PREPRINT: Infants Prefer those who 'Bow Out' of Zero-Sum Conflicts

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Abstract

Humans quickly and automatically evaluate others. We evaluate others on many dimensions, but two of the most basic are social rank and prosociality. Infants as young as six months evaluate others based on prosociality, liking helpers to hinderers. Infants also recognize cues of social rank. But how do infants feel about high- and low-ranking individuals? Recent studies have shown that toddlers ages 21 to 31 months prefer high-ranking individuals to low-ranking individuals. The present study asks this question about younger infants. In this series of nine experiments, infants ages 10 to 16 months watched puppet shows featuring two puppets with conflicting goals. In four experiments, we found that unlike toddlers, infants prefer (reach for) puppets who yield to another individual.

Two basic aspects of human social life are cooperation--where people coordinate their actions--and conflict, where people act against each other. Recent studies show that infants care about cooperation: 6-month-olds prefer those who help others and avoid those who hinder others (Hamlin, Wynn, & Bloom, 2007) and 4-month-olds prefer those who imitate others over those who do not (Powell & Spelke, 2017). Infants also have expectations about conflict: In a conflict between a larger and a smaller individual, 10-month-olds are surprised to see the larger individual yield to the smaller (Thomsen, Frankenhuys, Ingold-Smith, & Carey, 2011). Similarly, in a conflict between an individual with more allies and one with fewer allies, 6-month-olds are surprised to see the one with more allies yield to the one with fewer (Pun, Birch, & Baron, 2016). By the age of 15-months infants expect that an individual who has bested an opponent in one conflict will win a future conflict with the same opponent (Mascaro & Csibra, 2012). These expectations about conflict suggest that infants implicitly understand the basics of hierarchy: They expect more formidable individuals to be yielded to by less formidable ones, and they expect the relative ranks of two individuals to be stable across situations (Boehm, 1999; van Vugt & Tybur, 2014).

In the present series of experiments, we asked whether infants have preferences for individuals based on whether they yield or prevail in a conflict. Previous studies suggest they may prefer the winners: Three to five-year-old children who give larger treats and trust the testimony of individuals who make decisions for a pair (Charafeddine et al., 2016) and adults pay more attention to high-ranking individuals and like to affiliate with winners (Capozzi, Becchio, Willemsse, & Bayliss, n.d.; Cialdini et al., 1976; Dalmaso, Pavan, Castelli, & Galfano, 2012). Moreover, our own recent studies show that toddlers, ages 21-31, prefer puppets who

win right of way conflicts over puppets who yield the way, but avoid puppets who use force to win (Thomas, Thomsen, Lukowski, Abramyan, & Sarnecka, 2018). Moreover, humans' preference for winners puts us in good company: Bonobos, who are among our closest primate relatives, also seem to prefer winners—and unlike human toddlers, bonobos don't mind when winners use force (Krupenye & Hare, 2018).

On the other hand, for other species such as wolves and chimpanzees, subordinates avoid or withdraw from dominant others to avoid provoking aggression (Boehm, 1999; Goodall, 1986; Henrich & Gil-White, 2001; Oliveira, McGregor, & Latruffe, 1998; Silk, 2002). Indeed, in several primate species, dominant individuals commit random acts of aggression toward subordinates as a way of maintaining social rank (Silk, 2002). Moreover 10-month-old humans prefer 'victims' to 'bullies' (Kanakogi, Okumura, Inoue, Kitazaki, & Itakura, 2013).

Experiment 1 of our series tested these two possibilities. Do infants have the same preference as toddlers, preferring the individual who prevails in the conflict? Or do they prefer the one who yields? To do this, we had infants watch a puppet show where two puppets were in a right-of-way conflict. This puppet show was based on those used in previous studies (Pun et al., 2016; Thomas et al., 2018; Thomsen et al., 2011). The puppet show began with a familiarization phase, during which each puppet appeared alone at one end of the stage and crossed to the other side. The purpose of this was to show children that each puppet liked to cross the stage in a particular direction. This was repeated until the infants looked away for at least half of the sequence, or a maximum of ten times. (Videos of the puppet shows for all experiments can be found in the supplemental materials).

