Visual preferences and understanding of goal-directed actions across cultures: Evidence from Tsimane' infants and children

Alyson Wong (alyson_wong@berkeley.edu)[1], Gabriella Morales (gabriella.morales@berkeley.edu)[1], Steven T. Piantadosi* (stp@berkeley.edu)[1] & Fei Xu* (fei_xu@berkeley.edu)[1]
[1]Department of Psychology, University of California Berkeley
Berkeley, CA 94704

Abstract

Previous research with infants from mostly western, developed countries has suggested that infants from a very young age have a sophisticated understanding of the world around them. However, it remains unclear whether the methodological approaches used to explore these topics, and their corresponding findings, extend across cultures or whether they vary with the specific cultural context. In the current study, across three experiments, we explore whether Tsimane' infants and children, a farmer-foraging group living in the Bolivian Amazon, have similar visual preferences as well as expectations regarding an agent's goal-directed actions compared to infants from the United States. Our results are the first to suggest that Tsimane' infants and children performed similarly to infants from the United States, holding similar expectations for agents to engage in goal-directed actions as well as similar preferences for faces and complex patterns.

Keywords: culture; infants; visual preferences; goal-directed actions; cross-cultural analysis

Introduction

A rich body of empirical research has documented infants' perceptual and cognitive development. Previous research on infants' perceptual development has found that infants have specific visual preferences, even from birth. Two of the most well-studied visual preferences in infancy are (1) the preference for faces and (2) the preference for patterns. Previous work exploring face preferences has found that newborn infants prefer looking at faces over non-faces, as well as prefer looking at non-face stimuli that share similar characteristics as faces compared to non-face stimuli that are not characteristic of faces (Macchi Cassia et al., 2008; Fantz, 1963; Morton & Johnson, 1991; Simion et al., 2002). Similarly, previous work with newborn to 3-month-old infants has found that infants have certain preferences for visual patterns, preferring more complex patterns (e.g., a bullseye) over simpler patterns (e.g., a triangle; Fantz, 1961; Fantz & Nevis, 1967; Karmel, 1969; Miranda, 1970; Thomas, 1965).

In addition to work exploring young infants' perceptual development, evidence from decades of research on cognitive development in infancy has found that within the first year of life, infants have sophisticated reasoning abilities across many domains. For example, previous research has found that infants as young as 4 or 5 months have a complex understanding of physical objects (Baillargeon, 2008; Baillargeon et al., 1985; Leslie & Keeble, 1987; Spelke et al. 1992). By 12 months of age they have a complex understanding of social agents (Gergely et al., 1995; Hamlin et al., 2007; Liu et al. 2022; Kovacs et al., 2010; Onishi & Baillargeon, 2005; Wellman et al. 2016; Woodward, 1998), as well as number, probability, and quantity (Denison & Xu 2014; Feigenson et al. 2004; McCrink & Wynn, 2007; Xu & Spelke, 2000; Teglas et al. 2007; Xu & Garcia, 2008). Even newborns possess many remarkable cognitive capabilities: they are capable of statistical learning (Bulf et al., 2011; Flo et al., 2022) and can discriminate between some quantities (e.g., 6 vs. 18 dots; Izard et al., 2009). Some have argued that these core knowledge systems provide the foundation for cognition and development (Carey, 2009; Spelke, 2022).

The vast majority of these studies utilize two looking time paradigms which are the primary methods used to study perceptual and cognitive development in infants—violation of expectation (VOE) and preferential looking (see Margoni et al., 2024; Tafreshi et al., 2014; and Golinkoff et al., 2013 for reviews). Both of these paradigms rely on the assumption that infants' spontaneous attention, as measured through the infant's looking behavior, reflects their underlying preferences and expectations. For example, VOE paradigms rely on the assumption that infants will pay more attention to unexpected events than expected events, which thus reflects an expectation for the expected event over the unexpected. Similarly, preferential looking paradigms rely on the idea that infants will spend more time looking at the stimulus or event that they prefer.

The current working assumption in developmental psychology and cognitive science is that these methods are valid across cultural contexts and that findings from using these methods may be broadly shared across different environments and cultural contexts. Since these findings are thought to be the starting points of development that provide the foundation for later-emerging abilities and preferences, it seems plausible that these abilities would be shared broadly. Some work using preferential looking time measures has provided evidence for this hypothesis. One study conducted with children ages 2 through 5 years from China, Ecuador, and Fiji found comparable false belief understanding as children from WEIRD populations (Barrett et al., 2013). Another study conducted with 7- to 9-month-old infants in rural Malawi found similar patterns of visual attention as infants from Western countries (Pyykkö et al., 2018).

