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Developmental differences in infants' fairness expectations from 6 to 15 months of age

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Abstract

The present research investigated the developmental trajectory of infants' fairness expectations from 6 to 15 months of age (N = 150). Findings revealed a developmental transition in infants' fairness expectations between 6 and 12 months, as indicated by enhanced visual attention to unfair outcomes of resource distribution events (a 3:1 distribution) relative to fair outcomes (a 2:2 distribution). The onset of naturalistic sharing behavior predicted infants' fairness expectations at transitional ages. Beyond this period of developmental transition, the presence of siblings and infants' prompted giving behavior predicted individual differences in infants' fairness concerns. These results provide evidence for the role of experience in the acquisition of fairness expectations and reveal early individual differences in such expectations.

Keywords

Fairness; Developmental differences; Individual differences

A concern for fairness is a fundamental feature of human morality: considerations of what is fair and just affect interpersonal interactions, govern workplace behaviors, and play a role in societal decision making and legal judgments. While fairness takes many forms, including concerns that processes of decision making and dispute resolution are carried out in a just way (procedural fairness), or concerns with the just punishment of wrongdoings (retributive fairness), concerns about how goods and resources should be distributed (distributive fairness) are chief among adults' fairness considerations. Notably, adults' concerns about distributive fairness are governed by the principle of equality (Deutsch, 1975): other things being equal, goods should be divided evenly to recipients. In support of this claim, adults tend to distribute resources equally between themselves and an unknown partner in the context of economic games (Fehr & Fischbacher, 2003), and engage in costly punishment of those who defect from this norm of equality (Johnson, Dawes, Fowler, McElreath, & Smirnov, 2009). Moreover, fair resource allocations activate the brain's reward circuitry (Tabibnia, Satpute, & Lieberman, 2008).

Thus, given the prominence of distributive fairness considerations in adult social interactions, there has been growing interest in characterizing the developmental

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underpinnings of these tendencies. Of particular relevance is the question of when a sensitivity to fairness first arises in development, and what factors facilitate its emergence. In addition to elucidating the developmental origins of distributive fairness per se, identifying the developmental trajectory of distributive fairness expectations can also inform classic debates in the field including the question of whether moral judgment is present in infancy (Bloom, 2013) or only constructed later in development (Kohlberg, 1969), possibly as a product of experience (e.g., Brownell, Svetlova, Anderson, Nichols, & Drummond, 2013; Dunn, 2006).

Children's fairness concerns and moral development

Existing research has established that, like adults, children adhere to equality in resource distributions. In third-party situations, children will prioritize equal distributions over family relationships or previous friendships, if sufficient resources are available (Olson & Spelke, 2008), and will even choose to dispose of a resource rather than create an unequal distribution (Shaw & Olson, 2012). When children themselves are recipients of resources, they exhibit negative emotional reactions upon experiencing an unequal allocation (LoBue, Nishida, Chiong, DeLoache, & Haidt, 2011), prefer to reject allocations that disadvantage them relative to a peer, and by age 8, also reject advantageous allocations (Blake & McAuliffe, 2011). Perhaps the most stringent test of children's fairness considerations comes from their responses on the dictator game (Kahneman, Knetsch, & Thaler, 1986). In this task participants are given a single opportunity to share their own resources (e.g. stickers) with a hypothetical partner, thus removing any external reward or potential punishment. In these experiments, 8-9 year olds typically share more equally than younger children who more often keep all the resources to themselves (Benenson, Pascoe, & Radmore, 2007; Fehr, Bernhard, & Rockenbach, 2008). Furthermore, such sharing behavior has been related to the ability to sympathize with anonymous others (Malti, Gummerum, Keller, Chaparro, & Buchmann, 2012), and to children's emotional attribution in response to moral transgressions (Gummerum, Hanoch, Keller, Parsons, & Hummel, 2010). Children's need-based donating behavior is predicted by their moral reasoning capacities (Ongley, Nola, & Malti, 2014). The prominence of distributive fairness considerations in childhood motivates asking whether more basic roots of fairness expectations might even be detected in infancy, and if so, whether their development is linked to specific attributes indicative of infants' early moral understanding.

The developmental origins of a sense of fairness

A nascent sensitivity to fairness can be traced back to infancy. At 15 months of age, infants look longer at unfair distribution outcomes (i.e., a 3:1 distribution) compared to fair outcomes (i.e., a 2:2 distribution; Schmidt & Sommerville, 2011). This looking time preference suggests that infants expect resources to be distributed equally among recipients and they are able to identify a violation of this norm of equality. Infants also adjust their fairness expectations in accord with contextual information such as relative effort in completing a shared chore (Sloane, Baillargeon, & Premack, 2012), or the race of the distributor and recipients involved in the situation (Burns & Sommerville, 2014). By 15 to 16 months, infants prefer to interact with previously fair individuals, and expect others to

take fairness into consideration when deciding whom to approach. (Burns & Sommerville, 2014; Geraci & Surian, 2011; see also Meristo & Surian, 2013, 2014 for evidence that infants show enhanced attention when agents interact with unfair distributors). Thus, infants' fairness sensitivity is not only reflected in attention to distribution outcomes, it also serves as a guide to social affiliation, and shapes their expectations about third-party interactions.