Next came the action phase of the puppet show, when the two puppets appeared on opposite ends of the stage and tried to cross at the same time. The puppets met in the middle and bumped into each other. Then both puppets backed up and tried to cross the stage again, bumping again in the middle. This bumping and backing up was repeated five times. On the sixth approach, the puppets stopped short of meeting in the middle, and one puppet yielded the way to the other. The other puppet then passed in front of the yielding puppet and continued across the stage (see Fig. 1). This action phase was repeated until the infant looked away for more than half of the sequence, at least 3 times but no more than 10 times.

After the puppet show ended, we asked infants which puppet they liked. To do this we held out both puppets and said, ‘Hi, look, which one do you like?’ and the dependent measure was which puppet the infant reached for.

Figure 1. Left panel is a diagram of action phase of the puppet show in Exp. 1; right panel is a photograph (from the baby’s perspective) showing the choice procedure used in all experiments.

In Experiment 1, 24 of the 30 infants included in the analysis chose the puppet who yielded the way (two-sided binomial test $p=.001$; Bayes factor of 47.43, meaning that these data were 47.43 times more likely to arise if infants were choosing one puppet more than 50% of the time than if they were choosing both puppets equally). Results from this and all experiments are summarized in Figure 6.

In Experiment 2, we replicated this finding with a different group of participants and different puppets—still clay shapes with eyes and mouths, but of different colors and shapes. (See supplemental information for materials used in this experiment.) Again, we found that 17 of 19 infants chose the puppet who yielded the way (two-sided binomial test $p<.001$; Bayes factor of 71.98 in favor of the hypothesis that infants showed a preference).

In Experiment 3, we asked whether infants actually need to see one puppet cross the stage (i.e., reach its goal) in order to prefer the yielding puppet. We asked this question because experiments by Hamlin and colleagues (see Hamlin et al., 2007) have shown that infants prefer those who help others achieve a goal. If our results in Experiments 1 and 2 could be explained by the ‘infants prefer helpers’, then infants should need to see a goal achieved in order to prefer the puppet who ‘helped’ by yielding the way. We tested this question by stopping the scene as soon as one puppet yielded. The curtains closed with the other (non-yielding) puppet still standing at center stage.

Figure 2. Diagram of action phase for Experiment 3.

This time, 17 of 20 infants chose the puppet that yielded the way ($p=.003$; $BF=28.11$ in favor of infants having a preference for one puppet over the other). In other words, the infants preferred one puppet as soon as it yielded the way; they didn't need to see the other puppet go on to reach its goal.

In Experiment 4, we stopped the puppet show at an even earlier point: After the puppet had bowed down, but before it had moved aside. As in Experiment 3, we wanted to find out when (in the scene) the infants began to prefer one puppet over the other.

Figure 3. Diagram of action phase for Experiment 4

The results of Experiment 4 surprised us: When one puppet bowed but then did not move aside, 25 of 34 infants liked the *upright* puppet better (two-sided binomial test $p=.009$, BF of 10.62 in favor of there being a preference for either puppet). In other words, unlike in the previous three experiments, infants in Experiment 4 showed preferred the puppet who remained upright and did *not* bow.

This finding is intriguing, and potentially worth pursuing in future research. We did do one follow-up experiment (Experiment S1 in the supplemental materials), which found that in the absence of any social interaction, infants again avoided the puppet that bowed (i.e., stopped moving, rotated down to face the floor, and then didn't move anymore). How infants interpret this motion, and why they dislike the puppet that makes it, is unclear. But for the purpose of the present series of experiments, what matters is that Experiment 4 rules out the possibility that infants always prefer a puppet who prostrates toward the ground in a conflict.

In Experiment 5, we asked whether infants prefer a puppet who defers to its opponent in a different type of conflict, where right-of-way is not the issue. Rather than clay blocks with

eyes and mouths, this experiment used two plush hand puppets who both wanted the same toy (a rattle).

The puppet show was similar to those in Experiments 1-4: First there was a familiarization phase. One puppet appeared alone at one side of the stage. It moved to center stage, picked up a rattle that lay there, took the rattle back to its place at the side of the stage and shook it, making a rattling noise. Then the puppet returned the rattle to its place in the center of the stage, and the puppet exited. This was repeated until the infants looked away for at least half of the sequence. Then a second puppet appeared at the other side of the stage, and repeated the same sequence. This was repeated the same number of times as the first sequence.

