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Cross-Cultural Differences in the Influence of Peers on Exploration During Play

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Abstract

Certain social context features (e.g., maternal presence) are known to increase young children's exploration, a key process by which they learn. Yet limited research investigates the role of social context, especially peer presence, in exploration across development. We investigate whether the effect of peer presence on exploration is mediated by age or cultural-specific experiences. We test its impact on exploration across development (2–11 years) and across cultures (United States and the Tsimane', indigenous farmer-foragers in Bolivia). Specifically, peer presence does not boost exploration among young U.S. children and becomes more inhibitory among school-age children. In contrast, peer presence facilitates exploration and provides an additional boost for older Tsimane' children, who differ from U.S. children in their cultural-specific learning experiences (e.g., formal education), among other differences. We discuss potential cultural factors and mechanisms by which peer presence may boost exploratory behavior.

Keywords: Development; Cross-cultural analysis; Exploration; Discovery; Learning; Play; Social development

1. Introduction

Children engage in exploration during play to learn in many domains, from intuitive physics (Bonawitz, van Schijndel, Friel, & Schulz, 2012) to category and concept learning (Markant & Gureckis, 2012; Sim, Tanner, Alpert, & Xu, 2015). During play, children can propose and test hypotheses about causal relations through novel interventions (e.g., Gopnik, Meltzoff, & Kuhl, 1999; Schulz & Bonawitz, 2007). How a child chooses to explore may depend on the child's beliefs about the world (e.g., Bonawitz et al., 2012),

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inferences about his or her learning context (e.g., Bonawitz et al., 2011), and properties of his or her social context (e.g., Rheingold, 1969). Although there are empirical data suggesting social contexts matter, there is little previous work on the influence of peers on play. Here, we investigate social context effects on exploration and ask whether the presence of peers influences exploration during play.

1.1. The influence of social context on play

Previous evidence suggests young children's social contexts—who is present and how these individuals behave—impact exploration and play. For example, 10-month-olds entering a novel play room will explore at greater rates when they enter an unfamiliar play room with their mothers compared to when they enter the room with an experimenter (Rheingold, 1969). One- to 3-year-olds also restrict play and exploratory responses when their mothers temporarily leave (Cox & Campbell, 1968). Other people's behavior also impacts children's actions. In the first year, infants develop the ability to imitate actions on objects (Meltzoff, 1988). Imitative learning is an important tool for skill acquisition in the first few years of life and beyond. For example, in a classic experiment by Bandura, Ross, and Ross (1961), children were more likely to play violently with toys (e.g., hit and kick) after observing an adult play violently with toys. This and other studies of imitative behaviors highlight how children's social contexts can have substantial effects on children's subsequent behaviors. Thus, an open question is whether the presence of peers influences children's play. Here, we consider the influence of peer presence on exploratory behaviors.

Within the limited number of empirical studies that investigate the influence of peer context on exploration during infancy and toddlerhood, few have investigated how the contexts impact children as they progress through development, or at older ages. One-year-old infants play less and spend more time unengaged in the presence of a peer compared to when playing alone (Gunnar, Senior, & Hartup, 1984; Turkheimer, Bakeman, & Adamson, 1989), possibly due to the social distraction inherent in the presence of another child. Two-year-olds are reported to explore more in peer contexts: Toddlers explore larger areas, venture further from their mothers, and play for longer durations in the company of an older sibling than alone (Samuels, 1980). These changes lead to more visual exploration and object manipulation, thereby increasing possible learning instances. Though data on the subject are sparse, the existing overall pattern in the literature suggests that the impact of peer presence on exploration could shift from inhibitory to facilitatory early in development. If that trend observed in toddlerhood continued across development, peer presence would be expected to have stronger facilitatory effects in school-aged children.

In contrast, the presence of peers during play may lead to an overall decrease in exploration among school-aged children as they engage in more sophisticated, social peer-oriented play (Rubin, Watson, & Jambor, 1978). This finding is reported among preschoolers and kindergarteners. As children age, the development of social skills and peer-oriented play may lead to reduced curiosity for toys and object-centered play.

Understanding the impact of peers on exploration is especially important for maximizing children's learning potential in educational contexts, where the presence of peers is a common feature. Yet no previous work has examined the influence of peers on school-aged children's exploration. This is surprising because research from communication and human computer interaction shows that rapport between peers plays a critical role in maximizing learning outcomes (e.g., Bernieri & Rosenthal, 1991; Ryokai, Vaucelle, & Cassell, 2003). Additionally, *virtual* peers are effective teachers of literacy (e.g., Ryokai et al., 2003) and may help as an intervention tool for children with autism (e.g., Tartaro & Cassell, 2006). Therefore, it is important to understand how peers might shape exploratory behaviors.

1.2. Cross-cultural differences in social contexts during play

Across cultures, the type (e.g., parent, related adult, unrelated adult, sibling, related child, unrelated child) and frequency of children's play partners vary. For example, 12- to 24-month-old children from Western communities (United Status and Turkey) engage in dyadic play with adults significantly more than with other children, while the opposite pattern is found for children from non-Western, rural communities (Guatemala and India; Göncü, Mistry, & Mosier, 2000). These differences may reflect culturally specific beliefs about child-rearing or the purpose of play. Although these findings highlight how the social context of play differs across culture, no previous work to our knowledge has measured how these differences impact children's exploration. Here, we ask whether culture-specific differences (which could include cultural beliefs about parenting, education, and play) impact how peers influence exploration and learning throughout and beyond toddlerhood.

