average" knowledge/skills and then copied.

Generally, adolescents were seeking to refine and improve skills or techniques they had acquired from their parents as children (e.g., how to make a trap or pot, or build a house) rather than learning an entirely new skill. Some examples:

> I go to learn from her [the innovator]. I learned from my mother. But some things she did not teach me, so I went to her [the innovator] to learn the best

way. To make sure my mother taught me the best and correct way. (Chabu female adolescent)

My mother teaches me everything, how to make pottery. I go to S to learn a new design, I go to learn more from her, things my mother did not teach me, to make sure I have learned the best way and correct way. S is better at making pottery; she is a good teacher, she teaches everything she knows and everyone comes to learn from her. She teaches very slowly so it helps to learn fast, while she is showing how she explains carefully. S is the best at making pottery so I learn how from her. (Adolescent Chabu female)

I learned how to hunt from my father. But I learned to make the new spear from A. He taught us how to make the new spears. He took us to the forest, showed us the proper wood to use and how to cut it and prepare it for a spear. He took us hunting with him to learn how to use the spear. (Chabu male adolescent)

My father taught me by building my house (dhipo) alongside him. He showed me and I watched. My father taught me how to make a beehive; he showed me and told me how to do it. If I made a mistake he undid it and had me do it again. Now I have gone and asked an older person who has a very good house how to build. The walls and roof are better. (Chabu adolescent male)

Similar results were found among the Aka in informal interviews and observations of teaching–learning sessions with ten adults, including five adult "innovators" and 20 adolescents. Aka adolescents said they learned innovations from adults other than their parents (oblique transmission) rather than other adolescents. As a young Aka female explained,

The *bokala* and *ngondo* learn from adults. They want to learn because they want to know to have experience and knowledge in life . . . to help them live better. . . . They (bokala) choose someone (innovators/specialists) who has the best knowledge of dancing, singing, or to make a basket, find food, and if they see someone like this they chose them because they have the knowledge to teach. *Ngondo* and *bokala* want to learn things from the older people because they have many experiences and knowledge. . . .

An Aka adolescent male said,

When I was young my father taught me how to climb the tree, to net hunt, to fish, to find yams. . . . I choose people to learn from who do good things, the best thing. It is important because I want to learn this knowledge from men who have special knowledge, the best.

Adults other than parents, for both groups, were free-listed by adolescents and included those considered to be the best or most skilled at performing the new task (and often noted to be the "best at teaching"), suggesting skill-based biases.

Table 7 Adolescent and adult salience analysis of free-listing data of innovator attributes

Aka			Chabu		
Attributes	Σ	Σ/*n* (*n* = 20)	Attributes	Σ	Σ/*n* (*n* = 18)
Quiet	8.61	0.43	Good	6.67	0.74
Kind	5.80	0.29	Generous (with time and knowledge)	4.09	0.45
Wise	7.08	0.35	Peaceful	2.49	0.27
Happy	5.75	0.29	Shares (e.g., food)	2.42	0.26
Advisor	5.27	0.26	Hard worker	1.92	0.21
Intelligent	3.52	0.18	Loves people	1.00	0.17
Good	2.47	0.12	Kind	0.25	0.11

Predictions 4 and 5 Adolescents (4) desire to learn new skills and knowledge efficiently and (5) will therefore seek out innovators who are very successful, generous, good teachers, and of the same sex.

The attributes of identified adult innovators included descriptions by others of generosity and willingness to share skills and knowledge. Aka and Chabu adolescents and adults described innovators in free lists as people who work hard, who had the "spirit to create" and were "different from others" (Table 7). The Aka male and Chabu female innovators with the highest free-listing composite salience scores (0.68 and 0.45, respectively) were also most often described by the adolescents as having highly valued personal characteristics. For the Aka, this meant being quiet, kind, and wise; for the Chabu, being good, generous, and peaceful. They were also known as good teachers and having highly sought-after skills (for Aka, songs, dances; for Chabu, pottery designs). Innovative people were more likely said to be concerned about others' well-being and were willing to teach others in order to help them. As an Aka male identified as being an "innovator" explained,