Next came the action phase. Both puppets appeared simultaneously on opposite sides of the stage. They approached the rattle, picked it up together, and pulled it back and forth as if struggling over it. Then the puppets both put down the rattle together, and each moved back toward its own side of the stage, where it jumped up and down several times as if in frustration. This 'struggle' sequence repeated three times. On the fourth time, both puppets approached the rattle again, but one puppet yielded by backing away and bowing its head down. The other puppet picked up the rattle, went back to its side of the stage, and shook the rattle before the curtain closed on the scene.

In this experiment, 15 of 17 infants chose the puppet who had yielded the rattle ($p=.002$, $BF=28.78$ in favor of infants preferring one puppet over the other). Thus, it seems that the preference for a yielding puppet shown in Experiments 1-3 is not limited to right-of-way

conflicts among clay block puppets, but generalizes to at least one other type of agent (plush animals) and more importantly, to at least one other type of conflict (a dispute over a toy.)

Figure 4. [Left Panel] Still photographs taken from a video of the action phase in Experiment 5. [Right Panel] Choice procedure.

In Experiment 6, we returned to the setup used in Experiment 1, in order to test several alternative explanations. Recall that in Experiment 1, infants preferred the puppet that yielded

the way in a right-of-way conflict. The purpose of Experiment 6 was to test whether this preference could be explained by any of several other differences between the puppets. For example, infants might prefer a puppet that stops halfway across the stage over one that crosses completely; they might prefer a puppet that is briefly occluded over one that is never occluded; they might prefer a puppet that bows down and moves aside over one that remains upright; they might prefer the puppet that moves last, or they might prefer a puppet that does something novel, behaving differently during the test phase than it did during the familiarization phase.

In Experiment 6, we used the same clay block puppets (a red rectangle and a yellow oval) as in Experiments 1, 3 and 4. During familiarization phase, first one puppet appeared alone and moved across the stage. Then the other puppet appeared alone and crossed in the same direction. (This differed from the familiarization phase in Experiments 1, 3 and 4, where the puppets crossed the stage in opposite directions.) During the action phase of the show, the puppets both appeared at one side of the stage. One puppet moved forward, stopped at center stage, and made the yielding motion from Experiments 1 and 3 by bowing down and moving aside. Then the other puppet crossed in front of the bowing puppet and continued on across the stage. This scene replicated the scene from Experiment 1 in many ways (examples listed above) but lacked the conflict between the two puppets.

Figure 5. Diagram of action phase in Experiment 6.

Results of Experiment 6 showed that 18 of 26 infants chose the puppet that remained upright and crossed the stage over the one that bowed down and moved aside (two-sided binomial test $p=.075$. BF of 2.11 in favor of the alt. hyp.). That is, we found anecdotal, but positive evidence that when there is no conflict between the puppets, infants actually prefer the puppet that stays upright, keeps moving, is never occluded, and so on. This result rules out a number of alternative explanations for the preference for the yielding puppet, which infants showed in Experiment 1 and its replications.

In Experiment 7, we tested a range of alternative explanations for the finding of Experiment 5, which was that infants prefer a puppet that yields a disputed toy (a rattle) to

another puppet. As was true with the clay block puppets in the earlier experiments there are many other explanations that might explain infants' behavior.

For example, infants might prefer the puppet that yielded the rattle because they find the rattling sound unpleasant and dislike the puppet that shook the rattle more or shook the rattle last; or they might prefer the puppet that yields because they enjoy the novelty of seeing a puppet move in an unexpected way (bowing slightly and standing aside, rather than remaining upright and picking up the rattle); or infants might avoid the puppet that moved last in the scene; and so on. Because a range of such alternative explanations exist we wanted to test infants using a puppet show that was as similar as possible to the one in the original experiment, but without the conflict over the rattle.

