7 Playing with Knives: Children's Learning, Cultural Niche Construction, and the Evolution of Technical Flexibility

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Introduction

For this project, the other authors and I have been asked to think about flexibility and rigidity in the production and reproduction of technical skills. In this volume, the subject is addressed from a diversity of perspectives and from the scale of individual cognition (Pope-Caldwell, this volume) to the social group or species (Astuti, this volume; Stout, this volume). My contribution lies in a middle ground and focuses on the interplay between the individual and the environment in the context of children's learning of technical skills across childhood (Gauvain 2005b; Greenfield et al. 2003). This approach draws from cultural niche construction theory. Niche construction is a coevolutionary theoretical perspective that links behavior and the environment as interacting forces of evolutionary change (Laland, Odling-Smee, and Feldman 2000; Odling-Smee, Laland, and Feldman 2003). Specifically, organisms are observed to change their environments through their actions in ways that can then change selective pressures acting on them. *Cultural* niche construction refers to the powerful ways in which humans construct spaces, ideas, and artifacts within lifetimes and across generations that shape how we develop and behave, including how we further change the environment (Laland and O'Brien 2011; Sterelny 2004; Stotz 2010). In this chapter, my central claim is that through cultural niche construction, specific regular features of children's developmental contexts can facilitate learning of complex technical skills with great flexibility in the learning mechanisms.

I situate this claim within debates on the evolution of cultural learning and on cultural variation in children's learning contexts. I then draw on data from my fieldwork among BaYaka people in the Congo Basin and describe how stable features of the BaYaka physical and social environment allow children to learn to expertly use blade tools like knives and machetes to perform a huge range of daily tasks with very little direct input from their elders.

First, my understanding of "flexibility" and "rigidity" in regard to technical skill learning is informed by interdisciplinary discussions of the evolution of the human capacity for cumulative culture (Boyd and Richerson 2005; Dean et al. 2014; Laland 2017; Tomasello 1999). In this literature, humans are seen as having constructed a technically complex niche in which adaptation to the environment relies on "high fidelity" social learning mechanisms to reproduce technical skills, some of which have been modified over generations (hence

the "cumulative" nature of such culture). Here, "high fidelity" means that a learner can reproduce a behavior with relatively few errors. As such, imitation (Gergely and Csibra 2006; Hoehl et al. 2019; Nielsen and Tomaselli 2010) and teaching (Boyd, Richerson, and Henrich 2011; Csibra and Gergely 2011; Morgan et al. 2015; Strauss and Ziv 2012; Tomasello et al. 2012) are typically regarded as critical "high fidelity" social learning mechanisms for the reproduction of the sometimes-opaque technical skills that have been central to human evolution. While undoubtedly critical to our success as a species, these mechanisms are theoretically and empirically associated with costs in terms of individual- and population-level flexibility. For example, there is the theoretical possibility of imitating behaviors that are maladaptive in current or future environments (Boyd and Richerson 1995; Enquist, Eriksson, and Ghirlanda 2007; Rogers 1988). Additionally, teaching entails opportunity costs for teachers, who might be better off applying their skills instead of sharing them (Fogarty, Strimling, and Laland 2011; Thornton and Raihani 2008). Moreover, while teaching is adaptive because it saves the learner time and energy by directing their attention to specific information to be learned, it has also been shown to constrain learners' exploration and innovation (Bonawitz et al. 2009, 2011).

Thus, in order to build and maintain complex technical traditions, humans must balance the benefits of high-fidelity social learning against the costs of teaching and of filtering out techniques that are poor fits to the current environment. We must also remain flexible in the face of environmental change—being ready to apply technical traditions in new ways or create new ones. In this chapter, I explore how our very capacity for creating material change in the environment through complex technical innovations, along with our unique sociality and life history, creates feedback that can support high-fidelity (i.e., rigid) reproduction of technical skills with great flexibility in how children learn them. I also show how variation in our culturally shaped environments can enhance or constrain this flexibility, with implications for how technical skills are distributed in communities of learners.

Culturally Constructed Contexts of Learning

Cultural niche construction was likely a dominant force in human evolution, perhaps at least since tools became a regular and increasingly diverse feature of hominid economic and social life (Jeffares 2012; Sterelny 2004; Stotz 2010). Theorists tie the use of and reliance on tools (broadly defined) with the evolution of developmental systems of social cognition (Dean et al. 2014; Tomasello 1999), which likely also coevolved with brain size as well as changes in ancestral human social systems that began to favor central-place foraging (Kuhn and Stiner 2019; Stiner 2021), cooperative child-rearing, altricial birth, and an extended childhood period (Burkart and van Schaik 2016; Hill, Barton, and Hurtado 2009; Hrdy 2009; Kramer 2010; Sterelny 2012). As a result of this coevolutionary history, typically developing human children are equipped with the fundamentals that facilitate acquisition of technical skills: the ability to infer the goals and intentions of their tool-using elders and an environment populated by the material basis of learning and a variety of models to learn from.