> I started to create songs when I was a child. I continue because this is a good thing. Music is important because it is a pleasure, it gives people courage. I make songs to teach. I teach the children to love their parents because the parents are the ones who take care of you. I sing about *djengi*, "Don't forget the people," I sing about people not fighting, people must be peaceful. Songs are to teach. (E, a 25-year-old male innovator)

> I create many songs and dances. I called all the men and boys together and taught them this song . . . it is to give them the idea to work. They slept too much and seemed weak and I sing to get men to work (M, a 32-year-old Aka male innovator)

> You [an innovator] have to be good and wise . . . and don't imitate your neighbor, create new things. First, I want to be responsible and give people pleasure. . . . It gives me pleasure to make people happy. It takes time to create . . . it has to

> be quiet so I can think well. To create is good, to know many (types) of medicine to help sickness, to help heal people. (E, a 30-year-old male innovator)

> People who are like this [innovators] are different because they try to do something to help people. The person who created the knife helped people to cut meat and *koko* leaves. I created a special basket . . . and it helps people to carry because it is too hard to carry (things) in their hands. It [basket] has to be special so that it lasts for people when they carry their things. Other baskets break so I made mine strong to last. (M, a >25-year-old innovator)

Being selective in who they learned from, specifically electing to learn from those who were competent teachers, in addition to being generous and kind, was important to the adolescents. Several Aka adolescents mentioned they regarded a particular adult as being an innovator with superior knowledge and skills, but chose not to learn from them because they were either "not good" at teaching or were "loud" or taught "too quickly." High-fidelity transmission of complex cultural practices and beliefs best transpires when high-quality teachers are transmitting the knowledge.

Chabu individuals identified as innovators and sought out by the adolescents were also the most likely to be described as "good teachers." As a Chabu adolescent female explained, "She is a good teacher; those who want to learn go to her home, watch, and she shows them. They ask and she tells them how. People watch when she is making pots. There is no payment; people are grateful. She is a specialist." As another young Chabu adolescent girl explained, an innovator "is a good teacher; she is not angry if I make a mistake. She is *danka ufa* [a good person]." The Chabu adolescents described a "good teacher" as a person who was patient, who explained carefully, corrected mistakes, or demonstrated a task until the "student" could proficiently perform the skill. Innovators known as being good at teaching were highly sought after by the adolescents, as were those who exhibited prosocial characteristics (e.g., kindness, generosity, empathy), paralleling the attributes of good teachers mentioned by the Aka adolescents: "She is patient. I heard from others she is a good, patient teacher so I went to her to learn."

> She is a very good person. There is no one else like her here in this village. Her willingness, she gives whatever she has to others. She is generous. People go to her for her love. She is a person who loves more than others . . . *teng-uti.* (Chabu adolescent)

The innovators indicated that they wanted to share and transmit their skill or knowledge to others because they had a sense of responsibility to help others so "they can become good in their life." Another innovator expressed a similar sentiment: "I teach people . . . so they can take care of themselves in the future. . . . Angdhatta people love more than others, they have more love; this is why I teach."

However, among the Aka, not all innovators altruistically shared and transmitted their knowledge or skill, and some would charge a "fee" (e.g., money, necklaces,

chicken, an ax, or pot) for their "owned knowledge" (see Hewlett, 2013; Lewis, 2015). And innovators seemed to benefit in other ways as one young adult explained:

> My father told me to create songs and dances because I am a man and one day will have children. If I create songs and dances, I will be able to take care of my family. My wife wanted to marry me because I sang and danced well. We married when I was a bokala. Many women loved me.

Aka adolescents were more than willing to pay for the specialized skill or knowledge, to learn from those they regarded as the best at creating songs, dances, and new craft technologies. "M is the *njamba*, the best. I have paid to learn *djengi*; he taught me the new song. I paid him a *makodi* (necklace) and 1,000 CFA (Central African Franc), to find girlfriends." An Aka adolescent female also related that she too had paid to learn. "I paid him because I used his time and I wanted to learn his special knowledge." Although Chabu adolescents expressed a willingness to compensate their teachers, those they regard as the best at creating and those they identified as "owners" of the new technology or idea, unlike among the Aka, they were not asked to pay for this knowledge or for the time spent transmitting a particular skill.

