

Infants' recognition of social conventions

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Abstract

From early in life, humans expect members of the same social group to act like one another. What drives this expectation? Across two experiments, we investigated how 8- and 9-month-old infants' (N = 100) expectations about shared behaviors align with accounts based on collective identities, ritualistic actions, or conventions. In Experiment 1, infants inferred that an action would generalize to a new group member only when they had previously seen more than one group member share that action, suggesting that multimember demonstration influences infants' inductive reasoning. In Experiment 2, infants did generalize an action after observing it from just one group member, but only if they had observed that same action shared by two members of another group in a different social context. Together, these findings suggest that infants learn to recognize which actions are socially conventional and then readily generalize these actions even in new social contexts.

Keywords: infants; social conventions; reasoning

Introduction

People often think members of social groups will, or should, act alike. This is the basis of core phenomena, including stereotyping and conformity, that have broad consequences for human social life. The tendency to expect group members to act alike has been found from very early stages of human development, in children and even infants (Powell & Spelke, 2013; Liberman et al., 2016; Diesendruck & HaLevi, 2006; Roberts et al., 2017). Here we investigate what accounts for this expectation at its origins. When, and why, do human infants expect social group members to act alike?

One possibility is that whenever infants observe one or more members of a social group act in a particular way, they expect other group members to behave similarly. This could result from a domain-general process of categorical induction, akin to infants' learning that an object kind has a particular function (e.g. Baldwin et al., 1993; Gweon et al., 2010). However, given evidence that infants' patterns of generalization differ for social and physical categories (Powell & Spelke, 2013), broad and rapid generalization across social groups may instead be based on domain-specific inferences. For instance, Thomas (2025) has proposed that when infants perceive group members as joined in a collective communal sharing relationship, they then expect those group members to enact similar behaviors that underscore a sense of "oneness."

Another possibility is that infants are predisposed to connect specific kinds of behaviors with social groups, and that those are the behaviors infants will most readily generalize to new group members. One proposal is that infants innately associate language and food preferences with social group membership, given the consistent roles of those attributes as cultural markers (Kinzler et al., 2007; Liberman et al., 2016). A broader, more abstract class of actions that infants may preferentially associate with social groups are "ritualistic" actions that are inefficient with respect to instrumental goals (Legare & Watson-Jones, 2015; Liberman et al., 2018; Yasuda et al., 2025). Studies on infants' expectations for shared group behaviors have generally used actions of this type (e.g. Powell & Spelke, 2013; Köster & Hepach, 2024). Past work also finds that infants and toddlers selectively infer affiliation from shared inefficient or non-instrumental actions (Liberman et al., 2018; Köster & Hepach, 2024; Powell & Spelke, 2018; Thomas et al., 2022; Wen et al., 2016; Yasuda et al., 2025). For instance, infants expect affiliation between two actors when one imitates the other's inefficient action (e.g., turning on a light with their head when both hands are free), but not when the action shared is instrumentally efficient (e.g., turning on a light with their heads when both hands are constrained; Liberman et al., 2018). The expectation of a strong connection between shared inefficient actions and social bonds, possibly encoded in core knowledge of social relations (Yasuda et al., 2025), could account for rapid generalization of such behaviors to new group members.

A third possibility is that infants are not inherently quick to generalize any actions, efficient or inefficient, to whole social groups, but that they learn which actions generalize in this way. Specifically, infants may come to recognize certain actions as *conventional*, or actions shared by social partners when interacting or coordinating with one another (Hawkins et al., 2023; Lewis, 1969; Rakoczy & Schmidt, 2011). When infants see interacting group members engage in the same behavior, they may learn not just about the behavioral profile of that group but also about the nature of the shared behavior. If infants do recognize conventional behaviors of this sort, then once they have seen evidence that a specific action is conventional, they may readily expect it to generalize both to other participants in that interaction and amongst members of other social groups when encountered in new social settings.

These hypotheses offer different, though not mutually exclusive, explanations for infants' expectation that members of a social group will act alike: infants recognize group members as a collective who behave as "one" (Hypothesis 1), infants preferentially associate social groups with shared, inefficient, ritual actions (Hypothesis 2), or infants identify conventions, tracking actions they have seen as coordinative or socially shared and expecting that these behaviors to be shared by group members (Hypothesis 3). These hypotheses make somewhat different predictions about when infants will expect a behavior to generalize across group members. In two experiments, we test these predictions by manipulating the distribution of actions across social groups and examining infants' expectations about whether those actions will generalize to new group members.