These fundamentals aside, culturally constructed developmental contexts (Flynn et al. 2013; Kendal 2011; Super and Harkness 1986) vary in the accessibility of materials for technical learning (Lancy 2016b), in how experienced, capable, and willing children's models are (Morelli, Rogoff, and Angelillo 2003), and in the dominant behavioral processes through which children "learn to learn" (Glowacki and Molleman 2017; Mesoudi et al.

2016). Variation in these dimensions influence, at the individual level, children's approach to learning and their familiarity with their society's cultural repertoire, and at the community level, a group's flexibility in the face of environmental change.

For instance, several researchers (Lancy 2012; Lave and Wenger 1991; Mead 1970; Ochs and Izquierdo 2009; Scribner and Cole 1973) compare what Barbara Rogoff and colleagues (Rogoff et al. 2003; Paradise and Rogoff 2009) call learning through "intent participation" with the tradition of formal school-based learning. The latter tradition is dominant in industrialized and postindustrial contexts where households are typically isolated and children's daily experiences are spatially separate from their parent's economic and social activities. In these contexts, learning is conceived of as a formalized, objectified, and decontextualized process; language is the nearly exclusive means of information exchange; learners are age-graded and have little interaction with children of other ages outside the home, and they are situated in hierarchical relationships with teachers, parents, and other adults who are the sole sources of cultural knowledge (Lancy 2016a; Rogoff et al. 2003; Scribner and Cole 1973). The material basis for learning everyday domestic tasks (e.g., using pots, knives, cleaning tools) as well as work in the public sphere (e.g., tools, computers) are often off-limits to children, who are given their own material culture (Lancy 2008; Morelli, Rogoff, and Angelillo 2003). While children certainly learn from observation in such contexts, there may be relatively little regularity in approaches to teaching or in specific cultural knowledge or behavior among models observed across the complex and diverse contexts they experience daily (Ochs and Izquierdo 2009), and there may be limited opportunities to apply what they observe (Morelli, Rogoff, and Angelillo 2003).

More research is needed to understand the specific mechanisms, but children who grow up in these contexts emphasizing formal school-based learning tend to be more extrinsically motivated (Coppens and Alcalá 2015; Ochs and Izquierdo 2009) and attend only to teaching directed at them, following this closely rather than exploring alternative possibilities (López et al. 2010; Shneidman et al. 2016; Silva, Correa-Chávez, and Rogoff 2010). Such a learning style may be effective at preparing children for an environment in which survival is based on specialization within a highly competitive, meritocratic labor market (Bowles and Gintis 1977, 2002). However, there are reasonable concerns that this relatively rigid and costly educational tradition amplifies social inequalities (Croizet et al. 2019; Jackson and Holzman 2020), is inflexible with regard to learning differences (Cainelli and Bisiacchi 2019; Shifrer 2013), and leads to decreases in mental health and children's well-being (Boyce et al. 2012; Gray 2013; Narvaez et al. 2012).

In contrast, the "intent participation" tradition is typical of small-scale subsistence societies where children are embedded in the daily economic and social activities of their communities. As such, children can learn the norms, practices, skills, and knowledge essential to life in their community through observation and legitimate participation, with teaching used sparingly for abstract or specialized tasks or symbolic knowledge (Gaskins 2000; Lancy 2010; Maynard 2002; Rogoff et al. 2003). Through intent participation, children's learning is embodied and affectively linked to its performance alongside close family, friends, and neighbors, and it is often scaffolded within collaborative learning within mixed-age child groups (Whiting and Edwards 1988). These social learning processes seem to facilitate the development of both an internal motivation to learn through helping others in their work and an open attentional stance in which children learn readily from observation, collaboration

with others, and listening to others being taught (Correa-Chávez and Rogoff 2009; Gaskins and Paradise 2010; López et al. 2010; Mejía-Arauz et al. 2007; Silva, Correa-Chávez, and Rogoff 2010).