Adolescents' choices of individuals from whom to learn were based on types/complexity of skills being taught and the innovativeness of the person. All were adults (save the two Aka and one Chabu male adolescents); most were innovators. Among both groups, the adolescents not only identified the most skilled, the best teacher, but also when and what they desired to learn. Learning, for the Aka and Chabu adolescents, was self-directed:

> I choose to learn from people who do good. I choose the best thing. It is important; I want to learn from people who have special knowledge. (Aka adolescent female)

> If he [Aka male identified as innovator] organizes a dance here, many people come to learn. They know because of the drum; the drum announces and then they come. They come because he knows many things. He knows medicine and people come and we are next to him. When he hunts, we are next to him; when he goes into the forest we are next to him. We learn many things and become more. (Aka adolescent male)

> I choose who to learn from, and if I see someone who knows better how to make a song or a basket, I approach them to learn from this person who does the best. Bokalas like to learn because they are free. It is important for bokalas to learn to prepare; when they will be married and get a family, they will be able to keep life. (Aka adolescent male)

Finally, there was a same-sex bias in terms of whom the adolescents chose to learn innovations from. Both Aka and Chabu adolescent males choose adult males to learn from: "the best teacher is a brave one, one who teaches everything he knows, the new things. Adult men are the best teachers" (Chabu adolescent male). Likewise, adolescent females choose specific adult females to learn from; however, they

did list adult males from whom they learned dances and songs. Both Aka and Chabu adolescents typically did not choose their parents to learn the innovative skills from, but rather those who had a reputation as being a good teacher and innovator.

Prediction 6 Teaching is more efficient for learning complex skills and knowledge than observation and imitation; therefore, teaching complex innovative skills and knowledge should be common.

If teaching is more efficient than observation and imitation only, then teaching of complex skills and knowledge is expected to be a common feature of social learning during adolescence. The Aka language includes very specific words encompassing processes of teaching and social learning: *vézâk*, to learn; *pézâk*, to teach; *búnd*, to watch/observe; *támb*, to practice; and *péz*, to show. Aka adolescents were asked during semi-structured interviews how they learned the innovative skills and tasks from the innovators they listed (Table 8; see Table 1 for definitions of processes).

In the following quotes, adolescents describe the teaching process (italics mine):

> His [M, an adult male innovator] drumming and singing is good. *M tells me to watch* and after, M gives me the drum and *says,* "*Do this*," and when I drum wrong, *he corrects me.* (Aka adolescent male)

> I choose people to learn from who do good things, the best thing. It is important because I want to learn this knowledge from men who have special knowledge, the best to learn how to make the drum. N *first showed me* then *took my hand to help me*. (Aka adolescent male)

> *I watched him*, M [specialist in basket making], every day. *He took my hand* and *showed me*, I wanted to learn so I make a good basket and people will come and buy this and I will make a good life. I paid E [who makes special/traditional bags] 1000 CFA to learn to make this. *I was near him* and when he was making the bag, *he took my hand and we made it together*. He found the vine of making the bag and put it into the sun to be strong, to make the bag strong and hard. I chose him because his way of making the bag is the best. (Aka adolescent male)

Innovators were also asked to describe how they taught the adolescents:

> When I want to teach someone, they are *next to me and see* how I make it and *I tell them how*. First I make a small amount, then *I give it to them to try*. When they make it *wrong I take it and make it again* and they see and after *I tell them to try again*. (M, a >25-year-old male innovator)

> When I am singing and dancing and people want to learn, I say, "watch how I do this, how I sing and how I dance" and I have them try and I watch them, and if they make a mistake I repeat it again, I repeat, repeat, repeat until they get it correct. (E, a 30-year-old male innovator)

Table 8 Frequency of processes of transmission mentioned by Aka adolescents when learning innovations ($n = 18$)

Domains	Processes						
	Observation and imitation	Imitation only	Teaching only	Teaching with			
				Demonstration	Direct physical proximity	Correction	Storytelling
Manufacturing							
Baskets	2				4		
Knives	1						
Drum					4		
Cultural practices							
Dance/song together	16		12	15	4	6	3
Miscellaneous skills							
Hunting				4			
Gathering				3			
Cooking	1						
Drumming	2					1	

