# Autonomy and risk perception in Congo Basin developmental systems

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## ABSTRACT

This paper explores how cultural learning dynamics shape children's encounters with risk and, through developmental feedbacks, lead to stability or change in community-level risk perception and adaptation. I draw on cultural evolutionary theory to describe trade-offs communities face in shaping how children perceive and encounter risks: between social learning and individual learning; learning via teaching versus situated and collaborative learning; and inter- versus intra-generational social learning. After reviewing theoretical implications of these trade-offs, I examine how they manifest in intensive parenting in the Global North, which emphasizes teaching and vertical transmission (from parents) in children's learning about risk. This case study illustrates the potential for cultural evolution of maladaptive perceptions of risk in the face of environmental change. Then, I use the trade-off framework to analyze time allocation data from children (ages 4–16 years) from two small-scale societies in the Central African Republic, the Aka and the Ngandu. I show that Aka and Ngandu children spend more time with other children than with adults. Bayesian regression modeling further shows that adult availability decreases the probability children engage in risky activities, including work, which is consistent with respect for children's autonomy and an age-graded division of labor. Yet, when adults are available, risky work—but not play or other activities—increases probability of adult intervention, typically to guide children's work, not to avoid risks. Using these case studies, I discuss how autonomy is critical to balancing trade-offs inherent to conservative and rigid culture learning in contexts of local environmental change.

## 1. Introduction

This paper explores how cultural learning dynamics shape children's encounters with risk and, through developmental feedbacks, lead to stability or change in community-level risk perception and adaptation. In particular, drawing on cultural evolutionary theory (Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981; Fogarty et al., 2011), I describe three sets of trade-offs communities face in shaping how children come to perceive and encounter risks. After reviewing the theoretical implications of these trade-offs, I examine how they are manifested in contemporary intensive parenting in the Global North, and how this case study illustrates the critical roles of environmental change and social complexity in creating possibilities for the cultural evolution of maladaptive perceptions of risk. Then, I use the trade-off framework to guide an analysis of time allocation data from children (ages 4–17 years) from two small-scale societies in the Central African Republic, the Aka and the Ngandu. I show how these groups' different parental ethnotheories – or cultural understandings of the goals of parenting and the needs of the developing child – result in balancing these trade-offs in distinct ways, but that, in both cases, these

developmental systems support children's autonomy to engage in risky behavior by the standards of intensive parenting. In these cases, coping with risks facilitates learning culturally valued and locally adaptive skills and knowledge. Ultimately, I argue that autonomy in children's learning is often key to cultural adaptation in most contexts.

### 1.1. Risk and adaptation

Children's risk-taking is essential to healthy development (Baumrind, 1987; Brussoni et al., 2015; E. B. H. Sandseter & Kennair, 2011). One central way risk-taking leads to adaptive developmental outcomes is through learning from coping with uncertainty (Compas et al., 2001), be it in the context of physical (Engelen et al., 2013; Lavrysen et al., 2017; Pellegrini & Smith, 1998), socio-emotional (Dodd & Lester, 2021; Dworkin, 2005) or cognitive development (Blades, 1989; Kyttä, 2004; Rissotto & Tonucci, 2002). This is true from motor development during early childhood (Adolph, 2019) through experimentation in young adulthood (Dworkin, 2005). However, ecological context, social structures, and culture each shape risk perception, risk management and their socialization across human communities.

Variation in normative beliefs around risk can be seen as cultural negotiations over what degree or type of risks children can come to manage at different ages in a particular context (Harper, 2017; Little et al., 2012, 2011). Because coping with risks can lead to adaptive learning, the role of caretakers and the community in intervening in children's risk-taking behaviors can be described in terms of trade-offs. In particular, cultural evolutionary theory identifies at least three important trade-offs inherent to adult intervention in children's development of risk perception and management: those between social learning and individual learning; between learning via teaching versus situated and collaborative learning; and between inter- and intragenerational social learning.

Cultural evolutionary theory is a framework for understanding how cultural traits emerge, move within and between individuals and populations, and influence human adaptation (Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981; Enquist et al., 2024; Fogarty et al., 2024; Henrich & McElreath, 2003; Laland, 2004; Mesoudi, 2017). At the population level, social learning is central to cultural evolutionary theory and the spread of culture because individuals can acquire information faster from others than via individual trial-and-error learning (Boyd & Richerson, 1995). However, a reliance on social learning risks the spread of information that is maladaptive in the current environment (e. g., the information is wrong or the environment changes) (Giraldeau et al., 2002; Rogers, 1988). Individual learning is therefore important for introducing innovations into cultural systems and as a check on the spread of maladaptive behaviors (Borenstein et al., 2008; Enquist et al., 2007; Fogarty et al., 2015; Rendell et al., 2010). At the individual level, both social and individual learning interactively facilitate internalization during everyday learning across development, (Adolph & Hoch, 2019; Boyette, 2016b; Downey, 2010). For instance, in the context of perceiving and managing risks, social learning from observing others how to take a risky jump during play may then be individually learned via neuro-muscular and affective feedbacks upon jumping. However, socially learning to avoid such a risk trades-off this individual learning opportunity for safety.

The second trade-off concerns a specific type of social learning: teaching. Teaching can be defined minimally as when one individual pays a cost (e.g., in time, effort) to induce learning in another individual (Fogarty et al., 2011; Kline, 2015; Thornton & Raihani, 2008). The sort of teaching characteristic of formal schooling is an intensive type of teaching, but this definition also encompasses more subtle behaviors meant to shape others' learning, including task commands (Boyette & Hewlett, 2017; Boyette & Lew-Levy, 2021) or deliberate demonstration (Boyette, Cebioglu, et al., 2022). In these later cases, a learner's attention is still intentionally drawn to the subject of learning, even if no information about "how" or "why" is conveyed as it might in a pedagogical interaction. While the "cost" of these behaviors may vary, they can be contrasted with learning through observing others behaving as they would in the absence of an observer (Boyette & Hewlett, 2017; Fogarty et al., 2011). Teaching was likely important in the evolution of human culture because it can convey unobservable information, such as the opaque means-end relationships common to cultural traits like symbolic language or complex tools (Fogarty et al., 2011; Sterelny, 2012). It can also convey information that is generalizable to other instances of a class of learning situations, as opposed to localized information specific to a current learning situation (Gergely & Csibra, 2006). Because of these advantages, humans may have evolved early developing cognitive specializations to attend to and learn from teaching (Csibra & Gergely, 2011; Kruger & Tomasello, 1996; Strauss & Ziv, 2012). However, the cost of these abilities is that teaching may reduce effort in exploratory learning (Bonawitz et al., 2011). At least in the domain of technology, preschool children (Bonawitz et al., 2011) and adults (Derex et al., 2025) explore a problem space less if they receive an explanation or demonstration of an object's function, even if the explanation is incorrect (Derex et al., 2025). More research is needed in domains other than technology, and there is evidence that even young

children consider a broad range of information in trusting their teachers (Harris & Corriveau, 2011). However, in the context of the cultural transmission of information pertinent to risk perception and management, teaching may help cement certain perceptions while limiting the potential self-correcting effects of individual learning.

Despite its trade-offs, social learning is central to human cultural adaptation. Rather, the third theorical trade-off concerns modes of cultural transmission, or *from whom* children should socially learn. Theorists describe several modes, including: vertical transmission, or learning from one's parents; oblique transmission, or learning from others of the parental generation; and horizontal learning, or learning from one's same-generation peers (Cavalli-Sforza & Feldman, 1981). These are not all of the possible modes (e.g., B. S. Hewlett et al., 2024), but they capture the theoretically critical trade-off of interest here. That is, vertical transmission is the most conservative and slowest to spread new cultural traits as it follows the pathway of genetic transmission, keeping traits within families. Oblique transmission is less conservative, for example allowing rare expertise to move between generations across families (Aunger, 2000; Reyes-García et al., 2009). In contrast, horizontal transmission is least conservative and can spread new cultural traits quickly across families through members of the same generation (Acerbi & Parisi, 2006; Jang et al., 2024; Lew-Levy & Amir, 2024). A trade-off emerges in the context of environmental change, when what can be learned socially from parents or other members of an older generation may be out of date, such that learning from peers, or in collaboration with them (Tomasello et al., 1993; Vass & Littleton, 2010), may be more advantageous (Acerbi & Parisi, 2006; Cavalli-Sforza & Feldman, 1981; Lew-Levy & Amir, 2024). For example, a simulation modeling study of the cultural transmission of risk attitudes shows that, while vertical transmission of risk attitudes is adaptive across a wide-range of environmental conditions, more uncertain environments promote learning from peers (Velilla et al., 2025). However, in their model, this is true only if learners are buffered from risk, by plentiful resources or a social safety net to support exploration of the problem space among peers (Velilla et al., 2025).

