Teaching through collaboration: Flexibility and diversity in caregiver-child interaction across cultures

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Abstract

Teaching supports the high-fidelity transmission of knowledge and skills. This study examined similarities and differences in caregiver teaching practices in the U.S. and Vanuatu ($N = 125$ caregiver and 3-8-year-old child pairs) during a collaborative problem-solving task. Caregivers used diverse verbal and non-verbal teaching practices and adjusted their behaviors in response to task difficulty and child age in both populations. U.S. caregivers used practices consistent with a direct active teaching style typical of formal education, including guiding children’s participation, frequent praise, and facilitation. In contrast, Ni-Vanuatu caregivers used practices associated with informal education, and divided tasks with children based on difficulty. We discuss the implications of our data for claims about the universality and diversity of caregiver teaching.

key words: caregiver-child interaction, collaboration, cross-cultural comparison, observational learning, teaching, Vanuatu
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Children learn critical skills through independent, active exploration of their environments (Gopnik & Wellman, 2012), yet much of what they know, they learn from others (Gelman, 2009; Harris, 2012; Vygotsky, 1978). Social learning allows children to acquire the cumulative cultural knowledge of previous generations and is often more efficient than independent trial-and-error learning (Boyd & Richerson, 1996; Henrich, 2015; Legare, 2017). A protracted childhood allows for social learning by providing children with an extended period for interaction with caregivers and peers (Bjorklund & Ellis, 2014; Cole, 2007). Teaching, or a change in behavior that is contingent upon or coordinated with the anticipated or expressed needs of a learner (Boyette & Hewlett, 2017; Caro & Hauser, 1992; Hewlett & Roulette, 2016; Kline, 2014), is a key feature of social learning and is one of the primary means by which knowledge, practices, and skills are transmitted within and across generations (Strauss & Ziv, 2012).

Studying both similarities and differences in teaching during caregiver-child interaction across diverse populations deepens our understanding of vertical cultural transmission (i.e., the transmission of cultural knowledge between generations) (Cavalli-Sforza, Feldman, Chen, & Thornbush, 1982) and the development of children’s social learning (Lave & Wenger, 1991; van Leeuwen et al., 2018).

There is a lack of consensus, however, about the extent of both quantitative and qualitative global variation in teaching practices. Despite claims within the psychological literature that teaching is a natural and universal feature of human childrearing (Csibra & Gergely, 2009; 2011), some anthropologists report relatively infrequent teaching outside of WEIRD (Western, Educated, Industrialized, Rich, and Democratic; Henrich, Heine, &
Norenzayan, 2010) populations (Lancy, 2016; Lancy, 2010). Data from hunter-gatherer (Boyette & Hewlett, 2017; Hewlett, Fouts, Boyette, & Hewlett, 2011; Lew-Levy, Rackin, Lavi, Cristóbal-Azkarate, & Ellis-Davies, 2017), subsistence agricultural (Kline, Boyd, & Henrich, 2013; Little, Carver, & Legare, 2016), and industrialized populations (Csibra & Gergely, 2011; Hess, Azuma, Kashiwagi, Holloway, & Wenegrat, 1987) have provided support for claims about the universality of some teaching behaviors, such as pointing and joint attention. In contrast, other teaching behaviors, such as direct instruction and demonstration, vary substantially in frequency and kind between populations (Lancy, 2012; Lave & Wenger, 1991; Scribner & Cole, 1973; Steward & Steward, 1973). Explanations for the lack of consensus about the extent of variation in teaching include how it has been defined (for a review, see Kline, 2014) and the populations typically sampled in psychological versus anthropological research (Hewlett & Lamb, 2005).

Previous research suggests, however, that variation in teaching practices may be associated with between- and within-population differences in educational, economic, and social structures (see Legare, 2017; Paradise & Rogoff, 2009). In the current study, we examined similarities and differences in caregiver-child interaction and caregiver teaching behaviors in two populations with different educational, economic, and social institutions: a formally educated, urban, industrialized population (high socioeconomic status U.S.; hereafter HSUS) and an informally-educated, rural, subsistence agricultural population (Tanna, Vanuatu; hereafter Tannese). Both formal and informal education are the products of particular cultural institutions and operate within complex economic and social contexts (Paradise & Rogoff, 2009); thus, the objective of this study is not to attribute similarities or differences in caregiver-child interaction or teaching style between populations exclusively to educational style. Instead, our objective is to build upon previous research documenting the relations between the frequency and form of
particular teaching practices and formal (i.e., institutionalized) versus informal (i.e., observational learning and apprenticeship) education (Greenfield, 2009) using a structured task that allows for direct comparison within- and between-populations.

Below, we focus our review on differences in caregivers’ beliefs and teaching behaviors between communities that practice formal versus informal education and discuss how they may influence caregivers’ teaching. We map these differences onto predictions related to caregiver-child interaction style and caregiver teaching behaviors between populations. We then discuss the ways in which caregiver teaching may be similar across these diverse populations in response to task difficulty and child age.

**Formal Versus Informal Education and Teaching Practices**

Formal education segregates children from community activity (Lancy, 2010, 2012; Rogoff, 2003) and institutionalizes particular styles of instruction (Paradise & Rogoff, 2009). One type of instruction common in formal educational settings is *direct active teaching*, or the explicit verbal or physical presentation of information that emphasizes interchange between teachers and learners (Greenfield, 2009; Kline, 2014). Formally-educated caregivers’ beliefs about how children learn reflect a hierarchical relationship, in which information is transmitted from teacher to student (Childs & Greenfield, 1980; Greenfield & Lave, 1982; Scribner & Cole, 1973). This may be a consequence of caregivers’ own experiences with direct active teaching as students in formal education settings (Crago, Annahatak, & Ningiuruvik, 1993; Kağıtçıbaşı, 2007; Keller, 2017; Laosa, 1980; LeVine, Levine, Schnell-Anzola, Rowe, & Dexter, 2012). Formally-educated caregivers also believe that adults are responsible for imparting knowledge to children (Odden & Rochat, 2004) through the use of verbal interaction (including questions and praise; Clark & Bernicot, 2008; Dixon, Levine, Richman, Brazelton, & Url, 1984; Hess,
Kashiwagi, Azuma, Price, & Dickson, 1980), explicit demonstration of behaviors (Little et al., 2016), and modification of tasks and materials to make them more accessible (Hammond, Müller, Carpendale, Bibok, & Liebermann-Finestone, 2012; Wood, Bruner, & Ross, 1976). Teaching behavior is far more diverse than the direct active teaching emphasized in formally-educated populations, however, and this explicit instruction is only one way that caregivers share knowledge with children (Greenfield, 2009; Kline, 2014).

Rather than segregating children from community activity, informal education requires participation in community activity and learning through observation (Paradise & Rogoff, 2009). Teaching behaviors consistent with expectations that children learn by observing the actions of others and actively participating (hereafter, observational learning) have been documented in a number of small-scale populations globally (Bird & Bliege Bird, 2002; Gaskins & Paradise, 2010; Odden & Rochat, 2004). Informally-educated caregivers believe that children are responsible for their own learning (Greenfield & Lave, 1982) and expect children to learn by observing and actively participating in meaningful activities with other community members (Rogoff et al., 1993). Small-scale, subsistence agricultural populations with limited experience with formal education may thus be less reliant upon direct active teaching to educate their children (Childs & Greenfield, 1980; Greenfield, 2009). In informal education settings, caregivers support children’s learning through practices that are distinct from direct active teaching, but instead emphasize children’s observational learning, such as teaching by social tolerance (i.e., allowing children to observe behaviors), teaching by social provisioning (i.e., allowing children to participate collaboratively with others), and teaching by stimulus enhancement (i.e., drawing children’s attention to features of on-going behavior; Kline, 2014). Teaching behaviors consistent with informal education practices have been documented in both
anthropological and psychological research in some informally-educated populations (for a review, see Rogoff, 2003), however, global variation in teaching behaviors is still critically understudied (Kline, 2014; Nielsen, Haun, Kärtner, & Legare, 2017).

**Study Sites**

**Austin, Texas, U.S.**

Our sample of high SES U.S. caregivers and children (HSUS) was recruited from Austin, TX based on the population’s high rates of participation in formal education. In 2017, approximately 73% of Austin’s adult population had attended college or received an advanced degree. Over 70% of Austin’s workforce work in fields such as sales, management, business, and academics (U.S. Census Bureau, 2017). Most of Austin’s population lives in urban and suburban neighborhoods in and around the metro area. Formally-educated urban populations, such as our HSUS sample, are the kinds of populations typically sampled in psychological research (Henrich et al., 2010; Nielsen et al., 2017).

**Tanna, Vanuatu**

Our sample of caregivers and children from Tanna, Vanuatu (Tannese) was selected due to the population’s limited experience with formal education (Aime, Broesch, Aknin, & Warneken, 2017; Aknin, Broesch, Hamlin, & Van de Vondervoort, 2015; Lindstrom, 1996). Most of Tanna’s population is divided among a number of small villages and communities located throughout the island (Dixson, Komugabe-Dixson, Dixson, & Low, 2017). Although attending primary school has become more common in recent years, particularly among children in coastal villages with access to schools, few Tannese adults have attended secondary school (Gregory & Gregory, 2001, 2002). Most Tannese adults participate in subsistence agriculture (Aknin et al., 2015; Lindstrom, 1996) though some are employed in the tourism industry.
TEACHING THROUGH COLLABORATION

Cross-cultural Comparisons of Children’s Learning in HSUS and Tannese Populations

Previous research with Tannese and HSUS caregivers suggests that Tannese caregivers may emphasize practices associated with observational learning to a greater extent than direct active teaching. For example, when asked to interact with a novel toy with their infants, Tannese parents were less likely than HSUS parents to directly teach their infant an affordance of the toy (Little et al., 2016). Tannese children and caregivers also expect children to observe and closely imitate an adult model without instruction to do so (Clegg, Wen, & Legare, 2017; Wen, Clegg, & Legare, 2019) and Tannese primary school-aged children imitated a modeled behavior at higher levels of fidelity than HSUS children (Clegg & Legare, 2016). Thus, starting in infancy, Tannese caregivers use teaching practices that reflect expectations that children will learn by closely watching and imitating others, consistent with informal education. In interviews conducted in the U.S. and Vanuatu about caregivers’ ethnotheories of children’s learning, the majority of HSUS caregivers indicated that adults are responsible for the transmission of information to children and that children learn from direct active teaching, consistent with formal education practices. In contrast, the majority of Tannese caregivers indicated that children are responsible for their own learning by observing others, consistent with informal education (see Supporting Information Appendix A).