The puppet show in Experiment 7 followed the script of Experiment 5 during the familiarization phase and in the first part of the action stage, where the puppets take turns picking up the rattle. But at the beginning of the final action sequence, a barrier appeared at center stage, blocking one puppet's access to the rattle. The puppets then carried out the final sequence of the action phase, with one puppet--the one who could reach the rattle--picking it up and shaking it, and the other puppet, making the same motions as in Experiment 5, but without actually holding the rattle.

The results of Experiment 7 showed that 16 of 29 infants chose the puppet that picked up the rattle (two-sided binomial test $p=.458$. BF of 2.11 in favor of the null hypothesis that infants were choosing each puppet half of the time). In other words, this experiment provided positive evidence that when there was no conflict, infants either prefer the puppet with the rattle or no puppet. This result argues strongly against the alternative explanations for the

result seen in Experiment 5 (e.g., that infants dislike the puppet that shakes the rattle more, shakes it last, etc.)

Figure 6. Summary of results for all seven experiments.

These studies show that infants, ages 10 to 16 months, like an individual who yields in a zero-sum social conflict more than they like an individual who prevails. We have shown this for two types of conflict--a conflict over right-of-way and a conflict over a toy. The preference is elicited as soon as one puppet yields the way (bowing down and moving aside); infants do not need to see the 'winning' puppet go on to reach its goal of crossing the stage. Several control experiments eliminated a range of alternative explanations for this main finding.

These results must be considered together with the recent discovery that children just a few months older (ages 21-31 months) show the opposite preference when tested on the same right-of-way tasks. That is, whereas babies prefer the puppet that yields the right of way, toddlers prefer the puppet that does *not* yield (Thomas et al., 2018). Thus, we must not only explain infants' preference for the yielder, but also explain why children shift to having the opposite preference just a few months later.

One explanation that fits well with the present results (although less well with the finding that toddlers prefer winners) is that infants prefer a puppet that yields because they construe yielding as helping (Hamlin et al., 2007). When one puppet moves out of another's way or gives up a disputed toy, infants may see the yielder as helping the other puppet reach its goal (of crossing the stage or getting the toy) in which case a preference for the yielder is a preference for a helper. A potential problem for this account is that infants also preferred the yielder in our Experiment 3, where they did not see the other puppet reach a goal. But this problem is resolved if we suppose that infants have a preference not for helpers *per se*, but for prosocial actors (i.e., kind or caring individuals) in a broader sense. A general preference for prosocial individuals could explain both the present results and Hamlin's helper/hinderer findings.

The difficulty with this explanation is that it doesn't explain why toddlers ages 21 to 31 months would prefer the puppet that did *not* yield (Thomas et al., 2018). Toddlers of that age do care about prosociality, as shown by another study in the same series, where the toddlers disliked a puppet that physically knocked another one out of the way. But if infants see the puppet that yields right-of-way in the present studies as prosocial, and they prefer it for that

reason, and if toddlers also prefer prosocial actors, then why do toddlers prefer the *other* puppet—the one that does *not* yield-- in the right-of-way conflict? This is a weakness of the prosociality explanation.

Alternatively, we might take these results as evidence for the development of children's thinking about social hierarchies. Infants might avoid the non-yielding puppet because they see it as dominant and thus potentially threatening. This would be consistent with evidence from non-human animal species in which subordinates avoid or withdraw from dominant individuals, and dominant individuals commit random acts of violence against subordinates (Silk, 2002).

The developmental shift from infants to toddlers may reflect the fact that toddlers have a more sophisticated representation of social hierarchy in which high-ranking individuals are not necessarily to be feared. Unlike the hierarchies of many other species, human social hierarchies involve more than dominance. Among humans, high rank does not necessarily reflect physical power. Instead, it may reflect greater resources of other kinds: More cultural know-how, more money, better social connections, etc. Thus, high-ranking individuals are not necessarily to be avoided. In fact, as long as they don't present a threat, high-ranking individuals are good people to affiliate with.

So one explanation for the difference between infants' and toddlers' behavior on the right-of-way task is that children of both ages view the interaction in terms of social hierarchy. But whereas infants see it as a dominance contest (just as many non-human animals might), toddlers see it as an interaction between a more-prestigious and a less-prestigious individual (Henrich, 2015).