Given the early emergence and complexity of fairness expectations, questions relating to their developmental origin warrant further consideration. The present research sought to identify the onset of the most basic form of fairness expectations, that is, detection of a violation of the norm of equal resource distribution, track the developmental trajectory of these early fairness expectations, and examine individual differences in early fairness concerns.

Regarding the developmental trajectory of infants' fairness expectations, on the one hand, it has been claimed that sensitivity to fairness would be evolutionarily advantageous in cooperative societies. From this perspective, fairness expectations should be present early and continuous across development, with limited reliance on experience. In support for this claim, it has been argued that other species show a rudimentary expectation for equitable resource distribution (e.g., Brosnan & de Waal, 2003). Furthermore, mathematical models simulating the evolution of a preference for fair resource divisions using the ultimatum game have shown that fairness evolves when individuals know there is a possibility of interacting with a wide variety of other social partners in the future, and therefore an opportunity to switch roles in subsequent interactions (André & Baumard, 2011). On the other hand, fairness expectations might be experientially derived and arise more gradually over development. Suggesting a role for environmental factors, research has uncovered variability in the degree to which adults and children from different cultures subscribe to fairness norms (Henrich et al., 2005; Schäfer, Haun, & Tomasello, 2015). Moreover, past research has also shown that much of infants' early social cognitive knowledge is influenced by experience. For instance, infants' own ability to produce goal-directed actions, and their experience doing so, causally influences their understanding of other people's goals (Sommerville & Woodward, 2005; Sommerville, Woodward, & Needham, 2005). Such findings raise the possibility that infants' fairness expectations may similarly rely on experience.

To date, studies comparing different age groups have found inconsistent evidence for the emergence of fairness sensitivity over development. For example, as previously mentioned, 16-month-olds prefer to interact with fair individuals, and expect bystanders to selectively approach fair distributors as well. At 10 month of age, however, the evidence is mixed, with some studies showing that babies are surprised when others approach unfair individuals (Meristo & Surian, 2013, 2014), and other studies showing no approach preference even in infants' own selections (Geraci & Surian, 2011). Thus, it is unclear when babies first start using fairness as a guide to social affiliation. One study examined infants at 12 months of age and compared their performance on a violation-of-expectation task to a group of 15-month-olds (Sommerville, Schmidt, Yun, & Burns, 2013). Participants were shown video distribution events in which the final distribution outcome was occluded, and were subsequently presented, in alternation, with still images of equal and unequal distribution outcomes. Findings showed that while 15-month-olds looked longer at the unfair

distribution, 12-month-olds looked at both images equally. Further examination of these results, however, revealed strong order effects in the 12-month-old sample whereby infants looked longer at the outcome that was presented to them first. Accordingly, it is yet to be determined whether these findings are illustrative of age-related differences.

In the current paper, we hypothesized that there might be both a developmental transition in the onset of infants' fairness expectations, as well as individual differences in infants' fairness expectations that become entrenched beyond this developmental transition. Our hypothesis is consistent with research showing that, overall, Western adults expect and endorse equality in economic games, but there are individual differences in adults' tendency to do so (see Fehr & Fischbacher, 2003 for a review). Thus in the current experiments we investigated infants' sensitivity to fairness across a range of ages, from 6 months of age to 15 months of age, using the same violation-of-expectation task, to more clearly determine whether fairness expectations are continuous across development or whether they change with age.

The importance of sharing in infants' fairness expectations

One goal of the current paper was to identify the types of experiences that might be associated with developmental shifts in infants' fairness expectations. In particular, we sought to investigate the potential role of spontaneous sharing in the developmental onset of fairness expectations. Sharing is a prosocial behavior that requires the identification of others' unmet material desires, and a motivation to rectify this situation (Dunfield, 2014) by giving up an object that is in the sharer's control (Brownell, Iesue, Nichols, & Svetlova, 2013). Spontaneous sharing, in which infants give over objects without prompting, is an early type of sharing behavior. Infants' spontaneous sharing with their parents (Hay, 1979; Rheingold, Hay, & West, 1976) and peers (Hay, Caplan, Castle, & Stimson, 1991) has been documented in laboratory settings as early as 12 months of age. Thus, in the current paper we investigated the relation between the onset of naturalistic spontaneous sharing and the onset of infants' fairness concerns.

We hypothesized that the onset of participation in spontaneous sharing interactions may be associated with a developmental shift in the onset of infants' fairness expectations. The turn-taking nature of sharing interactions may provide infants with the opportunity to experience both being the agent and recipient of fair and unfair behavior, and thus learn about the impact that fair behavior has on others. Since sharing interactions inherently emphasize equality and reciprocity, such experiences may contribute to a developing sense of fairness. To address this possibility we capitalized on individual variability in infants' fairness expectations at a transitional time point (9 months of age) to determine whether it was linked to the onset of sharing in naturalistic settings, as a means for identifying potential candidate mechanisms or experiences driving the developmental onset of infants' fairness expectations.