Study Objectives and Hypotheses

Our first objective was to examine the kinds of teaching practices HSUS and Tannese caregivers use during collaborative activity with children. Caregivers’ teaching practices are shaped, in part, by their beliefs about children’s learning (Harkness & Super, 2002; Kağıtçıbaşi, 2007) and experience with formal education (Greenfield, Maynard, & Childs, 2003; Keller,
2017; LeVine et al., 2012). Thus, if caregivers expect children to learn by observing others, they should provide opportunities for children to observe when learning a new skill and actively participate when a skill is within their ability, rather than directly structuring children’s involvement (Greenfield, 2009; Keller, 2017; Paradise & Rogoff, 2009). In contrast, if caregivers believe that children learn as a result of direct active teaching, they should prioritize children’s active participation in all parts of a task and guide this involvement with high amounts of verbal and physical scaffolding (Willard et al., 2019).

To examine the extent to which HSUS and Tannese caregivers’ teaching practices were consistent with different expectations for children’s learning associated with formal versus informal education, we invited caregivers and children to complete a novel joint problem-solving task—creating shapes out of smaller tangram pieces. The design of this study is based on previous research that has used one task across diverse populations to explore variation in teaching style and interaction [(e.g., origami and toy construction (Lopez, Correa-Chavez, Rogoff, & Gutierrez, 2010; Mejia-Arauz, Rogoff, Dexter, & Najafi, 2007), puzzle building (Chavajay & Rogoff, 2002), and Tinkertoy construction (Laosa, 1978)] while also providing for an opportunity to explore variability in caregiver and child behaviors in response to different levels of task difficulty. We selected a task that would be interesting and challenging for children of a variety of ages across early childhood. We examined two components of caregivers’ teaching practices during this task—how they interacted with children (interaction style) and how they used non-verbal and verbal teaching behaviors to scaffold children’s participation (teaching behaviors).

Previous research using similar methods (e.g., caregivers and children constructing three-dimensional puzzles) has examined how caregivers and children interacted when completing a
collaborative task. In these studies, Guatemalan Mayan caregivers with limited formal education experience worked collaboratively with children (i.e., all parties attended to the same elements of the task), whereas caregivers with more experience with formal education assumed a hierarchical director role to guide children’s participation (Chavajay, 2008; Chavajay & Rogoff, 2002). In this research, caregivers were often asked to interact with multiple children at once and overall assessments were made about the actions of the group, which limits conclusions about the direct contributions of the adult versus child partners in the completion of the task.

In this study, we examined dyadic interaction by directly assessing children’s versus caregivers’ active participation in the task in specific increments (e.g., 10 seconds rather than minutes). We also measured when children’s active participation was the direct result of caregiver instruction versus independent involvement in the task. When coding interaction styles, we examined when caregivers and children actively participated together (shared participation), when caregivers were the primary active participants (caregiver primary participation), when children were receiving or responding to caregiver instruction or direct active teaching (caregiver-led participation), and when children were acting independently as the primary active participants (child primary participation). Overall, shared participation and caregiver primary participation correspond with non-hierarchical practices associated with observational learning because they emphasize either joint participation or the child watching the caregiver completing the task. In contrast, caregiver-led participation corresponds with direct active teaching because the caregiver is guiding the child’s direct involvement. In contrast, child primary participation captures children’s independent completion of the task which could correspond with both observational learning and direct active teaching. In both formally and informally educated
populations, children might be encouraged and permitted to independently participate when they are completing activities that are within their ability level.

In addition to documenting styles of caregiver-child interaction as a component of caregiver teaching practices, we also examined the prevalence of different non-verbal (i.e., pointing, stopping, and facilitation) and verbal (i.e., planning, correction, encouragement, and imperatives) teaching behaviors. Previous research has tended to focus on either interaction or teaching behaviors, however, in this study we were interested in capturing both as complementary components of caregiver teaching practices. Some teaching behaviors, such as pointing and child-directed verbal instruction, have been documented in a number of different cultural contexts and caregiver educational backgrounds, but other behaviors, such as facilitation and verbal planning, are less common outside of formally-educated populations (Boyette & Hewlett, 2017; Dixon et al., 1984; Teichman & Contreras-Grau, 2006). Here, we coded for behaviors that might be used in both populations, rather than privileging behaviors typically associated with direct active teaching practices. We predicted that both HSUS and Tannese caregivers would engage in similar levels of teaching behaviors previously documented to occur across distinct cultural contexts, such as pointing and verbal imperatives. In both contexts, these behaviors might be used to enhance children’s attention to key elements of the task. In contrast, we predicted that, consistent with previous studies of informally-educated caregivers and children, Tannese caregivers would use behaviors associated with direct active teaching less frequently overall (Childs & Greenfield, 1980; Dixon et al., 1984; Laosa, 1978, 1980). Thus, we predicted that HSUS caregivers would demonstrate higher levels of facilitation, planning, and encouragement since these behaviors are directly associated with direct active teaching and are more commonly used by formally-educated caregivers.
Our second objective was to examine the impact of task difficulty on caregivers’ teaching practices. In recent work challenging the definition of teaching often used within the child development literature, Kline (2014) draws from ethnographic and experimental evidence to argue that, across cultures, caregivers’ teaching varies in response to factors such as task difficulty and importance and learners’ abilities (see also Freund, 1990; Pratt, Kierig, Cowan, & Cowan, 1988; Rogoff, Ellis, & Gardner, 1984). In particular, caregivers from diverse cultural contexts should use direct active teaching methods more when children are learning more demanding and higher cost tasks. In contrast, caregivers should expect children to observe or work alongside them during less demanding tasks. Thus, to provide an empirical test of this claim using a structured task, we assessed variation in caregivers’ teaching practices in response to task difficulty over the course of the joint problem-solving task.

The actions required to successfully complete the joint problem-solving task varied in complexity. To complete the task, caregiver-child pairs needed to select tangram pieces (less difficult preparation activity) before arranging the pieces to make a designated target shape (more difficult construction activity. The construction component was more complex because it required spatial rotation of multiple objects. Caregivers, regardless of their experiences with informal versus formal education, should be sensitive to task difficulty and prioritize children’s direct participation during activity that aligns with their abilities (Kline, 2014). We predicted that children’s active participation would be most prevalent during less difficult activity, either in the form of child primary participation, shared participation, or caregiver-led participation—as all of these interaction categories included children’s active participation in the task. Children’s participation in this activity may need to be guided through the use of teaching behaviors. We predicted that caregivers might use teaching behaviors more frequently during less difficult
activities. In contrast, we predicted that caregivers would take a more active role in the complex activity through caregiver primary participation. We also predicted lower frequency of teaching behaviors as the caregivers worked to complete the task themselves rather than guide children’s involvement. Another possibility, however, is that caregivers from both populations use more direct active teaching during the difficult parts of the task to scaffold children’s learning.

Our third objective was to examine the impact of child age on caregiver teaching practices. Caregivers are sensitive to children’s abilities (Kline, 2014; Vygotsky, 1978) and may adjust their teaching behavior in response to child age (Rogoff et al., 1984; Wertsch, Mcnamee, McLane, & Budwig, 1980) based on the expectation that older children may be more capable than younger children. We predicted that, in both populations, caregivers might give older children more autonomy to complete the task, and therefore pairs with older children would have lower rates of caregiver-led participation and caregiver primary participation, and that caregivers would use fewer teaching behaviors with older children than with younger children.

In sum, in this study we examined both the similarities and differences in caregiver teaching behaviors in a HSUS population and Tanna, Vanuatu. We predicted that when examining overall trends in caregiver teaching practices, including interaction style and non-verbal and verbal teaching behaviors, that there would be distinct patterns in the prevalence of behaviors associated with direct active teaching versus observational learning between populations. We also predicted cross-population similarities, however, in caregivers’ sensitivity to task difficulty and child age, such that caregivers would use different teaching practices more frequently during difficult components of the task and as children became more adept at the task with age.

Method
Participants

**Austin, TX, U.S.**

Eighty caregiver-child dyads (52 female caregivers; 36 female children, mean child age = 4.73) were recruited from a children’s science museum. Children were between the ages of 3- and 6-years-old. Demographic data gathered for the study indicated that the families recruited were primarily Euro-American (70%) and that approximately 95% of the caregivers had some college experience. The composition of this sample is consistent with that of previous research with samples recruited from the same and other children’s science museums in the U.S. (Soren, 2009). All materials in this study received approval from the University of XXXX’s Institutional Review Board, Protocol #2010-06-0059 – The Development of Imitation, for testing in both the U.S. and Vanuatu. HSUS caregivers completed written informed consent forms for themselves and separate consent forms for their children.

**Tanna, Vanuatu**

Forty-eight caregiver-child dyads (41 female caregivers; 32 female children, mean child age = 5 years; exact birthdate information was unavailable for most children) were recruited from residences and community gathering areas around Tanna. Children were between the ages of 3- and 8-years-old. Beyond primary and some secondary school, caregivers had limited exposure to Western-style education (22% of the caregivers had no school experience, 45% completed school through primary school, and 33% obtained some secondary school experience or completed secondary school). Our Tannese sample size was smaller and the age range was larger than the HSUS sample size due to more limited access to caregiver-child pairs. Tannese caregivers provided verbal consent for themselves and their children after being read an IRB-
approved consent script translated and back translated with the aid of research assistants fluent in English and Bislama.

Detailed demographic information by population and agent (caregiver, child) is included in Supporting Information Appendix B. A further explanation of recruitment procedures is included in Supporting Information Appendix D.

**Age Differences Across Samples**

We acknowledge that our Tannese sample featured a wider age range of children, which was reflective of the kinds of environments we drew our samples from (e.g., a children’s museum that targeted a slightly younger age range in Austin and village centers with more variability in child age in Tanna). Expanding the age range in Tanna also allowed us to increase our sample size to make it more comparable with the HSUS sample. To account for these differences in the age range of the studies, we also conducted supplementary analyses comparing the 3-6-year-old subset of the Tannese sample with the HSUS sample (Supporting Information Appendix C).

**Procedure and Materials**

In Austin testing was conducted in English in a quiet room in the museum. Female research assistants conducted all testing after building rapport with the caregivers and children to establish a level of comfort with the experimental setting and familiarity with the experimenter.

In Tanna testing was conducted in a quiet room or secluded outdoor area in each of the recruitment locations. The study protocol was translated into Bislama and back-translated into English by two Tannese teachers who were highly proficient in English. Two female Tannese research assistants were recruited from local villages and were extensively trained by the first author on how to execute the protocol. All sessions were transcribed and translated into English.
to ensure compliance with the experimental protocol and to provide a transcript of caregiver-child conversation.

Before beginning each study session, the research assistant explained to the caregiver that none of the tasks were tests and that the caregiver and child should act as they normally would when playing a game together. The research assistant presented the caregiver and child with a tangram puzzle game in which they were instructed to use plastic shapes in a bowl to make a shape indicated on a card (for a full script and a description of research assistant training see Supporting Information Appendix D). The goal shapes on the cards were a hexagon and a six-sided polygon (see Figure 1). Each dyad completed the same two cards, one at a time. To ensure similar task comprehension in both locations, the Tannese research assistant demonstrated how to complete an example card. In both locations, the research assistant was seated across from the pair and if asked a question about the task, she answered without prescriptive language and repeated the goal of the task. Each dyad’s interaction was video-recorded for coding purposes. Task completion rates were high in both populations; 95% of HSUS pairs and 98% of Tannese pairs completed both cards.