Barry Hewlett and I (Boyette and Hewlett 2017) note that there is also variation across intent participation communities in the organization of learning. In particular, among many small-scale farming and pastoralists societies, children are typically expected to be obedient to their parents and other elders (Erchak 1980; LeVine et al. 1994), such that their learning is within the context of task assignments by elders oriented toward supporting the family economy. As obedience and correct behavior is normatively valued in such contexts, parents use more direct instruction and rigid behavioral control in their teaching. For example, Boyette and Hewlett (2017) measured a small but statistically significant difference in the amount of direct instruction received by farmer children compared to Aka forager children. Indeed, forager parents highly endorse their children's autonomous learning in most domains (Boyette and Lew-Levy 2021; Briggs 1991; Naveh 2016), and though they often assign tasks as a means of teaching, compliance is not expected (Boyette and Lew-Levy 2021; Johnson 2003).[1] My claim here is that such variations in the learning context (e.g., cultural models of learning) are part of the culturally constructed niche in which technical skills are socialized (table 7.1).

Of course, there is enormous variation in cultural models of learning within school-based learning societies as well (Kusserow 2004), and some alternatives to the stereotypical pattern I described above parallel aspects of the intent participation tradition (Gray and Feldman 2004; Lillard and Taggart 2019). As suggested in table 7.1, a relative reliance on rigid versus flexible social learning mechanisms may scale up to influence how flexible communities are able to be when confronted with environmental change. A full discussion of this variation is beyond the scope of this chapter; however, I would suggest that an investigation of how such variation is related to flexibility in response to environmental change is an area in need of investigation. For now, the case study that follows focuses on the ways in which cultural niche construction by BaYaka foragers flexibly facilitates learning of complex technical skills.

Learning Blade Tool Use

Unfortunately, there are few empirical studies of cultural niche construction as such. In the following case study, I focus on children's acquisition of nonhunting blade tool techniques to illustrate how the processes of cultural niche construction can facilitate high-fidelity learning. I focus on nonhunting blades for several reasons. Hunting tools and the techniques involved in their use are, arguably, not as flexible as the use of other types of blade tools, as they have been crafted for more specific purposes (e.g., the pursuit of specific types of game in specific ecologies). Additionally, hunting techniques are also typically learned later in life and not necessarily mastered until the third decade of life (Koster et al. 2020). Furthermore, hunting techniques are typically learned by males, with young male foragers already showing a greater interest in hunting than females from early childhood. Adults endorse this gendered division of activity interest (which supports the gendered division of labor) by giving males toy hunting tools and girls toy foraging tools (Lew-Levy et al. 2018).[2] Finally, nonhunting blade tools are perhaps more evolutionarily relevant, since it is likely that early hominid stone tools were general purpose and not used for the types of pursuit hunting common today (Plummer 2004). Thus, a focus on the acquisition of nonhunting

Table 7.1
Cultural learning contexts and their hypothetical implications for learning technical flexibility

Culturally constructed learning context	Accessibility of materials	Accessibility of models	Dominant social learning processes	Hypothetical implications for cultural learning of technical flexibility
Formal schooling (industrial model, Western, decontextualized)	Few materials freely accessible; toys and learning tools (often standardized) used to enhance cognitive flexibility, not practical, embodied know-how	Limited; parents in domestic spaces; teachers in school; variable regularity across contexts	Teaching, rigid adult-led scaffolding, competitive motivation, play	Limited opportunities for embodied learning; high specialization; *individuals learn narrow technical repertoire; may limit community flexibility with adaptation requiring coordination across multiple, specialized institutions*
Intent participation—hierarchical (e.g., small-scale farmers, pastoralists)	Highly accessible; child-sized tools as early scaffolds	Highly accessible; extended family most available; little separation from adult and child spaces; high regularity across contexts	Observation, play, adult-mediated participation, collaboration, teaching of specialized skills	Many opportunities for embodied learning of critical skills; open learning stance; *individually flexible; community may be less flexible as result of subsistence specialization*
Intent participation—egalitarian (e.g., some contemporary mobile foragers)	Highly accessible; child-sized tools also used	Most accessible; residential community available; little separation from adult and child spaces; high regularity in social and cultural contexts; physical contexts flexible with regular features	Observation, play, autonomous participation, collaboration, teaching of specialized skills	Many opportunities for embodied learning of all skills; open learning stance; *most flexible—individually autonomous learning of broad repertoire; flexible subsistence strategy, with skills transferable to new tasks and domains*

Source: All sources used to compile this table are cited in the text.

techniques by children is a better model of how such cultural learning may have been involved in the evolution of human tool use. However, I will come back to such cases of more specialized techniques later.