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Supplementary Materials

General Methods

Materials

The puppet stage used in all experiments was 75 cm tall, 32.5 cm deep, and 95 cm long. It sat on a folding table covered with black fabric. There were black curtains hanging at the left and right sides of the stage, and a black curtain was used to cover the stage between scenes. Another black curtain behind the stage hid the experimenter who was

manipulating the puppets. This curtain had two layers, which the puppeteer sat between. There was another piece of black cloth that was hung behind the puppet stage. This allowed the puppeteer to see the infant while remaining hidden from view. The puppeteer wore black clothing, with long sleeves pulled down to hide her hands.

The puppets used in Experiments 1-4 and 6 were 12.5cm tall and made of polymer clay. Each had one plastic craft eye with a fixed pupil (so that the puppet always seemed to be looking straight ahead) and a rectangular piece of black electrical tape forming a mouth. In Experiments 1, 3, 4 and 6, one puppet was a yellow oval and the other was a red square. In Experiment 2, one puppet was an orange triangle and the other was a green hexagon. A black wooden dowel was attached to the back of each puppet and used to move it across the stage.

The plush puppets used in Experiments 5 and 7, were a dinosaur and a monkey, each approximately 25 cm tall.

Procedure

Participants were recruited from among the visitors to a children's museum during regular business hours. Experimenters approached parents on the museum floor and invited them to participate if their child was in the target age range. Parents filled out a consent form while the experimenter interacted with the infant before leading both parent and infant into the testing room. Before entering the testing room, parents were briefed about the procedure. They were asked to remain quiet during the puppet show and to close their eyes during the choice procedure.

The participating infant sat on their parent's lap. One experimenter, standing behind the stage and occluded from view, acted as the puppeteer. A second experimenter who

could not see what the puppets were doing onstage stood to the side of the stage and opened and closed the curtain between segments, saying "Down goes the curtain!" or "Up goes the curtain!" each time.

The puppet show consisted of a familiarization phase and an action phase. The purpose of the familiarization phase was to establish the goal of each puppet, either to cross the stage or to hold the rattle. In Experiments 1 to 4 along with Experiments S1 and S2, in the familiarization phase infants first saw one puppet who was alone on the stage, cross the stage, then they saw the other puppet, also alone on the stage, cross in the opposite direction. In Experiment 6, the puppets both moved in the same direction during familiarization. In Experiments 5 and 7, infants saw one puppet appear on one side of the stage, approach the rattle and shake it. Then they saw the other puppet do the same action starting from the other side of the stage. Each infant was shown the first puppet's familiarization sequence until they looked away for at least half of it, as judged by the puppeteer. Then the infant was shown the other puppet's familiarization sequence the same number of times. Next, the action phase was shown to the infant until they looked away for more than half of the sequence.

In all experiments, one puppet at a time was visible during the familiarization phase and both puppets were visible during the entire action phase. The directions traveled by the puppets across the stage, the order in which the puppets crossed the stage, and the specific puppet assigned to play each role were counterbalanced. We also counterbalanced the puppets' positions when presented to the infant at the end—for example in Experiment 1, the 'winning' puppet was on the infant's right exactly half of the time.

After the puppet show came the choice procedure. First, an experimenter who was blind to the condition asked the parent to close his or her eyes. The experimenter then held one puppet in each hand so that the infant could see, but not reach them. The experimenter looked at the child and said, "Hi! Look!" and then looked down, fixing her gaze directly in the center of two puppets. Then the experimenter said, "Which one do you like?" and moved the puppets toward the infant so that the infant could reach them. If the infant reached simultaneously for both puppets (one with each hand), the trial was coded 'both.' If the infant chose neither puppet, the procedure was repeated. If after three times the infant had still made no choice, the trial was coded 'no response.' These exclusion criteria, along with others described below, were decided after pilot testing and before we started data collection for Experiment 1.0. The video of the choices were coded by an experimenter blind to the condition.

Exclusion criteria, including if the infant chose both puppets, chose neither puppet, experimenter errors (e.g. orienting a puppet incorrectly during the puppet show, or forgetting to remind the parents to close their eyes), interference (if a sibling or parent interfered in the choice) or disturbances in the testing environment, were modeled after Thomas et. al, 2018. We were testing in a museum. The room we were using was off the main floor and quiet, but it was a less controlled environment than in a laboratory. For example there were several children that were excluded because of sibling interference.