> I call the people all together and *teach them little by little*. *I sing a little* and *have them sing it back to me*. *I repeat it back*, then they repeat it back until they get it correct. (M, a 32-year-old male)

Observation and imitation with limited verbal instruction of a new trait (i.e., the adolescent observes and imitates the adult, who demonstrates the task and gives very little verbal instruction) was mentioned sixteen times during the learning of the tasks in which the adolescent was taught a novel behavior or skill. Teaching with *direct physical proximity* (e.g., adult innovator sits by the adolescent, demonstrating a technique, then has the adolescent perform the task and guides the learner's hands in the correct method). "I watched, then E took my hand with the bag and together we made it" (Aka adolescent male). This process was reported by the adolescents as occurring four times during the learning process (manufacturing a drum or basket), much less frequently than either observation with verbal direction or observation, demonstration, and imitation (which typically occurred sixteen times). For definitions of domains, modes, and processes of social learning, see Garfield et al., 2016.

Aka adolescents described a diversity of other social learning processes. Teaching was described twelve times. Teaching with demonstration was more common than other methods when the adolescents were learning singing and dancing. Often the teacher would demonstrate a song, or dance movement and then have the student repeat the same task until it was correctly reproduced. In the Aka culture, music and dance are particularly pronounced. They have a reputation as being the best singers and dancers in central Africa. The polyphonic singing in particular communicates culture—the values, beliefs, desires, actions, locations, and objects important to the Aka people. As a form of cultural transmission, the language of music and sound communicates more than the surface meaning of the words. Discourses of sound and song representing cultural realities carry a web of meanings and complex knowledge. Furthermore, this musical "language" carries action—the action of social learning, gendered discourses, cultural and political practice, and ideological subtext. Metaphorical song, dance, and storytelling serve to bind together, inform, and define the lives of the Aka (Arom et al., 2008; Fürniss & Joiris, 2010; le Bomin, 2010; Lewis, 2008).

The Chabu language, as with the Aka language, includes very specific words encompassing processes of teaching and social learning: *temare*, to learn; *e'tote'*, to teach; *yeayeah*, to watch; *doya*, to practice; and *yemba*, to show. Twelve Chabu adolescents (and five of the adults) very specifically described processes of social learning that included observation ("I watched her many times before I tried to make the pot *gauche* by myself") and imitation of technique, such as seeing a new pottery design and imitating the trait. Nine of the 12 adolescents specifically mentioned watching as an adult demonstrated a particular skill while giving verbal instruction, such as "Do it like this, *ekukum* (the correct way)." Adolescents also reported receiving direct instruction from an adult innovator who was demonstrating a technique. The adolescent then performed the same task and the adult suggested/showed the correct method (Table 9).

Adults also mentioned how they were taught as children:

Table 9 Prevalence of processes of transmission mentioned by Chabu adolescents ($n = 12$)

Domains	Processes				
	Observation and imitation	Teaching only	Teaching with		
			Demonstration	Direct physical proximity	Correction
Manufacturing					
Pottery	5		4		3
Spears/knives	1	5	2	2	3
Guitar	1		1		1
Cultural practices					
Dance/song together			1		1
Miscellaneous skills					
House building	2		2		2
Beehive building	1		1		1

> I learned how to make pottery from *watching* my mother. My mother would have me make a pot while she watched, and *she corrected if I made a mistake*. I learned this when I was very young. I sold my pots at the market when I was a young *kota*. After my marriage people began to notice my pots with the new *gauche* (design she created) and I became known as a specialist. (S, a >28-year-old female innovator)

This style of directed teaching demonstration in close proximity (not to be confused with "hand-to-hand") and teaching with verbal instruction/correction was not as common as observation and imitation, being reported by only three individuals, and in those cases seemed to be used to teach more complex skills:

> My father brought me to the forest to collect materials. He showed me the good wood and the bad wood. We came back to the village and *he showed me* how to build a good house. *I watched my father working and I helped*. My father warned me when I built incorrectly, *he would take out the bad way and do it correctly and make me do it also*. We built my house together. I built alongside my father. (14-year-old male)

> M [male adolescent innovator of songs] *sings and then I sing after* and M *corrects me if I make a mistake* and *he sings it again*. His songs are about the Chabu and Chabu language. (adolescent male, 12–14 years old)