Importantly, I am focusing my analysis simply on the availability of nonhunting blade tools (hereafter "blade tools") and the opportunities to observe, be taught, and practice their use. In other words, I do not examine blade tool construction. Undoubtedly, the construction and use of blade tools for a variety of subsistence tasks was a fundamental cultural adaptation for our species (McBrearty and Brooks 2000; Morgan et al. 2015; Stout 2011) and remains so today. It also may have involved more concentrated learning and teaching than, I will argue, use of nonhunting blade tools does (Morgan et al. 2015; Stout 2011). However, in the region where I work, as in much of the world today, blades are rarely locally made but imported. Among the BaYaka subjects of this case study, there are those with knowledge of iron forging who can craft axe heads and knife blades, but these tools typically come from nonlocal sources and are acquired through trade. Thus, the vast majority of other blades are made of steel, and their construction is not part of the daily learning experiences of interest here. It should be noted, though, that novice toolmakers' presence near and participation in the construction of blade tools is inferred from sites across the world and deep into human evolutionary history (e.g., Grimm 2000; Takakura 2013). While we cannot be sure of the ages of the novice toolmakers, we can infer that with the emergence of the "domestic space"—a central place for food sharing and cooperative child-rearing—juveniles were at least present to observe various uses of stone tools beginning as early as 450 thousand years ago (Kuhn and Stiner 2019). Today, while the use of blade tools by children tends to be discouraged in families from modern, large-scale industrial and postindustrial societies, this is not the case across contemporary small-scale subsistence societies, where children begin to manipulate knives, machetes, and other tools long before they can productively use them (Lancy 2016b). This is the context to which I now turn.

Case Study: BaYaka Children's Experience with Blade Tools

The BaYaka are a group of several populations of tropical forest foragers living across the Congo Basin (Lewis 2002). "BaYaka" is a general term for several groups, including those referred to in publications as the Aka (Bahuchet 1985; Boyette 2016; Boyette and Lew-Levy 2019; B. L. Hewlett 2005; B. S. Hewlett 1991), the Mbendjele (Lewis 2002), the BaYaka (Boyette et al. 2020; Lew-Levy et al. 2020) or Mbendjele-BaYaka (Jang et al. 2019; Sonoda, Bombjaková, and Gallois 2018) who live in the northern Republic of the Congo and southwestern Central African Republic. Here, I'll be drawing on qualitative and quantitative data from two BaYaka populations I have worked with: the Aka of the Lobaye Province in the Central African Republic and the BaYaka of the Motaba River region in the Likouala Province of the Republic of the Congo. In my analysis, I'll use the term "BaYaka" to refer to these two populations because the data I will draw from can be reasonably generalized to both, who intermarry and share the same language, values, expressive culture, and sharing norms, with some regional variation.

BaYaka Cultural Niche Construction

As noted above, the processes of cultural niche construction can support cultural learning through lowering costs to learning, such as making it easier to find models to observe, teach-

ers to teach, or opportunities to practice. In this way, BaYaka settlements are highly supportive of blade tool use learning. Barry S. Hewlett and colleagues (2019) describe BaYaka spaces and spatial use as intimate, even in comparison to a general trend toward close living among foragers as compared to food-producing peoples. For instance, Aka typically live in a one-room dwelling, 4.8-square-meters in size, accommodating an average of 3.1 people or about one-square-meter of space per person, on average. Importantly, these houses are, on average, placed within 4.3 meters of the nearest neighbors, and very little is done inside the dwellings other than sleeping, with much of life being conducted outdoors in sight of all other members of the community. BaYaka settlements are generally of two types: smaller forest settlements with traditional *mongoulou* domed houses and village settlements with larger, mud-brick houses. However, the public nature of most activities is consistent across both types of settlements, and children in particular are never barred from entering any dwelling, no matter who is currently sleeping therein. Hewlett and colleagues (2019) find consistencies between Aka spatial use patterns and cultural models of social relationships—especially between parents and children and between marital partners—as valuing physical closeness among social partners. Anecdotally, when joining a group of people sitting together, BaYaka people will often sit so as to be in physical contact with one another, no matter how much space is available.

These spatial aspects of cultural niche construction are consistent with a larger emphasis on sharing that is common to mobile foraging peoples. Construed widely, this sharing includes not only food but also other material resources, time, and knowledge (Lavi and Friesem 2019). Here, I will emphasize in particular that these spaces facilitate both sharing of material bases for learning techniques, such as blade tool use, as well as the knowledge and skills embodied in others. In terms of the former, as noted, most work is done outside the house, and most household objects are also stored outside. Blades are prominent among these objects. For example, a brief survey of items used in food preparation of a random sample of 14 Aka households at a village settlement in Central African Republic (CAR) in 2012 shows that most households had at least two knives or machetes, making these blade tools the second most numerous of 12 items named, after plates and tied with the number of cooking pots per household (table 7.2). Note that the traditional BaYaka axe, the *djumbi*, was not counted among these items, nor were, for example, razor blades, or *gileti*, which are commonly in circulation though disposed of after one or two uses. Thus, table 7.2 reflects a bare minimum of children's opportunities to observe and interact with blades throughout daily life, and these blades are used to chop wood, clear the ground around camp, build a house, make baskets and mats, crack nuts, peel manioc, skin game, divide meat, cut edible leaves, dig for wild yams, style hair, and cut fingernails.