However, other research suggests that some findings from early cognitive development research are not universal and may depend on environmental factors. Walker et al. (2013) found that, unlike infants and toddlers from Western cultures, infants and toddlers from Tanzania did not generalize novel object labels from pictures to real objects, suggesting that early experiences with representational media influence

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children's ability to learn from these representations. Other work has also found differences in generalization of object labels, such that U.S. children were more likely to generalize labels to objects based on shape (e.g., two objects of the same shape likely share the same label) whereas Tsimane' children, an indigenous group living in the Bolivian Amazon, were more likely to generalize labels based on the objects' material (Jara-Ettinger et al., 2022). Similarly, Piantadosi et al. (2014) found that Tsimane' children learned number words along a similar developmental trajectory as children from the U.S., Russia, and Japan, though the timeline of this trajectory in Tsimane' children was delayed compared to their peers from industrialized countries. These findings further highlight the complex interplay between underlying universal cognitive abilities and external environmental/cultural factors .

In addition to these findings on cultural differences in cognitive development, previous work has also argued there may be cultural differences in visual perception. One study by Yoon et al. (2014) found differences in perceptual reorganization between U.S. and Pirahã adults, such that Pirahã adults underperformed at a two-tone image recognition task compared to U.S. adults. Segall et al. (1963) also found differences in the perception of geometric illusions between participants from WEIRD populations and participants from non-WEIRD populations. However, others argue against these claims, providing evidence that even non-human animal species can perceive visual illusions and that other factors may contribute to previously found cultural differences (e.g., attention, vision disorders, etc.; see Amir & Firestone, 2025 for a review). Taken together, it, again, remains unclear which aspects of perception and cognitive development may be broadly shared versus dependent on specific environmental or cultural contexts, and similarly, which environmental/cultural factors may contribute to these differences.

One environmental/cultural factor that may be particularly relevant for the topic of infant perception and cognitive development is parenting practices. Previous work has found that parenting practices differ across cultures (Harkness & Super, 2002). For example, in the United States and in many other WEIRD cultures, parents of infants, nearly from the beginning of their infant's birth, engage in frequent direct interaction with their infants as well as engage in joint attention, which has been shown to facilitate social cognitive development (Mundy & Jarrold, 2010), language learning (Baldwin, 2014), and object processing (Striano et al., 2006). This also forms the basis for infant looking paradigms, such that they directly draw infants' attention to certain events in the hopes of eliciting specific patterns of attention/looking to further discern infants' expectations and preferences about certain phenomena.

However, these types of direct interactions between parents and their children are not consistent across cultures. For example, previous research has found that children from a Yucatec Maya village, as well as children from Papua New Guinea, were rarely directly spoken to in comparison to Western populations (Shneidman & Goldin-Meadow, 2012; Casillas et al., 2021). However, despite being rarely spoken to directly, Foushee and Srinivasan (2024) found that infants from an indigenous population in Southern Mexico showed a similar understanding of common nouns as their U.S. peers, thus, again, raising the question of the impact of environmental/cultural factors on cognitive development or whether certain perceptual preferences and cognitive abilities are broadly shared, potentially universal.

The current study aims to explore infant perception and social cognition with infants from a cultural context where direct parent-child interactions are infrequent. Specifically, the goals of the current study are two-fold: (1) methodologically, to explore whether infant looking time paradigms as predominantly used with WEIRD populations produce similar patterns of looking behavior in a non-WEIRD population and (2) to explore whether findings relating to visual preferences and reasoning about social events are consistent across cultural contexts. We investigate these questions by conducting infant experiments with Tsimane' infants.