**Coding**

Pairs’ interactions were divided into ten-second segments and each segment was coded for how the caregiver and child interacted while completing the task (caregiver-child interaction), the non-verbal and verbal behaviors caregivers used to guide children’s involvement (caregiver teaching behaviors), and the parts of the task being completed (task difficulty). Pairs’ interactions were coded from the time the research assistant gave the pair a card to the time they confirmed completion for both of the cards. All coding was completed using
Datavyu coding software (Datavyu Team, 2014). A table of coding categories and their subcategories is available in Supporting Information Appendix E.

**Caregiver-Child Interaction**

Each segment was coded as one of four mutually-exclusive interaction categories: *shared participation*, *caregiver primary participation*, *child primary participation*, or *caregiver-led participation*. If both the caregiver and the child actively contributed (e.g., selecting pieces, moving pieces, constructing the shape) to the completion of the same parts of the task, the segment was coded as *shared participation*. If the caregiver worked on the task while the child observed or made a minimal contribution, the segment was coded as *caregiver primary participation*. Segments were coded as *child primary participation* if the child appeared to participate without caregiver direction or by ignoring caregiver direction while the caregiver observed or made a minimal contribution. Segments were coded as *caregiver-led participation* if the child’s actions were the result of caregiver direction (verbal and/or non-verbal). This subcategory also included segments when caregivers provided instruction to children but children did not actively participate. In line with past research on caregiver-child interaction (Chavajay, 2008; Chavajay & Rogoff, 2002), we also included two additional categories in our coding: *division of labor* (caregiver and child worked on separate parts of the task while attending to each other’s actions) and *non-coordinated effort* (caregiver and child worked independently and did not attend to each other’s actions or one interaction partner was not attending to the task). Division of labor occurred in 1% of pairs’ interactions overall and non-coordinated effort occurred in 3% of pairs’ interactions, so these categories were not included in analyses. For Tannese pairs, coding was primarily conducted by the first author. A second coder blind to the study hypotheses coded one-third of the caregiver-child pairs to establish reliability.
and interrater reliability was calculated using Cohen’s kappa and indicated good reliability
\( \text{kappa} = .69 \). For HSUS pairs, coding was conducted by two trained coders blind to the
hypotheses of the study. Coders were trained on the coding scheme and coded six pairs to 95%
and then coded an additional five pairs to establish reliability \( \text{kappa} = 0.52 \).

**Caregiver Teaching Behaviors**

We coded whether or not caregivers displayed the following *non-verbal* and *verbal*
teaching behaviors during each time segment.

**Non-Verbal Teaching.** Caregivers’ non-verbal teaching behaviors of interest included
*pointing* and *facilitation*. *Pointing* was defined as the caregiver pointing to any materials
associated with the task. *Facilitation* included the caregiver holding the tray or card for the child,
moving materials closer to the child, or handing the child a piece to facilitate the child’s
completion of the task.

**Verbal Teaching.** Tannese pairs’ interactions were translated and transcribed by the first
and second authors in collaboration with Tannese research assistants. Two trained coders blind to
the hypotheses of the study coded the translated Tannese and HSUS caregiver utterances. Coders
were trained on the coding scheme to 95% reliability. The first author assessed the completed
coding to ensure consistency with the context of the files. Coded utterances were then mapped
onto each ten-second segment to assess whether or not each type of verbal teaching occurred.
Verbal teaching included three mutually exclusive categories: planning, encouragement, and
imperative. Planning included verbal prompts from the caregiver to the child to consider her own
or the caregiver’s current or future action. Encouragement included utterances when the
caregiver verbally praised the child or provided affirmation. Imperatives included verbal prompts
by caregivers for children to engage in an action related to the completion of the task.
Task Difficulty

We coded each 10-second segment for the difficulty of the activity being completed. The behaviors associated with the task were categorized as either less difficult preparation behaviors or more difficult construction behaviors. Preparation actions included moving plastic shapes in the bowl, selecting or replacing a plastic shape from the bowl, and placing a plastic shape on the hint bubble on the card. Construction actions included placing or arranging the plastic shapes to make the target figure. If both types of actions occurred, we categorized the segment as construction, given that this was the more complex behavior. If no actions occurred (e.g., caregiver and child were looking at the card), we categorized the segment as preparation.

Results

Due to differences in the completion time of different pairs analyses were conducted on the proportion of segments in which the behaviors that we coded for were displayed. Table 1 presents the frequency of the interaction styles and teaching behavior by population, child age, and task difficulty. All proportions were transformed using an arcsine transformation. Caregiver gender was included in preliminary analyses of interaction styles and caregiver teaching behaviors. It did not significantly contribute to differences in interaction styles or behaviors, thus gender was not included in the analyses reported below. We also examined the influence of caregiver education within each population, but education did not significantly predict interaction styles or behaviors, so education was not included in the analyses below.

Three MANOVAs were run to examine the relation between population, child age, and their interaction on the prevalence of interaction styles (shared participation, caregiver primary participation, child primary participation, and caregiver-led participation), caregivers’ nonverbal teaching behaviors (pointing and facilitation), and verbal teaching behaviors (planning,
encouragement, and imperatives). In some instances, the arcsine transformation did not fully address the problem of non-homogeneity, therefore any significant effects based on parametric tests were also verified using non-parametric tests.

**Interaction Style**

Using Wilks’s lambda, there were significant effects of population, \( \Lambda = 0.54, F(4, 112) = 23.54, p < .001 \), partial \( \eta^2 = 0.46 \), and child age, \( \Lambda = 0.64, F(20, 372.41) = 2.73, p < .001 \), partial \( \eta^2 = 0.11 \), and a significant interaction between population and child age, \( \Lambda = 0.79, F(12, 296.62) = 2.27, p = .009 \), partial \( \eta^2 = 0.07 \). Separate post-hoc ANOVAs (\( p \)-values Bonferroni corrected to \( p < (.05/4) = .013 \); for a full summary of coefficients see Table 2) were run to examine the effects of population and child age and their interaction on the prevalence of each interaction style. These post-hoc analyses indicated no significant interactions between population and child age on the prevalence of the different types of interaction styles. For each interaction style, there was a main effect of population. As indicated in Table 1, HSUS pairs were more likely to display child primary and caregiver-led interaction whereas Tannese pairs were more likely to display caregiver primary and shared interaction styles. Pairs with older children also had significantly higher prevalence of child primary interaction.

**Nonverbal Teaching Behaviors**

Using Wilks’s lambda, there was a significant effect of population, \( \Lambda = 0.85, F(2, 114) = 10.12, p < .001 \), partial \( \eta^2 = 0.15 \), and child age, \( \Lambda = 0.78, F(10, 228) = 3.07, p = .001 \), partial \( \eta^2 = 0.12 \), on the prevalence of caregivers’ nonverbal teaching behaviors, but there was not a significant interaction between population and child age, \( \Lambda = 0.97, F(6, 228) = 0.67, p = .677 \). Separate post-hoc ANOVAs (\( p \)-values Bonferroni corrected to \( p < (.05/2) = .025 \); for a full summary of coefficients see Table 2) were run to examine the effect of population and child age
on the prevalence of each type of nonverbal teaching behavior (pointing, facilitation). HSUS caregivers used facilitation ($M = 0.35, SD = 0.29$) more than Tannese caregivers ($M = 0.07, SD = 0.13$; Mann-Whitney $U = 651.00, p < .001$). Caregivers with younger children used more facilitation (Spearman’s $r = -0.50, p < .001$). There was no difference between populations in caregivers’ use of pointing (HSUS: $M = 0.39, SD = 0.23$; Tannese: $M = 0.36, SD = 0.21$), and caregivers with younger children used more pointing (Spearman’s $r = -0.41, p < .001$).

**Verbal Teaching Behaviors**

Using Wilks’s lambda, there was a significant effect of population, $\Lambda = 0.34, F(3, 113) = 72.03, p < .001$, partial $\eta^2 = 0.66$, on the prevalence of caregivers’ verbal teaching behaviors, but there was not a significant effect of child age, $\Lambda = 0.89, F(15, 312.35) = 0.93, p = .537$ or a significant interaction between population and child age, $\Lambda = 0.88, F(9, 275.16) = 1.72, p = .084$. Separate post-hoc Mann-Whitney $U$ tests ($p$-values Bonferroni corrected to $p < (.05/3) = .017$) were run to examine the effect of population on the prevalence of each type of verbal teaching behavior (planning, encouragement, and imperatives). HSUS caregivers used planning ($M = 0.32, SD = 0.19$) more than Tannese caregivers ($M = 0.02, SD = 0.05$; Mann-Whitney $U = 143.00, p < .001$). HSUS caregivers also used encouragement ($M = 0.33; SD = 0.21$) more than Tannese caregivers ($M = 0.04, SD = 0.08$; Mann-Whitney $U = 249.50, p < .001$). There was no significant difference between populations in caregivers’ use of imperatives (HSUS: $M = 0.37, SD = 0.23$; Tannese: $M = 0.44, SD = 0.22$; Mann-Whitney $U = 1463.00, p = .083$).

**Non-Verbal and Verbal Teaching Behavior by Interactional Style**

We coded for the frequencies of the most common non-verbal (pointing) and verbal (imperatives) teaching behaviors in each population by interactional style.

_Tannese Caregivers_
Tannese caregivers’ use of pointing and imperatives in each interaction style were as follows: Caregivers pointed most frequently during caregiver-led participation ($M = .71, SE = 0.05$), followed by shared participation ($M = .36, SE = 0.05$), caregiver primary participation ($M = .14, SE = 0.04$), and child primary participation ($M = .09, SE = 0.03$). Tannese caregivers used imperatives most frequently during caregiver-led participation ($M = .80, SE = 0.04$), followed by shared participation ($M = .48, SE = 0.05$), caregiver primary participation ($M = .24, SE = 0.04$), and child primary participation ($M = .11, SE = 0.04$).

**HSUS Caregivers**

HSUS caregivers’ use of pointing and imperatives in each interaction style were as follows: Caregivers pointed most frequently during caregiver-led participation ($M = .54, SE = 0.03$), followed by shared participation ($M = .39, SE = 0.05$), caregiver primary participation ($M = .37, SE = 0.08$), and child primary participation ($M = .12, SE = 0.03$). HSUS caregivers used imperatives at similar levels of frequency across three of the four interaction styles: caregiver-led participation ($M = .48, SE = 0.03$), shared participation ($M = .46, SE = 0.05$), caregiver primary participation ($M = .48, SE = 0.09$). Imperatives were less frequent during child primary participation ($M = .07, SE = 0.02$).