The choices of the infants were recorded, on a written data sheet, at the time of the experiment, and then a blind researcher assistant (i.e. someone who did not know the roles of the puppets) coded the choices by watching videos of the experiments (when available) (e.g. for 'both', 'none', 'yellow' or 'red'). In cases where these two pieces of information

disagreed, the video coder would re-watch the entirety of the video to check the other aspects of the puppet show. If they were unsure a third researcher would settle the dispute.

The following experiments were tested in the same session: Experiments 2 and S1, Experiments 3 and 5, and Experiments 6 and 7. The procedure for these experiments were as follows: infants watched one puppet show using the procedure as described above. Then, came the first choice procedure for that puppet show. Then infants watched the second puppet show and did the second choice procedure. The order that infants saw the experiments was counterbalanced. The exclusion criteria was applied to each experiment, meaning that some infants were included in one of the experiments, but not the other. For example, if an infant did not make a choice in the first experiment, we still showed them the second experiment after which they could make a choice. The only exception to this was if an infant became overly fussy during the first experiment, then the infant would not see the second experiment. Details about specific infants can be found by looking at the data sheets. Each infant has one ID number.

Sampling Strategy

We used a flexible stopping rule where we checked the Bayes Factor after each testing session and tested infants until we had a sufficiently strong Bayes Factor to answer the question at hand. During each testing session we tested between 1 and 12 infants (the average was around 2). Note that although frequentist statistical analyses do not allow for preferential stopping, Bayesian analyses do (Csibra, Hernik, Mascaro, Tatone, & Lengyel, 2016; Schönbrodt & Wagenmakers, 2017). We also included frequentists statistics in the paper since more people are familiar with this type of analysis.

To calculate Bayes Factors we used the proportionBF function in the BayesFactor package in R (Morey, Rouder, & Jamil, 2014) with a null value of $p=.5$. To calculate p-values we used the binom.test function in R (Team, 2015).

Experiment 1: Right-of-Way

Participants

We tested 51 infants (20 boys, 31 girls), ages 10 to 16 months (*Range*: 316-516 days, *Mean*=437 days, *SD*= 61days). Data from 21 of these infants were excluded from the analysis for the following reasons: 8 infants chose both puppets (reaching both hands forward toward both puppets at once), 5 infants became fussy so the experiment was stopped and we did not conduct the choice procedure, 4 were excluded because of interference (the parent or sibling touched one of the puppets, or talked excessively throughout the puppet show), 3 infants chose neither puppet, 1 infant was excluded because of experimenter error (the eye fell off of one of the puppets during the puppet show). These exclusion criteria were decided before testing based on previous experiments with toddlers (Thomas et al., 2018).

Some of the participants who participated in the Experiment 1 data were tested in a different experiment that used the identical procedure but tested infants between the age of 16 and 20 months. This was an experiment conducted after the initial group of participants in Experiment 1 to investigate whether other factors, such as developments in language or motor abilities might predict whether infants chose the winning puppet or losing puppet. There were 12 of these infants, (noted on the data sheet) and they are included in the analysis and summary of participants above.

Experiment 2: Replication of Experiment 1

Experiments 2 and S1 were conducted in the same session, in counterbalanced order. In Experiment 2 the puppets were an orange triangle and a green hexagon; in Experiment S1 the puppets were a red square and a yellow oval. The Experiment 2 puppet show was the same as the one in Experiment 1 except that it used these different puppets.

Participants

We recruited 33 infants for Experiments 2 and S1 (15 boys; 18 girls) ages 10 to 16 months (Range: 306-432 days, Mean=407 days, SD= 54 days). Of these, 14 infants were excluded from the analysis for Experiment 2 for the following reasons: 5 infants chose both puppets; 3 chose neither puppet; 3 were excessively fussy and had to stop the experiment; and 3 were excluded because of experimenter error (in one case the puppets were presented to the child upside-down, in another case the curtain went up before the puppets had been reset; in a third case one of the puppets was oriented incorrectly).