The Tsimane' are an indigenous group living in the Bolivian Amazon that speak the native Tsimane language, inhabit nearly 100 villages comprised primarily of extended family units, and live a self-sustaining lifestyle involving foraging, slash-and-burn farming, fishing, and hunting (Godoy et al., 2006; Huanca, 2006; Masferrer-Vodas et al., 2012; Vadez et al., 2008). In addition to these lifestyle differences as compared to industrialized societies, the emphasis on formal schooling also differs. Some reports in the early 2000s and 2010s suggested that only 45% of adults had at least 1 year of formal education and the literacy rate among adults was only at 25% (Reyes-Garcia et al., 2007; von Rueden et al., 2015). However, rates of education have increased recently, with up to 5% of Tsimane' adults ages 18-25 in larger villages close to the nearest market town being high school graduates. Similarly, although Tsimane remains the native language, many Tsimane' adults speak some Spanish as a result of shifts in curriculum that emphasize Spanish fluency to conform with standards set by the Bolivian Ministry of Education (Gurven et al., 2017).

Notably and most relevant to the current study, Tsimane' parenting practices differ greatly from parenting practices in industrialized societies, which reflect the demands of a farmer-foraging community. For example, infants are typically carried in a sling by the mother during the day. However, in contrast to parents in the United States who strongly emphasize parent-child interactions and engage in high levels of infant-directed speech, the Tsimane' engage in direct interaction with their infants considerably less, averaging less than one minute per daylight hour of one-to-one conversations with children younger than four years of age (Cristia et al., 2019).

In the current study, we adapted three classic studies from infant studies in the United States to explore with Tsimane' infants and children—(1) visual preferences for complex patterns over simple patterns (Experiment 1A), and (2) visual

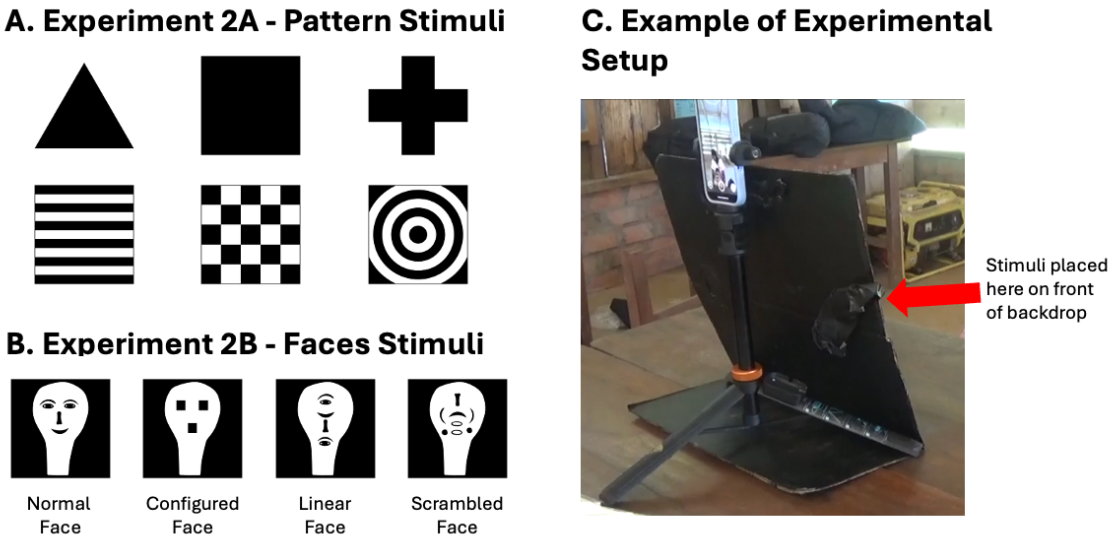

Figure 1. Depiction of stimuli and experimental setup used in Experiments 1A and 1B

preferences for faces over non-faces (Experiment 1B) and (3) the understanding of goal-directed actions (Experiment 2).

Experiment 1A: Pattern Perception

Methods

Participants Eight 3- to 6-month-old infants participated in this study (Mean Age = 4.42 months). Ages of participants were reported by parents of participants, though are generally rough approximations due to cultural differences in the documentation of birthdates and differences in the importance given to exact age.

Stimuli and Procedure The stimuli were adapted from Fantz (1958), which explored pattern perception in young infants in the United States. The six specific patterns used in the Test Trials, in order of complexity, were a triangle, a large square, a cross, horizontal stripes, a checkerboard, and a bullseye (see Figure 1A). Each pattern was printed individually in black and white on 8.5- x 11-inch paper then laminated. Two additional black and white pictures of objects that were thought to be familiar to Tsimane' infants, a bird silhouette and a leaf, were used during the Familiarization Trials to orient infants to the task. Stimuli were attached one at a time to a black cardboard backdrop using Velcro.