Individual differences in infants' fairness expectations and their predictors

An additional goal of the current paper was to determine which factors predict individual differences in infants' sensitivity to fairness beyond the period of developmental transition. We hypothesized that differences in infants' altruistic tendencies could be related to their fairness concerns. Altruism is defined as a behavior that benefits others at a cost to the self (e.g., Grusec, Davidov, & Lundell, 2002), and studies have revealed that children's altruism in the dictator game is influenced by considerations of a resource's value: children are more generous when distributing their least favorite stickers compared to their most favorite stickers (Blake & Rand, 2010), when distributing items that required a relatively small rather than large amount of effort to obtain (Benozio & Diesendruck, 2015), or when resources are plentiful vs. scarce (Posid, Fazio, & Cordes; 2015). Similarly, infants will more readily help an experimenter by handing her a toy they received in lab rather than a favorite toy from home (Svetlova, Nichols, & Brownell, 2010). These findings indicate that variability in altruistic tendencies could be assessed by examining the relative cost infants are willingness to incur in response to others' unmet needs. Importantly, it has been suggested that the cognitive processes underlying the level of generosity (i.e., the decision how many resources to give) are separate from those underlying the decision whether to donate at all, and follow distinct developmental pathways (Blake & Rand, 2010).

Earlier work provides evidence for individual differences in infants' fairness expectations that are related to their altruistic giving acts at 15 months of age. Schmidt and Sommerville (2011) showed that infants who gave an actor a toy that they preferred when she produced an ambiguous request for a toy looked longer at an unfair distribution outcome relative to a fair outcome, whereas infants who shared a toy that they did not prefer displayed the opposite pattern of looking in a violation-of-expectation task. These findings suggest that although as a group, 15-month-olds enhanced their attention to events that violate fairness norms, within this group there were individual differences in the extent to which particular babies cared about violations of fairness.

In the current experiments, we tested whether individual differences in altruistic giving could account for variability in fairness expectations of 12- and 15-month-olds, ages at which spontaneous sharing behavior is already in place. We predicted that following a developmental shift in infants' fairness expectations, and replicating prior work (Schmidt & Sommerville, 2011), whether infants chose to give an experimenter a preferred over a non-preferred toy would predict individual differences in infants' fairness expectations. As mentioned earlier, infants' willingness to give up valued toys at these ages may serve as a dispositional measure indicative of the extent to which they care about meeting others' needs or desires, or are willing to suppress their own desires and needs in order to do so (Brownell, Svetlova, & Nichols, 2009). Such individual differences could in turn impact how infants respond to unfair outcomes of resource distribution events.

Another goal of the current research was to investigate whether the presence of siblings might allow infants more opportunities to observe and engage in sharing interactions and acts of fair and unfair resource allocations, and could therefore promote fairness expectations. Indeed older children's interactions with their younger siblings often entail

offering of objects (Lamb, 1978) and sibling conflict often arises due to issues of object possession or sharing (Dunn & Munn, 1987; McGuire, Manke, Eftekhari, & Dunn, 2000). Naturalistic observations have shown that siblings influence each other's cooperative behavior in toddlerhood (Dunn & Munn, 1986), and sibling interactions promote other aspects of cognitive development such as imitative learning in infancy (Barr & Hayne, 2003) and Theory of Mind in older children (Perner, Ruffman, & Leekam, 1994). Finally, a study of children's resource allocation reported sibling effects such that children with siblings were less willing to engage in costly sharing behavior compared to children who had no siblings (Fehr et al., 2008). Therefore, we collected information regarding whether our participants had siblings or not in order to test any links with infants' performance on the violation-of-expectation task.

Overview of the current experiments

Across 3 experiments, the current research tested fairness expectations in four age groups between 6 and 15 months of age using a violation-of-expectation (VOE) task similar to the one developed by Sommerville and colleagues (2011, 2013) in which resources are distributed to two recipients. Notably, the current study was designed to overcome the observed order effects in 12-month-old infants' looking responses, by presenting outcome images simultaneously rather than sequentially. This change also enabled testing younger infants using the same paradigm and thus allowed us to gain a better understanding of the developmental course of infants' fairness expectations. Consistent with past findings (e.g., Sloan et al., 2012; Schmidt & Sommerville, 2011) fairness expectations were operationalized as longer looking toward an unfair rather than a fair distribution outcome. This measure indicates that infants have detected a violation of the norm of equal distribution, and that they are surprised when others do not abide by this norm. Crucially, this task also included control trials in which resources were distributed to pillows, rather than people, a situation in which fairness norms should not be applied. To test whether infants' altruistic behavior at 12 to 15 months of age predicts their fairness expectations, in addition to taking part in the VOE task infants took part in a prompted giving task (akin to Schmidt & Sommerville, 2011) in which an experimenter requested a toy from the infant, and we examined whether participants chose to give a preferred or a non-preferred toy (Experiment 1). To investigate whether the developmental onset of naturalistic sharing was linked to the developmental onset of infants' fairness expectations, parents of 9-month-old infants completed a sharing interview, which enabled us to assess whether infants have begun to share spontaneously (Experiment 2). Pilot work revealed that no parents of 6-month-old infants reported naturalistic sharing; thus in Experiment 3 6-month-old infants only received the VOE. In all three experiments, we collected information about whether infants had any siblings in order to assess whether the presence of siblings influences infants' expectations of fairness.