### 1.2. Culture, autonomy and risk-perception

In this section, I will describe intensive parenting culture and the ways each of these trade-offs manifest within the societies where this culture has emerged. Intensive parenting beliefs and practices can be considered a parental ethnotheory, a culturally-shaped cognitive framework by which parents identify children's needs across development and organize the goals of their social role (Harkness et al., 1992; Harkness & Super, 1992; Keller, 2006). The intensive parenting ethnotheory emerged and spread over the last half-century in the United States (S. Hays, 1996), the United Kingdom (Faircloth, 2023) and in Europe (Gauthier et al., 2021; Ruckdeschel, 2024; Walper & Kreyenfeld, 2022). Intensive parenting: centers family life around the child, involving significant investment of resources; is emotionally absorbing, with parents strongly motivated by the need to be a "good parent"; relies on expert guidance to define what constitutes "good" parenting and "healthy" development; and prescribes heavy involvement by parents in children's education and school achievement throughout their careers—from early preparation for primary school, to homework, to college admission (Gauthier et al., 2021; S. Hays, 1996; Nelson, 2010; Nomaguchi & Milkie, 2020). According to this ethnotheory, children are vulnerable and parents are responsible for protecting their children from any risks that may undermine their development (Nomaguchi & Milkie, 2020; Stearns, 2009).

Because of its resource cost, intensive parenting in the US was originally only adopted by middle-class households, but a recent survey suggests a majority of parents across social classes in the US, at least, now see intensive parenting as normative (Ishizuka, 2019). As such, it has also fundamentally reshaped American beliefs concerning risks to children (Nomaguchi & Milkie, 2020; Thomas et al., 2016). According to

a striking study by Thomas et al. (2016), Americans perceive a child unsupervised by an adult to be inherently at risk, and, furthermore, that American perceptions of risk are directly mediated by their moral judgements of the parents. In their study design, participants recruited on Amazon Mechanical Turk read a series of vignettes about unsupervised children ranging from 10 months (15 min alone) to 8 years (45 min alone). The reasons given for why the child was left alone varied in morally relevant ways (either unintentional, or so that the parent could relax, work, or have an extra-marital affair), and with minimal variation across conditions, participants rated parents unintentionally leaving their child alone as less risky than intentionally doing so, despite there being no difference in the child's situation (Thomas et al., 2016).

From the cultural evolutionary perspective summarized above, intensive parenting prescribes social learning about risk, especially via teaching, and predominantly via vertical transmission, with some oblique transmission from school or other authorities. As such, these parents are trading-off enabling individual learning and social learning from peers in favor of safety and risk avoidance. Theoretically, such a strategy could lead to maladaptation if parents are not accurately tracking a changing environment. That such is the case is consistent with analyses by sociologists who argue that people in complex, technologically-dependent, globalized societies are bombarded by perceptions of risk whose effects on their immediate lives may be impossible to calculate (Beck, 1992; Giddens, 1999; Jenkins, 2006). These perceptions do not need to reflect actual risk for them to become normative. For example, fear of child abductions amplified fears of safety and intensive parenting cultural practices and beliefs in the 1980s and 1990s, despite the actual risk to children being extraordinarily low (S. Hays, 1996; Thomas et al., 2016). Indeed, in line with this theoretical prediction, there is evidence that intensive parenting may be maladapted to the current risk environment (Gray et al., 2023; Nomaguchi & Milkie, 2020).

For instance, researchers have been concerned over the decline in opportunities for risky outdoor play among young and school-aged children in those communities in the Global North where intensive parenting culture dominates. Risky play is associated with numerous physical, social, and cognitive developmental benefits, including self-regulation and decision-making in the face of uncertainty (Ball, 2004; Brussoni et al., 2012; Dodd & Lester, 2021; Lavrysen et al., 2017; Little et al., 2012; E. B. H. Sandseter & Kennair, 2011), but opportunities for risky play have decreased dramatically over the past half-century because of increased time in school, less time outside, and reduced child autonomy overall (Brussoni et al., 2015; Gray et al., 2023). Another area of concern has been children's independent mobility (Jones et al., 2000; Kyttä, 2004; O'Brien et al., 2000) and autonomous use of space (Aminpour et al., 2020), where studies show autonomy in children's spatial exploration is associated with factors suggestive of better risk perception and management, including greater spatial knowledge, lower fear of crime, and more socializing with peers (Blades, 1989; Ferreira et al., 2024; Prezza et al., 2001; Rissotto & Tonucci, 2002). These researchers note that children have experienced significant decreases in independent mobility in a number of countries since the mid-twentieth century, in concert with increased concerns around safety (Ferreira et al., 2024; Marzi & Reimers, 2018).

Research is also uncovering potential mechanistic links between intensive parenting's risk-avoidant practices and challenges to children's adaptive development into young adulthood. For instance, one longitudinal study examined the effects of overcontrolling parenting (a synonym for intensive parenting) over an 8-year time span and found evidence for early life impacts on children's self-regulatory skills (Perry et al., 2018). In particular, overcontrolling parenting at toddlerhood was negatively associated with emotion regulation and inhibitory control at age 5, and was then associated with poorer social skills and academic performance at 10-years-old. Other studies show that helicopter parenting (another synonym for intensive parenting) is linked with depression and anxiety among adolescents (Vigdal & Brønnick, 2022) and undermines college students' sense of competence and autonomy

(Schiffrin et al., 2014).

Parents too are experiencing decreases to their wellbeing as a result of intensive parenting practices (Ishizuka, 2019; Nomaguchi & Milkie, 2020). As normative expectations for investment of time and resources is high, parents are feeling overwhelmed, anxious, and depressed (Nomaguchi & Milkie, 2020). Yet, because intensive parenting practices and beliefs have become normative and regarded as morally correct, many parents are conforming and are continuing to curb their children's abilities to perceive and manage risks, creating feedback in the cultural system (Thomas et al., 2016). Altogether, the evidence is generally consistent with the predictions of the cultural evolutionary framework presented: in terms of children's learning of risk perception and management, those populations following these cultural norms are in a state of maladaptation in the face of environmental change—in this case, a rapidly shifting informational, technological, and geo-political landscape.

However, it is critical to acknowledge that adaptation is always relative to a particular environmental context. Thus, I am not claiming that intensive parenting is generally maladaptive across individuals and communities whom perceive it to be normative, as others have (e.g., Gray, 2012, 2013; Gray et al., 2023). Extreme social inequality means intensive parenting may be advantageous for parents with sufficient wealth to buffer the stressors and usher their children through top universities and continue to maintain familial status and wealth (Lareau, 2011; Nomaguchi & Milkie, 2020; Velilla et al., 2025), but it may not be sustainable for parents in poverty or who otherwise face discrimination, and whose children are also likely to face truly different types and degrees of risks (Elliott et al., 2015; Lareau, 2011; Nomaguchi & House, 2013; Novoa et al., 2022). Intensive parenting practices are meant to meet the goal of socializing children to compete in a merit-based capitalist economic system, predominantly through formal education (S. Hays, 1996; Lareau, 2011). Should this goal be achievable across social groups, then the emphasis on vertical transmission and social learning through teaching may be adaptive at the population level. However, educational research has shown that school achievement measures disadvantage many types of learners depending on individual differences and early life experiences (Cole, 2005; Kroupin & Zeng, 2024; Okagaki & Sternberg, 1993; Sternberg et al., 2001). Indeed, humans likely evolved under highly variable, often harsh, environmental circumstances, which promoted experience-dependent developmental plasticity (Frankenhuis & Amir, 2021; Humphreys & Salo, 2020). As such, behaviors often regarded as maladaptive within formal education contexts may be adaptive responses to exposure to cues of a harsh environment (Frankenhuis & de Weerth, 2013; Sternberg et al., 2001).

In light of such complexity and inequality, anthropologists and cross-cultural psychologists have long used comparisons between modern, large, stratified industrial and post-industrial capitalist societies and small-scale subsistence societies to illustrate the effects of the culturally-shaped environment on children's socialization (Lancy, 2021; Mead, 1970; Morelli et al., 2003; Ochs & Izquierdo, 2009; Rogoff et al., 2003; Whiting, 1980; Whiting & Edwards, 1988). While small-scale societies are highly variable in their parental ethnotheories and means of environmental adaptation, social learning processes and modes of transmission are often stably organized to meet the demands of a particular subsistence strategy. In what follows, I examine the role of adults in shaping children's exposure to risks in two small-scale societies, the Aka and Ngandu of the Central African Republic. I show how adult respect for children's autonomy in encountering risks is central to socialization and, therefore, cultural transmission of adaptive knowledge and skill, but also that adults do intervene in children's activities that involve risk, but in targeted ways.