One reason to predict different effects of peer presence on play across cultures is due to culture-specific differences in child-rearing practices. In Western industrialized societies, children's learning experiences are largely facilitated by caregivers and authority figures, who actively engage and instruct children. Although caregiver-directed learning is common in Western industrialized societies, these interactions can be less common in non-Western societies, such as indigenous American societies (e.g., Mayan, Tsimane'). For example, parents in Mayan cultures do not commonly structure learning experience for their children; rather, children tend to learn through observing interactions of others, frequently their older siblings (e.g., Gaskins, 1999; Shneidman, Gaskins, & Woodward, 2016; Shneidman, Gweon, Schulz, & Woodward, 2016). Rather than adult-initiated teaching, Mayan children often learn cultural expectations and tasks from their older siblings, who are effective teachers by 6 years old (Bazyk, Stalnaker, Llerena, Ekelman, & Bazyk, 2003; Gaskins, 1999).

These differences in child-rearing practices may reflect cross-cultural differences in social structures: While Western societies are considered hierarchically organized (characterized by the presence of authority figures and a division of labor where people are often assigned tasks or jobs), other societies, such as the Mayans and the Tsimane', have a more horizontal organization (characterized by mutual engagements and collaboration).

1.3. Influence of formal education on social engagements

Cultural-specific beliefs and practices related to learning may also influence how peer presence impacts exploration. As children grow older, part of the enculturation process includes learning how to learn. In Western societies, this often includes exposure to formal education at an early age. Previous work has shown that the child-directed teaching strategies of Chicano and Anglo-American mothers is best explained by maternal education (Laosa, 1980). Exposure to formal education, through direct (e.g., school) and indirect (e.g., individuals) means, may lead to differences in social play dynamics across age. In non-Western societies, formal education can sometimes introduce new beliefs about social structure and teaching (e.g., Chavajay & Rogoff, 2002; Maynard, 2004). While indigenous American societies typically have a horizontal social structure which is characterized by cooperation and mutual responsibility, formal Western schooling has a hierarchical structure where an adult authority figure—the teacher—manages children's behaviors and activities (Chavajay & Rogoff, 2002). Experience with formal schooling has observable effects on human social interactions. In a puzzle assembly task (Chavajay & Rogoff, 2002), Mayan mothers who have minimal schooling engage with children using more horizontal behaviors (e.g., working together). In contrast, Mayan mothers with more extensive formal schooling engage with children using more hierarchical behaviors (e.g., directing the child's behaviors, suggesting goals or jobs to do). These differences seem to shape how children interact during the activity: during the game, older children interacting with less-educated mothers produced a similar number of suggestions as the mothers, while older children interacting with higher-educated mothers produced fewer suggestions than the mothers.

More broadly, these studies demonstrate that cultural beliefs and practices related to learning have a strong impact on children's social interactions. These experiences may in turn shape children's play behaviors and their beliefs about play, including social dynamics during play and frequency of play behaviors (e.g., peer-oriented play, toy-oriented play, and exploration).

1.4. About the Tsimane'

Here, we focus on the children of the Tsimane', an indigenous farmer-forager society in the lowlands of Bolivia who spend far less time in formal educational settings and far more time interacting and learning from their peers. The Tsimane' are farmer-foragers with a population of approximately 8,000 in the lowlands of Bolivia (Godoy et al., 2005; Ringhofer, 2010). Unlike U.S. children, Tsimane' children typically have few formal educational obligations (e.g., school). Tsimane' children spend most of their daily lives with children and members of their community. At 6 months of age, Tsimane' children are directly cared for by an adult approximately 57% of daylight hours; however, by 2 or 3 years of age, they spend 15% or less of daylight hours in adult care (Winking, Gurven, Kaplan, & Stieglitz, 2009). Additionally, they are taught to perform and assist with adult duties, such as cooking, hunting, and farming (Ringhofer, 2010; Schniter, Gurven, Kaplan, Wilcox, & Hooper, 2015). Sixty percent of Tsimane' villages have primary schools that offer instruction for

3.5 h a day, Monday through Friday (Godoy et al., 2005). School attendance, however, is voluntary and there is wide variation in attendance rates among Tsimane' children (Ringhofer, 2010). During the agricultural season, it is not uncommon for school to be cancelled or for children to be taken out of school to work. The average Tsimane' adult completes approximately 2 years of schooling (Reyes-García et al., 2010).

1.5. How does peer presence impact play across development and cultures?

Experiment 1 examines the impact of peer presence in U.S. children across development and finds an unexpected shift starting at around age 4. Specifically, peer presence does not affect very young children's exploration rates more than what would be predicted from two children exploring in parallel, and it could potentially inhibit exploration in older children. In Experiment 2, we use the same exploration task to test Tsimane' children. In contrast with U.S. children, Tsimane' children overwhelmingly receive far less formal education protracted across older ages and spend more time with peers in informal settings. In Experiment 2, we find that peer presence offers a boost to exploration in young Tsimane' children that increases with age. This pattern is consistent with the theory that culturally specific learning experiences, such as experience with formal education and informal interactions with peers, may potentially impact how peer presence affects exploration cross-culturally in children. We additionally note that any two cultures vary along many dimensions, any number of which could potentially be relevant factors in explaining cross-cultural differences. These observed cross-cultural differences thus may also arise from differences in other factors, such as differences in expectations about where learning should take place, who should be regarded as a valuable source of knowledge, and how much time is spent independently versus with community members.