We hypothesized that a) there would be differences in infants' fairness expectations across age groups, b) the *onset* of naturalistic sharing behavior will be associated with the acquisition of fairness expectations at transitional ages (9-month-olds), c) variability in infants willingness to give a preferred toy will be associated with variability in the fairness expectations of older infants (12-15-month-olds), and d) presence of siblings would be

associated with infants' fairness expectations at 12 to 15 months of age. Finally, we also investigated whether individual differences in infants' general development could explain differences in fairness expectations. If the onset of sharing behavior merely reflects more advanced development, any relation between fairness and sharing would be less direct. To test this possibility, we collected measures of motor and language skills as assessments of broader developmental status.

Experiment 1

Method

Participants—Thirty-two 12-month-old infants (M = 12 months 4 days; range: 11 months 23 days – 12 months 19 days; 20 female, 12 male), and thirty-four 15-month-old infants (M = 15 months 12 days; range: 14 months 25 days – 16 months 10 days; 19 female, 15 male) participated in the study. All infants were born full term (within 3 weeks of due date), and were typically developing. Data were collected from January to April 2012. Participants were recruited from a university maintained database, and were identified by their parents as White (n = 47), Asian/Pacific Islander (n = 2), Hispanic (n = 2), Native American (n = 1), Mixed race (n = 12), or Other (n = 2). The majority of parents (78%) had a college degree or higher. One additional 12-month-old was tested but excluded from the study due to an equipment malfunction.

Materials and Procedure—Infants took part in a violation-of-expectation (VOE) paradigm and a prompted giving task.

VOE paradigm: During the VOE task, infants sat in a parent's lap at a distance of approximately 80cm from a 52-cm television monitor, which was flanked by two 54-cm computer monitors. Parents wore darkened glasses that prevented them from viewing the display and were asked to avoid interacting with their infant throughout the testing session.

All infants received two trials of the experimental condition and two trials of the control condition of the task (the motivation for pursuing a within subjects design stemmed from our desire to be able to follow up the participants longitudinally in the future). The trials were blocked by type such that participants saw two consecutive experimental trials and two consecutive control trials, order counterbalanced. In both conditions, participants viewed resource distribution events on the central TV monitor followed by 2 still-frame distribution outcomes presented simultaneously on the flanking monitors (see Figure 1).

The experimental video depicted three women seated at a table: one distributor and two recipients. The distributor sat in front of a clear bowl containing 4 crackers, and the recipients each sat beside her on either side. Each recipient had a white plate in front of her. The clip began with the distributor saying, "Hello" to the camera and greeting the recipients. She then lifted the clear bowl, said, "Yummy", and placed the bowl back on the table. The recipients simultaneously said, "Please" and pushed their plates toward the distributor. Next, a black rectangle appeared on the screen occluding the bowl and both plates from infants' view (such that infants could subsequently tell that the distributor was distributing crackers but not how many were placed on each plate). The distributor placed crackers on the plate to

the right followed by the plate to the left using a single hand movement whilst saying, “Here”. The clip ended with the distributor lifting the clear empty bowl from behind the occluder and saying, “All gone” while looking at the camera. This final frame remained on screen for 2 seconds and faded to a black screen until the next trial. Throughout the clip, the distributor maintained a positive facial expression and tone of voice. The total clip length was 24 seconds.

Immediately after the distribution video, a fair and unfair distribution outcome appeared simultaneously on the side monitors for 20 seconds. These images depicted the distributor with an empty bowl in front of her and the two recipients gazing neutrally at their plates of crackers. In the fair distribution outcome image each recipient had 2 crackers on her plate, and in the unfair distribution outcome image the recipient on the right had 3 crackers on her plate whereas the recipient on the left only had one. Images were approximately 39.5 × 20 cm in size and were centrally positioned against a black background. Whether the fair outcome was first shown on the left or on the right screen was counterbalanced across infants. The second experimental trial began after a 3-second interval in which all three screens were black. Participants again watched the distribution video and still-frame distribution outcomes. Positioning of the fair and unfair images was reversed for the second trial.

The control condition was similar to the experimental condition except that resources were allocated to two pillows and thus the event was devoid of any social meaning. A novel distributor (who did not act in the experimental condition) with the same bowl of crackers said, “Hi,” while looking at the camera and acknowledged the presence of the pillows by saying, “Oh wow,” while looking at each pillow. Empty white plates were positioned in front of each pillow. The distributor next lifted the bowl and said, “Yummy” to the camera. As soon as she placed the bowl back on the table the black occluder appeared, preventing infants from seeing the number of crackers placed on the plates. Crackers were placed on the plates in the same manner as the experimental condition, while the distributor said, “There”. The clip ended when the distributor revealed the empty bowl above the occluder and said, “All done” to the camera. As in the experimental condition, the final frame remained visible for 2 seconds and faded to black. The control video was 26 seconds long. The equal and unequal outcome images of the control condition were identical to the experimental images except that pillows replaced the recipients by the table. These images were shown for 20 seconds following the video and their initial left-right positioning was matched to the first experimental trial. A second control trial was presented after a 3-second interval, and the positioning of the outcome images was reversed.