Experiment 1

In Experiment 1, we test whether infants expect an observed behavior to generalize to other social group members based on a single group member's action, or if they require evidence from more than one group member to form this expectation. If infants' expectations of group alignment stem from a broad assumption that groups tend to be similar either across all behaviors (Hypothesis 1) or across all inefficient, "ritualistic" behaviors (Hypothesis 2), then the behavior of only one group member may be sufficient to elicit expectations about others in the same group. Alternatively, infants may require evidence that an action is socially shared before they expect it to generalize (Hypothesis 3). To test this, infants were shown two social groups each associated with a different behavior. The frequency of the association was held constant, but the distribution varied: in familiarization, infants either saw two different members of each group perform their group-relevant behavior once, or saw only one member perform the behavior twice. We then tested infants' expectation that the behavior would generalize to another group member who had not yet acted. We expected that infants familiarized to two group members performing each action would expect it to generalize based on prior work (Powell & Spelke, 2013). The question of interest was if infants in the single exemplar condition would do so as well.

Methods

Participants

Forty-eight 8- and 9-month-old infants participated in Experiment 1 (M_{age} : 8.3 months, range: 7.57-9.2 months, 26 females). An additional 4 participants were recruited but ultimately excluded from participation due to fussiness (2), sibling interference (1), or experimental error (1). For all infants, a parent or guardian provided consent to participation according to procedures approved by the institutional review board of Harvard University.

Design & Procedure

Participants sat on a parent's lap, approximately 1.5 m from a 1 x 1.5 m projection screen. The on-screen display consisted

of a green background, a brown rectangular platform near the center of the screen, and six characters. The characters were all circles with two eyes and a smiling mouth; three were red and three were yellow. The two groups of characters began the experiment clustered in the top left corner (red) and top right corner (yellow) of the screen. The experiment consisted of several phases of events. First, infants observed a group introduction phase, in which the two groups alternated in synchronous, dance-like movements, accompanied by group-specific sounds, that were intended to depict them as two distinct social groups. After this phase the members of each group spread out along the sides of the screen.

Next, infants saw familiarization and test events in which a single character would move to the central platform and repeatedly jump or slide side-to-side while making their group-specific sound. The movements presented during the familiarization events differed by group; actor(s) from one group always jumped, while actor(s) from the other group always slid side-to-side. For infants in the "dual exemplar" condition, the first four familiarization events featured the top two members of each group engaging in their group-specific actions. For infants in the "single exemplar" condition, the first four familiarization events featured only the topmost member of each group engaging in their group-specific actions, each acting in two trials. In both conditions the test trials presented the bottom-most character from each group, both performing the same movement (i.e., both would jump or both would slide), resulting in one actor performing a "group-consistent" action and one performing a "group-inconsistent" action. After the first two test events, infants observed two group reminder events, in which members of each group would approach one another and move synchronously again. They then observed two additional familiarization events (featuring the topmost member of each group regardless of condition) and two more test events. After each familiarization and test event the video paused until coding by a naïve, online experimenter indicated that the participant had looked away for 2 consecutive seconds (an additional threshold of 120 s cumulative looking was never reached). The pairing of group and action (jumping or sliding), the group that was consistent at test, and the order of the groups' actions during familiarization and test events (red group first or second) were orthogonally counterbalanced.

Data Analysis

A naïve offline coder assessed looking times to test trials for 54% of participants; correlation with the online coder's looking times was 0.92. Trials were excluded if the offline coder judged that the online coder cut the trial short (3 trials). Valid looking times to test trials were required to include at least 0.5 seconds of looking to the jumping or sliding motion. Because test trial pairs were separated by group reminder and familiarization events, overall looking to the second test trial pair was substantially shorter than looking to the first pair. To equate the contribution of the two test pairs, to help correct for skew in infant-controlled looking times (Csibra et al., 2016), and to match prior analyses of similar data sets