2. Experiment 1

We designed a task to quantify the impact of peer presence on exploration using a simple procedure that was easily administered across a wide range of ages and could be administered cross-culturally. While exploration describes a wide range of behaviors (e.g., focused exploration of a stimulus, broad exploration of an environment) with different motivations (e.g., novelty reduction, boredom reduction, hypothesis testing), for the purposes of our study we will operationally define exploration as a simple measure of novelty- and information-seeking: the number of hidden toys that children discovered from a set during a fixed time interval, either individually or with a peer.

2.1. Methods

2.1.1. Participants

Seventy-six U.S. children between the ages of 2 and 11 years (M = 5.56 years) recruited from the Rochester, New York, area participated in the study in the Rochester

Baby Lab at the University of Rochester. Fifty-two children participated in the dyad condition (M = 5.63 years, SD = 2.09 years, range = 2.15–10.72 years), and 24 children participated in the solo condition (M = 5.39 years, SD = 2.17 years, range = 2.74–9.71 years). Four additional children were excluded due to shyness (n = 4), as determined by failure to reach out for an example toy before the task began.

2.1.2. Conditions

Children participated in one of two social conditions: dyad or solo. Children in the dyad condition participated with a sibling. In the solo condition, children participated in the task by themselves. In both conditions, an experimenter was also present during the task. This was necessary to keep experimental conditions consistent across both experiments.[1]

2.1.3. Procedure

Prior to the experiment, children spent time in the lab space with a research assistant who engaged with the child. To keep conditions similar across Experiments 1 and 2, the children

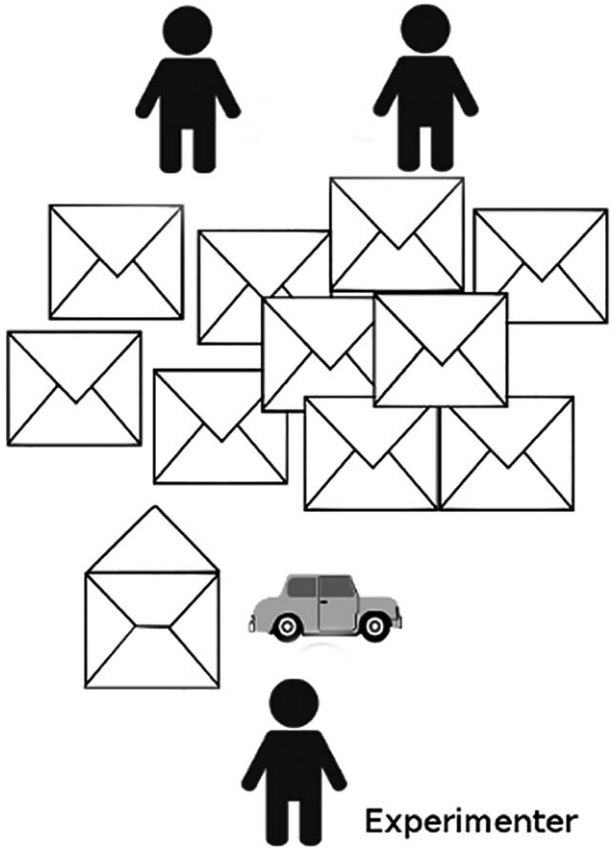

Fig. 1. Experiment 1 and 2 task schematic.

were told by a research assistant in the child's native language (here, English) that the experimenter spoke another language other than English, such as Spanish, German, or Serbian (a language that the child did not speak, according to parental report). This allowed the experimenter to have minimal involvement in the free play session that followed. To start the experiment, the experimenter, research assistant, and participants walked together to a nearby, separate room where 11 envelopes were preplaced on the floor (see Fig. 1 for a task schematic). Each envelope contained one toy from a set of toys that were selected to appeal to children across a broad range of ages and cultural backgrounds (e.g., shakers, toy animals, wooden vehicles, all of which were familiar to both Tsimane' and U.S. children). The experimenter gestured for the child(ren) to sit down on pillows next to the envelopes. During the warm-up period, the experimenter opened an envelope, looked inside, and offered the contents of the envelope to the participant(s). In the dyad condition, the experimenter offered one toy, sequentially, to both children. If the participant(s) took the toy, a 2 min free-play session started when a participant reached for the first envelope. If children did not reach for another envelope within 10 s of the demonstration envelope, the experimenter pushed an envelope toward the participant(s) to encourage them to open the envelope and start the free-play session. During the 2 min free-play session, the experimenter recorded the number of opened envelopes. After the 2 min free play session ended, children were told that the experimenter not only spoke a different language (Spanish, German, or Serbian), but also spoke English. All children included in the analyses played for the entirety of the 2 min free-play session (Fig. 2).

Fig. 2. Dyad participating in the task.