> She invited me to her house to *watch her make* the new design. When *I made a mistake, she was watching and she corrected me*. She would complete the design if I made a mistake. She teaches very slowly (*laquka ezagen*). While she is showing us, *she explains carefully.* (13-year-old female)

Often the adolescent would observe the task multiple times and then practice at home, coming back to show their various attempts to the teacher, who would make suggestions until it was correctly reproduced. "He shows me how to make a guitar. I watch and then I make the guitar in my own house and then show him what I have done. *If I make a mistake he corrects me*" (19-year-old young man).

Adolescents often related how they not only sought out those with expertise or special knowledge or skill, but, as noted earlier, they also sought out the "best" teachers—those who were patient, taught slowly, gave directed instruction, and ensured the student correctly performed the new task, particularly when learning new pottery designs. Qualitative and quantitative data suggest that because of their recent integration into a market economy, Chabu adolescents (females especially) are particularly likely to learn from adults other than parents and learn through observation, imitation, and directed teaching.

During childhood, less-complex skills taught vertically were "practiced" for some time and then built upon during adolescence. Many times, the adolescent, among both Aka and Chabu, had prior knowledge and skill learned from a parent, but they reported seeking out those who were more skilled, innovative, or knowledgeable in order to refine the skill. Additionally, increasingly complex skills were generally taught obliquely (by adults other than parents) and from "the best," often those identified as innovators.

Finally, an interesting theme emerged from the interviews with the Aka and Chabu adolescents—that is, the importance of knowledge acquisition during this time in their lives. The majority of Aka adolescents listed mate attraction as a prime reason to learn innovative skills, and as noted earlier, they were sufficiently motivated to pay a fee to the owner of the knowledge to teach them particular skills. Several adolescents explained,

> M sings and I listen and repeat them; together we sing. . . . Many are *bokala* who do this to learn new songs and dances because they do this so many women will love us. Girls are interested in me and I found a girl because of learning this new song and dance. It was costly to pay a knife and ax but I am not sad. (young Aka male)

> He [N, a male innovator] taught me a dance and charged me 1000 CFA. I paid this because it was a good dance and song. It made me happy. I wanted to learn this because boys would notice me. (Aka adolescent female)

Aka adolescents often mentioned that adolescence was the time to learn new skills, dances, and songs because learning was a means to obtain a "good life." An older Aka adolescent male explained,

> *Bokala* (adolescence/adolescent males) want to learn new things more than older people or young people (children) to be successful in making a basket or cooking or hunting. We learn there are new ways to live; in life you have to know new things. You learn when you are young. . . . It is good for our life now to learn new ways. When you learn something, you get knowledge of life.

Another adolescent added, *Bokala* is the time to learn for your life. Old people learn too but it is difficult for them to understand very quickly because they have hard heads, but *bokala* and *ngondo* (adolescent females) have quiet heads. It is easy for *bokala* to understand things, but older people have . . . families and children. When you are *bokala*, the head is quiet and you are free to learn.

Aka are often taught about specific knowledge in association with varying life stages. For example, puberty and menstrual blood are associated with many taboos and are often entry points for learning more about the supernatural (Lewis, 2008). A young adolescent Aka girl explained,

> My parents did not teach me this when I was too little and did not have knowledge, but when I was older . . . I was given knowledge. . . . This knowledge comes from both your mother and father, from grandparents to grandparents. It is passed down generation after generation.

The young Aka adolescent girl then provided a lengthy list of her taboo foods, taught to her around the time of her first menses.

Chabu adolescents more often cited independence from others as being the motivating factor. A 13-year-old Chabu male said, "It is important now to learn to be self-sufficient, to be independent without seeking the support of others." Not to say that mate attraction was not on their minds: "I want to be *dhiwe ufe*, a popular man, to do things well and have lots of girlfriends" (14-year-old Chabu male).

The importance of Chabu adolescence as being a time of learning, as the Aka expressed, was notable among the conversations with males and females, as well as the decision about what to learn, as the following quote suggests: "Deciding what is most important to learn is the best quality of an *attine* (adolescent)," said a 13-year-old Chabu male. Adolescents from both groups were well aware of the importance of learning from those most proficient at particular skills, including innovations, in order not only to attract a mate at present, but to gain skills and knowledge enabling them to provide for their future families.