Participants’ looking times at the equal and unequal distributions during the four 20-second outcome presentations were measured offline by a trained coder, using a designated computer program (jHab; Casstevens, 2007).

Prompted giving task: The prompted giving task took place in a different room than the VOE task.

Choice phase: Infants were seated in a parent's lap and given the opportunity to select one of two toys set on a table in front of them (54 cm apart). Toys were a Lego block (4 × 7 cm) and a plastic doctor figure (4 × 8 cm). The left-right positioning of the toys was counterbalanced across participants. Infants' first choice was noted by the experimenter and considered their preferred toy, as is common in infant research (e.g., Hamlin, Mahajan, Liberman, & Wynn, 2013; Hauf, Paulus, & Baillargeon, 2012; Kinzler, Dupoux, & Spelke, 2007). The experimenter then handed the second (non-preferred) toy to the infant, such that both toys were now in the infants' hands.

Test phase: Once the infant was holding both toys, parents were instructed to turn the chair toward a novel female actor who was kneeling down on the floor approximately 45 cm away. The actor held her hands out close enough for infants to reach, and directed her gaze toward her hands. After 5 seconds, she made eye contact with the infant and said, "Can I have one?". The actor then continually alternated her gaze between her own hands and the infant. After 10 additional seconds she again looked at the infant and said, "Can I have one, please?", then gazed back and forth between her hands and the baby. These two request prompts were repeated in 10-second intervals until a total of 45 seconds had elapsed or until the infant released a toy into the actor's hand, which ended the trial. Importantly, the actor never looked at either of the toys she requested.

An experimenter coded live whether infants gave a toy to the actor and which toy was given (preferred or non-preferred). If no response was produced on the task, a different observer coded from video infants' reactions to the experimenter's prompts and determined the possible reason for their lack of response according to the following categories:

- Shy or stranger anxiety: Infants were scared of the experimenter or did not want to interact with the experimenter. Infants were coded as shy or anxious if they looked at their parent, leaned back into the parent, or remained still while staring neutrally at the experimenter.
- Conflicted: Infants were unsure which of the toys to give. Conflicted infants either looked back and forth between the two toys or reached out their hands as if they were going to share yet ended up keeping the toys.
- Unwilling: Infants wanted to keep both toys for themselves and showed signs that they are uninterested in sharing. Infants were coded as unwilling if they shook their head in response to the experimenter's request, smiled and played with the toys, held the toys away from experimenter or pushed the experimenter's hands away. Importantly, these infants did not show signs of stranger anxiety.
- Other: Infants displayed behaviors that do not fit into the above categories: dropping the toys or throwing them on the ground.

Coder Reliability: A second trained observer, who was unaware of the lateral position of the images, offline coded infants' looking times toward the still outcome images during the VOE task. Observers' judgments were highly correlated ($r = .98$, $p < .001$).

Additionally, a second observer coded the prompted giving task from video and determined which toy infants selected first, whether they gave a toy to the actor, and which toy was given. There was 100% agreement with the experimenter's live coding on all judgments.

Other measures: In order to assess other dimensions of infants' development and to examine their relations to infants' performance on the VOE, parents were asked to fill out the MacArthur Short Form vocabulary checklist (Level 1; Fenson, Pethick, Renda, Cox, Dale, & Reznick, 2000), a widely used measure of infants' receptive and expressive vocabulary size. The number of words that parents indicated their infant "understands" or "understands and says" were separately summed. In addition, parents were given a 24-item Motor Abilities Checklist (Loucks & Sommerville, 2013), adapted from the Bayley Scales of Motor Development (Bayley, 2006). The checklist contains questions regarding children's motor skills (e.g., "Can your child sit alone while playing with a toy?", "Does your child attempt to walk?", "Can your child stand on one foot with help?"), organized in chronological order of developmental milestones. The highest consecutive item parents checked served as a measure of motor development.

Siblings: As an additional measure of infants' experience with distribution of resources and sharing behavior, both as observers and as participants, parents were asked whether their infant had any siblings.

Results

For each experiment we first present the results of a one-sample t-test comparing experimental and control trials to chance, followed by an omnibus ANOVA comparing experimental and control conditions with sibling status as a between-subjects variable, and an omnibus ANOVA comparing experimental and control conditions including infants' prompted giving behavior (Experiment 1) or naturalistic sharing behavior (Experiment 2) as between-subjects variables. Follow up t-tests and comparisons to chance are included for main effects that are significant or marginally significant in the omnibus tests.