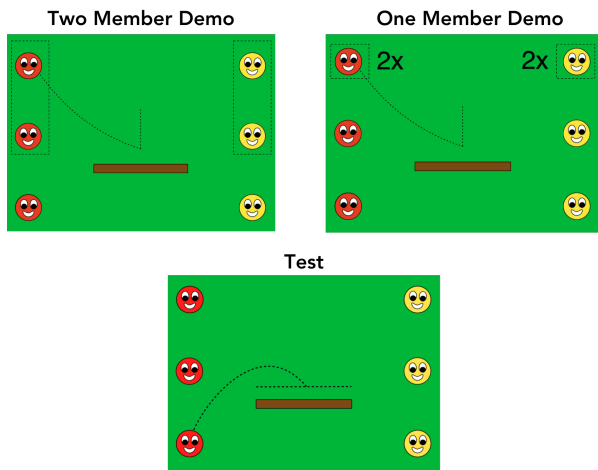


Figure 1: Overview of stimuli in Experiment 1. Infants in the dual exemplar condition saw two members from each group perform a group-specific action (jumping or sliding) during familiarization; infants in the single exemplar condition saw one member from each group perform a group-specific action in two separate times. During test trials, infants saw the bottom-most character from each group either jump or slide.

(Powell & Spelke, 2013), we converted looking times for consistent and inconsistent test trials to proportions of the relevant test pair. If one trial in a test pair was invalid, both trials from the pair were excluded. This resulted in the exclusion of one pair of trials each from two participants.

We compared mean looking times to consistent and inconsistent test trials using a repeated measures ANOVA, with condition, group order, and test trial order as between-subjects factors. We followed up on significant interactions with t-tests or ANOVAs of data subsets where appropriate.

Results

The ANOVA revealed a significant interaction between trial type and condition ($F(1,40) = 4.14, p = .049$). A paired sample t-test showed that infants in the dual exemplar condition looked significantly longer to inconsistent test trials ($M = 54.4\%$ of test trial looking) than consistent test trials ($M = 45.6\%$; $t(23) = 2.16, p = .041$). In contrast, infants in the single exemplar condition looked equally at the two trial types (inconsistent $M = 49.6\%$; consistent $M = 50.6\%$; $t(23) = 0.31, p = .759$). There was also a three-way interaction between trial type, condition, and test order ($F(1,40) = 10.80, p = .002$). This reflected the propensity of infants in the single exemplar condition to look longer at the first test trial presented regardless of trial type (trial type \times order interaction: $F(1,20) = 8.64, p = .008$), while infants in the dual exemplar condition showed only a main effect of trial type ($F(1,20) = 5.863, p = .025$) and no interaction with order.

In the dual exemplar condition, infants familiarized to two social group members performing an action expected a remaining group member to act alike (replicating Powell & Spelke, 2013). In contrast, infants in the single exemplar condition did not expect the actions of a single individual to

generalize to its group member, even though the action types and frequency of familiarization to the group-action pairing were the same.

The lack of generalization by infants in the single exemplar condition narrows hypotheses about the mechanism driving expectations observed in the dual exemplar condition. It indicates that, in the space of novel inefficient actions, infants will not use minimal evidence for a group-behavior pairing to rapidly guide expectations that other group members will act alike. This speaks against accounts in which infants expect communal groups to act as one and those that posit a privileged relationship between shared inefficient actions and affiliation (Hypotheses 1 & 2). Note, however, the data do not conflict with the proposal that infants expect social groups to share a more specialized set behaviors that have historically been consistent markers of group membership, such as language and food preference (Kinzler et al., 2007; Liberman, Woodward, & Kinzler, 2017); in these cases, infants may draw inferences about group behaviors from a single exemplar (see Liberman et al., 2016).

As predicted, infants who were shown a group-specific action demonstrated by two group members expected a third group member to behave similarly. This finding highlights the importance of multimember demonstration in infants' tendency to generalize social behavior to a group. Why do infants readily generalize from this type of evidence?

Experiment 2

Our primary interpretation of the results of Experiment 1 is that infants in the dual exemplar condition, but not the single exemplar condition, inferred from the familiarization events that the jumping and sliding actions were conventional, prompting them to expect the same actions from additional group members. However, at least two alternative explanations remain plausible. First, in the single exemplar condition only a clear minority (1 of 3 group members) was associated with each action during familiarization; perhaps a behavior must be associated with a larger proportion of a group before infants will generalize it to other members. Second, perhaps infants only expect group members to act alike, in general (Hypothesis 1) or with respect to ritual behaviors (Hypothesis 2), when they have recently observed shared behavior, as in the 'dual exemplar' familiarization, thus priming such expectations. In Experiment 2, we test the conventional account against these alternatives by examining what evidence leads infants to more readily generalize an action from just one individual to additional group members.