Before beginning the study, instructions for parents were translated from English to Spanish, and Tsimane translators, who were bilingual in Spanish and Tsimane, read the instructions to parents/guardians of participants. Parents were asked not to point or talk to their infants during the study, as well as to close their eyes throughout the study so they would not influence the infants' gaze.

Familiarization Trials. Infants sat on their parent's lap. The experimenter then drew infants' attention to the backdrop by saying, "Look!" in Spanish, followed by the experimenter presenting the first stimulus to the infant (Figure 1C). The experimenter then ducked out of view behind the backdrop and left the stimulus up for 10 seconds during which the participant's looking time was coded manually using Datavyu (afterwards, from video recordings). The experimenter then removed the stimulus. This process was repeated one more time for a total of two familiarization trials. The order of presentation of the two familiarization stimuli was counterbalanced across participants. Infants then proceeded immediately to the Test Trials.

Test Trials. The procedure for test trials was identical to the procedure of the familiarization trials. Participants were presented with a total of six test trials, with the order of presentation of stimuli counterbalanced across participants.

Results

Looking times were first log-transformed. A linear mixed-effects model predicting Looking Time with Age and Complexity (scored on a scale of 1-6 based on Fantz (1958)) revealed a marginal effect of Complexity in an omnibus test ($F(1, 32) = 3.93$, $p = .056$). The data showed a trend towards longer looking times for more complex stimuli than for less complex stimuli (Figure 2). This is consistent with findings from Fantz (1958), which found that U.S. infants looked longer to more complex patterns than to simpler patterns.

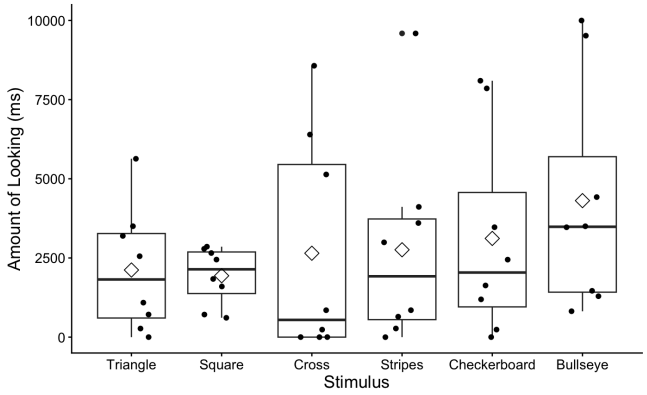

Figure 2. Average looking time across stimuli (represented by the diamonds).

Additionally, the Age x Complexity interaction was significant ($F(1, 32) = 5.29$, $p = .028$), with younger infants, but not older infants, looking longer to more complex stimuli than to less complex stimuli (Figure 3).

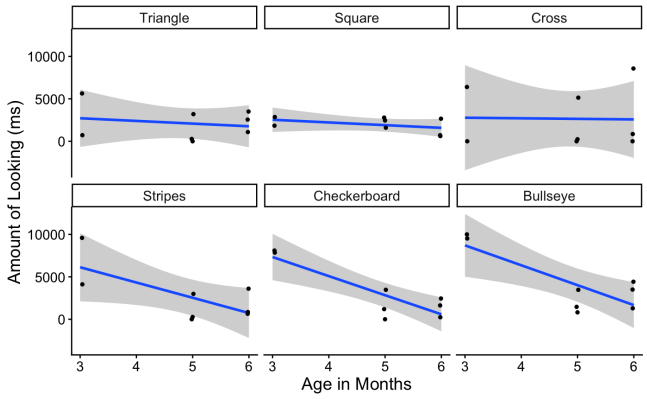

Figure 3. Average looking time by Age and stimuli.

Discussion

Consistent with prior work finding that young infants in the United States are sensitive to pattern complexity and look longer to more complex patterns (Fantz, 1958; Fantz, 1961), these preliminary results suggest that Tsimane' infants are similarly sensitive to stimuli complexity. Interestingly, this effect seems to be driven by younger infants in our experiment, with only younger, but not older, infants looking longer to more complex stimuli. This is in contrast to Fantz (1958) which found no differences in pattern preferences with age. However, Fantz (1958) originally investigated pattern perception in very young infants, specifically testing infants of only one- to 14-weeks (~3 months) of age. It is possible, since our age range is notably older than the originally tested infants, that these pattern preferences may change over the course of development which was not captured in the original Fantz (1958) experiment. Additionally, our sample size is very small, which prevents us from drawing any strong conclusions.