Infants' attention to the distribution events and outcomes in the VOE paradigm—

Infants' raw looking times toward the distribution events and outcome images were converted to proportion scores, as is customary in studies using simultaneous presentations (e.g., Colombo, Mitchell, & Horowitz, 1988; Richards, 1997).

In order to be able to directly compare infants' performance on the experimental and control conditions it was important to ensure that attention to the distribution events was equivalent across conditions. In doing so, any differences in looking toward the outcome images across the experimental and control conditions could not be explained by discrepancies in attention to the distribution information. For each condition, infants' summed looking time toward the two distribution videos was divided by the summed length of the clips (Experimental condition: 48 seconds, Control condition: 52 seconds) and these proportion scores were examined. Although there were no significant differences in attention to the two types of distributions for the sample as a whole (Proportion Experimental = 90%, Proportion Control = 88%, $t(65) = 1.522$, $p = .133$) further inspection revealed that a subset of infants showed

extreme differences of 20% or more in attention across the two different distributions. Thus, in Experiment 1, and all subsequent experiments, analyses focused on infants whose attention was equivalent to the control and experimental distributions, as defined by a less than 20% difference in attention across the conditions. Nine infants in the current experiment exceeded this criterion and were therefore excluded from analysis. The final sample size was consequently $n = 57$.

To analyze infants' test performance, their proportion of looking at the outcome images was calculated for each condition. In the experimental condition, these scores were derived by dividing infants' looking time toward the unfair outcome on a given trial by their summed looking time toward both the fair and unfair outcome images on that trial. In the control condition, proportion scores were calculated by dividing infants' looking time to the unequal outcome by their summed looking toward the equal and unequal outcome images on each trial. These proportion scores were averaged across the two trials of each condition.

Infants' expectations of equal resource distributions—The critical question of interest was whether infants expected resources to be distributed equally among the recipients. A one-sample t-test revealed that the proportion of infants' looking toward the unfair distribution outcome in the experimental condition was significantly above chance levels ($t(56) = 3.034$, $p = .004$, Cohen's $d = .40$). In contrast, infants' looking toward the unequal outcome in the control condition did not differ from chance ($t(56) = .512$, $p = .611$, $d = .07$). Thus, infants expected fairness only in the context of a social interaction. See Figure 2(a).

Relations between infants' VOE performance and the presence of siblings—Next we directly compared infants' performance across control and experimental trials, and investigated whether the presence of siblings, as a potential source of experience, might be related to infants' fairness expectations. Additionally, since one of the goals of the current experiment was to overcome previous limitations in assessing 12-month-olds' fairness expectations, we examined performance on the VOE task as a function of age. Thirty-two participants in our sample did not have siblings (12-month-olds: $n = 10$; 15-month-olds: $n = 22$), and 25 participants had at least one sibling (12-month-olds: $n = 16$; 15-month-olds: $n = 9$). An ANOVA with Condition (Experimental/Control) as a within-subjects factor and Age (12 or 15 months) and Sibling Status as between-subjects factors showed a marginally significant main effect of Condition with a medium effect size ($F(1,53) = 3.455$, $p = .069$, $\eta_p^2 = .06$), and a between-subjects effect of Sibling Status ($F(1,53) = 11.939$, $p = .001$, $\eta_p^2 = .18$), which were qualified by a significant Condition by Sibling Status interaction ($F(1,53) = 5.549$, $p = .022$, $\eta_p^2 = .095$). Subsequent analyses examined each sibling group separately. Directly comparing infants' performance in the experimental and the control conditions of the VOE showed that the proportion of looking at the unfair outcome of infants with siblings ($M = .59$) was significantly greater than their proportion of looking at the unequal outcome ($M = .51$; $t(24) = 2.48$, $p = .021$, $d = .50$). Furthermore, infants who had siblings looked at the unfair outcome significantly above chance levels, yet looked at the unequal outcome at rates no different from chance, see Table 1.

In contrast, there was no difference in the proportion of looking toward the unfair (M = .49) and the unequal (M = .51) outcomes of infants without siblings ($t(31)$ = .672, p = .507, d = .12). Moreover, their proportion of looking at the unfair and the unequal outcomes both did not differ from chance (see Table 1). Together, these findings suggest that expectations of fairness are in place at 12 months of age and are linked to the experiences infants gain from having siblings.

Relations between infants' VOE performance and prompted giving behavior— Since we hypothesized that infants' altruistic tendencies might be linked to fairness expectations the relation between their performance on the prompted giving task and the proportion of looking in the VOE was examined. Two infants (12-month-olds: n = 1; 15-month-olds: n = 1) gave both toys to the experimenter and were therefore excluded from further analyses. Twenty-eight participants (12-month-olds: n = 13; 15-month-olds: n = 15) produced no response on the prompted giving task and their reactions to the experimenter's requests were categorized according to our coding criteria as follows: shy (n = 11), conflicted (n = 3), unwilling (n = 11), other (n = 3).