Infants were assigned to one of two conditions. The first condition ("no prelude") was similar to the single exemplar condition of Experiment 1, except each social group consisted of only two characters, the one who acted during familiarization events and the one who acted at test. If infants' failure to expect shared behavior in the single exemplar condition was driven by the familiarization actor's minority status, then this new condition should lead infants to expect shared behavior. If, instead, the failure maps onto one of the other explanations offered above, this new condition

should yield the same result, as it neither primes expectations of shared behavior nor provides evidence of conventionality.

The second condition (“jump prelude”) contained all of the same events as the no prelude condition but began with a preliminary scene that featured a third, distinct social dyad, who entered the screen together and took turns jumping on the central platform. If simply witnessing any two social affiliates copy one another primes infants to expect group members to act alike, then all infants in the jump prelude condition (but not those in the no prelude condition) should expect group members in test trials to act alike, regardless of the action associated with a group (jumping versus sliding).

Alternatively, the jump prelude may inform infants that jumping, specifically, is a conventional behavior. This would potentially impact infants’ reasoning about jumping even in other social contexts. Unlike rituals, which often have group-specific forms, conventions can be shared by multiple groups (e.g., people from different countries may use the same language and drive on the same side of the road) and still function to support coordination or indicate social alignment amongst group members. Infants could thus learn about a convention in one social context and then rapidly generalize the same behavior in a new social context. On this account, infants in the jump prelude condition should expect the jumping action to generalize from one group member to another in the familiarization and test phases; they should not expect the same for sliding, as there is no prior evidence of sliding being socially shared in the jump prelude condition.

Methods

Participants

Fifty-six 8- and 9-month-old infants participated in Experiment 2 (M_{age} : 8.4 months, range: 7.5-9.67 months, 21 females). 24 infants were assigned to the no prelude condition, and 32 were assigned to the jump prelude condition. Increased sample size in the jump prelude condition was planned for greater power to detect expectations of shared behavior for each action type. The mean effect size in relevant past experiments (the dual exemplar condition of Exp 1, and Exp 1, 2 and 5 of Powell & Spelke, 2013) is $d = 0.66$, so with 16 participants, we had power of 0.81 to detect the effect with a one-tailed test.

Design & Procedure

The procedure for the no prelude condition was the same as that of the single exemplar condition in Experiment 1, with one exception: one of the three group members was removed entirely from all phases of the experiment. The resulting two-member groups engaged in the same dancing, jumping, and sliding actions as before, in the same order. The procedure for the jump prelude condition was the same as that in the no prelude condition, except that an initial sequence featuring a separate social group was added to the beginning of the experiment. The screen was initially empty, and then two characters in a distinct blue color entered in tandem (Figure 2). They stopped side-by-side in the upper left corner, and

then alternated in moving to the platform and performing the same jumping action that would be associated with one of the two groups in the familiarization phase. There was 1 s pause (and no infant-controlled threshold of continuing only after a 2 s look away) following each of these actions. After each of the characters had taken two turns jumping on the platform, they exited the screen together, and then the characters for the main experiment entered and began the group introduction.