Blade Tools and Early Childhood

In terms of the specific ways that BaYaka cultural niche construction enhances social and individual learning opportunities, I will now discuss how such knowledge and skill sharing occurs across childhood to gradually (re)produce technically competent members of the community. In general, respect for autonomy is a core cultural model—or foundational cultural schema (Boyette 2019; B. S. Hewlett et al. 2011)—among the BaYaka, and this is true for all individuals regardless of age (Boyette and Lew-Levy 2021). As such, BaYaka parenting is considered indulgent. For instance, infants nurse on demand and are responded

Table 7.2
Aka kitchen item inventory (n = 14 households)

	Object	Sum	Mean
1	Plate	32	3.56
2	Cooking pot	30	2.31
3	**Knife/machete**	**30**	**2.31**
4	Spoon	21	1.62
5	Jerry can	14	1.56
6	Sieve	9	1.12
7	Basin	8	1.60
8	Bucket	4	1.33
9	Mortar + pestle	3	1.00
10	Cup	1	1.00
11	Cutting board	1	1.00
12	Stirring stick	1	1.00

to immediately when distressed by any nearby caregiver, typically but not always a parent, who nurses or sooths them (B. S. Hewlett et al. 1998). One aspect of the autonomy granted to young children is that they are permitted to engage with any objects they find around camp, including blade tools. Parents and other caretakers are not being negligent when allowing children access to these tools. Indeed, children being cut or cutting others with blades is a common concern among BaYaka parents (Boyette, unpublished data). However, they indulge children's autonomous interest and even encourage interaction with these tools. For example, when the hafts of knives used in food preparation break, these now "useless" blades are given to young children to play with. In the parlance of social learning, this is a classic example of opportunity scaffolding. In a sample of 10 Aka infants aged 12 to 14 months, Barry S. Hewlett and Casey Roulette (2016) observed opportunity scaffolding nearly once every hour, on average, in their sample of 10 hours of infant-focused video. While they did not code the objects used, knives were prominent across the range of teaching behaviors they observed, including instances of natural pedagogy, moving a child's body, and demonstration. These observations are not surprising, given the spatial prominence of these blades and their regular use by people across a wide range of everyday tasks.

Blade Tools from Middle-Childhood to Adolescence

Until around age 7, BaYaka children typically stay nearby the settlement, typically under the casual supervision of at least one elder who remains in camp if others are away. As BaYaka children transition from toddlerhood and weaning into middle childhood, across the ages of four to six years old, children start spending their time with a multiage, all-child play group, and as a group, they may venture into the forest to play or autonomously forage (Bombjaková 2018; Boyette 2016; B. S. Hewlett et al. 2011; Lew-Levy, Kissler, et al. 2020). This context offers significant opportunities for social learning and individual practice with blade tools through scaffolded interactions with other, slightly older children (Gauvain 2005a; Lew-Levy, Kissler, et al. 2020). As a quantitative demonstration of such opportunities, I present data collected during my study of Aka children's time allocation and social learning in CAR in 2010.

More details of the methods used to collect these data can be found elsewhere (Boyette 2016; Boyette and Hewlett 2017; Lew-Levy and Boyette 2018). Briefly, I used systematic behavior coding during focal follows of 50 individual Aka children aged 4 through 17, with a mean of 238.62 observations per child.[3] These children were from eight different forest settlements. While I did not specifically set out to record blade use, early during my observations, I started noting such use in the margins of my data sheets, as I was struck by how capable children were with machetes, axes, and knives. These notes are not as systematic as the behavioral coding that was the focus of my study, but they do reflect a bare minimum estimate of the presence of blade tools in children's everyday contexts across my observations.