### 1.3. Risk in Congo Basin developmental systems

In this section, I describe the study populations and how their parental ethnotheories articulate with the trade-offs between modes of

transmission and learning processes. My description and the analysis that follows are focused on the developmental period from the transition to middle-childhood through adolescence. Across cultures, children's autonomy tends to increase throughout this period (Lancy, 2021; Ochs & Izquierdo, 2009; Rogoff et al., 1975; Sameroff & Haith, 1996; Weisner, 1996). As the study groups espouse different ethnotheories around children's autonomy, comparing children's experiences across these ages will allow us to understand how these ethnotheories impact children's exposures to risk and adults' roles in shaping children's learning.

The peoples of the Congo Basin are ethnically and linguistically diverse but the Aka and the Ngandu represent two major groups often glossed as "hunter-gatherers" and "farmers" for simplicity (Boyette, Lew-Levy, et al., 2022). These groups live in the southwestern Lobayé region of the Central African Republic, at the northern edge of the Congo Basin tropical forest. While typically described as hunter-gatherers (Bahuchet, 1985; B. L. Hewlett, 2013; B. S. Hewlett, 1991), Aka economic practices are forest-oriented but flexible and opportunistic. Aka families tend to reside in the forest for part of the year to harvest seasonal resources, and may spend other parts of the year living in farmer villages or near to market towns, where they trade forest produce or labor. The Ngandu are Bantu-speaking farmers who cultivate manioc, plantains, oil palms and other crops for subsistence and small-scale commerce. While the Ngandu also utilize the forest, and may temporarily reside in forest camps, they typically rely on the Aka as guides and laborers.

Aka society is organized by age and gender egalitarianism and strong resource sharing norms, meaning that Aka children are treated with respect and have equal rights to demand shares of resources as well as an equal obligation to share (Boyette, 2019). In this sense, children are not thought of ontologically as much different than adults, other than having greater needs and growing abilities. However, Aka parental ethnotheories emphasize the child's autonomy above all else (Boyette, 2019; Boyette & Lew-Levy, 2021; B. S. Hewlett et al., 2011). For instance, Bombjaková (2018) found that among the Mbendjele-BaYaka, a related group in the Republic of the Congo, parents see child development as like a fruit ripening. That is, children are understood to take their own time to grow and learn, and they should be left to do so autonomously. Similarly, Boyette and Lew-Levy (2021), found that BaYaka children across middle-childhood and adolescence consistently refused task commands given by their elders in about one-third of their observations. Parents were helpless to enforce compliance, and in fact would be reprimanded by other parents if they became angry at their child for refusing. When asked why parents respected their children's rights to refuse, for instance to help them in their foraging, they said their children had their own "stories to make in the forest."

In contrast, Ngandu parental ethnotheories emphasize obligation to family and deference to elders, in line with their social hierarchy based on gender, age, and social role. (Boyette & Lew-Levy, 2019; B. L. Hewlett, 2013; B. S. Hewlett, 1991). Children are expected to contribute to the family economy and to help care for infants and young children. Obedience is expected and may be enforced by corporal punishment (B. S. Hewlett, 1991). Contrasts with the Aka are most revealing of Ngandu parental ethnotheories. For instance, Aka informants told Hewlett (1991) that they did not like how often the Ngandu beat their children, but do like that Ngandu children listen to their parents. A study on the socialization of sharing found that Ngandu adults were more likely (at a statistically significant level) than Aka adults to support punishing a child for selfishness and to disapprove of a child acting selfishly (Boyette & Lew-Levy, 2019).

While the role of adults in socialization is starkly different in their parental ethnotheories, evidence suggests modest differences in social learning processes between the groups, including around conveying information about risk. A comparative study of social learning among these children found that observational learning was far more common than being taught in both groups, but neither was common; observing others was counted in less than 10 % of observations and teaching in less

than three (Boyette & Hewlett, 2017). However, the domain "Health/Safety", defined as teaching "Directed toward increasing knowledge related to physical safety, health, or general hygiene" constituted about one-fourth of all teaching in both groups (Boyette, 2013). This included instances such as when an Aka mother told her five-year-old daughter, who was practicing preparing *ndosi* caterpillars, to get away from the fire, or when an Ngandu mother told her daughter to wash her hands (Boyette, 2013). It is possible that the frequency of such direct or indirect interventions on risk in this study was undercounted. In a later study among the BaYaka, a southern Aka group, using similar methods but focused on task commands and with a local interpreter translating each instance of a command directed toward the focal child, Boyette and Lew-Levy (2021) reported an average of 2.5 commands per hour compared to the average of 0.86 per hour reported by Boyette and Hewlett. In one example of a subtle command that may have been missed without the live translations,

> "Lew-Levy observed an adolescent girl running up and down a small hill with a baby on her back. She stopped suddenly and grabbed a knife which she used to dig out a small sapling stump which was poking through the dirt on the hill and which could have injured her had she stepped on it. At the same time, Lew-Levy's translator noted that a man a few feet away from the teenager, looking away from her, had told the girl to clear the stump." (Boyette & Lew-Levy, 2021, p. 12)

This example draws attention to what kinds of risks are salient to the Aka but how these are dealt with indirectly and with minimal curtailment of children's autonomous—and often helpful—activities. An analogous study among the Ngandu has not be conducted, however, Boyette and Hewlett (2017) found that Ngandu children received teaching from adults more frequently overall than did Aka children, and Aka children were just as likely to receive teaching from other children than adults. Together, these findings suggest that both groups use teaching to inform children about risk, and Ngandu adults use teaching more widely. In both cases, though, the amount of teaching observed was incredibly small compared to the hours of instruction per day received by school children, especially those in the same contexts where intensive parenting is normative (Gray et al., 2023).

Despite variation in subsistence contexts and activities, and parental expectations around economic contributions, both Aka and Ngandu children spend considerable time working and playing, including play that is pretense of work activities (Boyette, 2016b). In both cases, time allocated to play decreases with age, and time allocated to work increases, which was taken as evidence of successful learning and identification with these group-specific subsistence activities (Boyette, 2016a; Lew-Levy & Boyette, 2018). During these activities, both groups of children were typically observed in mixed-age, mixed-gender groups, and these did not always include adults (Boyette, 2013). One analysis of the role of vertical transmission in Aka children's play showed that adults were out of children's sight in 70 % of observations of children's play in the forest, including 78 % of the observations of "work-themed pretense play" (Boyette, 2016b). These data were used to point out that vertically transmitted culture (i.e., traditional subsistence practices) is internalized through individual and collaborative peer learning among the Aka (Boyette, 2016b).

With regards to the trade-off framework, this evidence suggests that vertical and oblique transmission and teaching may play a stronger role in shaping risk perception among the Ngandu than the Aka, but that in both cases, children are given significant autonomy in their movement and activities, allowing for situated learning (Lave & Wenger, 1991), both individually and socially via a range of cultural transmission modes. However, the relationship between adult presence and children's engagement with relatively riskier activities across middle-childhood and adolescence has not been examined; nor has the relative likelihood of adult intervention during riskier activities. In what

follows, I directly compare adult availability across children's daily life, and analyze the relationship between adult availability and risky behavior, and between risky behavior and adult intervention. The data is imperfect for strong tests, having not been collected with risk in mind. However, we can evaluate the results in terms of their relative support for one or more logical propositions:

1) Adult availability has **no effect** on the probability of risky behavior. This might be the case if children's risk-taking is part of their activities which are normally done independent of adult availability. This hypothesis is consistent with what we know of the Aka and Ngandu, though inconsistent with a potentially greater role for vertical/oblique transmission of risk perception and management among the Ngandu.

2) Adult availability **increases** the probability of risky behavior. This might be the case if children are open to taking risks but tend to see adults as security in case of accident, or if adults choose to be in proximity to children when they know they will engage in risky behavior (e.g., because they assigned them a risky work task which they can monitor). This may be consistent with the greater vertical/oblique influence among the Ngandu, but is not obviously consistent with Aka autonomy and adult-child relationships. This possible group difference can be tested by examining the **interaction** between adult availability and Ngandu ethnicity, where it would be expected that the increase is augmented among the Ngandu.

3) Adult availability **decreases** the probability of risky behavior. This is consistent with a tendency for adults to discourage risky behavior and/or for children to engage in risky behavior away from adults. For instance, in the context of risky play, children may feel more open than when around adults. This has been reported for children in the US (Floyd et al., 2011), but is not clearly consistent with Aka or Ngandu ethnographic accounts. However, this possibility is also consistent with adults being unavailable in the context of a household division of labor, where children participate in work tasks with inherent risks away from adults, perhaps playing in the course of such tasks. The relative strength of each of these explanations can be evaluated by modeling the effect of adult availability on risky play and risky work separately. Additionally, examining the **interaction** between adult availability and ethnicity in terms of this proposition could also effectively test for greater vertical/oblique influence among the Ngandu if the decrease is muted compared to the Aka.