Experiment 1B: Face Perception

Methods

Participants Eight 3- to 6-month-old infants participated in this study (Mean Age = 4.42 months). These participants were the same participants from Experiment 1A.

Stimuli and Procedure The stimuli were adapted from Morton and Johnson (1991). The four specific stimuli used were (1) a Normal Face, with normal facial features configured in a normal way, (2) a Configured Face, with black squares replacing facial features (two eyes and a mouth) but still configured in a normal way, (3) a Linear Face, with normal facial features but configured in a vertical line on the face, and (4) a Scrambled Face, with normal facial features deconstructed and reorganized on the face (see Figure 1B). Similarly to Experiment 1A, stimuli were attached one at a time to a black cardboard backdrop using Velcro.

Because infants completed Experiment 1A immediately prior to this experiment, there were no familiarization trials. Participants were presented with four test trials, with the order of presentation of stimuli counterbalanced across participants. The procedure was identical to the procedure of the test trials in Experiment 1A.

Results

Looking times were again log-transformed before analyzing. A linear mixed-effects model predicting Looking Time with Age and Stimulus Type revealed no significant effects or interactions ($ps > .3$). However, infants tended to look longest at the Configured Face ($M = 4.89$s), followed by the Normal Face ($M = 3.22$s), then the Linear ($M = 2.70$s) and Scrambled Faces ($M = 2.67$s) (Figure 4).

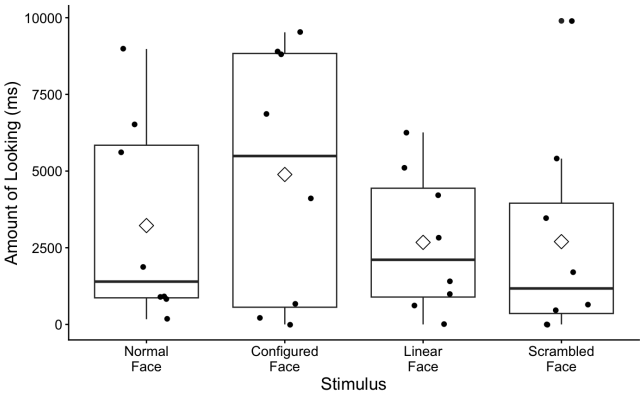

Figure 4. Average looking time across stimuli.

Discussion

Contrary to previous work that found that infants in the United States looked longer to the Normal face, followed by the Configured face, the Linear face, and lastly the Scrambled face (Morton & Johnson, 1991), our preliminary results

suggest that Tsimane' infants did not look reliably longer to any one face over the others. However, infants tended to look longest to the Configured Face, followed by the Normal face, and looked less to the other two scrambled faces. In other words, infants tended to look longer to both of the normally configured faces, despite one face not containing normal facial features, over faces where features were scrambled. Although the exact pattern of looking across stimuli is not fully consistent with findings from Morton and Johnson (1991), the general pattern of looking longer to properly configured faces over non-properly configured faces is consistent with the finding that 10-week-old infants in the United States looked longer to the normal face and configured faces than to the other two faces. Again, our sample size is very small; a bigger sample would be needed to draw any firm conclusions.

Experiment 2: Goal-Directed Actions

Methods

Participants Forty-five 6- to 48-month-old Tsimane' infants and children participated in this study (Mean Age = 22.6 months). Ages of participants were reported by parents of participants, though are generally rough approximations due to cultural differences in the documentation of birthdates and differences in the importance given to exact age. In contrast to infant studies with WEIRD populations which typically focus on a restricted age range (e.g., only 12-month-olds), the age range here was expanded to provide opportunities for participation for as many participants as possible.[1]

Stimuli and Procedure The procedure was adapted from Woodward (1998; 1999), which explored whether infants in the United States expected an agent's actions to be goal-directed. Participants were randomly assigned to one of two conditions: the Experimental Condition (n = 23, Mean Age = 20.74 months) or the Control Condition (n = 22, Mean Age = 24.64 months). Four objects were used as the target and distractor objects: a black and white panda stuffed animal, a pink round rattle, a brown teddy bear, and a green oblong rattle.