Experiments 3: Bow-Move

Experiments 3 and 5 were conducted in the same session, in counterbalanced order. For Experiment 3 we used the puppets that were used in Experiment 1; in Experiment 5 we used plush puppets: a dinosaur and a monkey. (During one session, experimenter accidentally used the orange triangle and green hexagon used in Experiment 2 instead of the yellow oval and red rectangle).

Participants

We tested 26 infants (16 boys, 10 girls), ages 10 to 16 months (Range: 312-512 days, Mean=391 days, SD= 64 days). Of these, 6 infants were excluded from the analysis for

Experiment 3 for the following reasons: 4 for excessive fussiness; 1 because the child grabbed both puppets, and 1 because of interference from a sibling.

Experiment 4: Bow Only

Experiment 4 was not conducted with any other experiment. The puppets used were the same used in Experiments 1 and 3.

Participants

We tested 49 infants (23 boys, 26 girls), ages 10 to 16 months (*Range*: 312-517 days, *Mean*=415 days, *SD*= 55 days). Of these, 15 infants were excluded for the following reasons: 5 infants chose both puppets at the same time; 4 infants did not choose either puppet; 4 infants were excessively fussy, causing us to stop the experiment; 1 child's data was excluded because of experimenter error (the experimenter forgot to tell the parent and sibling to close their eyes, sibling said, "I want this one" and pointed to one of the puppets); 1 child's data was excluded because a sibling reached for a puppet before the infant did.

Experiment 5: Rattle

Experiment 5 was conducted in the same session as Experiment 3 (see above) in a counter balanced order.

Materials

The materials were the same as in Experiments 1-4, but instead of the clay puppets used previously, we used two plush puppets: A monkey (<https://www.amazon.com/Folkmanis-2123-Monkey-Hand-Puppet/dp/B00000K1Y9>) and a dinosaur (the dinosaur puppet was used in previous experiments in the lab and

purchased around 10 years ago. Similar ones can be purchased on ebay by searching 'animal alley' dinosaur'). We also used a rattle that was approximately 4" wide and made a jingling noise when shaken.

Participants

The same infants who participated in Experiment 3 also participated in Experiment 5. Of the 26 infants we tested, 9 infants were excluded from Experiment 5. Of these, 3 were excluded because of experimenter error (in one case, the puppeteer moved the puppets in the wrong way such that the 'winning' puppet returned the rattle to the center of the stage at the end of one of the action sequences; in another case the action phase did not show one of the puppets 'winning' the rattle; and in the third case two different puppets 'won' in two repetitions within the same action phase). Another 3 infants were excluded because they did not choose either puppet; 2 were excluded because they chose both puppets at the same time; and 1 was excluded because the infant became overly fussy and the experiment was stopped early.

Experiment 6: Footrace

Experiments 6 and 7 were conducted in the same session and presented in a counter balanced order. In Experiment 6 we used the same puppets (yellow oval and red rectangle) used in Experiments 1, 3, and 4. For Experiment 7 we used the same puppets we used in Experiment 5. However, for three of the participants the experimenter accidentally used the orange triangle and the green hexagon used in Experiment 2.

Participants

We tested 52 infants (25 boys, 27 girls), ages 10 to 16 months (*Range*: 315-500 days, *Mean*=414 days, *SD*= 54.29 days). Of these, 26 infants were excluded from the analysis for the following reasons: 19 infants chose both puppets; 4 infants failed to choose either puppet, 3 experiments were stopped short because the infant became overly fussy.

Experiment 7: Barrier-Rattle

Experiment 6 and 7 were conducted in the same session and presented to the infants in a counter balanced order.

Materials

The materials were the same as those used in Experiment 5, except that the action phase included a barrier (a magazine holder, approximately 24x8x32 cm, covered with white paper).

Participants

The participants in Experiment 7 were the same infants as in Experiment 6. Of the 52 infants tested, 23 were excluded from the Experiment 7 analysis for the following reasons: 8 infants chose both puppets; 7 infants failed to choose either puppet, 5 infants were too fussy to complete the procedure; 1 infant was excluded because the experimenter knocked over the barrier during the action phase, 1 was excluded due to interference from a sibling, and 1 was excluded because the infant did not watch the puppet show.