2.2. Results

To evaluate the influence of peer presence on exploration across age, we first compared the number of envelopes discovered in each session across social conditions (solo and dyad) and age by constructing a linear regression predicting discovery rate from social condition, age, and their interaction. Next, we compared children's discovery rate in the dyad condition to *double* the discovery rate of children in the solo condition to understand the degree to which peers facilitated exploration compared to what would be predicted from two children playing in parallel. For analysis purposes, age was calculated as the average age of children in each session: For children in the solo condition, this means that age is defined the exact age of the child; for children in the dyad condition, this means that age is defined as the average age of the two children.[2] There was no effect of gender on children's exploration in the solo condition (or with age + gender + age × gender), so gender was not included as a factor in further analyses.[3]

2.2.1. Young U.S. children with a peer explore no more than two children in parallel: First, we conducted a linear regression predicting discovery rate from social condition (dyad, solo), age (average for the session), and their interaction as predictors (see Table 1 and Fig. 3 for results). U.S. children in the dyad condition discovered significantly more toys within the 2-min period ($M = 4.23 \pm 3.12$) as compared to U.S. children in the solo condition ($M = 3.33 \pm 2.85$).[4] Although there was no effect of age overall, there was a significant interaction of social condition and age. A simple slope comparison revealed that while younger children (< 4 years of age) in the dyad condition explored significantly more toys than those in the solo condition ($\beta = -1.04$, $t(46) = -2.36$, $p < .05$), older children (5.5 years and above) explored less—but not significantly so—in the dyad condition (at the mean: $\beta = 0.92$, $t(46) = 1.13$, $p > .20$; 1 *SD* above the mean: $\beta = -1.07$, $t(46) = -0.92$, $p > .30$).[5]

To test whether exploring with a peer provided *additional* benefits beyond the effects of two children exploring in parallel, we compared children's discovery rate in the dyad condition to *double* the number of toys that children discovered in the solo condition, using a linear regression justified by the data.[6] If social condition significantly predicts discovery rate in our original regression but not in our doubled regression, this would

Table 1
Regression coefficients from linear regression predicting number of explored toys within a 2-minute period by for U.S. children in Experiment 1

Term	Coefficient	*SE*	*t*	*p*<
Intercept	4.51	1.28	3.52	.0001***
Social Condition (solo)	−6.64	2.57	−2.59	.05*
Age (average)	−0.12	0.22	−0.55	>.10
*Condition * Age*	−1.04	0.44	−2.36	.05*

*$p < 0.05$; ***$p < 0.001$

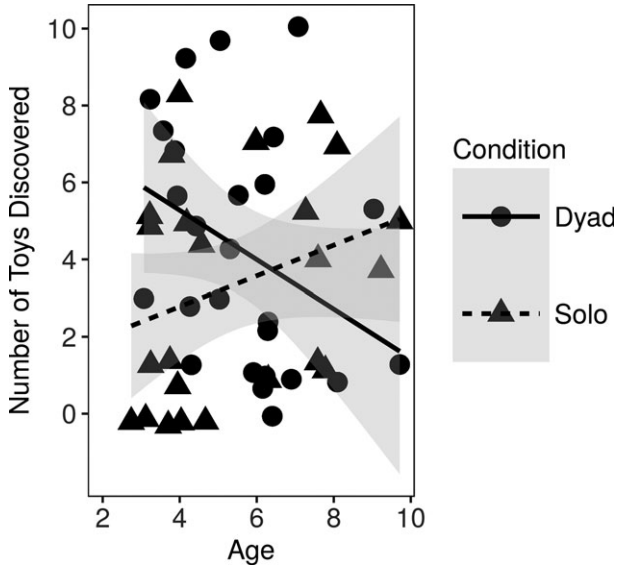

Fig. 3. Number of toys discovered by U.S. children across social conditions. The figure shows the number of toys discovered by children in the dyad (circle, dotted line) and solo (triangle, solid line) conditions across age (averaged by session). Lines are linear model fits by condition (dyad = solid; solo = dashed). Shading indicates the 95% confidence interval. The solo child data indicate that children do not explore significantly more with age (though the data trends in this direction). The dyad condition, however, shows that peer presence has an inhibitory effect on exploration in older school-aged U.S. kids.

suggest that peer presence increases exploration compared to exploring alone, but it does not differ from what is expected from two children exploring in parallel. On the other hand, if social condition significantly predicts discovery rate in the doubled regression, this would indicate that peer presence facilitates exploration above and beyond what would be expected from two children exploring in parallel. Here, we find a marginal main effect of social condition and interaction between average age and social condition, $\beta = 5.86$, $t(46) = 1.81$, $p = .077$ and $\beta = -1.32$, $t(46) = -2.40$, $p < .05$ respectively. Simple slope analysis indicated that there was no effect of social condition on discovery rate at one standard deviation below the mean (3.59 years) or at the mean (5.51 years), $\beta = 1.10$, $t(46) = 0.74$, $p > .4$ and $\beta = -1.45$, $t(46) = -1.40$, $p > .1$. At one standard deviation above the mean (7.44 years), social condition significantly predicted children's discovery rate: Playing with a peer was associated with a significantly lower discovery rate (-2.0) compared to playing alone, $\beta = -3.99$, $t(46) = -2.71$, $p < .01$. Comparing these results to those found in our first analysis, we find that while young children in the dyad condition discovered significantly more toys than young children in the solo condition, the benefits gained from peer presence are less than what would be predicted from children discovering toys in parallel, at the same time. Older children discovered a similar amount of toys when with a peer compared to when alone, which is significantly less than what would be predicted from two children exploring in parallel.