Familiarization Trials. Participants sat either on their parent/guardian's lap or on a chair. They then watched an agent/experimenter place two objects on a table, with one object on the left (e.g., the panda stuffed animal) and one object on the right (e.g., the pink rattle), about equal distance from her. The familiarization trial began with the agent drawing the attention of the participant by saying, "Look!" in Spanish, and then reaching for one of the two objects (e.g., the pink rattle on the right). Then, the agent's hand landed on top of the object, stayed still for three seconds, then retracted her hand. This process was repeated two more times for a total of three familiarization trials, with the agent always reaching for the same object in the same location on the table.

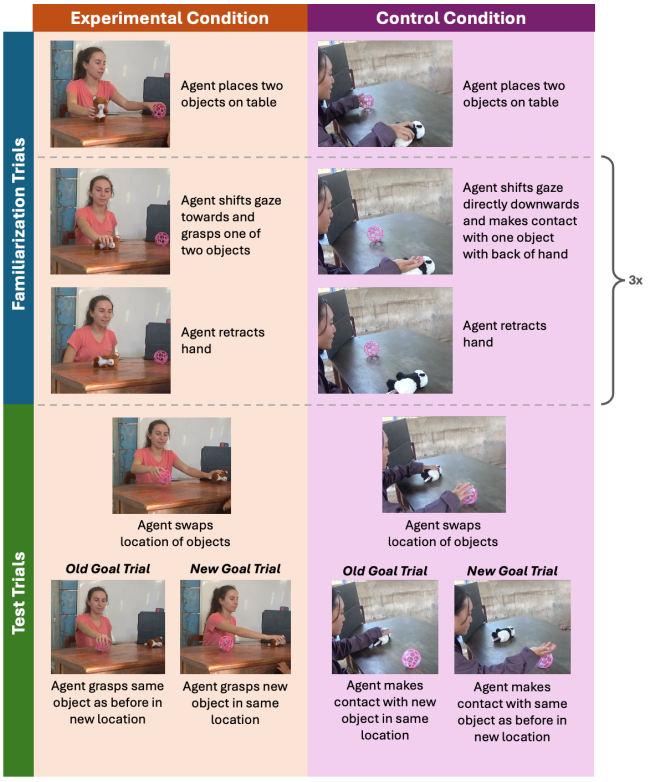

Figure 5. Sequence of events for familiarization and test trials per condition

Test Trials. Participants then viewed the agent cross their arms and swap the location of the toys, with the panda stuffed animal now on the right and the pink rattle now on the left. The agent then engaged in one of two actions depending on the trial type. In the Old Goal Trial, the agent reached for the old goal in the new location and shifted their gaze towards the object or directly downwards depending on condition (i.e., the pink rattle now on the left). In the New Goal Trial, the agent reached for the new goal in the old location, with the agent's gaze varying across conditions (i.e., the panda stuffed animal now on the right). In both trial types, the agent froze for 10 seconds after grasping the object, during which participant's looking time was coded manually (afterwards from video data). Each participant was presented with two test trial pairs, with each pair comprised of one Old Goal and one New Goal trial. A new set of objects was introduced for the second pair of test trials (e.g., the brown teddy bear and green rattle). The order of trials was counterbalanced across participants.

[1] Previous infant looking-time studies have primarily tested infants up to about 24 months of age. With older children in the United States and other industrialized countries, looking-time studies are not typically possible with older children, as they often walk away, get distracted, or attempt to engage with their parents and/or the experimenter during these studies. In contrast, Tsimane' children sat on a chair and watched intently to these events, thus making it possible to collect looking-time data from older children.

In the Experimental Condition, the agent performed all actions in both the familiarization and test trials with the front of their hand while fixating their gaze on the target object when reaching to convey that her actions were purposeful. In the Control Condition, all actions were performed with the back of the hand (e.g., touching the object with the back of hand instead of grasping it) while the agent's gaze was averted (i.e., looking directly downward between the two objects) to convey that her actions were non-purposeful.