4) Risky behavior has **no effect** on probability of adult intervention. Similar to (1), this might be the case if parents fully support children's autonomy and expect risk-taking to be part of their children's learning. As show above, though, both Aka and Ngandu parents do intervene in children's risky behavior, so this outcome is not consistent with existing data.

5) Risky behavior **increases** the probability of adult intervention. This is consistent with accounts of teaching in regards to risk among these two groups as noted in Section 1.3, but a stronger role of adults among the Ngandu is consistent with their parental ethnotheory. This possibility can be tested by examining the **interaction** between risky behavior and Ngandu ethnicity.

6) Risky behavior **decreases** the probability of adult intervention. This possibility is consistent with a strong emphasis on autonomy by parents, such that any intervention that may occur is outside of the context of risk. It is not clear that such a systematic decrease of intervention during risky behavior is consistent with Aka or Ngandu data.

While these propositions are framed in terms of causation, in reality, the data I examine can only demonstrate co-occurrence, and the direction of causality cannot be determined. However, at a minimum, evidence of patterned co-occurrence—or a lack of co-occurrence—allows us to infer the likelihood adults were available and could feasibly intervene when these children engaged in relatively riskier behavior, and, given their availability, that risky behavior would be more likely than not associated with adult teaching.

## 2. Material and methods

### 2.1. Data

Here I draw on systematic behavioral observations of Aka hunter-gatherer ($n = 50$, 52 % female) and Ngandu farmer ($n = 48$, 50 % male) children that were collected in 2010 in the southwestern Central African Republic (ages 4–16 years, M = 9.3, SD = 3.8). One Aka community was observed in a village settlement, and seven were observed in forest settlements. All Ngandu children were observed in the village. At the time the data were collected, there were public and private elementary schools in the village, and one school specifically for the Aka, but none of these were in session, and the Aka school was sparsely attended. Thus, the observations are of children's lives outside of any immediate influence of formal school. The observation and behavioral coding procedure are described in detail elsewhere (Boyette, 2016a; Boyette & Hewlett, 2017; Lew-Levy & Boyette, 2018). Briefly, focal follows of individual children were conducted over a randomized series of days and hours, balanced across morning, midday and afternoon, and behavior was coded every minute during 45-minute observation blocks following a 30-second-observe, 30-second-record procedure. This analysis will make use of data coded each minute on the child's activity, the setting, and whether the focal child's mother, father, any adult, or no adult was within visual range of that child. Additionally, every five minutes, the identities of all persons within roughly three-meters of the child were recorded. If these individuals were unknown, their ethnicity and gender were recorded and their approximate age was coded as one of six categories (infant, early childhood, middle childhood, adolescence, adult, elder adult). While not all individuals in proximity to the child were necessarily directly involved in the child's activities, these data are a reasonable approximation of the child's social companions across their activities and, in case of this study, are a strong measure of who was available to respond to risky behavior.

### 2.2. Plan of analysis

The analysis will use both the full data set (mean minutes observed = 234, sd = 56.5, total number of minutes of observation = 22,896) and the subsample with social companion data (mean minutes observed = 50.9, sd = 12.3, total number of minutes = 5035). First, I will examine the variation in adult availability across the day in each setting in which children were observed. I will then use a Bayesian regression modeling framework to examine the association between adult availability on children's risky behavior, and between risky behavior and adult intervention, adjusting for other relevant variables.

**Risky activities** represent a subset of all coded activities, which included a broad range of "primary activities," including work and play, and a set of "secondary activities," which specified particular work and play types when these were the coded "primary activities" (Boyette, 2013). For categorizing risk, I followed the categorization of Sandseter (2007) for risky play: 1) Play with great heights; 2) Play with high speed; 3) Play with harmful tools; 4) Play near dangerous elements; 5) Rough-and-tumble play; and 6) Play where the child can 'disappear'/get lost. While designed for use with young children, these categories have been used for analyses of risky play across early and middle childhood (e.g., Brussoni et al., 2015) and provide a reasonable means of assigning relative risk to the play, work, work-themed pretense play, and other categories. To note, Aka and Ngandu children's "real" work often involved greater risk than "pretend work." For instance, work activities involved blade tools, climbing trees, fetching water from streams, travel to and from distant gardens and through the dense tropical forest, and so on. However, the same "secondary activities" were coded as risky for pretense work play as for work.

Some categories are weaker than others at their approximation of risk because the original coding scheme was not designed with risk in mind. For instance, gathering activities (mostly engaged in by Aka children) included both the relatively safe and effortless collection of fallen caterpillars from the ground and foliage in the forest, but also climbing into the canopy to harvest tree fruits, edible leaves, or honey. However, there are other risks to working in the forest, such as the possibility of encountered dangerous animals, that help to justify gathering being categorized as risky in comparison to other activities (e.g., commerce work, rest). "Play gathering" is also ambiguous, as it includes collecting inedible leaves around camp as well as climbing trees or pretending to dig for tubers using a real machete, but to remain consistent, "play gathering" was coded as risky play for the analysis (as noted above). Finally, because of the omnipresence of blade tools around Aka and Ngandu households, children interacted with these in the context of many different activities, including those coded as otherwise non-risky, such as object play. While it was not part of the original coding design, I kept margin notes on blade tool use in my data sheets, and for a prior analysis of these data, these notes were coded to enable quantification alongside the other data (Boyette, 2024). These data were incorporated here as a separate category of risky behavior. As these were not systematically collected, they represent a minimum estimate of their use. In all, these codes should reflect *relatively more* and *relatively less* risk. The categorization scheme is summarized in Table 1.

**Table 1**
Behavior coding scheme used to code for relative risk.

| Risky behaviors | Description of risks[a] |
|---|---|
| Risky work and play work | |
| Gather | Tree-climbing, blade tools, animal encounters |
| Hunt (spear, snare, net, etc.) | Harmful tools, animal encounters |
| Food preparation (including cooking, fetching water and firewood) | Use of fire, proximity to streams, harmful tools, falling trees/limbs |
| House construction | Harmful tools, cuts from materials |
| Risky play | |
| Swing | Great heights, speed |
| Ball/ruled games | Speed, rough physical contact |
| Rough and tumble play | Rough physical contact |
| Exploration | Getting lost |
| Chase/hide | Speed, disappearing |
| Tree climb | Great heights |
| Other risky behaviors | |
| Travel | Getting lost |
| Blade tool use (including during non-risky behavior)[b] | Harmful tools |

| Non-risky behaviors | Description |
|---|---|
| Work | |
| Commerce | Selling produce, prepared foods, or commodities |
| House/garden cleaning | Sweeping, weeding |
| "Other" | e.g., Small errands |
| Play | |
| Object play | Fiddling with objects |
| Pretense (not work-pretense) | Playing with toys, character pretense |
| Gentle-and-tumble | Rolling around under a sheet, on a mat |
| "Other" | e.g., Spontaneous dancing, jumping |
| Other behaviors | |
| Eat/drink | Eating or drinking |
| Childcare | Caring for an infant or other younger child |
| Visit | Talking, socializing |
| Rest | Sleeping, sitting quietly |
| Music | Dancing, drumming or other alone or in a group |
| Hygiene | e.g., Bathing, cleaning, doing hair |
| Church | Attending church service |
| "Other" | e.g., Interacts with domestic animals, watches others' actions |

[a] Based on Sandseter (2007).
[b] Described in Boyette (2024).

**Adult availability** was measured in two ways. In the full data set, availability is coded as a categorical variable indicating whether one or both parents, parents and/or other adults, or no adults are within line-of-sight to the child. In the social-companions subsample, individuals were re-coded as *parent, other adult, older child, same-aged child, younger child,* or *none* (indicating there was no one within three meters of the child during those observations). Thus, adults, in general, and parents, specifically, can be compared to other children in their relative availability.

**Adult intervention** is defined as whether an adult provided any form of teaching to a child. Here, teaching is defined broadly to include negative and positive feedback, task commands, rough-joking (a form of moral shaming), as well as verbal or non-verbal instruction (see Boyette & Hewlett, 2017). While some instances of teaching did involve instruction specifically around risks (Section 1.3), here the question is if such instances were systematically associated with risky behavior.