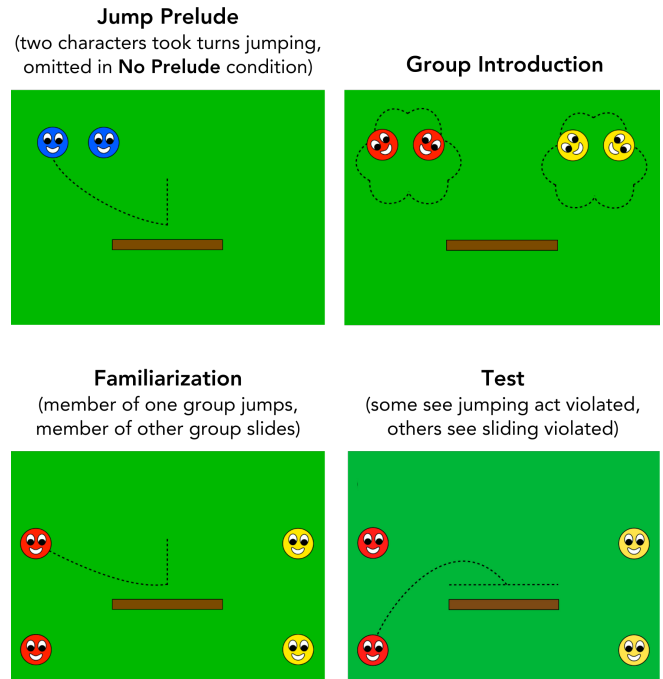


Figure 2: Overview of stimuli in Exp 2. In the jump prelude condition, infants saw an initial sequence featuring a separate social group (blue characters) who took turns jumping on the platform. In both conditions, infants saw a group introduction and were familiarized to each group-specific action (jumping or sliding). During test trials, infants saw the bottom character from each group either jump or slide, such that one of characters violated their group-specific action.

Data Analysis

The same trial exclusion and proportional transformation procedures were followed as in Experiment 1 (resulting in 1 excluded trial). We compared looking times to consistent and inconsistent test trials using a repeated measures ANOVA, with condition, group order, test trial order, and violated action as between-subjects factors. If the null result in the single exemplar condition resulted from the fact that only a minority of each group had been associated with a behavior before test, then the ANOVA here should show a main effect of test trial type across both conditions. If the jump prelude prompted infants to expect alignment in general, then the ANOVA should show a trial type x condition interaction, with infants in the jump prelude but not the no prelude condition looking longer to group-inconsistent test trials,

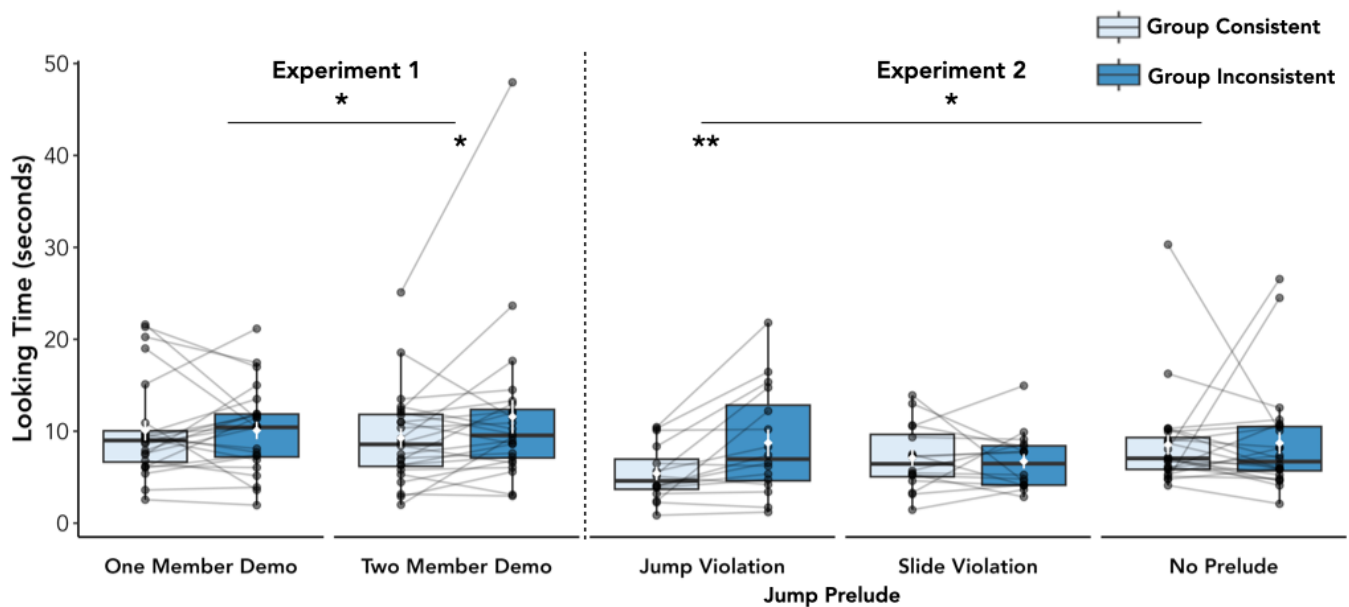


Figure 3: Results of Experiments 1 and 2. Infants' mean looking times to each trial type (group consistent or group inconsistent) for each condition (labeled on horizontal axis) plotted in seconds. Data for Jump Prelude condition are separated by which type of action was violated by the group-inconsistent actor. Gray lines connect mean looking times contributed by the same participant. * $p < 0.05$, ** $p < 0.01$.