Our main analyses focused on infants who gave a toy to the experimenter (n = 27; 12-month-olds: n = 12; 15-month-olds: n = 15). An ANOVA with Condition as a within-subjects factor, and Age and Giving Status (preferred or non-preferred toy) as between-subjects factors showed a marginally significant Condition by Giving Status interaction with a large effect size ($F(1,23)$ = 3.514, p = .074, $\eta_{partial}^2$ = .13). All other main effects and interactions were not significant (all ps > .25). Follow-up analyses separated by Giving Status revealed that for infants who gave their preferred toy to the experimenter (n = 14; 12-month-olds: n = 7; 15-month-olds: n = 7) there was a marginally significant difference between their proportion of looking at the unfair outcome in the experimental condition (M = .57) and their proportion of looking at the unequal outcome of the control condition with a medium effect size (M = .48; $t(13)$ = 1.883, p = .082, d = .50). When examining infants who gave their non-preferred toy to the experimenter (n = 13; 12-month-olds: n = 5; 15-month-olds: n = 8), results showed no significant difference between their proportion of looking at the unfair (M = .50) and unequal outcomes (M = .53; $t(12)$ = .895, p = .388, d = .25). Furthermore, the proportion of looking at the unfair outcome of infants who gave their preferred toy to the experimenter was significantly above chance levels whereas infants who gave their non-preferred toy looked at the unfair outcome at rates no different from chance; see Figure 3 and Table 1. Thus participants' performance on the experimental condition of the VOE was tied to their altruistic tendencies as indexed by their willingness to part with a preferred or non-preferred toy in order to fulfill the experimenter's request.

Our coding revealed that a subset of infants who did not give either toy to the experimenter did so because they were unwilling to share and wanted to keep both toys. Since these infants were reluctant to incur a minimal cost to meet the experimenter's desires, their VOE results were combined with those of infants who shared their non-preferred toy (total n = 24; 12-month-olds: n = 11; 15-month-olds: n = 13) and examined in relation to infants who shared their preferred toy. An ANOVA with Condition as a within-subjects factor, and Age and Giving Status (preferred or non-preferred toy + kept both toys) as between-subjects factors showed a marginally significant main effect of Condition ($F(1,34)$ = 3.194, p = .083,

η_p^2 = .086), qualified by a significant Condition by Giving Status interaction (F(1,34) = 4.756, p = .036, η_p^2 = .123). Follow-up analyses showed that there was no significant difference between the proportion looking at the unfair outcome (M = .51) and the proportion of looking at the unequal outcome (M = .52) of infants who gave their non-preferred toy or kept both toys for themselves (t(23) = .524, p = .606, d = .11). Furthermore, both these proportions did not differ significantly from chance (see Table 1). Thus, the VOE performance of infants who gave their preferred toy to the experimenter (see previous paragraph) differed from the performance of infants who gave their non-preferred toy and those who wanted to keep both toys for themselves. These results further substantiate the link between infants' altruistic dispositions and their fairness concerns.

Our findings suggest that individual differences in infants' fairness expectations at 12-15 months of age are not only tied to experiences with siblings but also to infants' willingness to give up a valued toy. Since both the presence of siblings and prompted giving behavior were related to infants' VOE performance, we examined whether having siblings is related to rates of giving the preferred or non-preferred toy. Of the infants without siblings who responded on the prompted giving task, 7 of 15 gave their preferred toy and of the infants with siblings, 7 of 12 gave their preferred toy (Fisher's exact p = .704). Thus, infants with siblings were as likely to give a preferred toy as infants without siblings, suggesting that experiential factors related to the presence siblings and dispositional factors tapped by the prompted giving task are independent predictors of infants' responses on the VOE task.

Examining relations with motor and language development—In order to ensure that the observed links between giving status and fairness expectations are not merely due to broader developmental differences, we examined whether the two groups differed on measures of language and motor skills. Data on language and motor development were missing for one participant who gave the preferred toy. Analyses showed no difference between the groups in their motor abilities ($M_{preferred}$ = 15.46, $M_{non\text{-}preferred}$ = 18.08; t(24) = .99, p = .332) or vocabulary sizes (receptive: $M_{preferred}$ = 20.38, $M_{non\text{-}preferred}$ = 17.46; t(24) = .56, p = .580, expressive: $M_{preferred}$ = 7.77, $M_{non\text{-}preferred}$ = 6.92; t(24) = .25, p = .808), allowing us to rule out the possibility that infants who gave their preferred toy were overall more developmentally advanced than infants who gave the non-preferred toy.

Moreover, we examined whether looking patterns during the experimental condition of the VOE were linked to these other indices of development across the entire sample. Language and motor development information was missing for one additional participant from the 15-month-old group. There were no correlations between the language and motor development measures and infants' proportion of looking toward the unfair distribution outcome (motor: r = .022, p = .872, receptive vocabulary: r = −.098, p = .476, expressive vocabulary: r = −.029, p = .834).

Experiment 2

In Experiment 1, 12- and 15-month-old infants looked longer at the unfair distribution outcome in the experimental condition of the VOE, yet looked at the control images equally. These findings suggest that participants expected resources to be distributed equally, but

only in the context of a social interaction. The results extend past research (Sommerville et al., 2013), in showing that when outcome images are presented simultaneously (rather than sequentially) in the VOE, 12-month-old infants expect fairness. It has been shown that observation of contrastive, rather than sequential, exemplars allows infants to recognize distinct categories (Oakes & Ribar, 2005). Thus, it is possible that infants in Experiment 1, similarly benefited from directly comparing the two outcomes, which enabled us to detect their fairness expectations.