*2.3. Bayesian regression modeling*

Bayesian regression modeling was implemented in RStudio Version 2024.12.0 using the *brms* package. In each case the, outcome variable was a dichotomous variable – risky behavior or adult intervention – and was modeled using a Bernoulli distribution with a logit link function and default, "flat" priors. To account for the possibility of baseline variation in the probability of risky behavior between individuals and across times of the day, a unique identifier for each focal child and a numerical variable representing the minute of the day of the observation were each modeled as random intercepts in the models. Resulting estimates were based on 4000 iterations of the model. These values provide a sense of the strength and uncertainty of the modeled relationships between parameters given the data.

Three sets of models of risky behavior were run: All risky behavior; risky play; and risky work (as defined in Table 1). In the models of risky behavior from the full data, the main predictor variable was whether parents or other adults were in visual range. Additionally, age in years (centered), child sex (female as reference), and ethnicity (Aka as reference) were included as independent covariates, as each was previously found to be associated with frequencies of work and play in these data (Boyette, 2016a; Lew-Levy & Boyette, 2018). Additionally, the model was also run with an interaction between ethnicity and adult availability to test for the possibility of an ethnicity dependent increase in the probability of risky behavior (Propositions 2 and 3). In models using the subsample data, the main predictor variable was the six-category social companions variable, and the same covariates were included. For the models examining risky behavior on probability of adult intervention, the data was restricted to only those observations where adults were within visual range, such that an adult was at least available to intervene (17,453 observations, 76 % of the data set). The three dichotomous risky behavior variables (all, play, and work) were each use used in separate models as predictors of adult intervention. The covariates were the same as the other models, and the same models were also run with an interaction term to test if Ngandu ethnicity augmented the likelihood of adult intervention (Proposition 5).

**3. Results**

*3.1. Adult-child proximity across time and space*

Table 2 summarizes the adult availability and intervention data. Children in both groups were most often in sight of at least one adult. On average, Aka children were in sight of only one or both of their parents in 12 % of observations, any adult in 64 % of observations, and were out of visual range of an adult in 33 % of the observations. The Ngandu were a little more often in sight of only their parents, but, as expected, given the relatively dense, open village context, they were in sight of at least one other adult in 82 % of observations and out of sight of adults in only

**Table 2**

Mean (sd) proportion of observations in the data for the key variables.

|  | Aka | Ngandu |
|---|---|---|
| Adults in visual range[a] | | |
|   Parent | 0.12 (0.19) | 0.18 (0.14) |
|   Any adult | 0.64 (0.23) | 0.82 (0.18) |
|   No adult | 0.33 (0.23) | 0.18 (0.14) |
| Social companions w/in 5 m[b] | | |
|   None | 0.12 (0.06) | 0.15 (0.10) |
|   Parent | 0.07 (0.06) | 0.06 (0.06) |
|   Non-parent adult | 0.17 (0.11) | 0.09 (0.08) |
|   Older child | 0.22 (0.18) | 0.20 (0.14) |
|   Younger child | 0.22 (0.16) | 0.33 (0.23) |
|   Same-aged child | 0.32 (0.18) | 0.26 (0.14) |
| Adult intervention (teaching) | 0.01 (0.10) | 0.01 (0.11) |
| All risky activities[a] | 0.35 (0.48) | 0.40 (0.50) |
| Risky play[a] | 0.13 (0.34) | 0.23 (0.42) |
| Risky work[a] | 0.16 (0.36) | 0.12 (0.33) |

[a] These are calculated from the full data set, though the means and standard deviations are roughly equivalent in the subsample.

[b] These are based on the subsample where social companions were recorded.

18 %. However, zooming in, adults were relatively infrequently among those within 5-meters of the focal child in both groups. While non-parental adults were more often within 5-meters of the Aka than Ngandu children, older, younger, and same-aged children were, on average, more frequently children's social companions. However, as can be seen by the standard deviations around these mean values in Table 2, there is a lot of variation. This can be partially accounted for by time of day and by age of the focal child.

For instance, Fig. 1 plots the probability a child was in or out of sight of at least one adult across the day. The plot shows both major differences between the groups and developmental patterns of adult availability. For the Aka, younger children experienced a u-shaped pattern of adult availability, where they were most frequently in sight during the morning and evening—when people prepare for work and return to the household—but had a 50 % chance of being out of adult sight at midday, when most adults are away working. In middle childhood, Aka adults were similarly available in the morning, but then the probability quickly dropped for the rest of the day. Adolescents among the Aka were more likely to be out of sight in the morning and again at midday. For the Ngandu, morning and evening had the highest probability across age groups, with adults being more likely available to younger children than

older children across the day, but adults being generally more available all day than among the Aka.

The relative likelihood that parents versus other adults were available across ages is plotted in Fig. 2. Here, the major difference between the groups was a large spike in probability that Aka 8 to 11-year-olds were away from adults. Otherwise, for both groups, the probability that only children's parents were available remained relatively low. This is also seen in the social companion subsample as seen in Fig. 3. Here, parents remain relatively low in their probability of being near the focal child compared to other children. Other adults increased in their probability of proximate availability for the adolescent focal children, but Ngandu children were more likely to be alone across ages than in close proximity to other adults or their parents. These plots clearly show the opportunities for horizontal transmission among Aka children in middle-childhood who were by far more likely to be near same-aged children than any other companions. Also, Ngandu adolescents were much more likely to be in proximity to younger children, consistent with their roles of responsibility in the household. Finally, Fig. 4 shows that these relative trends in probability of proximity—as a measure of availability—hold relatively constant across contexts.

### 3.2. Modeling risky behavior and adult intervention

Table 3 shows the estimates from the Bayesian regression models and the associated 95 % credibility intervals as a measure of their certainty. Results presented are only from the models using the full data set where the predictor variable was whether an adult was in visual range of the focal child or not. Models using the adults in visual range data that distinguished parents from others, as well as the social companion subsample had qualitatively similar results. In some models, parents had a stronger effect than other adults, but otherwise, the direction and certainty of the effects were equivalent. These models show that adult availability actually decreases the probability of risky activities, consistent with Proposition 3, whereas Ngandu ethnicity increases it. However, including the interaction between Ngandu ethnicity and adult availability shows that while adult availability does decrease the probability overall, compared to the Aka, adult availability almost doubles the odds that Ngandu children do risky activities ($e^{0.65} = 1.92$). The models of only risky work and risky play activities, respectively, are consistent with prior results examining work and play in general in that age increased the probability of work and decreased the probability of
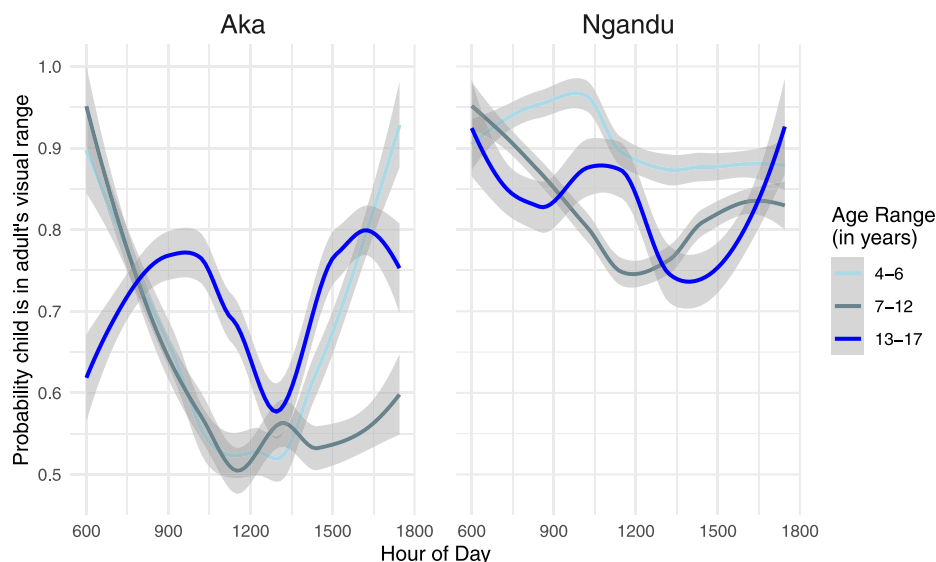