To test whether children's education level moderated exploratory behavior, we conducted two model comparisons to determine whether our original model (predicting discovery rate from average age, social condition, and their interaction) would explain significantly more variance with the inclusion of children's education levels (see Table S3 in Supporting Information for additional information on the education analysis). Including the average education level or the highest education level reached by a participant did not significantly improve model fit, $\chi^2(1, n = 44) = 8.62$, $p > .3$, and $\chi^2(1, n = 44) = 23.85$, $p > .1$ respectively. Important to note, the level of education in our sample was not equally distributed: While 23 children were in preschool, for example, only 6 children were in grades 3–6. Additionally, both of our education measures were highly correlated with average age ($r = .93$, $t(42) = 17.09$, $p < .0001$, and $r = .90$, $t(42) = 13.47$, $p < .0001$ respectively). Attributed to the limitations of our data, it is not possible to draw strong conclusions from the failure to find an effect of education on discovery rate, as this is likely just a result of the correlation between age and number of years of formal education.

2.3. Discussion

Among U.S. children, young children explored more toys with a peer compared to exploring alone, but not more than would be predicted by two children exploring in parallel. Peer presence did not lead to an increase in exploration among older school-aged children, either—and in fact, older children playing with a peer explored less than what would predicted from two children exploring in parallel. While we did not find an effect of education on children's discovery rate, it is possible that cultural-specific formal and informal learning experiences may shape children's exploration behaviors (e.g., Butler & Markman, 2012). In our sample, an uneven distribution of education levels (see Table S3 in Supporting Information) and strong correlations between age and education measures may have contributed to why we did not observe a significant effect of education on exploration. If experience with cultural-specific learning (e.g., schooling) restricts exploratory behavior, older children with less exposure to formal education may not exhibit the same inhibitory effect on exploration in the presence of a peer because they may not have the same default expectations about social interactions or the pedagogical context of the play situation.

Another possibility that exploration in the dyad condition decreased with age may be related to increases in peer-directed play. Previous studies have shown that peer-directed play increases with age. Toddlers engage in more object-directed play than peer-directed play (e.g., Bronson, 1975, 1981). Similarly, Kindergarteners engage in more peer-oriented play and less isolated play than preschoolers (e.g., Rubin et al., 1978). These changes coincide with increases in the frequency of child-to-child interactions, from an estimated 10% of social activity at 2 years of age to over 40% at 7 years of age (Barker & Wright, 1955). Therefore, it is also possible that the frequency of peer play may increase with frequency of daily child-to-child interactions. If this is the case, children with greater

exposure to other children may engage in more peer-oriented play and less object-oriented play compared to other children their age who spend less time with other children.

In Experiment 2, we use the same paradigm as Experiment 1 to investigate the effect of peer presence on discovery rate in children in a culture with differing learning experiences. The Tsimane' have an optional, less formal educational system. Compared to U.S. children, Tsimane' children have less formal education and begin formal education at later ages. Rather, Tsimane' children spend much of their daily lives with other children, starting from an early age. In doing this, we aim to better understand how cultural-specific differences in formal and informal learning shape the effect of peer presence on exploration.

3. Experiment 2

3.1. Methods

3.1.1. Participants

Seventy-two Tsimane' children between the ages of 2 and 11 (M = 5.22 years, SD = 2.29 years, range = 2–11 years) were recruited from the villages of Cara Cara, Las Minas, Puerto Mayera, and Limoncito surrounding San Borja, Bolivia. Forty-eight children participated as pairs in the *dyad condition* (M = 5.2 years, SD = 2.35 years, range = 2–11 years) and 24 children participated in the *solo condition* (M = 5.3 years, SD = 2.24 years, range = 2–11 years). Three additional children were excluded from the study due to shyness (as determined by the same criteria in Experiment 1).

3.1.2. Conditions

Similar to Experiment 1, children participated in one of two social conditions: dyad or solo. Children in the dyad condition participated with a sibling or well-known village neighbor. The Tsimane' social structure is community-oriented compared to the nuclear family structure common in the United States, so both siblings and neighboring children within the same village spend comparable amounts of time with shared caregivers as siblings in the United States. In both conditions, an experimenter was also present during the task. As in Experiment 1, the children were informed by a translator that the experimenter did not speak Tsimane' in order to minimize experimenter involvement during the play session to follow.

3.1.3. Procedure

Participants in the villages of Cara Cara, Las Minas, and Limoncito were tested in schoolhouses. A large tent was used to isolate the participants from other children so that others would not be able to see the study. Prior to the study, the participants were encouraged to play in the tent to become comfortable with the setting and the presence of the experimenter (similar to procedures used in the Rochester Baby Lab). Participants were

seated on the floor next to the experimenter. The procedure was identical to Experiment 1, with a comparable set of toys (e.g., noisemakers, animal figures) adjusted so as to be similarly familiar and attractive to the Tsimane' children as the toys used in Experiment 1 were to U.S. children. In advance of the study, the children heard directions from a Tsimane' speaker which included the information that the researcher did not speak the child's native language.

3.2. Results

Similar to Experiment 1, we investigated whether the number of envelopes explored in the free-play session was influenced by peer presence and the age of the children in the session.[7] As in Experiment 1, age was averaged across children participating together in each session. There was no effect of gender on children's exploration in the solo condition (or with age + gender + age × gender), so gender was not included in further analyses.[8] To test the effect of peer presence and age on exploration, we first used a linear regression to predict discovery rate (number of toys discovered within a 2-min session) from social condition (solo or dyad), age, and their interaction. Next, we compared children's discovery rate in the dyad condition to double the discovery rate of children in the solo condition.