regardless of the violated action type. If the jump prelude taught infants that the jumping action was a socially shared action type (i.e., conventional), the ANOVA should show a three-way interaction between trial type, condition, and violated action, with infants looking longer to the group-inconsistent test trials when the jumping action was violated, but only in the jump prelude condition.

Results

The repeated measures ANOVA found a significant three-way interaction between trial type, condition, and violated action ($F(1,48) = 5.31, p = .026$). This reflected the propensity of infants in the jump prelude condition who saw jump violations to look longer at group-inconsistent trials ($M = 58.2\%$) than group-consistent trials ($M = 41.8\%$; $t(15) = 3.15, p = .003$, one-tailed). That is, when infants from the jump prelude condition saw both test characters slide, they looked longer at the jumper's group member sliding than the slider's group member's sliding. (Note that the two test characters' actions are always the same, so action familiarity is always equated across test trials). In contrast, infants who saw other condition-violation pairings did not differentiate between the trial types (all $p > .4$; Figure 4). There was not a significant two-way interaction between trial type and condition and, examined separately, infants in the no prelude condition did not differentiate the two trial types ($t(23) = 0.56, p = .58$).

Cumulative Analysis

The results of Experiment 2 were consistent with our hypothesis that infants use observations of shared behavior during social interactions to identify conventional behaviors, which they then readily generalize even in new social contexts. However, this conclusion is largely based on results from a relatively small portion ($N = 16$) of the overall set of

data collected here ($N = 100$). A cumulative analysis would allow us to test if the overall pattern of results is better accounted for by the "convention learning" hypothesis, or by a more domain-general hypothesis that infants are most prone to generalize a behavior to new social group members when they have already seen multiple individuals making up the majority of the group engage in the behavior.

We conducted this cumulative analysis using mixed effects regression models (Muradoglu et al., 2023). This approach can handle unbalanced designs resulting from testing different factors across experiments. It also provides a more direct means of accounting for the decrease in looking time that occurs across successive trials. Rather than relying on mean proportional looking times, these analyses were performed on looking times from individual test trials, log-transformed to address skew (Csibra et al., 2016).

In model comparisons incorporating all data from both experiments, we sought to examine two potential influences on looking time to the two trial types (group-consistent vs. -inconsistent). First, we asked if looking time was subject to an interaction between trial type and the number of group members infants saw associated with a behavior during familiarization trials (2 in the dual exemplar condition from Experiment 1, 1 in all other conditions). We created a full model incorporating these factors as well as trial number a participant-level random effect:

$$\text{LookTime} \sim \text{trial.type} + \text{trial.num} + \text{numGroupDemo} + \text{trial.type}:\text{trial.num} + \text{trial.type}:\text{numGroupDemo} + (1|\text{SubID})$$

We used a log likelihood ratio test to compare this full model to a reduced model without the interaction between trial type and number of group members who demonstrated the behaviors prior to test. The comparison did not yield evidence for a significant interaction effect of trial type and group exemplar number on looking time, $b = 0.06, \chi^2(1) = 1.16, p = .28$. This indicates that, across the full data set, the number of group members demonstrating a behavior before

test did not reliably impact infants' relative interest in group-consistent and group-inconsistent behavior at test.