Experiment S1: Bow to Barrier

In Experiment S1, we set out to explore the results of Experiment 4, where infants preferred an upright puppet to whom another puppet ‘bowed’ without moving aside. In Experiment S1 we reproduced the action on a two-level stage with barriers to see whether, in the absence of any social interaction, infants would still prefer the upright puppet over the ‘bowing’ one. During the familiarization phase of Experiment S1, we showed the goal of each puppet by having the puppet appear alone, on either the upper or the lower level, and cross the stage twice. Before the action phase began, barriers were added at center stage on both levels. During the action phase, both puppets appeared at the same time— one on the upper level and one on the lower. The puppets approached and retreated from the barriers, following the same meet-and-retreat motions as in the other experiments. The puppet show ended when both puppets approached the barrier and one puppet rotated forward, stopping in the prone position but not moving aside, just as in Experiment 4.

Figure S1. Diagram depicting action phase of Experiment S1

Participants

The same 33 infants who participated in Experiment 2 also participated in this experiment. As described above, this included 33 infants (15 boys; 12 girls) ages 10 to 16 months (Range: 306-432 days, Mean=407 days, SD= 54 days). There were three infants who saw Experiment 2, but did not see Experiment S1. Of the 30 remaining infants we tested, 13 were excluded from the analysis for Experiment S1: 6 infants chose both puppets, 2 infants chose neither puppet, 1 experiment was stopped because of fussiness, 1 because of interference from a sibling, and data from 3 infants were excluded because of experimenter error (in one case the curtain uncovered the stage before the puppets had reset; in another case one of the puppets pushed the barrier over; and in the third case the puppets were presented to the infant upside down); one infant was excluded because a parent touched one of the puppets before the infant did. This left 17 infants in the analysis.

Results

15 of 17 infants chose the puppet that remained upright (two-sided binomial test $p=.002$; Bayes Factor of 28.73 in favor of the alternative hypothesis that infants were choosing one of the puppets more than 50%). In other words, the results were the same as in Experiment 4: When one puppet bends over and stops moving (with or without social interaction), infants prefer the other puppet—the one that remains upright. (See Figure S.3.)

Experiment S2: Win/Win

This puppet show began the same way as in Experiments 1,2,3, and 5, with a familiarization phase where each puppet crosses the stage twice, followed by an action phase where two puppets attempt to cross in opposite directions at the same time, and wind up blocking each other's path. In this experiment, one puppet bowed and moved aside, the other puppet crossed in front of it and continued to the other side of the stage, and then (unique to this experiment) the bowing puppet 'stood up' (i.e., rotated back up until it was facing forward again) and continued across the stage. Thus, one puppet still yielded to the other, but both eventually reached their goals.

Figure S2. Diagram of action phase in Experiment S2.

Participants

We tested 55 infants (21 boys, 35 girls), ages 10 to 16 months (*Range*: 304-505 days, *Mean*=387 days, *SD*= 50 days). Data from 25 of these infants were excluded from the

analysis for Experiment S2 for the following reasons: Ten of the infants chose both puppets; 8 chose neither puppet, 5 were excluded because of experimenter error (there was black tape stuck to one puppet's face during the puppet show; the experimenter forgot to tell the parent to close their eyes during the choice procedure; the faces on the choice puppets did not match the puppets used in the puppet show; the stage fell off the table during the puppet show; the puppeteer was looking at the wrong child when habituating the infant). 1 infant's data were excluded because the experiment was stopped short due to fussiness; 1 infant's data were excluded because a sibling pointed to a puppet before the infant did. The analysis was based on data from the remaining 30 infants.

Results

12 of 30 infants chose the puppet that yielded (two-sided binomial test $p=0.36$; Bayes Factor of 1.48, providing weak evidence in favor of the null hypothesis that infants were choosing one of the puppets 50% of the time). If we ask whether these data are more likely to arise in a situation where infants are choosing the yielding puppet more than 50% of the time versus less than 50% of the time, the data are 4.62 times more likely to arise in the latter situation. This is moderate evidence that if infants had a preference at all, it was for the puppet that remained upright throughout the scene.

Figure S3. Results from Experiment S1 and S2