Adolescents in both communities were particularly interested in attracting a marriageable partner and establishing the means to prepare for the responsibilities of significant subsistence contribution, parenting, and marriage, the "good life."

Discussion and Conclusion

Innovation has been hypothesized to increase not only individual fitness and adaptability but also the diversity of cultural traits/cultural variants over time (Reader & Laland, 2001). Human adolescents are at a key point in their development: possessing social and cognitive abilities, learning and problem-solving skills, risk-taking and exploratory behaviors, and engaging in reputation building, mate attraction/selection and social network building (Hewlett, 2013). It is little wonder then that adolescents are eager to seek out socially valued innovative skills and knowledge from those seen as "successful." Adolescents search for competent teachers and

creative innovators because that knowledge potentially serves to increase their learning, social rank and reproductive success. Indeed, both groups of adolescents were adept at identifying the "best" or most skilled/knowledgeable adult and actively sought out those individuals.

Reader and Laland (2001) found patterns of male-biased innovation in nonhuman primates under a wide range of conditions and in varying environments; nevertheless, individuals vary in their degree of risk aversion in particular ways, and innovators, both male and female, are simply more tolerant of risk-taking and uncertainty (Henrich & Gil-White, 2001:8; Hewlett, 2016. Indeed, those Aka and Chabu individuals with the highly sought innovative skills, demonstrating greater incidence of innovative behavior, were male and female (generally nonparental) *adults*, not peers, unlike what was predicted. Innovative individuals, both male and female, are more willing to adopt a new trait based on limited (uncertain) evidence. Risk-taking for males and females in particular environments may lead to mating success and establishment of broader social-economic and "innovative" networks (Henrich 2001:8). However, among the Chabu, unlike the Aka, more adult females were listed as being the creators of new ideas and skills. Since the Chabu women produce highly valued and desired artifacts, such as pottery with *gauche* or innovative designs, which sells well at the local market, it is perhaps not surprising that women are listed more frequently as innovators. Thus, these data suggest that innovative gender bias is domain- and culture-dependent.

Although humans share a biological heritage with other animals, humans have characteristics that are seemingly unique, such as teaching (Csibra & Gergely, 2009) and over-imitation (Berl & Hewlett, 2015). These characteristics enhance the ability to rapidly acquire novel innovative behaviors and knowledge. Oblique modes of transmission were found with greater frequency among the Aka and Chabu adolescents than learning from parents (vertical transmission) or peers (horizontal transmission). This is related to frequency dependence; there are more non-parents than parents, and generally the adolescent's parents were not the innovators. During childhood, less complex skills taught vertically are "practiced" for some time, and during adolescence, increasingly complex skills are generally taught obliquely by adults other than parents. Adolescents are highly motivated to learn—not, as predicted, from other adolescents who have already acquired this knowledge, but from "the best" individuals, those often identified as innovators, generally from adults other than parents. Innovation builds on knowledge, practice, and experience, all attributes more common in adults than adolescents and children (Hewlett, 2016; Reader & Laland, 2001:802). Modeling studies suggest that cumulative culture will not occur in low population densities with limited migratory activity of subpopulations unless the offspring selects to learn from more knowledgeable (and numerous) adults other than parents (Powell et al., 2010:143).

Adolescents in both societies were quick to define and give examples of innovations, but it was the adolescents themselves who identified the adult innovators and chose many of them as "teachers." They furthermore chose not only from whom to learn, but *what* to learn: in other words, learning was self-directed (see Hewlett et al., 2011; Hewlett & Hewlett, 2013; Hewlett, 2016 for further discussion of self-directed learning among adolescents). And, more often than not, the innovators they

chose were known not only for being kind, generous, and willing to share their skills and knowledge with others, but for being good teachers. These prosocial qualities were attractive to adolescents because they enhanced the learning process.