**Impact of Task Difficulty on Teaching Practices by Population**

We examined the impact of task difficulty on the rates of different interaction styles and teaching behaviors by population given overall differences in the frequency of the different interaction styles and teaching behaviors. For the analyses presented below, we used multilevel models to examine the impact of task difficulty (2: preparation, construction) while controlling for child age (Tannese 3: 3-4-year-olds, 5-6-year-olds, & 7-8-year-olds; HSUS 2: 3-4-year-olds & 5-6-year-olds)—both fixed effects—on the prevalence of each interaction style and teaching
behavior with a random effect of pair to account for non-independence of observations. All proportions were transformed using an arcsine transformation. The full results of each of these analyses are reported in Table 3. Below we report the key findings.

**Tannese Caregivers**

**Impact of Task Difficulty on Caregiver-Child Interaction.** The results of the multilevel models indicate that the prevalence of two interaction styles—caregiver primary participation and caregiver-led participation—differed significantly when pairs were completing less difficult preparation versus more difficult construction activities. This was not the case for the other two interaction styles. Posthoc analyses using paired-samples *t*-tests and Bonferroni-corrected *p*-values of .025 (.05/2 comparisons) were used to examine the significant main effects. The analysis for caregiver primary participation indicated that caregivers were more likely to actively participate while children observed during construction (*M* = .30, *SE* = 0.04) than during preparation (*M* = .07, *SE* = 0.02; *t*(44) = -7.42, *p* < .001, *d* = 1.92). In contrast, the analysis for caregiver-led participation indicated that caregivers directed children more during preparation (*M* = .44, *SE* = 0.05) than during construction (*M* = .16, *SE* = 0.02; *t*(44) = 5.56, *p* < .001, *d* = 1.75).

The multilevel model analyses indicated a significant effect of age on the prevalence of caregiver primary participation and child primary participation, but not on any of the other interaction styles. For any significant effects of age in these and subsequent difficulty analyses, we further examined the effects using one-way ANOVAs to assess impact of child age on the overall prevalence of each interaction style and teaching behaviors. We present these analyses in the *child age* analyses below.
Impact of Task Difficulty on Caregiver Teaching Behaviors. For Tannese pairs, we examined the impact of task difficulty on two teaching behaviors: pointing and imperatives. We limited our analyses to these two teaching behaviors since encouragement and planning occurred in less than 4% of pairs’ task completion segments and facilitation occurred, on average, in only 7% of pairs’ task completion segments. The results of the model for pointing indicated significant effects of both task difficulty and child age. We further explored the impact of task difficulty on caregivers’ use of pointing using a paired-samples t-test. Caregivers pointed significantly more often during preparation activity ($M = .51, SE = 0.05$) than during construction activity ($M = .27, SE = 0.03$; $t(44) = 4.94, p < .001, d = 0.86$). The impact of child age is further explored in the child age analyses below. There was not a significant effect of task difficulty or child age on the prevalence of imperatives.

HSUS Caregivers

Impact of Task Difficulty on Caregiver-Child Interaction. The results of the multilevel models indicate that the prevalence of three interaction styles—shared participation, caregiver primary participation, and caregiver-led participation—differed significantly when pairs were completing less difficult preparation versus more difficult construction activities. There was not a significant effect of task difficulty on child primary participation. Posthoc analyses using paired-samples t-tests and Bonferroni-corrected p-values of .017 (.05/3 comparisons) were used to examine the significant main effects. The analysis for shared participation indicated that caregivers and children were more likely to actively participate together during construction ($M = .15, SE = 0.02$) than during preparation ($M = .10, SE = 0.02$; $t(73) = 2.89, p = .005, d = 0.33$). In contrast, the analysis for caregiver-led participation indicated that caregivers directed children more during preparation ($M = .64, SE = 0.03$) than during
construction \((M = .49, SE = 0.04; t(73) = -3.81, p < .001, d = 0.44)\). The analysis for caregiver primary participation did not support a significant difference between construction \((M = .06, SE = 0.01)\) and preparation \((M = .02, SE = 0.01; t(73) = 1.88, p = .064, d = 0.22)\).

The multilevel model analyses indicated a significant effect of age on the prevalence of all four interaction styles, which is further explored in the child age analyses below.

**Impact of Task Difficulty on Caregiver Teaching Behaviors.** For HSUS pairs, we examined the impact of task difficulty on the following teaching behaviors: pointing and facilitation (nonverbal) and imperatives, planning, and encouragement (verbal) since each of these behaviors, on average, occurred in 30% or more of pairs’ task completion segments.

The results of the models indicated significant effects of task difficulty on the frequency of pointing and encouragement. We further explored the impact of task difficulty on caregivers’ use of pointing and encouragement using paired-samples \(t\)-tests with Bonferroni-corrected \(p\)-values of .025 (.05/2 comparisons). Caregivers pointed significantly more often during preparation activities \((M = .47, SE = 0.04)\) than during construction activities \((M = .35, SE = 0.03; t(73) = 3.62, p = .001, d = 0.42)\). Caregivers used encouragement significantly less during preparation activities \((M = .23, SE = 0.03)\) than during construction activities \((M = .38, SE = 0.03; t(73) = -4.75, p < .001, d = 0.56)\). There was not a significant effect of task difficulty on caregivers’ use of facilitation, imperatives, or planning.

There was a significant effect of child age on caregivers’ use of pointing, facilitation, imperatives, and encouragement, but not on planning. The impact of child age is further explored in the child age analyses below.

**Impact of Child Age on Teaching Practices by Population**

_Tannese Caregivers_
**Interaction Style.** A MANOVA was run to examine the impact of child age (3: 3-4-, 5-6-, and 7-8-years-old) on the prevalence of the four interaction styles. Using Wilks’s lambda, there was a significant effect of child age, $\Lambda = 0.61, F(8, 78) = 2.78, p = .009$, partial $\eta^2 = 0.22$. Separate post-hoc ANOVAs ($p$-values Bonferroni corrected to $p < (.05/4) = .013$; for a full summary of coefficients see Table 4) were run to examine the effects of child age on the prevalence of each interaction style. These post-hoc analyses indicated there was a significant influence of child age on the prevalence of child primary participation, but not on any of the other interaction styles. Tukey posthoc tests examining the prevalence of child primary participation by age indicated that pairs with 3-4-year-olds ($M = .11, SE = 0.07$) displayed significantly less child primary participation than pairs with 7-8-year-olds ($M = .30, SE = 0.06; p = .013$), but there was not a significant difference between pairs with 5-6-year-olds ($M = .15, SE = 0.06$) and 3-4-year-olds ($p = .640$) or 7-8-year-olds ($p = .103$).

**Teaching Behaviors.** Separate one-way ANOVAs were used to examine the impact of child age (3: 3-4-, 5-6-, and 7-8-years-old) on the prevalence of the two most common teaching behaviors used by Tannese caregivers – pointing and imperatives (see Table 4). There was a significant effect of age on Tannese caregivers’ use of pointing. Tukey posthoc tests examining the overall prevalence of pointing by age indicated that caregivers interacting with 3-4-year-olds ($M = .48, SE = 0.06$) displayed significantly more pointing than caregivers interacting with 7-8-year-olds ($M = .24, SE = 0.04; p = .002$), but there was not a significant difference between pairs with 5-6-year-olds ($M = .38, SE = 0.05$) and 3-4-year-olds ($p = .309$) or 7-8-year-olds ($p = .089$). There was not significant effect of age on Tannese caregivers’ use of imperatives.

**HSUS Caregivers**
**Interaction Style.** A MANOVA was run to examine the impact of child age (2: 3-4-, 5-6-years-old) on the prevalence of the four interaction styles. Using Wilks’s lambda, there was a significant effect of child age, $\Lambda = 0.76$, $F(4, 75) = 5.89$, $p < .001$, partial $\eta^2 = 0.24$. Separate post-hoc ANOVAs ($p$-values Bonferroni corrected to $p < (.05/4) = .013$; for a full summary of coefficients see Table 4) were run to examine the effects of child age on the prevalence of each interaction style. These post-hoc analyses indicated there was a significant influence of child age on the prevalence of child primary participation and caregiver-led participation, but not on caregiver primary or shared participation. Pairs with 3-4-year-olds ($M = .18$, $SE = 0.03$) displayed significantly less child primary participation than pairs with 5-6-year-olds ($M = .43$, $SE = 0.05$; Mann-Whitney $U = 415.00$, $p < .001$). In contrast, pairs with 3-4-year-olds ($M = .62$, $SE = 0.04$) displayed significantly more caregiver-led participation than pairs with 5-6-year-olds ($M = .44$, $SE = 0.05$; Mann-Whitney $U = 519.50$, $p = .008$).

**Teaching Behaviors.** MANOVAs were used to examine the impact of child age (2: 3-4-, 5-6-years-old) on the prevalence of the non-verbal (pointing, facilitation) and verbal teaching behaviors (imperatives, planning, encouragement). Using Wilks’s lambda, the results of the MANOVA examining the non-verbal teaching behaviors indicates a significant effect of child age, $\Lambda = 0.89$, $F(2, 77) = 4.91$, $p = .010$, partial $\eta^2 = 0.11$. Separate post-hoc ANOVAs ($p$-values Bonferroni corrected to $p < (.05/2) = .025$; for a full summary of coefficients see Table 4) were run to examine the effects of child age on the prevalence of each non-verbal teaching behavior. These post-hoc analyses indicated there was a significant influence of child age on caregivers’ use of pointing, but not facilitation. HSUS caregivers interacting with 3-4-year-olds ($M = .43$, $SE = 0.03$) used pointing significantly more than those interacting with 5-6-year-olds ($M = .31$, $SE = 0.04$; Mann-Whitney $U = 501.00$, $p = .004$).
Using Wilks’s lambda, the results of the MANOVA examining the verbal teaching behaviors also indicates a significant effect of child age, $\Lambda = 0.84$, $F(3, 76) = 5.02$, $p = .003$, partial $\eta^2 = 0.17$. Separate post-hoc ANOVAs ($p$-values Bonferroni corrected to $p < (.05/3) = .013$; for a full summary of coefficients see Table 4) were run to examine the effects of child age on the prevalence of each verbal teaching behavior. These post-hoc analyses indicated there was a significant influence of child age on caregivers’ use of imperatives and encouragement, but not planning. HSUS caregivers interacting with 3-4-year-olds ($M = .43$, $SE = 0.03$) used imperatives significantly more than those interacting with 5-6-year-olds ($M = .27$, $SE = 0.03$; Mann-Whitney $U = 461.50$, $p = .001$). HSUS caregivers interacting with 3-4-year-olds ($M = .38$, $SE = 0.03$) also used encouragement significantly more than those interacting with 5-6-year-olds ($M = .26$, $SE = 0.03$; Mann-Whitney $U = 484.00$, $p = .003$).

**Discussion**

Teaching is a universal human behavior, yet there is substantial variation in the frequency and kinds of caregiver teaching within and between populations. We examined caregiver-child interaction style and caregivers’ teaching behaviors during a collaborative problem-solving task in the U.S. and Vanuatu, two populations that vary in experience with formal education and the socio-cultural institutions associated with formal education. Our data revealed both similarities and differences in caregiver teaching practices between populations, as well as evidence of caregiver responsiveness to task difficulty and child age. Below we review each of our research objectives, highlighting similarities and differences between populations.