**Fig. 1.** Relative probability that the focal child was within visual range of any adult across the day by age category. Lines are loess smoothing curves with standard errors in gray. Probabilities were calculated as the number of observations focal children in each age group were observed at that minute of the day within sight of an adult divided by the total observations of children of that age.
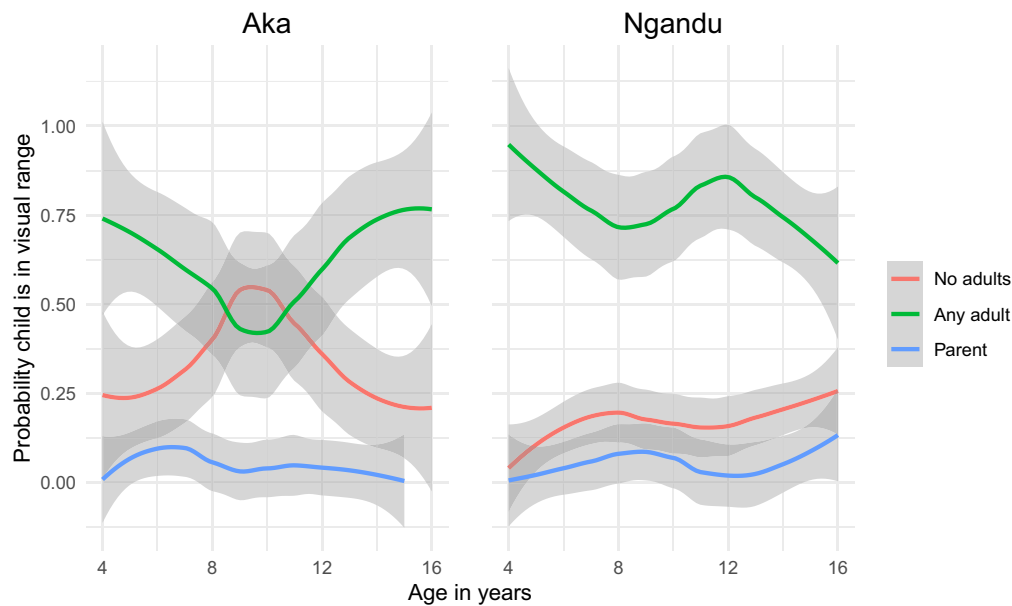
**Fig. 2.** Relative probability that the child is within visual range of one or both of their parents, their parents or one or more other adults, or no adults by age. Lines are loess smoothing curves with standard errors in gray. Probabilities were calculated as the number of observations focal children of each age were observed in each category of adult availability divided by the total observations of children of that age.
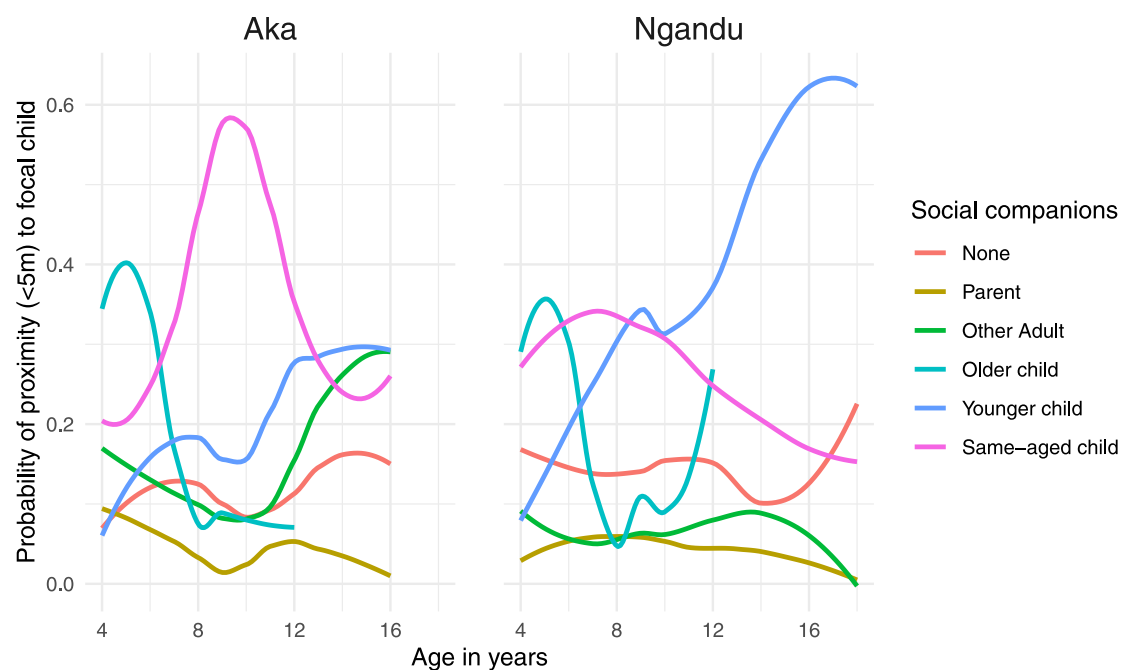


**Fig. 3.** Relative probability that the focal child was in proximity to each category of social companion or alone by age. Lines are loess smoothing curves. Standard errors around the curves are omitted for simplicity. The lines for older children stop at 12 years old because for focal children older than 12, social partners were either categorized as younger, same-aged (i.e., other adolescents) or as adults. Probabilities were calculated as number of observations of focal children at each age were within 5-m of each category of social partner divided by total number of observations of children of that age.

play, and boys were less likely to work and more likely to play (Boyette, 2016a). New here, however, we see that adult availability decreased the probability of either risky work or risky play, but that, for risky work, the negative effect of adult availability was muted in the Ngandu. Thus, for all risky activities, risky work alone, and risky play alone, these findings are consistent with Proposition 3 for both groups (availability decreases risky behavior), but the effect is muted for the Ngandu relative to the Aka.

The models of the effect of risky activities on the probability of adult intervention show complex and somewhat surprising patterns (Table 4).

When adults were available to intervene, children engaging in any risky activities had no effect on the probability of intervention. However, adding the interaction suggests the effect of risk is conditional on being Ngandu. Meaning compared to the Aka, among whom there was no overall effect, Ngandu children had 58 % (1-e^-0.86) *lower* odds of adult intervention when engaging in risky activities. However, this may be driven by certain risky activities (e.g., travel, blade tool use; see Table 1), because engaging in risky work, specifically, *doubled* the odds of adult intervention independent of ethnicity, consistent with Proposition 5. Conditioning on Ngandu ethnicity only increased the effect size
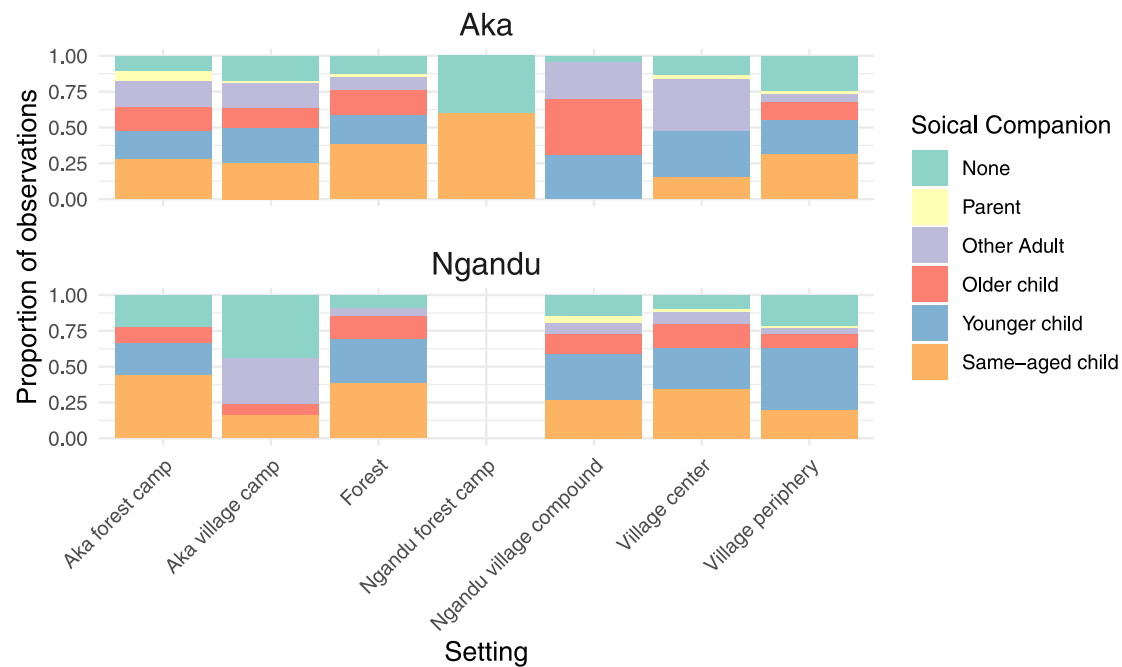
**Fig. 4.** Relative proportion of observations that children were with different social companions across settings. There are no observations of Ngandu children in Ngandu forest camps because these were briefly visited by Aka children during focal follows.