The personality characteristics of innovators (e.g., goodness, kindness, and generosity) could be understood as features of prosocial individuals that also facilitated easy and quick learning, features highly valued among both societies. Henrich and Gil-White (2001) suggest that more skilled/knowledgeable older adults and generous individuals should also be identified as being prestigious and people will seek out those individuals. The innovators were invested in teaching others for altruistic reasons, as they felt a responsibility to help others. This investment in and demonstration of prosocial behaviors, such as cooperative teaching by the innovators, suggests strategies related to fitness payoffs (Gintis et al., 2003; Henrich et al., 2005; Hill, 2002; Inkeles, 2000) in that it appears from observational data that Chabu learners pay with "prestige deference" and "public praise." However, further research is needed to ascertain whether public praise of and deference to innovators serves to increase their reproductive fitness (e.g., health status of innovator, number and health status of mates and children compared with others).

While some Aka innovators request a small fee as owners of spiritual dances, Chabu innovators did not charge for the time they spent teaching and sharing their knowledge or skill, nor did they list monetary support or increased status as a motivation for teaching. Also, dissimilar from the Aka, motivations for the Chabu wanting to learn a particular, innovative skill included the desire to be independent of others and being able to provide for their present and future families. These data lend limited support to the argument that individuals want to keep "owned" knowledge to themselves, the "cooperative dilemma" (Henrich & Gil-White, 2001). Natural selection, Henrich and Gil-White argue, has acted to address this problem, in that learners pay those from whom they learn with "prestige deference." However, in an egalitarian foraging society such as the Aka, who practice prestige avoidance, this takes the form of "small gifts, willingness to help, coalitional support" but not, I would argue, with "public praise" as the authors suggest (Henrich, 2010:112; Hewlett, 2016). At least among the Aka, autonomy and creativity are socially valued, but public praise and deference to specific individuals are not.

Chabu innovators were also described as being more hardworking than others. As with the Aka, Chabu began learning and practicing skills of varying complexity from the time they are small children and are provided an environment in which practice is supported and encouraged by those around them. Thus, innovators have been "working" on particular skills for a long time, practicing from childhood. As the Chabu term *agadhatta* suggests, innovation both is and comes from hard work. Practicing tasks and skills from a young age (often manifested through "play") has important implications and benefits that go beyond teaching "practical techniques of use." It also encourages children and young adults to familiarize themselves with the cultural, social, and emotional contexts of the objects, songs, dances, skills, and knowledge shared with them (Spikins et al., 2014:127). Importantly, it is also a stimulus for creativity and innovation (Nielsen, 2012; Nielsen et al., 2012). Indeed, it has been suggested that a childhood of preparation, practice, and support is necessary for innovation to occur (Gladwell, 2013).

Aka and Chabu adolescents, as noted, chose not only from whom to learn, but also *how* to learn. The process of cooperative social learning of an innovative skill should most often be teaching since it is a more efficient form than observation and imitation alone (Gergely & Csibra, 2006; Gergely et al., 2007; Hewlett, 2016; Hewlett et al., 2011; Shennan & Steele, 1999). Informal observations and qualitative data indicate that observation and imitation of a new trait accompanied by direct instruction (e.g., the adolescent observes and imitates the adult, who gives verbal instruction) occurred in a majority of instances among both the Chabu and Aka. Also, similar to the Aka data, observational imitation (e.g., observing a pottery design and imitating it without instruction) occurred less frequently among the Chabu. Although direct imitation/copying of others is a powerful form of learning that allows new skills to be rapidly acquired, of note are studies that emphasize social motivations underlying selective and over-imitation among humans (Dijksterhuis, 2005; Nadel et al., 1999; Nielson et al., 2012). Over and Carpenter (2012) argue that choices about what to (over- and/or selectively) imitate tend to be based on the desire to "do as others do." Put another way, imitation is a social process, often done under social pressure, in which individuals copy in particular ways what particular individuals do. This could take place within familial relationships, or with individuals who are known within the social group in general.