**Similarities and Differences in Caregiver Teaching Practices During Collaborative Activity**

**Interaction Style**
Three interaction styles—shared, child primary, and caregiver-led participation—all occurred with considerable frequency in both populations’ completion of the task. Our data provide evidence that both HSUS and Tannese caregivers used a variety of interaction styles when completing the task. Caregiver-child interaction in both populations was dynamic over the course of the task, suggesting that a universal feature of caregiver teaching may be its flexibility. This allows teachers to better meet the needs of the learners and supports claims that teaching is a constellation of a number of different behaviors rather than one static mode of transmitting information (Kline, 2014).

Differences between HSUS and Tannese pairs’ interaction styles were consistent with variation in teaching practices previously documented in formally- versus informally-educated populations (Greenfield, 2009; Paradise & Rogoff, 2009). HSUS caregivers encouraged children’s firsthand participation in all task activities and engaged in direct active teaching. Rather than completing the tasks themselves, caregivers structured children’s direct involvement using interaction styles associated with either the direct scaffolding of children’s participation or children’s independent participation. For example, HSUS caregiver-child interaction consisted primarily of caregiver-led participation and child primary participation, regardless of child age. In contrast, Tannese caregivers’ teaching practices were consistent with the expectation that children learn through observation and collaboration. Rather than the child directly completing the majority of the task activities, Tannese caregivers and children divided labor through high levels of shared participation. Tannese caregivers took a more direct role in the completion of the task than HSUS caregivers, although rates of caregiver primary and child primary participation were approximately equal overall for Tannese pairs. This kind of interaction may increase collaborative efficiency; tasks are allocated based on skill level and experience, rather than to
novices who require high levels of scaffolding. Caregiver behavior of this kind may also serve pedagogical functions, such as facilitating learning through intent participation and observation.

**Teaching Behaviors**

Caregivers from both populations also guided children’s participation using verbal and non-verbal teaching behaviors. HSUS and Tannese caregivers used similar levels of pointing and imperatives, consistent with the kinds of behaviors documented across populations in other studies of caregiver-child interaction examining both formally- and informally-educated populations (Boyette & Hewlett, 2017; Kline, 2014). The similarity in frequency of imperatives between the two populations is also consistent with past research that Tannese and HSUS caregivers engaged in similar levels of verbal interaction with infants (Little et al., 2016) and, that like their Western counterparts, Tannese caregivers adjust their speech when interacting with infants, potentially for instructional purposes (Broesch & Bryant, 2013, 2018).

In contrast to HSUS caregivers, however, Tannese caregivers displayed lower levels of facilitation, or adapting the task to fit the needs of the child, as would be expected if children are not completing actions beyond their ability levels. HSUS and Tannese caregivers also differed in their use of encouragement and planning, with HSUS using both of these verbal behaviors with higher levels of frequency. Encouragement and planning are features of direct active teaching that are associated with higher levels of caregiver experience with formal education (Childs & Greenfield, 1980; Dixon et al., 1984; Laosa, 1978, 1980). These behaviors may also serve other pedagogical functions, such as increasing comprehension, retention, and verbal fluency.

**Flexibility in Caregiver Teaching Practices Associated with Task Difficulty**

Our data provide evidence that both HSUS and Tannese caregivers were sensitive to task difficulty. Caregivers were more directly involved in the difficult parts of the task, with HSUS
caregivers working alongside children through shared participation and Tannese caregivers engaging in caregiver primary participation, which also corresponded with decreased frequency in pointing in both populations. Thus, caregivers’ increased direct involvement might also have resulted in a decrease in scaffolding via pointing. HSUS caregivers’ behavior reflected a continued emphasis on children’s direct participation; even though the frequency of caregiver-led participation decreased during the difficult parts of the task, caregivers directly participated with children through shared participation rather than engaging in the task alone. In addition to a decrease in the prevalence of pointing during difficult activity, the prevalence of encouragement increased. The increase in encouragement may reflect an attempt to keep children engaged during the more difficult portion of the task but could also correspond with overall task praise that would occur at the completion of a target shape. Differences in Tannese caregivers’ teaching practices in response to task difficulty reflected a focus on children completing the actions within their skill level and observing skills beyond their ability level. The frequency of caregiver primary participation increased and the frequency of caregiver-led participation and pointing decreased during the more difficult parts of the task. One potential explanation for the increase in caregiver primary participation is that by completing the more difficult task themselves, caregivers were modeling the behavior for the child, thus allowing for observational learning.

**Flexibility in Caregiver Teaching Practices Associated with Child Age**

Child age influenced caregivers’ teaching practices in both populations. Both HSUS and Tannese older children seem to have been given more leeway to complete the task independently. HSUS pairs with older children demonstrated higher levels of child primary participation and lower levels of caregiver-led participation, pointing, imperatives, and encouragement. Like HSUS pairs, Tannese pairs with older children engaged in higher levels of
child primary participation and caregivers displayed less pointing. These differences in the frequency of child primary participation and teaching behaviors between caregivers interacting with younger versus older children may reflect caregivers’ recognition of older children’s ability to complete the task without intervention.

Overall, our data demonstrate that caregiver teaching is a dynamic constellation of behaviors that is responsive to task demands and children’s abilities, but also reflects culturally-specific beliefs about children’s learning. Although differences in overall teaching practices between populations may be influenced by culturally-specific experiences such as exposure to formal education, teaching is a universal human behavior—a human adaptation for acquiring and transmitting information (Caro & Houser, 1992; Kline, 2014).

**Limitations and Future Directions**

Our data provide evidence for differences in teaching practices between the HSUS and Tannese caregivers that could be associated with experiences with formal education and differences in beliefs about children’s learning. Our data also reveal similarities in teaching practices that are reflective of universal features of teaching behaviors across populations. The current study is limited, however, in that it included samples from two populations completing one task and examined only two potential sources of within-subject variance in teaching—task difficulty and child age. Future research should more directly explore the link between formal education experience and teaching behaviors by examining gradation in experience rather than the two extremes represented in our data. There were substantial differences in relative experience with formal education between the populations studied here; most of the HSUS caregivers had college experience, whereas the Tannese caregivers had very little, if any, experience with formal education. Thus, examining threshold effects of education and how
variation in the amount and kind of formal education impact caregiver ethnotheories of children’s learning and teaching practices is necessary for better understanding of both within- and between-population variation in teaching practices.

Examining further sources of variation in teaching within- and between-populations beyond experience with formal education is also critical to increasing our understanding of global diversity in social learning and transmission (Legare, 2017). Children’s learning environments are shaped not only by their caregivers’ experience with formal education, but also broader cultural and class environments (Tudge, 2008; Tudge et al., 2006). In addition, systems of social organization, kinship structures, population size, economies, and ecologies may contribute to variation in teaching behaviors between populations (Nielsen et al., 2017). Comparisons between multiple populations that vary systematically on these dimensions are also needed to identify which factors explain cross-cultural variation in teaching beliefs and behaviors (Greenfield, 2009).

Finally, our joint problem-solving tangram task provided a controlled comparison of HSUS and Tannese caregivers’ teaching practices. Although the task was piloted prior to data collection to ensure accessibility in both populations, it is possible that this task may be interpreted as a more school-based task in both locations. This interpretation could have biased caregivers toward more direct active teaching practices. Although the Tannese pairs’ distribution of interaction styles does not support this claim, future research should also examine caregiver teaching across different types of tasks, particularly those that vary in their relative difficulty and ecological relevance. For example, examining variation in children’s chore learning within- and between-populations would provide the opportunity to assess children’s learning of ecologically-relevant behaviors both within and beyond their ability levels (Alcalá, Rogoff, Mejía-Arauz,
Coppens, & Dexter, 2014). Another direction for future research is to examine the extent to which caregivers’ responses to changes in task difficulty and child age might depend on the degree of task difficulty or the type of task. It is possible that if the joint problem-solving task had become much more difficult (e.g., well beyond the realm of children’s ability to complete the task alone), HSUS caregivers’ behaviors might have been more similar to those of Tannese caregivers. Moreover, direct instruction is not possible for all types of tasks. Consider, for example, children learning about a ritual performed only on special occasions—in this case, the only teaching practices available might be allowing children to observe.

**Conclusion**

This research illustrates the value of using controlled tasks to directly quantify and compare behavior between populations. By systematically measuring caregiver-child interaction and verbal and nonverbal teaching during the same task, we are better able to attribute variation in the frequency and kinds of teaching behavior to differences across populations, and not exclusively to context-specific differences in the particular kinds of tasks and skills characteristic of these populations. This study also reveals the importance of conducting cross-cultural comparisons. If the study had been conducted in only one of these populations or examined only one approach to teaching (e.g., direct active teaching) and generalized to caregiver teaching behavior globally—we would have drawn different conclusions about the frequency and kinds of teaching behaviors. For example, limiting the definition and exploration of teaching behaviors to only include those that capture direct active teaching (i.e., an emphasis on caregiver direction and scaffolding) may lead to limitations in viewing teaching as a cross-culturally pervasive behavior (Kline, 2014). Our data support the need to study populations that represent the global
diversity in human cognition and behavior while maintaining a broader definition of teaching to identify both similarities and differences in teaching behaviors.

The results of this study provide evidence that there were differences in HSUS and Tannese caregivers’ teaching practices that were consistent with expectations that children learn through direct active teaching versus through observing others. The use of particular caregiver teaching practices may vary substantially between populations. In both populations caregivers’ teaching practices varied in response to both task demands and children’s age. In sum, teaching practices include a flexible and diverse repertoire of behaviors that are responsive to multiple factors and support the transmission of skills and knowledge across diverse populations.
References


Kline, M. A. (2014). How to learn about teaching: An evolutionary framework for the study of teaching behavior in humans and other animals. *Behavioral and Brain Sciences, 38*(1), 1–70. https://doi.org/10.1017/S0140525X14000090


Distributions of caregiver-child interaction styles and teaching behaviors by population, child age group, and task difficulty. Proportions are reported as M(SE). Caregiver-child interaction proportions may not sum to 1 – two additional interaction styles were coded for, but were relatively low frequency and thus not included in the analyses.

1a. Caregiver-child interaction.