In our first model, Tsimane' children discovered significantly more toys in the dyad condition ($M = 8.2 \pm 0.25$) than in the solo condition ($M = 1.4 \pm 0.35$)—see Table 2 and Fig. 4.[9] Additionally, older children explored more than younger children, as revealed by the main effect of age. A significant interaction of age and condition suggested that peer presence was associated with an additional boost in exploration for older kids.

3.2.1. Tsimane' children with peers explored more than two children in parallel: To test whether peer presence facilitated exploration beyond the effects of two children exploring in parallel, we compared children's discovery rate in the dyad condition to *double* the number of toys that children discovered in the solo condition, similar to Experiment 1. Social condition was a significant predictor of discovery rate, with children in the dyad condition discovering significantly more toys than what would be predicted from two children exploring in parallel (the doubled solo condition), $\beta = 5.50$, $t(45) = 6.99$,

Table 2
Regression coefficients from linear regression predicting number of explored toys within a 2-minute period by Tsimane' children in Experiment 2

Term	Coefficient	*SE*	*t*	*p*<
Intercept	2.76	0.64	4.29	.0001***
Social Condition (solo)	4.01	1.29	3.11	.01**
Age (average)	0.39	0.11	3.43	.005**
*Condition * Age*	0.55	0.23	2.41	.02*

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

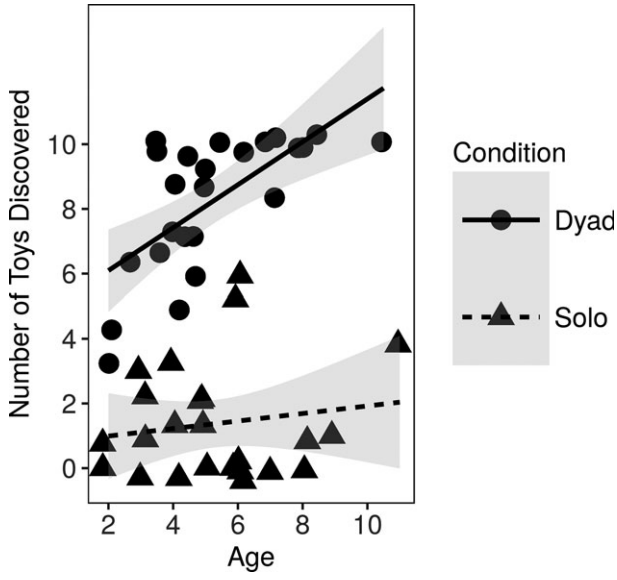

Fig. 4. Number of toys discovered by Tsimane' children across social conditions. The figure shows the number of toys discovered by children in the 2-min play period across social condition (dyad = circle, solid line; solo = triangle, dotted line) against average age in each session. Lines are linear model fits by condition. Shading indicates the 95% confidence interval. Children explored significantly more toys in the presence of a peer than children alone. Furthermore, peer presence had a larger impact on the exploration of older children than younger ones.

$p < .0001$. Age was also associated with a significant increase in discovery rate, with older participants (indexed by average age) predicted to have greater discovery rates, $\beta = 0.44$, $t(45) = 2.41$, $p < .05$. Comparing the results of this analysis to our original analysis, we find that peer presence facilitated Tsimane' children's discovery rates above and beyond what would be predicted if two children explored in parallel at the same rate across age.

Next, we investigated whether children's experience with education influenced children's discovery rate in the free-play session. To test this, we conducted two model fit comparisons between a model predicting discovery rate from average age, social condition, and their interaction with and without the addition of two measures of education: mean level of education and highest level of education reached by a child in the session. Including either education measure did not significantly improve model fit, $\chi^2(1, n = 48) = 0.13$, $p > .8$, and $\chi^2(1, n = 48) = 0.02$, $p > .9$ respectively. We may have failed to find an effect of education level on children's discovery rates for two reasons: First, our sample had a highly skewed, narrow distribution of education levels, where the majority of our participants (58/72) had zero or one years of experience with formal education (see Table S4 in Supporting Information). Second, children's average age and measures of education were highly correlated with each other ($r = .74$, $t(46) = 7.54$, $p > .0001$ and $r = .75$, $t(46) = 7.63$, $p < .0001$, respectively).

3.2.2. Peer presence and age boost exploration among Tsimane', but not U.S. children: Finally, we compared the influence of peer presence on discovery rate across U.S. (Experiment 1) and Tsimane' children (Experiment 2). We ran a linear regression predicting discovery rate from cultural group (U.S. or Tsimane'), social condition (dyad or solo), age (average per session), and their two- and three-way interactions (see Table 3 for results). The model explained a significant amount of variance in discovery rate ($R^2 = .55$, $F(7, 94) = 16.38$, $p < .0001$). Discovery rate did not significantly differ across U.S. children and Tsimane' children in the two experiments ($p > .1$). Across our U.S. and Tsimane' samples, the presence of a peer boosted exploration compared to when children explored independently. We also found a marginally significant interaction between Group and Age, suggesting that the effect of age on discovery rate was modified by culture—U.S. children explored similarly across age, while Tsimane' children explored significantly more with age. Finally, a significant three-way interaction was found, such that the effect of social condition and age on discovery rate was modified by culture. While young U.S. children explored more with a peer than alone—but not more than predicted from two children exploring in parallel—older U.S. children did not. In contrast, Tsimane' children explored more in the presence of a peer across age, and this effect was even stronger among older children.