**Table 3**
Estimates (log-odds) and 95 % credible intervals (CIs, in parentheses) from Bayesian regression models predicting risky activities without and with an interaction between Ngandu ethnicity and adult availability. Estimates whose 95 % CIs do not encompass zero are bolded to indicate the relative certainty of an effect.

| | All Risky Activities | | | |
|---|---|---|---|---|
| Age | 0.18 | (−0.00, 0.36) | 0.19 | (0.01, 0.36) |
| Male sex | 0.04 | (−0.32, 0.40) | 0.05 | (−0.29, 0.40) |
| Ngandu ethnicity | **0.36** | **(0.00, 0.71)** | −0.13 | (−0.50, 0.23) |
| Adult availability | **−0.90** | **(−0.97, −0.82)** | **−1.14** | **(−1.24, −1.0)** |
| Ngandu ethnicity*Adult availability | | | **0.65** | **(0.50, 0.81)** |

| | Risky Work | | | |
|---|---|---|---|---|
| Age | **0.50** | **(0.25, 0.76)** | **0.52** | **(0.25, 0.78)** |
| Male sex | **−0.79** | **(−1.31, −0.29)** | **−0.78** | **(−1.28, −0.28)** |
| Ngandu ethnicity | −0.12 | (−0.61, 0.38) | −0.31 | (−0.84, 0.22) |
| Adult availability | **−0.80** | **(−0.90, −0.70)** | **−0.90** | **(−1.02, −0.77)** |
| Ngandu ethnicity*Adult availability | | | **0.28** | **(0.07, 0.49)** |

| | Risky Play | | | |
|---|---|---|---|---|
| Age | **−0.47** | **(−0.74, −0.20)** | **−0.48** | **(−0.73, −0.21)** |
| Male sex | **0.96** | **(0.45, 1.47)** | **0.97** | **(0.45, 1.46)** |
| Ngandu ethnicity | 0.52 | (−0.02, 1.03) | 0.41 | (−0.11, 0.94) |
| Adult availability | **−0.15** | **(−0.25, −0.06)** | **−0.23** | **(−0.36, −0.09)** |
| Ngandu ethnicity*Adult availability | | | 0.17 | (−0.02, 0.36) |

of the main effect. At the same time, risky play *decreased* the odds of adult intervention by 59 %, an effect that the interaction term masks—meaning conditioning on Ngandu ethnicity weakens the certainty of the main effect, while not interactively effecting the probability of intervention.

## 4. Discussion

Cultural evolutionary theory describes the interface between individuals and culture in terms of social learning processes and cultural transmission modes, which conspire to promote adaptive behavior in particular environmental contexts (Boyd & Richerson, 1985; Cavalli-Sforza & Feldman, 1981). Stable cultural adaptation requires balancing trade-offs between tradition and innovation at the population level (Acerbi & Parisi, 2006; Borenstein et al., 2008; Boyette, 2016b; B. L. Hewlett, 2016) and between rigidity and flexibility in learning within individuals (Bonawitz et al., 2011; Charbonneau & Sperber, 2024; Derex et al., 2025). In this paper, focusing on the socialization of risk perception, I have argued that an over-emphasis on vertical cultural transmission and teaching among intensive parenting cultures undermines children's learning to cope with risks, with potential implications for population level adaptation. In contrast, I show data from Aka hunter-gatherers and Ngandu farmers that is consistent with their prioritizing children's autonomy in encountering risks and learning through collaborative and situated learning among peers, saving intervention for those risky activities which are critical to children's acquisition of subsistence skills and knowledge. Below, I review my findings and then discuss their meaning for how we understand diversity in the perception of risk. These findings align with applied research pushing for policy that supports children's autonomy in their interactions with their physical and social worlds while maintaining a balance between learning of culturally valued knowledge and skills and giving them opportunities for healthy risk-taking—and thereby learning to perceive and cope with risks. I argue that research and policy must recognize and understand community variation in adaptive developmental systems, and how environmental change is perceived at the local level.

**Table 4**
Estimates (log-odds) and 95 % credible intervals (CIs, in parentheses) from Bayesian regression models predicting adult intervention without and with an interaction between Ngandu ethnicity and risky behavior. Estimates whose 95 % CIs do not encompass zero are bolded to indicate the relative certainty of an effect.

| Adult intervention in all risky activities | | | | |
|---|---|---|---|---|
| Age | −0.14 | (−0.33, 0.06) | −0.13 | (−0.33, 0.07) |
| Male sex | −0.35 | (−0.74, 0.01) | −0.35 | (−0.73, 0.02) |
| Ngandu ethnicity | 0.03 | (−0.34, 0.40) | 0.27 | (−0.13, 0.68) |
| Risky activity | −0.20 | (−0.49, 0.08) | 0.26 | (−0.15, 0.65) |
| Ngandu ethnicity* Risky activity | | | **−0.86** | **(−1.39, −0.30)** |

| Adult intervention in risky work | | | | |
|---|---|---|---|---|
| Age | −0.18 | (−0.37, 0.02) | −0.18 | (−0.37, 0.02) |
| Male sex | −0.30 | (−0.67, 0.06) | −0.30 | (−0.69, 0.08) |
| Ngandu ethnicity | 0.00 | (−0.37, 0.38) | 0.09 | (−0.30, 0.48) |
| Risky work | **0.59** | **(0.24, 0.93)** | **0.83** | **(0.37, 1.28)** |
| Ngandu ethnicity* Risky work | | | −0.52 | (−0.18, 0.14) |

| Adult intervention in risky play | | | | |
|---|---|---|---|---|
| Age | −0.16 | (−0.35, 0.04) | −0.15 | (−0.35, 0.04) |
| Male sex | −0.30 | (−0.68, 0.07) | −0.30 | (−0.69, 0.08) |
| Ngandu ethnicity | 0.07 | (−0.30, 0.44) | 0.11 | (−0.26, 0.49) |
| Risky play | **−0.88** | **(−1.36, −0.43)** | −0.62 | (−1.31, 0.02) |
| Ngandu ethnicity* Risky play | | | −0.46 | (−1.28, 0.39) |

### 4.1. Autonomy and teaching in adaptation

This study was motivated by concerns over the intensity of social learning, especially via teaching and through vertical transmission, among intensive parenting cultures in the Global North. As expected, the groups examined here provide a stark contrast. In particular, in terms of children's daily social companions, adults were found to play a quantitatively minimal role among the Aka and the Ngandu. While children in both groups tended to be in sight of adults, adults were rarely children's close social companions in comparison to other children. These patterns were consistent across the contexts in which children were observed to work, play, and so on. Additionally, as expected, Aka children had more autonomy from adults, spending less time out of their sight. As presented here, these data generally illustrate a pattern where children and adults start their day in proximity, and then are more-or-less separate in space until returning together for the evening. For the Aka, this meant adults would leave for the forest and children might follow, or they may stay in the camp and pursue their own interests there or in the forest as well. For the Ngandu, parents would typically leave for their gardens or the market, or fathers would socialize and politic with other men, while the children were left with domestic and childcare tasks to undertake, which they would do interspersed with play. Children would sometimes accompany their parents or other adult relatives in their work, or they would cross adults' paths in the course of their activities.

Given these general trends, Bayesian regression modeling was used

to examine, when adults were available, whether children were more or less likely to engage in risky behavior, and whether risky behavior was associated with adult intervention. To remind the reader, risky behavior was defined by recoding children's observed activities into categories of risk based on Sandseter (2007), and intervention was represented by observations of teaching, broadly defined (Boyette & Hewlett, 2017). The analysis was guided by a set of logical propositions that differed in their degree of support from the existing research. There are two key results from this analysis.

First, across regression models predicting all children's activities, only work, or only play as outcome variables, adult availability *decreased* the probability that children engaged in risky activities. While, the association was reduced for the Ngandu for all activities combined and for work alone, these findings mean that children were *more likely* to engage in risky behavior when they were *out of sight* of adults, consistent with Proposition 3. That the finding held when work and play are predicted separately shows that it is not because adults would discourage risk if they were available. Rather, this is consistent with research among similar groups indicating that children have the autonomy to engage with risks away from adults as part of an age-graded division of labor (Kramer, 2002, 2021; Lancy, 2012). For instance, across a sample of 12 hunter-gatherer or horticultural-foraging societies, extrinsic risk from dangerous animals or poor water quality/quantity had no effect on children's time allocation to work, play, or other activities (Lew-Levy et al., 2022). Parents and children in these groups acknowledge risks in their environments—injury from tools, extreme weather, animal encounters, getting lost (Boyette, 2024; Crittenden et al., 2021; Davis & Cashdan, 2020; Lew-Levy et al., 2019)—but what can be learned by facing these risks is understood as central to development in these communities. Through facing risk, children build critical self-regulatory abilities to cope with future risks (Dodd & Lester, 2021; Sandseter & Kennair, 2011). At the population level, children's help in work contributes to resource pooling and sharing, which buffers larger and less predictable environmental risks such as droughts or epidemics (Cashdan, 1987; Kramer & Ellison, 2010; Lew-Levy et al., 2022).