To quantify blade tool use in these data, I performed a search of the notes I kept intermittently in a column of my minute-by-minute data coding sheets. Specifically, I searched for the following text strings: "chop," "cut," "dig," "kni," "machete," "yebe," "ax," "jumbi," and "blade." Note that *yebe* is the word for "knife," *djumbi* is the traditional axe, and machetes (and knives during children's play) are often used for digging. All notes that were found through the text search were then reviewed so that irrelevant observations could be excluded (e.g., if "cut" was in the word "cute" or the note did not reference the ongoing activity). Overall, one or more of these text strings was noted in 74 observations spread across 26 of the 50 children (16 female, 10 male), with an average of 2.8 observations per child. These included 22 mentions of "chop," 15 of "dig," 17 of "cut," and 25 mentions of a blade (five observations had mentions of a blade and an action, and these were counted as a single observation). It is also important to note that I included in these data mentions of blade use by the child *or* by someone with the child. For the sake of my argument, this distinction is not critical, as again, these data were not systematically collected and thus provide only a reasonable, minimal account of the opportunities to learn blade tool techniques in these children's lives.

First, while not noted that frequently overall, blades were noted persistently throughout my observations. For example, blade use was noted in focal follows of children from seven of the eight Aka forest communities, or "camps," in which I lived. Additionally, there was no obvious concentration of observations in any one camp, with 10.6 observations noted per camp. Furthermore, as plotted in figure 7.1a, these observations were not concentrated at any particular time during the study period, which extended from April until September (the gap in time in figure 7.1a was the time that I worked with Ngandu farmer children, who also used blade tools but are excluded from the current analysis). Nor was blade use noted among children of any one age (figure 7.1b), and observations were consistently distributed across boys and girls of different ages and throughout the study period, although use of the tools by girls was noted twice as frequently: 50 times for girls versus 24 times for boys.

Second, blade use was observed across a broad range of children's activities. In fact, as can be seen in table 7.3, it was *not* observed in only the three least frequently observed activities: childcare, music, and hygiene. Notably, blades were overrepresented in three activities relative to how frequent those activities were observed in the full dataset. In particular, while work-themed pretense play was observed in only 4.7 percent of all observations, 29.7 percent of the observations with blades were during this activity. This reflects 3.9 percent of all observations of work-themed pretense play, which was coded when a child reenacted traditional subsistence activities, such as digging for wild yams, making a playhouse, or chopping trees (Lew-Levy and Boyette 2018). While less frequently noted across children's activities, blades were also noted during child-initiated work and work at a higher frequency than was observed in the full

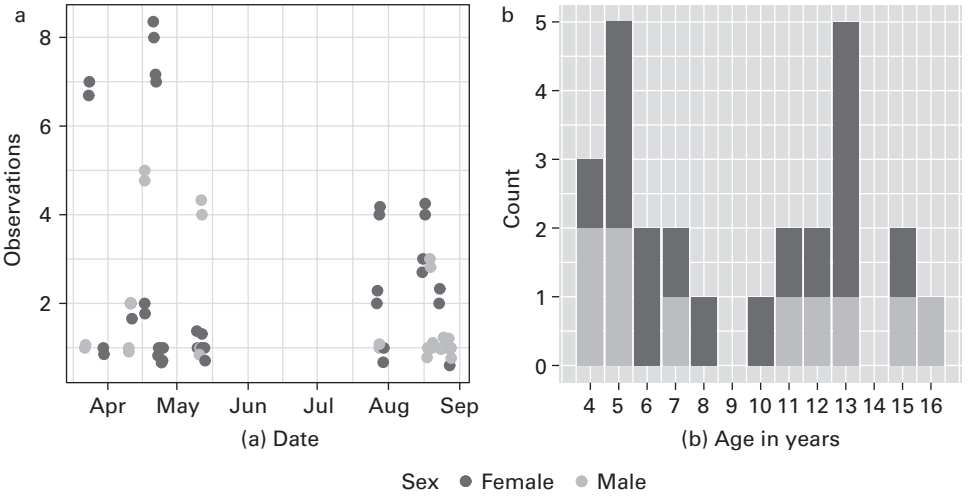

Figure 7.1
Counts of observations of blade tool use noted in field notes during focal follows of Aka children by (a) date of observation and (b) age of children in years. Each plot also shows the distribution of observations of females versus males across the study period and among the ages sampled. *Source*: Data collected by author. See references in text.

Table 7.3
Relative representation of blade tool use across all activities coded compared to the relative representation of each activity in the full dataset

Activity	Percent of full dataset	Percent of blade-use dataset	Percent of observations of activity in which blade tool use was observed[1]
Work-themed pretense play	4.70	29.70	3.90
Child-initiated work	10.30	17.60	1.06
Work	7.50	10.80	0.90
Other	4.80	4.10	0.52
Rest	27.70	20.30	0.45
Play	20.90	12.20	0.36
Travel	5.50	2.70	0.31
Eats	5.10	1.40	0.17
Visit	9.60	1.40	0.09
Childcare	1.30	NA	NA
Music	1.40	NA	NA
Hygiene	1.10	NA	NA

1. Percentages are calculated as count of all observations of activity when blade use was noted divided by the count of all observations of activity times 100.

dataset. The former was coded when the focal child was involved in subsistence work without involvement from adults, while the latter was coded when the child worked with an adult or the subsistence activity was initiated by an adult (whether or not the adult and child worked together at the task).