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<th>Caregiver-Led</th>
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Interaction Style - Preparation

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Interaction Style - Construction

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<tr>
<td></td>
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<td></td>
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<tr>
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<td>3 to 4</td>
<td>.31(0.06)</td>
<td>.32(0.06)</td>
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<tr>
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<td>.34(0.06)</td>
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<td>7 to 8</td>
<td>.35(0.05)</td>
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<td>.33(0.03)</td>
<td>.30(0.04)</td>
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</tbody>
</table>
### Table 1b. Caregiver teaching behaviors

**Nonverbal and verbal teaching behaviors**

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<thead>
<tr>
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<th>Imperative</th>
<th>Planning</th>
<th>Encouragement</th>
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<tr>
<td>3 to 4</td>
<td>.43(0.03)</td>
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<td>.35(0.03)</td>
<td>.36(0.02)</td>
<td>.31(0.02)</td>
<td>.33(0.02)</td>
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<tr>
<td>3 to 4</td>
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<td>.42(0.07)</td>
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<tr>
<td>7 to 8</td>
<td>.24(0.04)</td>
<td></td>
<td>.40(0.05)</td>
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<td>Overall</td>
<td>.36(0.03)</td>
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**Interaction Style - Preparation**

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<td>.51(0.06)</td>
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<td>.32(0.04)</td>
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<td>.35(0.05)</td>
<td>.38(0.05)</td>
<td>.13(0.04)</td>
</tr>
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<td>Overall</td>
<td>.47(0.03)</td>
<td>.39(0.04)</td>
<td>.44(0.04)</td>
<td>.38(0.03)</td>
<td>.24(0.03)</td>
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<td>Less than 10%</td>
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<td>7 to 8</td>
<td>.33(0.07)</td>
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<td>.37(0.06)</td>
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<td>Overall</td>
<td>.51(0.05)</td>
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**Interaction Style - Construction**

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<th>Imperative</th>
<th>Planning</th>
<th>Encouragement</th>
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<td></td>
<td></td>
</tr>
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<td>.41(0.05)</td>
<td>.42(0.03)</td>
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<td>.27(0.05)</td>
<td>.26(0.04)</td>
<td>.23(0.04)</td>
<td>.32(0.04)</td>
</tr>
<tr>
<td>Overall</td>
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<td>.34(0.04)</td>
<td>.34(0.03)</td>
<td>.29(0.02)</td>
<td>.38(0.03)</td>
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<td>.37(0.07)</td>
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<td>.40(0.08)</td>
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<td></td>
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<tr>
<td>5 to 6</td>
<td>.27(0.06)</td>
<td>Less than 10%</td>
<td>.41(0.06)</td>
<td>Less than 10%</td>
<td>Less than 10%</td>
</tr>
<tr>
<td>7 to 8</td>
<td>.18(0.04)</td>
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<td>.43(0.06)</td>
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<tr>
<td>Overall</td>
<td>.27(0.04)</td>
<td></td>
<td>.41(0.04)</td>
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Table 2.

Results of post-hoc ANOVAs examining the impact of population, child age, and their interaction on the prevalence of each caregiver-child interaction style and caregiver teaching behaviors. Partial $\eta^2$ reported for significant effects.

2a. Caregiver-child interaction

<table>
<thead>
<tr>
<th>Interaction style</th>
<th>Effect</th>
<th>$F$</th>
<th>$p$</th>
<th>Partial $\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared participation</td>
<td>Population</td>
<td>$F(1,115) = 16.27$</td>
<td>&lt;.001***</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>$F(5,115) = 1.30$</td>
<td>.268</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 1.34$</td>
<td>.265</td>
<td></td>
</tr>
<tr>
<td>Caregiver primary</td>
<td>Population</td>
<td>$F(1,115) = 73.15$</td>
<td>&lt;.001***</td>
<td>0.39</td>
</tr>
<tr>
<td>participation</td>
<td>Child age</td>
<td>$F(5,115) = 2.74$</td>
<td>.202</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 2.20$</td>
<td>.092</td>
<td></td>
</tr>
<tr>
<td>Child primary participation</td>
<td>Population</td>
<td>$F(1,115) = 14.00$</td>
<td>&lt;.001***</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>$F(5,115) = 4.88$</td>
<td>&lt;.001***</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 1.33$</td>
<td>.268</td>
<td></td>
</tr>
<tr>
<td>Caregiver-led</td>
<td>Population</td>
<td>$F(1,115) = 16.23$</td>
<td>&lt;.001***</td>
<td>0.12</td>
</tr>
<tr>
<td>participation</td>
<td>Child age</td>
<td>$F(5,115) = 0.57$</td>
<td>.658</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 1.06$</td>
<td>.370</td>
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</table>

*** $p < .001$

2b. Caregiver teaching behaviors

<table>
<thead>
<tr>
<th>Teaching behavior</th>
<th>Effect</th>
<th>$F$</th>
<th>$p$</th>
<th>Partial $\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pointing</td>
<td>Population</td>
<td>$F(1,115) = 1.39$</td>
<td>.241</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>$F(5,115) = 4.15$</td>
<td>.002**</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 0.54$</td>
<td>.657</td>
<td></td>
</tr>
<tr>
<td>Facilitation</td>
<td>Population</td>
<td>$F(1,115) = 18.15$</td>
<td>&lt;.001***</td>
<td>0.14</td>
</tr>
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<td></td>
<td>Child age</td>
<td>$F(5,115) = 2.13$</td>
<td>.016*</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 0.82$</td>
<td>.488</td>
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<tr>
<td>Imperative</td>
<td>Population</td>
<td>$F(1,115) = 4.20$</td>
<td>.043</td>
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<td></td>
<td>Child age</td>
<td>$F(5,115) = 2.10$</td>
<td>.071</td>
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</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 2.50$</td>
<td>.063</td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>Population</td>
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<td>&lt;.001***</td>
<td>0.54</td>
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<tr>
<td></td>
<td>Child age</td>
<td>$F(5,115) = 0.86$</td>
<td>.508</td>
<td></td>
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<td></td>
<td>Population x age</td>
<td>$F(3,115) = 0.68$</td>
<td>.567</td>
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<tr>
<td>Encouragement</td>
<td>Population</td>
<td>$F(1,115) = 85.58$</td>
<td>&lt;.001***</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>$F(5,115) = 0.55$</td>
<td>.740</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Population x age</td>
<td>$F(3,115) = 2.57$</td>
<td>.058</td>
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* $p < .025$ ** $p < .01$, *** $p < .001$
Table 3.

Results of multilevel models examining the impact of task difficulty, controlling for child age, on the prevalence of each caregiver-child interaction style and caregiver teaching behaviors by population.

3a. Caregiver-child interaction

<table>
<thead>
<tr>
<th>Interaction style</th>
<th>Tannese Effect</th>
<th>HSUS Effect</th>
<th>p</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Task difficulty</td>
<td>F(1,86) = 0.12</td>
<td>F(1,151) = 4.21</td>
<td>.726</td>
<td>.042*</td>
</tr>
<tr>
<td>Shared participation</td>
<td>Child age</td>
<td>F(2,86) = 0.42</td>
<td>F(1,151) = 5.33</td>
<td>.658</td>
<td>.022*</td>
</tr>
<tr>
<td>Caregiver primary</td>
<td>Task difficulty</td>
<td>F(1,86) = 40.10</td>
<td>F(1,151) = 9.73</td>
<td>&lt; .001***</td>
<td>.002**</td>
</tr>
<tr>
<td>participation</td>
<td>Child age</td>
<td>F(2,86) = 3.13</td>
<td>F(1,151) = 4.22</td>
<td>.049*</td>
<td>.042*</td>
</tr>
<tr>
<td>Child primary participation</td>
<td>Task difficulty</td>
<td>F(1,86) = 2.25</td>
<td>F(1,151) = 1.40</td>
<td>.137</td>
<td>.238</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>F(2,86) = 5.05</td>
<td>F(1,151) = 25.26</td>
<td>.008**</td>
<td>&lt; .001***</td>
</tr>
<tr>
<td>Caregiver-led participation</td>
<td>Task difficulty</td>
<td>F(1,86) = 17.41</td>
<td>F(1,151) = 5.65</td>
<td>&lt; .001***</td>
<td>.019*</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>F(2,86) = 0.42</td>
<td>F(1,151) = 9.41</td>
<td>.658</td>
<td>.003**</td>
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*p < .05, ** p < .01, *** p < .001

3b. Caregiver teaching behaviors

<table>
<thead>
<tr>
<th>Teaching behavior</th>
<th>Tannese Effect</th>
<th>HSUS Effect</th>
<th>p</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Task difficulty</td>
<td>F(1,86) = 19.67</td>
<td>F(1,151) = 8.14</td>
<td>&lt; .001***</td>
<td>.005**</td>
</tr>
<tr>
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<td>Child age</td>
<td>F(2,86) = 7.33</td>
<td>F(1,150) = 0.26</td>
<td>.001**</td>
<td>.613</td>
</tr>
<tr>
<td>Facilitation</td>
<td>Task difficulty</td>
<td>F(1,150) = 5.46</td>
<td>F(1,150) = 2.05</td>
<td>.021*</td>
<td>.154</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>F(1,150) = 4.62</td>
<td>F(1,150) = 2.05</td>
<td>.209</td>
<td>.154</td>
</tr>
<tr>
<td>Imperatives</td>
<td>Task difficulty</td>
<td>F(1,150) = 3.82</td>
<td>F(1,150) = 13.83</td>
<td>.074</td>
<td>&lt; .001***</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>F(1,150) = 2.05</td>
<td>F(1,150) = 2.05</td>
<td>.209</td>
<td>.154</td>
</tr>
<tr>
<td>Planning</td>
<td>Task difficulty</td>
<td>F(1,151) = 3.08</td>
<td>F(1,151) = 17.76</td>
<td>.081</td>
<td>&lt; .001***</td>
</tr>
<tr>
<td></td>
<td>Child age</td>
<td>F(1,151) = 2.18</td>
<td>F(1,151) = 5.78</td>
<td>.142</td>
<td>&lt; .001***</td>
</tr>
<tr>
<td>Encouragement</td>
<td>Task difficulty</td>
<td>F(1,151) = 17.76</td>
<td>F(1,151) = 15.78</td>
<td>&lt; .001***</td>
<td>.142</td>
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</table>

*p < .05, ** p < .01, *** p < .001
Table 4.

Results of planned (Tannese) and post-hoc ANOVAs (HSUS) examining the impact of child age on the prevalence of each caregiver-child interaction style and caregiver teaching behaviors by population. Partial $\eta^2$ reported for significant effects.