Second, despite the probability that children's risky activities were done out of adult sight, and despite how infrequent teaching by adults was observed (1 % of observations), when adults were available to children, engaging in risky work increased the probability that adults intervened on children's learning, consistent with Proposition 5. This does not necessarily mean that parents or other adults were stopping children from engaging in risky work activities. Sometimes this was the case, as in the examples noted in Section 1.3 ("Move away from the fire."), but often adults were giving children specific, simple instructions or a related task command (e.g., "Help me lift the water on my head.", "Hey, put those in a dish!" [not on the ground], "Like this, quickly.", "Bring me my ax."). Thus, the intervention was to guide children's activities, especially toward cooperative ends, independent of risk. The findings for all risky activities combined and for play were less clear, although they hinted at non-work risky activities being less likely to coincide with adult intervention, with some difference between the two groups. Together with the results on availability, these results indicate that children in these groups acquire culturally valued skills largely through legitimate participation, with only minimal social learning via teaching from vertical or oblique sources.

This interpretation is consistent with the large corpus of ethnographic material on other subsistence societies that indicates adults do not objectify learning nor risk, but rather trust that children will acquire what they need to know through their own, often collaborative, engagement with the environment (Kramer, 2021; Lancy, 2016, 2021; Mead, 1942; Mezzenzana, 2020; Morelli et al., 2003; Ochs & Izquierdo, 2009; Paradise & Rogoff, 2009; Siekiera & Białek, 2024). However, these findings are also consistent with the value of teaching as a means of accelerating the learning of valued cultural knowledge and skills, especially those related to the cooperative food quest (Boyette & Hewlett, 2018; Csibra & Gergely, 2011; Kline et al., 2013; Tomasello et al.,

2012). Indeed, given the Aka emphasis on children's autonomy and the Ngandu emphasis on obedience, the lack of a difference between the groups in parental intervention (through teaching) in risky work is telling, and supports the value of examining these data in this way. Then, in terms of the cultural evolutionary trade-offs guiding this analysis, both Aka and Ngandu societies structure children's learning environments in ways that balance social learning via the authority and localized expertise of vertical and oblique modes with substantial opportunity to check and update knowledge through horizontal transmission; and also balance individual learning through autonomous play and work in the context of collaborative learning among mix-aged children with occasional teaching from adults (Boyette, 2016b). While these data do not directly demonstrate learning through autonomous encounters with risks, focal child age increased the probability of work and decreased the probability of play in these models, in line with previous findings (Boyette, 2016a; Lew-Levy & Boyette, 2018), while the risks involved in the work only increased, if anything. For example, exploration ranges typically increase during adolescence (Cavalli-Sforza & Hewlett, 1982; B. L. Hewlett, 2004) and this is also when children begin to hunt (Lew-Levy et al., 2021).

## 5. Conclusion: risk, autonomy and cultural change

In the face of the trends in parental risk perception and mental health reviewed in the introduction, others have also contrasted the prioritization of risk-avoidance over children's autonomy among intensive parenting cultures with the greater autonomy and competence of children in small-scale subsistence societies like the Aka and Ngandu (Gray et al., 2023; Kramer, 2021; Lancy, 2021; Mead, 1970; Morelli et al., 2003; Ochs & Izquierdo, 2009). Gray, in particular, has evoked an evolutionary mismatch explanation for the mental health crisis among youth in the Global North (Gray, 2012, 2013; Gray et al., 2023). According to this explanatory framework, maladaptation occurs when a developmental system is expecting one environment—specifically, the one in which humans evolved—but experiences a different one—contemporary post-industrial modernity (Williams & Nesse, 1991). However, returning to a point made in Section 1.2, adaptation is always in relation to a current environmental context. This mismatch view may misrepresent the scope of human developmental plasticity and resilience (Frankenhuis & Amir, 2021; Humphreys & Salo, 2020), but it also underappreciates the dynamic nature of culture. Just as children enjoyed significantly greater autonomy in the US only a half-century ago (Hart, 1979; S. Hays, 1996; Stearns, 2009)—and may in less researched contexts today (e.g., rural contexts; Indigenous North American communities)—Indigenous and subsistence communities continue to experience dramatic changes across the world (Bauer et al., 2022; Doremus, 2019; Fernández-Llamazares et al., 2021). In both cases, one key variable is the pace of environmental change, and whether local developmental systems are able to balance the trade-offs between local traditional knowledge and practices and innovation. One major driver of the pace of change today is also one of the central motivations behind intensive parenting: formal schooling.

In general, formal schooling has long been shown to shape cognition in specific ways, especially toward abstract, depersonalized, and general ways of cognizing, and away from concrete, relational and local ways (Bruner, 1996; Cole, 2005; Kroupin & Zeng, 2024; Luria, 1994; D. R. Olson, 2003; Scribner & Cole, 1973). While this has its advantages in efficiently conveying certain kinds of thinking useful in a global capitalist economy (Bowles & Gintis, 2002), its reliance on teaching and standardized assessment disadvantages learners who may learn differently as individuals (Boyce et al., 2012; Cainelli & Bisiacchi, 2019; Shifrer, 2013) or who come from communities used to different social learning processes and modes of transmission (Bloch, 1993; J. Hays et al., 2019; Ninkova et al., 2022; Okagaki & Sternberg, 1993; Sternberg et al., 2001). Additionally, from a purely time allocation perspective, school takes children in subsistence contexts away from their role in the

family economy. This does not necessarily mean they will lose traditional knowledge or skill and maladaptation will result (Reyes-García et al., 2010). Indeed, many of the children in this study attended schools when they were in session. And among the Aka, whom face discrimination in public school, parents told me that they want their children to attend school because they see the material advantages of reading and writing. However, school does not immediately lead to improved outcomes if there is no use for school knowledge once acquired (Bloch, 1993), or, in terms of maintaining locally adaptive risk perception, if it means limiting children's autonomy from collaborative, embodied learning in the environment in favor of oblique transmission of abstract, acontextual knowledge.

From this perspective, to the extent that intensive parenting impedes adaptive risk perception and management for some in the Global North, to promote it as the key to improving the lives of Indigenous and subsistence peoples in other parts of the world is ethically dubious (Scheidecker et al., 2021). Yet, this is the specific goal of global early childhood development researchers (Ahun & Bacon, 2024; Black et al., 2017; Britto et al., 2017; Luoto et al., 2021; Richter et al., 2017; Weber et al., 2017). In these intervention studies, designed by researchers in the Global North, parents like those among the Aka and Ngandu are trained to play with their young children, hold them face-to-face, respond to their cues, and give them safe places to play around their homes in an effort to prepare them for school. These researchers and their funders, including UNICEF, are concerned that children who grow up like those studied here will not reach their "developmental potential." From the perspective of anthropologists and cross-cultural psychologists, such interventions are fundamentally culturally-bound—based on a single view of "developmental potential" that does not acknowledge local developmental systems (Morelli, Bard, et al., 2018; Morelli, Quinn, et al., 2018; Scheidecker et al., 2023). Indeed, it is the mismatch argument backwards, where the reference point for adaptation is intensive parenting instead of small-scale societies. In this context, it is worth noting that studies show overall high wellbeing among small-scale subsistence societies (Gurven et al., 2024; Reyes-García et al., 2021).

Ultimately, in supporting adaptive risk perception, parents and policy-makers must balance autonomy-supportive environments and practices with teaching, and traditional knowledge and practices with an openness to innovations all with respect to the local pace of environmental change. This a highly simplified framework, but I have shown that, in broad strokes, it explains the community level variation in children's ability to perceive and cope with environmental risks across these case studies. It is also consistent with the framework of social determination theory (Deci & Ryan, 1987; Gray et al., 2023; Ryan & Deci, 2000; Soenens & Vansteenkiste, 2010). Specifically, Aka and Ngandu developmental systems are highly supportive of both relatedness and autonomy, and thus it is not surprising that children achieve competence in dealing with risk. Cultural evolutionary theory adds additional rigor by delineating the trade-offs between different learning processes, which vary in their degree of autonomy support (e.g., from individual trial-and-error learning to observation to teaching) and specifying the community-wide implications of learning from different cultural transmission modes, which interact with specific forms of relatedness (e.g., parents, teachers, peers). In these ways, it may be a fruitful framework for further investigations of cultural diversity in risk perception and autonomy, and their implications for child, parent, and community wellbeing and adaptation, especially in the face of continued globalization and the looming acceleration in global environmental change.

**CRediT authorship contribution statement**

**Adam Howell Boyette:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

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## Data availability

Data will be made available on request.

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