Third, I also examined the presence of adults and the settings in which blade use was observed. During my observations, I coded whether mother, father, both parents, parents and other adults, or no adults were within visual range of the focal child. When blade tool use

was observed, 66 percent of the time the focal child was in sight of parents and others; 9 percent of the time either the children's mother or both parents were present; and 24 percent of the time no adults were in sight of the child. In terms of settings, the observations of blade tool use were fairly similar in their distribution to where children generally spent their time. In particular, 68 percent of the observations were in the domestic space of the forest camp, whereas 20 percent were in the forest. The other 12 percent were either in or near gardens or at the forest camp of an Ngandu farmer family with whom they spent time.

General Discussion

The analysis presented here is a relatively coarse-grained account of BaYaka children's experience with blade tools during their daily lives. A finer-grained analysis could only further support my conclusions. In brief, every BaYaka household owns multiple blade tools, which young children observe in use every day and seek to interact with. While parents worry about accidental cuts, they still begin to scaffold children's use of blades early, through opportunity scaffolding and occasional direct instruction. This in and of itself demonstrates that parents see the benefits of early acquisition of blade techniques as outweighing any costs. As children grow, blades remain present when children are in the domestic space and travel with them as they go into the forest to forage or play, whether or not adults are present. These tools are used across most contexts of daily life, especially during work-themed pretense play as well as legitimate productive subsistence work. Previous work has shown that BaYaka children work more and play less from early childhood through adolescence (Boyette 2016), including play that is an imitation of work (Lew-Levy and Boyette 2018). We have interpreted this pattern to indicate that play serves as a context in which children learn so that they increasingly become legitimate participants in daily economic life, consistent with the intent participation tradition (Lave and Wenger 1991; Lew-Levy and Boyette 2018; Paradise and Rogoff 2009; Rogoff et al. 2003). The complex techniques associated with blade tool use are critical to this learning. Through developmental feedback from the social and physical environment to their bodies and minds, BaYaka children will inevitably learn how to use knives, axes, machetes, and razor blades to perform the wide variety of technical tasks that their elders do with these tools.

Other ecocultural theories of child development emphasize how settings and the company children keep shape children's cultural learning opportunities (Markus and Kitayama 2010; Weisner 1984; Whiting 1963; Whiting and Edwards 1988). Consistent with such approaches, the cultural niche construction perspective emphasizes that regularities of children's developmental context have supported adaptation to particular social and ecological environments and can continue to serve such a role. For the BaYaka, the distributed nature of expertise in blade tool use likely contributes to the overall high level of coordination of subsistence activities and cooperation in general that characterizes their society. Barry S. Hewlett and colleagues emphasize that for BaYaka children, their settings are open to free exploration and that the entire community is available to learn from, such that few social roles or specific skills are hidden from young cultural learners (B. S. Hewlett 2014; B. S. Hewlett, Berl, and Roulette 2016). From infancy, responsive caregiving by many others and respect for autonomy to explore spaces and artifacts leads to security and trust and highly self-motivated learners, who see learning technical skills as part of belonging to the group (Over 2016). Such features of the BaYaka cultural niche enhance the cultural learning

of technical knowledge and skills through multiple learning processes and pathways throughout children's development.

Of these processes, top-down instruction in blade tool techniques does not appear to be as important as others. Multiple studies have demonstrated that teaching is an important part of BaYaka children's daily lives (Boyette and Hewlett 2017; B. S. Hewlett and Roulette 2016; Lew-Levy, Kissler, et al. 2020). However, teaching is far less frequent than observational learning (Boyette 2016). The importance of observational learning is clear in the data on middle-childhood that I present here. For instance, it is noteworthy that 20 percent of the observations were when children's activities were coded as "rest" (table 7.3), when children were simply watching others use blades or lying around fiddling with blades themselves. Such observations are then honed through individual learning by playing and working, as shown here by the disproportionate observations of blade use during these types of activities. Through this process, children become able to flexibly apply their skills across the wide range of subsistence tasks for which they are needed. Moreover, the openness of the BaYaka learning environment and diversity of others available to be observed leads to "concerted" or "many-to-one" cultural transmission (B. S. Hewlett and Cavalli-Sforza 1986). This mode of cultural transmission, through which cultural learners learn from many other, more experienced individuals, theoretically leads to low variation between individuals in the population and high conservation of skills across generations. At the same time, such conservation of skills is counterbalanced by a high degree of autonomy and mobility, the basis of which is, in part, to seek new information (MacDonald and Hewlett 1999), such that innovations are also learned and spread (Lew-Levy, Milks, et al. 2020).