### 4a. Caregiver-child interaction

<table>
<thead>
<tr>
<th>Interaction style</th>
<th>Tannese</th>
<th></th>
<th>Partial $\eta^2$</th>
<th>HSUS</th>
<th></th>
<th>Partial $\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shared participation</td>
<td>$F(2,42) = 0.10$</td>
<td>.904</td>
<td></td>
<td>$F(1,78) = 3.49$</td>
<td>.065</td>
<td></td>
</tr>
<tr>
<td>Caregiver primary participation</td>
<td>$F(2,42) = 2.39$</td>
<td>.104</td>
<td></td>
<td>$F(1,78) = 1.09$</td>
<td>.301</td>
<td></td>
</tr>
<tr>
<td>Child primary participation</td>
<td>$F(2,42) = 4.72$</td>
<td>.014*</td>
<td>0.18</td>
<td>$F(1,78) = 16.09$</td>
<td>&lt; .001***</td>
<td>0.17</td>
</tr>
<tr>
<td>Caregiver-led participation</td>
<td>$F(2,42) = 0.01$</td>
<td>.991</td>
<td></td>
<td>$F(1,78) = 7.86$</td>
<td>.006**</td>
<td>0.09</td>
</tr>
</tbody>
</table>

* $p < .05$, ** $p < .01$, *** $p < .001$

### 4b. Caregiver teaching behaviors

<table>
<thead>
<tr>
<th>Teaching behavior</th>
<th>Tannese</th>
<th></th>
<th>Partial $\eta^2$</th>
<th>HSUS</th>
<th></th>
<th>Partial $\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pointing</td>
<td>$F(2,42) = 6.72$</td>
<td>.003</td>
<td>0.24</td>
<td>$F(1,78) = 7.32$</td>
<td>&lt; .001***</td>
<td>0.09</td>
</tr>
<tr>
<td>Facilitation</td>
<td></td>
<td></td>
<td></td>
<td>$F(1,78) = 3.45$</td>
<td>.067</td>
<td></td>
</tr>
<tr>
<td>Imperatives</td>
<td>$F(2,42) = 1.03$</td>
<td>.366</td>
<td>0.05</td>
<td>$F(1,78) = 11.51$</td>
<td>&lt; .001***</td>
<td>0.13</td>
</tr>
<tr>
<td>Planning</td>
<td></td>
<td></td>
<td></td>
<td>$F(1,78) = 3.63$</td>
<td>.060</td>
<td></td>
</tr>
<tr>
<td>Encouragement</td>
<td></td>
<td></td>
<td></td>
<td>$F(1,78) = 8.89$</td>
<td>.004**</td>
<td>0.10</td>
</tr>
</tbody>
</table>

* $p < .05$, ** $p < .01$, *** $p < .001$
Figure 1. Incomplete hexagon card (top). Complete six-sided polygon card (bottom). Cards were presented to caregiver-child pairs one at a time.
Appendix A

Caregiver interviews about children’s learning

1. **Background.** We examined two facets of HSUS and Tannese caregivers’ beliefs about children’s learning – how children learn and who is responsible for ensuring new information is learned. We modified caregiver interviews used in previous research conducted in the South Pacific (Odden & Rochat, 2004) to ask HSUS and Tannese caregivers about the kinds of chores children should be able to do and how they learn to do them.

2. **Method.**

2.1. **Participants.** A criterion for participant recruitment in both the U.S. and Vanuatu was that participants were parents of young or primary school-aged children.

**Austin, TX, U.S.** Fourteen caregivers (7 females) were recruited at a children’s science museum. The caregivers were primarily Euro-American and from middle-to-high-socioeconomic status families. All of the caregivers in our sample reported having at least some college experience.

**Tanna, Vanuatu.** Fifteen caregivers (9 females) were recruited from residences in Ikunala Village. Ikunala is a kastom village and its residents reject Western influences, such as formal education (57). The caregivers interviewed had very limited experience with formal education.

2.2. **Materials and Procedure.** Research assistants from communities near our testing locations asked participants to identify chores that young or primary school-aged children need to learn and how they learn these chores. In the U.S., interviews were conducted in English. In Tanna, interviews were either conducted in Bislama (one of the national languages of Vanuatu) or the
local language of the region. Responses were translated to English onsite by the research assistants and recorded by either the first or second author.

2.2.1. Coding. Responses to the questions about how children learn particular chores were coded into categories describing the primary agent responsible for ensuring a skill was learned (adult or child agent) and the type of teaching behavior described (modeling/verbal instruction, observation, or imitation). Adult-agent responses described the adult as the primary agent (e.g., “parent shows how to complete the task”), whereas child-agent responses described the child as the primary agent (e.g., “watches his friends or older boys and then he tries”).

Modeling/verbal instruction responses included those describing an action being demonstrated for a child (e.g. “do it first”) or describing the adult giving instructions for how to complete a task (e.g., “explain the steps and ask her to do it on their own”). Observation responses described the child watching a caregiver or peer (e.g., “stay and watch what the mother does”). Imitation responses described the child copying the behaviors of caregivers or peers (e.g., “watch the bigger boys and then tries when they go away”).

3. Results. Mixed-effects binary logistic regressions were performed to test the effects of population on the likelihood of giving a response from each category for responses to the questions about how children would learn different chores. There were no predicted significant effects of age of the child being evaluated on participants’ responses, but this component was retained in the model to control for any variance due to differences in evaluations of children of different ages. Participants’ responses were not independent (i.e., participants provided an answer for both a 3-year-old and a 7-year-old), so a random effect of participant was included to control for error variance due to each participants’ pattern of responses. All predictor variables were standardized, so odds could be interpreted as the odds of providing a response in that
category for a 1 \( SD \) change in a predictor variable (full summaries of analysis coefficients are available in Table S1). The logistic regression model was fit to a probit curve due to cell size.

There was a significant main effect of population on the likelihood of providing a response in which the adult is the agent responsible for children’s learning. Tannese participants were less likely to provide adult-agent responses (32\%) than HSUS participants (81\%, odds ratio \( = 0.20, p < .001 \)). There was also a significant main effect of population on the likelihood of providing a response in which the child is the agent responsible for children’s learning. Tannese participants were more likely to provide a child-agent response (89\%) than HSUS participants (26\%, odds ratio \( = 6.89, p = .002 \)). Notably, when asked “Who do children learn from?”, caregivers from both populations indicated that children learn from parents. All of the Tannese respondents indicated that children learn from parents whereas HSUS participants provided a broader range of sources, including parents (86\%), peers/siblings (36\%), teachers (43\%), extended family (14\%), other non-family (14\%), everyone (21\%), and media (14\%).

There were also significant main effects of population on the likelihood of providing a response describing modeling/verbal instruction, observation, and imitation. Tannese participants were less likely to provide modeling/verbal instruction responses for how children learn (11\%) than HSUS participants (81\%, odds ratio \( = 0.11, p < .001 \)). There were relatively infrequent explicit verbal instruction responses (5\% of Tannese responses, 19\% of HSUS responses) compared to adult modeling responses (11\% of Tannese responses, 63\% of HSUS responses). Tannese participants were more likely to provide an observation response (84\%) than HSUS participants (11\%, odds ratio \( = 9.70, p < .001 \)). Finally, Tannese participants were also more likely to provide an imitation response (74\%) than HSUS participants (26\%, odds ratio \( = 5.63, p = .037 \)).
References

Appendix B.

Demographic information by population for caregivers and children

<table>
<thead>
<tr>
<th>Age</th>
<th>HSUS</th>
<th>Tannese</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-25</td>
<td>2%</td>
<td>19-25 – 18%</td>
</tr>
<tr>
<td>26-35</td>
<td>33%</td>
<td>26-35 – 41%</td>
</tr>
<tr>
<td>36-45</td>
<td>38%</td>
<td>36-45 – 14%</td>
</tr>
<tr>
<td>46-55</td>
<td>4%</td>
<td>46-55 – 10%</td>
</tr>
<tr>
<td>56+</td>
<td>0%</td>
<td>56+ – 12%</td>
</tr>
<tr>
<td>Not reported</td>
<td>23%</td>
<td>Not reported – 4%</td>
</tr>
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</table>

<table>
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<tr>
<th>Education</th>
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<th>Tannese</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school</td>
<td>5%</td>
<td>No school – 22%</td>
</tr>
<tr>
<td>Some college</td>
<td>10%</td>
<td>Primary school – 45%</td>
</tr>
<tr>
<td>Associates or Bachelor’s degree</td>
<td>43%</td>
<td>Some secondary school – 33%</td>
</tr>
<tr>
<td>Post-graduate degree</td>
<td>32%</td>
<td>Not reported – 11%</td>
</tr>
<tr>
<td>Not reported</td>
<td>11%</td>
<td>Not reported</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnicity*</th>
<th>HSUS</th>
<th>Tannese</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>3%</td>
<td>Tannese – 100%</td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>White, Hispanic</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Not reported</td>
<td>3%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>HSUS</th>
<th>Tannese</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-4</td>
<td>53%</td>
<td>3-4 – 31%</td>
</tr>
<tr>
<td>5-6</td>
<td>47%</td>
<td>5-6 – 33%</td>
</tr>
<tr>
<td>7-8</td>
<td></td>
<td>7-8 – 36%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education</th>
<th>HSUS</th>
<th>Tannese</th>
</tr>
</thead>
<tbody>
<tr>
<td>No school</td>
<td>6%</td>
<td>No school – 27%</td>
</tr>
<tr>
<td>Preschool or kindergarten</td>
<td>85%</td>
<td>Kindy (Preschool/kindergarten) – 43%</td>
</tr>
<tr>
<td>Some primary school experience</td>
<td>6%</td>
<td>Some primary school experience – 36%</td>
</tr>
<tr>
<td>Not reported</td>
<td>3%</td>
<td>Not reported – 2%</td>
</tr>
</tbody>
</table>

*Ethnicity information for both caregivers and children.
Appendix C

Supplemental Analyses with Restricted Tannese Age Range

1. Overall prevalence of teaching practices between populations.

Due to differences in the completion time of different pairs analyses were conducted on the proportion of segments in which the behaviors that we coded for were displayed. Table 1 presents the frequency of the interaction styles and teaching behavior by population, child age, and task difficulty. All proportions were transformed using an arcsine transformation.

Three MANOVAs were run to examine the impact of population, child age, and their interaction on the prevalence of interaction styles (shared participation, caregiver primary participation, child primary participation, and caregiver-led participation), caregivers’ nonverbal teaching behaviors (pointing and facilitation), and verbal teaching behaviors (planning, encouragement, and imperatives).

1.1. Interaction style. Using Wilks’s lambda, there were significant effects of population, $\Lambda = 0.52$, $F(4, 98) = 22.91$, $p < .001$, and child age, $\Lambda = 0.78$, $F(12, 259.58) = 2.15$, $p = .014$, and a significant interaction between population and child age, $\Lambda = 0.78$, $F(12, 259.58) = 2.15$, $p = .015$. Separate post-hoc ANOVAs ($p$-values Bonferroni corrected to $p < (.05/4) = .013$) were run to examine the effects of population and child age and their interaction on the prevalence of each interaction style. These post-hoc analyses indicated no significant interactions between population and child age on the prevalence of the different types of interaction styles. For all four interaction styles, there was a significant main effect of population (all $p$’s < .001). There was a significant effect of child age on child primary participation ($p = .005$), but not on the other types of interaction. HSUS pairs were more likely to engage in caregiver-led and child primary participation whereas Tannese pairs were more likely to engage in caregiver primary participation.
and shared participation. Pairs with older children also had a higher frequency of child primary interaction.

1. 1. Differences from analyses with full age range. These analyses produced similar results as those reported using the full Tannese age range. In particular, there was a significant effect of population for each interaction style.