3.3. Discussion

Compared to their U.S. counterparts, Tsimane' children spend more of their daily lives in the company of other children starting from a young age. Additionally, Tsimane' children have a schooling-optional system, so they may or may not have exposure to formal education. Rather, children typically learn from their peers in informal community settings. In Experiment 2, we find that peer presence boosts exploration among Tsimane' children. This effect increases with age, in contrast to the U.S. children in Experiment 1. Across all ages of Tsimane' children, the facilitatory effects of peer presence on exploration is significantly larger than what would be predicted if two children played in parallel. The results of Experiment 2 are inconsistent with the prediction that older children

Table 3
Regression analyses for impact of culture (U.S. and Tsimane') and interactions

Term	Coefficient	*SE*	*t*	*p*<
Intercept	3.44	0.69	4.96	.0001***
Age (average)	0.18	0.12	1.50	>.1
Social Condition	4.92	1.38	3.56	.0001***
Cultural Group	−1.34	1.38	−0.97	>.1
*Age * Social Condition*	−0.15	0.24	−0.64	>.1
*Age * Cultural Group*	0.42	0.24	1.75	.08
*Social Condition * Cultural Group*	−1.82	2.77	−0.66	>.1
*Age * Condition * Group*	1.4	0.48	2.92	.01**

**$p < 0.01$; ***$p < 0.001$

will engage more frequently in social-oriented play and less frequently in toy-oriented play. These results are consistent with the idea that cultural-specific format for learning experiences (formal and informal) may influence exploratory behaviors. Alternatively, other cultural-specific experiences, such as the type and frequency of interactions with other children compared to adults, may also explain the facilitative boost of peer presence on exploration.

4. General discussion

Taken together, Experiment 1 and Experiment 2 demonstrate how culture impacts the influence of peer presence on exploration. Young U.S. children explored at similar rates with a peer or by themselves; young Tsimane' children explored significantly more toys with a peer than what would be predicted by two Tsimane' children exploring in parallel. While this pattern decreased for older, school-aged U.S. children—such that older children in the dyad condition explored at effectively half the rate of children in the solo condition—it strengthened with age in the Tsimane' population.

Two major differences across the United States and the Tsimane' are their different social organizations and educational practices. Western societies are commonly hierarchically organized, such that there is a division of labor and individuals are allocated jobs, while some non-Western, indigenous societies are horizontally organized, such that cooperation and mutual responsibility are valued (e.g., Chavajay & Rogoff, 2002). Formal education, which is also hierarchically structured around a teacher, is also more common in Western societies: U.S. children overwhelmingly and rapidly transition into half- or full-time formal schooling around age 4, while the Tsimane' children do not. The Tsimane' villages from which the children here were recruited all follow "education optional" systems, in which parents and children can opt-in to formal instruction as they choose. In general, most children receive far less formal instruction and at substantially older ages. This difference in the amount of exposure to hierarchical learning contexts could modulate the impact of peer presence on exploration. In both experiments, we did not see an effect of education level on discovery rate. However, this null result should not be overinterpreted given the correlation between age and number of years of formal education in both populations (although the correlation was much stronger for the U.S. children in Experiment 1, it still existed for the Tsimane' children). Cultural-specific experiences with learning environments, in addition to other cultural differences such as the quantity of peer-to-peer interactions, could contribute to the observed differences across populations.

While previous work shows that peer interactions can boost learning (e.g., Bernieri & Rosenthal, 1991; Ryokai et al., 2003), our study shows that the effect of peer presence on exploration is moderated by culturally specific social information and by age (likely due to culturally different experiences). Although, at first glance, our result may seem discrepant from previous work on peer-facilitated learning, our study investigates peer-facilitated exploration rather than the learning that might result from it. It is possible that

school-age peers can boost learning but have no impact or even inhibit exploration. Future work should address how these two findings relate to each other; for example, a decrease in general exploration may be accompanied by an increase in focused discussion or specific information-seeking behaviors.

4.1. Cross-cultural differences in human interaction

Cross-cultural differences in the quantity and type of children's interactions with others may also be useful in understanding *why* peer presence differentially helps or hinders exploration in older children across the two cultures. In comparison to U.S. children, who are frequently supervised by adults across social contexts (e.g., at home, school, and in the community), Tsimane' children spend most of their time with little direct supervision, in the presence of children and community members (Winking et al., 2009). Cultural differences in child-rearing may shape children's beliefs about their own roles in informal learning, teaching, and play situations. For example, Tsimane' children may be more comfortable and willing to explore with and learn from their peers, whom they spend more time with compared to U.S. children. We attempted to control for comfort in general by providing all participating children with time to become accustomed with the play environment in advance of the study, and limiting our analysis only to those children who felt comfortable enough with the task to take the first toy from an envelope the experimenter offered. Collectively, cross-cultural differences in child-rearing, frequency of interactions with others, and nature of interactions with others may contribute to why we see a facilitatory effect of peer presence among Tsimane' children but not for U.S. children.