Second, we asked if looking time was subject to an interaction between trial type and the presence or absence of evidence for violated behavior's conventionality: that is, whether infants had ever seen the behavior being "socially shared" (as in the dual exemplar condition of Experiment 1 and jump prelude-jump violation condition of Experiment 2) or had not (as in the single exemplar condition of Experiment 1 and the no prelude and jump prelude-slide violation conditions of Experiment 2). Again we created a full model to express this hypothesis, similar to the one used above:

LookTime ~ trial.type + trial.num + conventionDemo + trial.type:trial.num + trial.type:conventionDemo + (1|SubID)

We again used a log likelihood ratio test to compare this full model to a reduced model without the interaction between trial type and the "conventionDemo" variable. The full model with the interaction term accounted for significantly more variance, $b = 0.12$, $\chi^2(1) = 6.76$, $p = .009$, indicating that the effect of test trial type differed when infants had vs. had not seen evidence that the violated behavior was conventional. Post hoc contrasts generated using the "emmeans" R package found a significant difference between looking to group-consistent and group-inconsistent trials following evidence that the violated behavior was conventional, $b = 0.10$, $t(290) = -2.78$, $p = .006$, but did not find reliably different test trial looking when such evidence was absent, $b = -0.02$, $t(290) = 0.67$, $p = .50$.

The collective data thus demonstrate that infants look significantly longer at non-conformity to a group member's behavior when that behavior has been demonstrated as socially shared, even if the demonstration occurred in another social context. They do not look longer at non-conformity to a group member's action when it has not been demonstrated as socially shared, and these two looking patterns are reliably different from one another.

Discussion

Across two experiments, infants inferred that actions would generalize to a new social group member either (1) when they had seen two members of that individual's group perform the same action, or (2) when they had seen two members of a separate social group perform a specific action in addition to one member of the individual's group. The pattern of findings in Experiments 1 and 2 suggest that seeing an action shared by social partners informs infants' reasoning about behavior in both the concurrent and other social contexts. Multimember demonstration of an action appears to guide infants' inferences about both group behavior and about the action itself. In line with the convention recognition hypothesis, infants who were shown two characters jumping together (Experiment 1) or taking turns jumping (Experiment 2) were surprised, during test trials, when a jumper's partner slid. If jumping was the only action they had seen shared, however, then they were not surprised if a slider's partner jumped, suggesting that those infants had learned only that jumping, not sliding, is a conventional behavior. Together,

these findings suggest that the core human tendency to expect group members to act alike may originate in infants' desire to recognize the conventions people use to engage with one another in social interactions.

Infants' concept of a conventional behavior remains elusive beyond the expectation observed here that what they generalize across group members can be shared in multiple social settings. Amongst adults, conventions are behaviors that help social affiliates coordinate or communicate through their shared meaning (Hawkins et al., 2023; Lewis, 1969). It is unknown whether infants themselves understand the coordinative or social-causal role of conventions (although some evidence suggests they may understand that language plays this role, Vouloumanos et al., 2012). It could be that they simply use the ability to detect conventionality as a source of information about social group membership. Under this model, infants may expect one-to-one correspondence between groups and conventions (e.g., they may believe all jumping members in the jump prelude of Experiment 2 to be affiliated). One reason to doubt this, though, stems from infants' equivalent looking when the slider's partner jumped. If infants consider a conventional action to characterize a specific social group, then they should have exhibited surprise when witnessing an individual clearly outside the group engage in the characteristic behavior.

The current findings serve as a starting point for future studies on how infants may think about the properties and functions of socially shared behaviors, and several open questions remain. For one, do infants expect group-consistent conventional behavior only in the context of social interaction? Many conventional behaviors (e.g., using utensils to eat, reading from left to right) are used in both social and non-social contexts, but can still be informative about the group to which the individual might belong. Similarly, a key feature of conventions is that they are typically either non-instrumental or arbitrary solutions to instrumental goals; their significance is a result of being socially shared (e.g., using a fork and knife in Western cultures), not their physical necessity (e.g., a fork and knife are not required for food consumption). Because conventions are about shared social norms rather than efficiency, they tend to be expected only from group members, though this depends on the scope of the evidence (Roberts et al., 2017; Partington et al., 2023). It is unknown whether infants' reason about the function of conventional behavior in this way. Future research could explore if infants' third-party expectations regarding social action sharing are different for instrumental and non-instrumental actions.

Learning and using conventions plays a central role in infants' and children's developing ability to participate in the social world. By identifying conventions, infants can learn to participate in social interactions, who belongs to a particular social group, and which behaviors signal affiliation. Over time, infants' capacity to recognize conventional actions as markers of social identity may unfold into the broader human tendency to expect social group members to act alike.

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