1. 2. Nonverbal teaching behaviors. Wilks’s lambda revealed a significant effect of population, $\Lambda = 0.85, F(2, 100) = 9.15, p < .001$, and child age, $\Lambda = 0.84, F(6, 200) = 2.96, p = .009$, on the prevalence of caregivers’ nonverbal teaching behaviors, but there was not a significant interaction between population and child age, $\Lambda = 0.96, F(6, 200) = 0.62, p = .717$. Separate post-hoc ANOVAs ($p$-values Bonferroni corrected to $p < (.05/2) = .025$) were run to examine the effect of population and child age on the prevalence of each type of nonverbal teaching behavior (pointing, facilitation). There was a significant effect of population on caregivers’ use of facilitation ($p < .001$) but not pointing ($p = .247$). There was also a marginally significant effect of age on caregivers’ use of facilitation ($p = .045$, greater than Bonferroni corrected $p$-value) and a significant effect of age on caregivers’ use of pointing ($p = .010$).

1. 2. 1. Differences from analyses with full age range. These analyses resulted in similar findings as those reported using the full Tannese age range. The one exception is that the significant effect of age on caregivers’ use of facilitation is a marginally significant effect when Tannese 7- and 8-year-olds are excluded from analyses.

1. 3. Verbal teaching behaviors. Using Wilks’s lambda, there was a significant effect of population, $\Lambda = 0.33, F(3, 99) = 67.87, p < .001$, on the prevalence of caregivers’ verbal teaching behaviors, but there was not a significant effect of child age, $\Lambda = 0.88, F(9, 241.09) = 1.39, p = .195$ or a significant interaction between population and child age, $\Lambda = 0.86, F(9, 241.09) = 1.66,$
Separate post-hoc Mann-Whitney U tests (p-values Bonferroni corrected to $p < (.05/3) = .017$) were run to examine the effect of population on the prevalence of each type of verbal teaching behavior (planning, encouragement, and imperatives). HSUS caregivers used planning more than Tannese caregivers (Mann-Whitney $U = 109.00, p < .001$). HSUS caregivers also used encouragement more than Tannese caregivers (Mann-Whitney $U = 156.50, p < .001$). There was no significant difference between populations in caregivers’ use of imperatives (Mann-Whitney $U = 885.50, p = .060$).

1. 3. 1. Differences from analyses with full age range. These analyses resulted in similar findings as those reported using the full Tannese age range.

2. Impact of task difficulty on teaching practices by population.

We examined the impact of task difficulty on the rates of different interaction styles and teaching behaviors by population given overall differences in the frequency of the different interaction styles and teaching behaviors. For the analyses presented below, we used multilevel models to examine the impact of task difficulty (2: preparation, construction) while controlling for child age (2: 3-4-year-olds & 5-6-year-olds)—both fixed effects—on the prevalence of each interaction style and teaching behavior with a random effect of pair to account for non-independence of observations. All proportions were transformed using an arcsine transformation. Below we report the key findings for the Tannese data with 7-8-year-olds excluded from the analyses. We do not report HSUS analyses since those analyses remain unchanged from what was reported in the manuscript analyses.

2. 1. Impact of task difficulty on caregiver-child interaction. The results of the multilevel models indicate that the prevalence of two interaction styles—caregiver primary participation, $F(1, 55) = 35.05, p < .001$, and caregiver-led participation, $F(1, 55) = 19.86, p <$
.001—differed significantly when pairs were completing less difficult preparation versus more
difficult construction activities. This was not the case for the other two interaction styles. The
multilevel model analyses did not indicate an effect of age on interaction styles.

2.1.1. Differences from analyses with full age range. These analyses resulted in similar
findings for the impact of difficulty on interaction style as those reported using the full Tannese
age range. In contrast to the findings reported in the manuscript, there was not a significant effect
of age on the frequency of any of the interaction styles.

2.2. Impact of task difficulty on caregiver teaching behaviors. For Tannese pairs, we
examined the impact of task difficulty on two teaching behaviors: pointing and imperatives. The
results of the model for pointing indicated significant effects of task difficulty, $F(1, 55) = 16.52,$
$p < .001,$ but not child age. The results of the model for imperatives indicated significant effects
of task difficulty, $F(1, 55) = 5.98,$ $p = .018,$ but not child age.

2.2.1. Differences from analyses with full age range. These analyses resulted in similar
findings for the impact of difficulty on pointing as those reported using the full Tannese age
range. In contrast to the findings reported in the manuscript, there was a significant effect of
difficulty on caregivers’ use of imperatives. Tannese caregivers interacting with 3- to 6-year-olds
used imperatives more during preparation. This finding, however, is consistent with our overall
interpretation of Tannese caregivers’ teaching practices emphasizing that children directly
participate when a task is within their skill level, but not necessarily when a skill or task is
outside of their skill level, as might be the case with the construction component of the task.

3. Impact of child age on teaching practices by population.
Below we report the key findings for the Tannese data with 7-8-year-olds excluded from the analyses. We do not report HSUS analyses since those analyses remain unchanged from what was reported in the manuscript analyses.

3. 1. Interaction style. A MANOVA was run to examine the impact of child age (2: 3-4- & 5-6-years-old) on the prevalence of the four interaction styles. Using Wilks’s lambda, there was not a significant effect of child age, $\Lambda = 0.89$, $F(4, 24) = 0.73$, $p = .583$.

3. 1. 1. Differences from analyses with full age range. Unlike the analyses with the full Tannese data set, the analyses with 3-6-year-olds does not result in a significant effect of age. This finding is consistent with those reported in the manuscript, however, as any significant effects of age were followed with paired-samples t-tests that indicated that significant differences were driven by differences between caregivers interacting with 3-4-year-olds and those interacting with 7-8-year-olds.

3. 2. Teaching behaviors. Based on the Tukey posthoc tests reported in the manuscript based on data with 3-8-year-olds, there was not a significant difference in caregivers’ pointing between pairs with 5-6-year-olds and 3-4-year-olds ($p = .309$). There was not significant effect of age on Tannese caregivers’ use of imperatives.

3. 2. 1. Differences from analyses with full age range. Unlike the analyses with the full Tannese data set, the analyses with 3-6-year-olds does not result in a significant effect of age for pointing. This finding is consistent with those reported in the manuscript, however, as any significant effects of age were followed with Tukey posthoc that indicated that significant differences were driven by differences between caregivers interacting with 3-4-year-olds and those interacting with 7-8-year-olds. Consistent with what was reported in the manuscript, there was not a significant effect of age on caregivers’ use of imperatives.
Appendix D

Research Assistant Training, Recruitment, Full Protocol, Protocol Justification, and for Joint Problem-solving Task

Research Assistant Training

Research assistants in both Austin, TX and Tanna, Vanuatu were trained by either the first or second author. Training included explicit instruction to not intervene when caregivers and children were interacting and trainers modeled how to respond to questions about the task. Research assistants were instructed to remind caregivers and children of the goal when asked for clarification (e.g., “Make the gray shape using the plastic shapes.”), but not to interfere otherwise. Videos of all Austin participants were reviewed to ensure research assistant adherence to the protocol. In Tanna, the first or second author was present for all testing and all videos were translated and reviewed to ensure research assistant adherence with the protocol.

Recruitment

In both testing locations, caregivers and children were recruited predominantly from public areas in the course of daily life. In Austin, recruitment occurred on the floor of a local children’s museum and at local public science events. Caregivers and children were told about the possibility of playing a game together and invited to participate. In Tanna, recruitment occurred at local markets, family compounds, and via word of mouth. As in Austin, Tannese caregivers and children were told about the possibility of playing a game together and invited to participate.

Protocol and protocol justification

Before beginning each study session, in both locations, the research assistant explained to the caregiver that the tasks they would be completing were not meant to be a test, but that
caregivers and children should play together as they normally would. In Tanna, the script presented in Bislama was: “Tudei bae yumi mekem sam pleiplei tugeta. Mi interes tu mas long hao yu tufala pleiplei tugeta mo finisem pleiplei tugeta. Plis yu save mekem pleiplei tugeta i saemak ol teim.” (Translation – Today we are going to play some games together. I want to know how you both play together. Please play together as you normally would.) The Bislama instructions were developed in partnership with a local translator and the research assistants to ensure that the instruction of playing together was an idea that caregivers would be familiar with and to make it clear that the task was not an evaluation or that there was a right or wrong way to complete the task. Similar language was used in the U.S. to communicate that the task was not an assessment or test.

In both the U.S. and Tanna, the research assistant then presented the caregiver and child with a tangram puzzle game in which they were instructed to use plastic shapes in a bowl to make a shape indicated on a card. To ensure task comprehension, the Tannese research assistant demonstrated how to complete an example card. Each dyad then completed two cards, one at a time. The goal shapes on these cards were a hexagon and a six-sided polygon (images of the cards are available below). The research assistant was seated across from the pair and placed the card with the target shape and the tray of the plastic tangram shapes in from of the child and caregiver. After pairs finished the first card, the research assistant confirmed that they were finished, thanked them, emptied the used pieces back into the tray. The researcher then placed the second card in front of the pair and declared, “Next one.” or “Now it’s time for the next one.” If caregivers asked the research assistant about the task, she answered without prescriptive language and repeated the goal of the task.
Appendix E.

Description of coding categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregiver primary</td>
<td>Caregiver worked on the task while the child observed or made a minor contribution.</td>
</tr>
<tr>
<td>Child primary</td>
<td>Child was primary actor and participated without caregiver direction or ignored caregiver direction while the caregiver observed or made a minor contribution.</td>
</tr>
<tr>
<td>Shared</td>
<td>Both the caregiver and the child actively contributed (e.g., selecting pieces, moving pieces, constructing the shape) to the completion of the same parts of the task.</td>
</tr>
<tr>
<td>Caregiver-led</td>
<td>Child was primary actor, but her or his actions were the result of caregiver direction (verbal and/or non-verbal). This subcategory also included segments when caregivers provided instruction to children but children did not actively participate.</td>
</tr>
<tr>
<td>Pointing</td>
<td>Caregiver pointed to location on the tangram card, to the tangram pieces, or to a component or object related to completing the task.</td>
</tr>
<tr>
<td>Facilitation</td>
<td>Caregiver held the shape bowl for the child, poured the shapes out of the bowl, held the game card in place, or handed the child a piece to facilitate the child’s completion of the task.</td>
</tr>
<tr>
<td>Instruction</td>
<td>Caregiver prompted child to engage in an action related to the completion of the task. Could be phrased as question, but clearly communicated adult’s desire for the child to complete an action.</td>
</tr>
<tr>
<td>Planning</td>
<td>Caregiver prompted the child to consider her own or the caregiver’s current or future action. Includes questions that ask the child to make a plan for future actions.</td>
</tr>
<tr>
<td>Encouragement</td>
<td>Caregiver praised the child or provided affirmation.</td>
</tr>
<tr>
<td>Preparation</td>
<td>Moved shapes in the bowl, selecting a shape, replacing a shape in the bowl, placing a shape on or near the game card (anywhere but the gray goal shape).</td>
</tr>
<tr>
<td>Construction</td>
<td>Actions required to making the goal shape - placing or arranging shapes to make the goal shape.</td>
</tr>
</tbody>
</table>