It is also possible that Tsimane' children were generally more comfortable exploring with their peers than alone because they regularly spend time with and learn from peers in their daily lives. This could explain why Tsimane' children explored significantly more while in the presence of a peer than when alone, but it fails to explain why U.S. children —who might be expected to be more comfortable in a lab room because of its similarity to formal education settings—failed to explore as much at older ages. On the other hand, the presence of the experimenter may have induced shyness at different rates for U.S. and Tsimane' children differently. In our experiment, the presence of the experimenter was necessary to facilitate data collection during the task. While U.S. children typically regard adults as authority figures, Tsimane' children may not have strong expectations about the presence of adults. Tsimane' children may have regarded the experimenter as a stranger more than U.S. children due to the foreigner status of the experimenter. If either is the case, we may expect U.S. and Tsimane' children to explore differently in the solo condition. To test whether differences in toy salience or novelty accounted for differences in U.S. and Tsimane' baseline exploration, we conducted a linear regression predicting children's discovery rate from age, culture (U.S. or Tsimane'), and their interaction. Neither population nor the interaction between age and culture was a significant predictor of children's discovery rate ($ps > .1$). In other words, U.S. and Tsimane' children explored at similar rates when alone. Therefore, while these differences in comfort may have

affected how U.S. and Tsimane' children behaved during the free-play session, this potential difference cannot alone explain our pattern of results.

4.2. Possible Mechanisms

Although the facilitatory effect of peer presence on exploration we observed was robust in the Tsimane' children, we do not understand the mechanisms underlying it. One possibility is that the toy sets were more novel to the Tsimane' children, leading to a general increase in curiosity and exploration. The toy sets used in Experiment 1 and 2 were selected to be comparably appealing to U.S. and Tsimane' kids. When alone with the toys, U.S. and Tsimane' children explore at similar rates (see above). Thus, it doesn't appear that differences in toy novelty or salience led to a baseline difference in exploration across cultures.

Another possibility is that peer presence during play may influence children's exploration via low-level attention mechanisms (via vocal interactions, novel toy sounds, or changes in the visual field). With another child present, a child's attention may be directed away from his or her own toy to the other child or other child's toy. Children may become more aware of the fact that there are additional toys to discover, thus increasing children's exploratory behavior. Importantly, how a child responds to an external pull in attention may vary as his or her ability to flexibly disengage and reallocate attention develops with age (Hanania & Smith, 2010). Alternatively, peer presence may lead to increased competition for resource control. The presence of another child may heighten each child's drive to discover toys in order to assert temporary control over a larger subset of toys from the available pool. In either case, the cross-cultural differences described above (e.g., in social organization and cultural-specific rearing practices) could potentially explain why the two groups would be differentially affected by the presence of a peer. Further work will be required to understand precisely how and why each factor contributes to the natural play dynamics between peers.

5. Conclusion

The type and frequency of social contexts and interactions are often overlooked factors in human and animal studies of exploratory behavior. The present study shows that the influence of peer presence on children's exploration differs across development and across culture. While young U.S. children explored at similar rates when with a peer and alone, older U.S. children explored less with a peer than what would be predicted from two children exploring in parallel. Among Tsimane' children, peer presence facilitated exploration above and beyond what would be predicted from two children exploring in parallel. This effect strengthened with age. Cultural factors such as social learning experiences (e.g., ideas about who children should learn from and how teaching occurs in formal and informal contexts) may influence the effect of social context on exploration. The results of this study have implications for learning in development—the effects of peer

presence on exploration diverge across cultures with age. Future studies should consider how (a) the structure of formal and informal learning contexts (e.g., teacher-led learning vs. collaborative group learning) influence informal learning behaviors such as exploration, and (b) the efficacy of formal and informal teaching strategies may vary across cultures due to cross-cultural differences in social structure, child-rearing, and beliefs about learning.

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Notes

1. As a result of the distraction of the presence of a camera, Tsimane' participants in Experiment 2 could not be recorded during the task. Therefore, an experimenter was present during the free play session in both experiments to make the experimental procedure similar across experiments.
2. The difference in age between children in the dyad condition (M = 2.16 years, Median = 2.39 years, range = 1.5–4 years) did not improve model fit for predicting the number of envelopes discovered by dyads. See Table S2 and Fig. S1 in Supporting Information for additional information regarding the difference in age for children participating in dyad sessions.
3. See Table S1 in Supporting Information for additional details about the gender distribution across conditions.
4. Of note, five solo children and one dyad explored zero additional items after they were offered the first toy by the experimenter—rather, they focused their exploration and play on the single toy for the entire 2 min. Additionally, two dyads explored all 10 toys during the play period, while zero children in the solo condition explored all 10 toys.

5. A median split analysis revealed a similar result (see Fig. S2 in Supporting Information for details).
6. For a more conservative analysis, we assigned values of 10 to doubled discovery rate values above 10. This prevents differences in the range of the dependent variable across social conditions (doubled-solo and dyad).
7. The difference in age for children in the dyad condition (M = 1.46 years, Median = 1 years, range = 0–4 years) did not improve model fit for predicting the number of envelopes explored by children in the dyad condition. See Table S2 and Fig. S1 in Supporting Information for additional details.
8. See Table S1 in Supporting Information for information about the gender distribution in our sample.
9. Of note, 10 Tsimane' children in the solo condition explored zero items during the 2-min play period (usually continuing to play with the first example toy instead), while no Tsimane' children in the dyad condition explored zero items. In contrast, no Tsimane' children in the solo condition explored all 10 items during the play period, while 11 dyads explored all items.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Table S1. Gender.

Table S2. Average age difference (years).

Table S3. Education demographics for U.S. children in Experiment 1.

Table S4. Education demographics for Tsimane' children in Experiment 2.

Figure S1. Age difference (years).

Figure S2. Median split analysis for U.S. sample (Experiment 1).