Results

Looking times were first log-transformed based on previous work indicating that log-normal distributions better fit looking time data than normal distributions (Csibra et al., 2016). We conducted a linear mixed-effects model predicting Looking Time with Condition (Experimental vs. Control), Trial Type (Old Goal vs. New Goal), Trial Pair (first vs. second), and Age. Results revealed a significant Trial Type x Condition interaction ($F(1,121) = 4.698$, $p = .032$), and no other significant effects or interactions ($ps > .1$). Similarly to results from U.S. infants as tested in Woodward (1998) and Woodward (1999), results from Mann-Whitney U tests on each condition separately revealed participants in the Experimental Condition looked reliably longer to the New Goal test trial ($M = 5.46$s) than the Old Goal test trial ($M = 4.27$s; $W = 758.5$, $p = .020$), whereas participants in the Control Condition looked equally to both trial types ($M_{New\ Goal} = 4.57$s; $M_{Old\ Goal} = 4.58$s; $p > .9$; Figure 6).

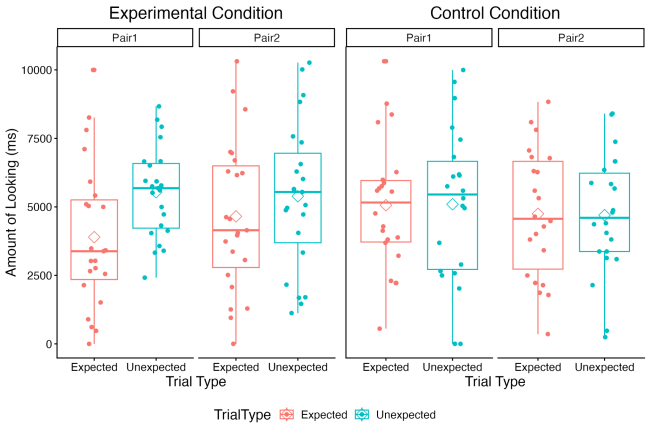

Figure 6. Average looking times across Conditions, Trial Types, and Trial Pairs.

Discussion

These results suggest that Tsimane' infants and children in our study expected the agent to engage in goal-directed actions only when actions were purposeful, but not when actions were not purposeful. These findings replicate the findings with U.S. infants from Woodward (1998, 1999).

General Discussion

Overall, the results of the current study with Tsimane' infants and children suggest comparable patterns of results as previous studies have found with children in the United States. Our study is the first to test Tsimane' infants using standard looking time paradigms, as well as the first to explore perceptual preferences and social understanding in Tsimane' infants. Our findings make two important contributions to the field of developmental cognitive science.

First, our study is the first to establish that violation of expectation looking time method is appropriate for testing Tsimane' infants and children, who grow up in a very different environment and cultural context. This suggests that, regardless of culturally specific parenting practices, infant looking time measures elicit similar looking behaviors across both cultural contexts, further suggesting that assumptions underlying looking time measures (i.e., that infants' attention reflects their preferences and expectations) may extend across different cultural contexts. This is consistent with previous work that has used preferential looking time measures with infants in cultures similar to the Tsimane' where direct parent-child interactions are less frequent than in Western cultures (Foushee & Srinivasan, 2024; Pyykkö et al., 2018).

Second, our study is the first to suggest that Tsimane' and U.S. infants' expectations for goal-directed actions, as well as visual preferences for patterns and faces, are similar. Specifically, infants and young children from both cultural contexts expected agents to engage in goal-directed actions, and they differentiate between intentional and non-intentional actions. Additionally, infants in both cultural contexts tended to prefer looking at more complex patterns (e.g., a bullseye) than simpler patterns (e.g., a triangle), and they also tended to prefer looking at normally configured faces over faces with scrambled facial features, though these patterns were notably not significant, likely due to the small sample size. These results suggest that these preferences and expectations are likely broadly shared and not specific to certain cultural contexts. This may further suggest that these social expectations and visual preferences reflect adaptations that are potentially universally present early on in development.

However, one limitation to the current study is that the sample sizes of Experiments 1A and 1B are very small, as there were not many infants within this target age range in the Tsimane' villages we visited. In future work, we plan to replicate these findings with a larger sample size.

The current study provides the foundation for exploring other aspects of early perceptual and cognitive development in Tsimane' infants and young children using looking time measures. In future work, we plan to investigate whether Tsimane' infants and children understand physical reasoning principles (e.g., object continuity, solidity, etc.) and other psychological reasoning principles (e.g., efficiency and rationality).

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