Importantly, there are examples among the BaYaka of specialized tools or techniques that require some degree of teaching and demonstration. For instance, hunting nets and snares and other tools that require specific types of knots (e.g., a basket to fetch honey from high trees) seem to require some degree of careful demonstration. For instance, I once watched a BaYaka friend put his two children in front of him on the ground as he laid his unfinished porcupine hunting nets on the mat and said, "Watch me. You're going to learn how to hunt." This was all the teaching that occurred, but he clearly marked the pedagogical nature of the context (Csibra and Gergely 2011) and placed the children in a position where they might best observe (Strachan, Curioni, and McEllin, this volume). The children were then given the opportunity to watch him finish tying. While I have not seen it, I predict that as a child begins to try to tie the cords together to weave the net, the method of teaching may change to some degree to include correction. Such teaching has been documented in the technique of weaving mats as described by Bonnie Hewlett (2013). Specifically, she describes being a novice learning to weave a basket and how her Aka teacher (another adult woman) would tell her "No, not like that" and correct her actions. As another example, during our observations of Aka nut-cracking (Boesch et al. 2017), we watched as BaYaka women and older girls would place a machete or an axe blade-side-up on the soft forest floor, stabilize it with their feet, then hold a nut carefully on the edge of the blade with its seam oriented vertically, so that they could hit the nut onto the blade with a wooden hammer to crack it open. Obviously, a miscalculation could result in severe injury if she gets a finger in between the hammer and the blade. However, even in this situation (where we did see adolescents cut themselves multiple times), the extent of teaching that we observed was a woman pointing to the nut's seam where it should be placed on the blade's edge. The teach-

ing moment lasted only a few seconds, and the learner, a preadolescent girl, stopped trying after a few attempts.

Even in the context of learning these specialized techniques—in which learners must already be of a certain developmental readiness and which require careful instruction from older individuals—the relatively minimal role of teaching lies in stark contrast with the cultural model of teaching represented by the formal school-based education tradition described in the introduction (see table 7.1). For BaYaka learners, learning is by their own autonomous design; the techniques of production, their material basis, and their purpose are accessible; the social environment is dense with familiar, trusted people from whom to learn. Techniques may be partially learned, played with, practiced, and honed, cognitively internalized and embodied over time, with minimal constraint. Such an educational context is highly flexible with respect to the needs of learners and likely robust to changes in the state of the environment, as new technical knowledge is easily integrated and shared (Astuti, this volume; Pope-Caldwell, this volume). Indeed, this may represent the learning context of many human foraging groups throughout history that spread across every environment on Earth.

To conclude, I do not suggest the BaYaka cultural niche or its effects on children's learning are representative of other foraging groups or of past human societies per se. However, I do think there are aspects of their social structure and ecological adaptations that can permit some inferences about how similar contexts of cultural learning would support the gradual and inevitable acquisition of blade tool techniques during individual lifetimes and the reproduction of such expertise across generations. In particular, with the coevolution of the human family, cooperative childcare, and the domestic space of the hearth, which becomes the center of social activity and sharing well before the evolution of *Homo sapiens* (Kuhn and Stiner 2019), the cultural niche construction perspective focuses the analytical lens on the opportunities afforded for the (re)production of at least some common techniques that have been critical to the evolution of human cumulative culture and cognition, such as the use of nonhunting blade tools.

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Notes

1. I thank Daša Bomjaková for pointing out that the domain of learning is important here. For instance, in ritual or religious education, compliance is expected and disobedience could lead to a refusal to teach (personal communication, July 2021).

2. Of course, this may also be an example of the coevolution of biology (e.g., sexual dimorphism in physiology, human mating, and family systems) and culture (e.g., gender socialization) that is supported by cultural niche construction. However, such an analysis is outside the scope of this chapter.

3. The "focal follow" is a method for systematically measuring time allocation—how much time is spent doing specific behaviors or activities. In this case, individual children were observed continuously during three two-hour

blocks of time, and their behavior was coded every minute according to a predetermined list of behaviors of interest (see Boyette and Hewlett 2017 for more details).

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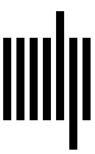

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