Finally, the use of hand-to-hand instruction to teach an innovative skill was neither mentioned nor observed among the Chabu, whereas this method was recorded and mentioned frequently among the Aka adolescents (Hewlett, 2013). Various demographic and cultural contexts contribute to the different ways in which social learning occurs. Aka families, who live in groups of 10–30 in small huts circling a central area, are together often throughout the day. They know each other exceptionally well and cooperate in many activities on a regular basis. The Chabu families in this study, on the other hand, live in larger villages, with husbands and adolescent males sometimes living away from the family home. Chabu husbands and wives participate in relatively few joint activities and may be inclined to know each other less well (Hewlett, 2016). Gender roles and tasks among the Aka are flexible, the capabilities of each are similar, gendered tasks are shared, and gender roles are fluid. Preliminary research seems to indicate that Chabu gender roles and tasks are somewhat more fixed and seldom shared. The close communities of the Aka and Chabu each begin with the family, where the acquisition of cultural skills, socialization, production, and reproduction occur. However, one could suggest that the egalitarian nature of Aka society promotes high physical closeness, including physical proximity during teaching events (i.e., hand-to-hand instruction). Thus, adolescents' choices concerning from whom, how, and what to learn are not willy-nilly considerations but are powerfully informed by social dynamics, motivations, and rewards (Hewlett, 2016; cf. Over & Carpenter, 2012).

Different high-fidelity learning processes, such as the teaching, observation and over-imitation, participation, and practice described by the Aka and Chabu, enable the student to quickly learn skills and knowledge (Hewlett et al., 2011). Additionally, although natural pedagogy is a seemingly unique trait of human cognition, the Aka and Chabu data suggests that cooperative, directed teaching enhances the

faithful transmission of innovative traits between individuals (Csibra & Gergely, 2011; Hewlett, 2013; Hewlett et al., 2011). Lewis and Laland's cultural transmission modeling study has shown that increasing the fidelity of social transmission of cultural traits between individuals plays an important role in the development of cumulative culture (Hewlett et al., 2011; Lewis & Laland, 2012:2175). Interactions between knowledgeable adults and naive individuals as described here may help to provide an understanding of how processes of social learning are factors in both the conservation of and change in culture over time (DeBoer, 1990; Gosselain, 1998; Greenfield, 1984).

This study has assessed existing hypotheses about *from whom* adolescents learn innovative skills and knowledge and by what processes adolescents are learning. The literature indicates complex skills or knowledge is likely to be acquired through teaching, and it was predicted that teaching would be an important process in the transmission of innovations. In summary, the study found that (1) cultural context patterned whether or not adolescents sought out adult male or female innovators; (2) oblique modes of transmission were mentioned with greater frequency than horizontal or vertical modes; (3) knowledge and skill bias was notable and explicitly linked by the adolescents to reproductive effort; and (4) teaching was same-sex-biased and was an important but not exclusive means of transmitting complex skills and social knowledge.

Other questions remain. For example, why are some adolescents or adults more driven to innovate? And are there potential interactions between capacities and motivations? What is the variation of traits (e.g., experience, wisdom, advanced knowledge, and physical skill/fitness) among adults, kids, men, women? More data from small-scale populations in contexts that characterized most of human history are necessary. By looking to these foraging hunter-gatherer societies with innovative adults, reproductively prompted risk-taking, explorative adolescents, and institutions favoring innovation, we can formulate more precise understandings of innovation; what is identified as novel, and how this knowledge is socially transmitted and learned, as well as the implications this may have for the bigger questions we are asking (Barton et al., 2011:725; Lewis & Laland, 2012:2175; see also Henrich, 2010; Hewlett et al. 2011; Hewlett, 2016). It is my hope that researchers will continue to engage in multidisciplinary explorations of these and other provocative questions regarding social learning, innovation, and cultural transmission.

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Data Availability The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Declarations

Ethics Approval Certification of Exemption, IRB No. 12339. Based on the Exemption Determination Application submitted for the studies "Social Learning among Aka Adolescents" and "Social Learning among Chabu Adolescents," the WSU Office of Research Assurances has determined that the study satisfies the criteria for Exempt Research at 45 CFR 46.101(b)(2). This study was conducted according to the protocol described in the Application and reviewed by the IRB.

Consent to Participate All informed consent forms, both written and verbal, were obtained from individuals to participate in the study prior to study and were freely given from participants (or their parent or legal guardian in the case of children under 16).

Consent for Publication The author affirms that human research participants' parents provided informed verbal consent of Figs. 2 and 3.

Competing Interests The author declares no competing interests.

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