Infants' performance in the VOE in Experiment 1 was also tied to individual difference factors. First, infants who had siblings, and therefore more opportunities to engage in sharing interactions, displayed greater attention toward the unfair outcome relative to the unequal outcome in the VOE, and looked at the unfair outcomes at above chance levels. Participants with no siblings looked at the unfair and unequal outcomes equivalently. Second, replicating previous findings (Schmidt & Sommerville, 2011), infants' propensity to give an experimenter a preferred toy as opposed to a non-preferred toy was related to fairness expectations. Our findings also go beyond this past work by providing a more comprehensive characterization of non-responders' reactions on the prompted giving task, which enabled us to uncover a group of infants who were unwilling to share since they wanted to keep both toys for themselves. Inclusion of these infants in the analyses showed strong support for the relation between infants' altruistic tendencies and fairness concerns. Interestingly, even though performance on the prompted giving task and the presence of siblings were both related to infants' looking patterns, these factors were not related to one another, suggesting that each of them independently predicts VOE performance.

The present experiment sought to test a younger age group, in order to assess whether the links between fairness expectations and individual differences in prosocial behavior and the presence of siblings, are continuous over development. A sensitivity to fairness may be in place by 10 months of age (e.g., Meristo & Surian, 2013, 2014), and given that sharing occurs naturally by 12 months of age, we opted to test 9-month-olds who are at the cusp of developing the capacity to share. In Experiment 1, our in-lab prompted giving task was meant to tap individual differences in infants' altruistic disposition, but in the current experiment our individual difference measure relied on parental reports of babies' naturalistic sharing, and served to assess whether they have gained experience producing sharing acts on their own. If sharing interactions provide an important experiential source for the development of fairness expectations, only infants who have started sharing should be sensitive to fairness norm violations.

Method

Participants—Thirty-four 9-month-old infants participated in Experiment 2 (M = 9 months 9 days, range: 8 months 25 days – 9 months 28 days; 23 females, 11 males). Data were collected from June to August 2012. Participants were recruited in the same manner as Experiment 1, and demographic information indicated that infants were White (n = 25), Hispanic (n = 1), Mixed race (n = 5), or Other (n = 1). All babies were typically developing and born full-term. Parents' education was predominantly college level or higher (78%). The parents of two infants declined to provide demographic information.

Four other infants were tested but excluded from the final sample due to fussiness ($n = 3$) or procedural error ($n = 1$). The results of one participant were excluded from analysis after data collection due to looking durations of less than 1 second in total toward the unfair outcome, summed across both trials of the experimental condition.

Materials and Procedure—Infants participated in the VOE paradigm described in Experiment 1. Parents completed the motor and vocabulary checklists, and information was collected regarding the presence of any siblings. In addition, at the end of the study, parents were interviewed about their baby's spontaneous sharing behavior. In particular, parents were asked whether their infant was sharing objects, and if so, whether such sharing behavior was limited to interactions with the primary caregiver, or included any other individuals.

Coder Reliability: Infants' looking times toward the outcome images in the VOE task were coded by a second observer. Interobserver agreement was high ($r = .97$, $p < .001$).

Results

Infants' attention to the distribution events and outcomes in the VOE paradigm—As in Experiment 1, raw looking times toward the distribution events and still outcomes in the VOE were converted to proportion scores and averaged for each condition.

Initial analyses of the sample as a whole showed that infants' proportion of looking toward the distribution videos did not differ across conditions (Proportion Experimental = 90%, Proportion Control = 88%, $t(32) = .850$, $p = .402$), however, one additional participant was excluded due to a difference of more than 20% in the proportion of looking at the experimental and control distribution videos, resulting in a final sample of $n = 32$.

Infants' expectations of equal resource distributions—Our initial question was whether babies at this age expect resources to be distributed fairly. A one-sample t-test revealed that participants' proportion of looking toward the unfair outcome during experimental trials was no different from chance levels ($t(31) = 1.67$, $p = .105$, $d = .30$). In the control condition, participants' proportion of looking toward the unequal outcome was not different from chance levels ($t(31) = .24$, $p = .812$, $d = .04$; Figure 2(b)). Thus, as a group 9-month-olds do not show expectations of equal resource distributions.

Relations between infants' VOE performance and the presence of siblings—Sibling information for one participant was missing. Of the infants in our final sample, 17 did not have siblings, and 14 infants had at least one sibling. In order to assess whether the presence of siblings was related to fairness expectations, infants' performance on the experimental and control conditions was compared across the sibling groups. A Condition (Experimental/Control) by Sibling Status ANOVA revealed a marginal main effect of Condition ($F(1,29) = 2.959$, $p = .096$, $\eta_p^2 = .09$) but no interaction between Condition and Sibling Status ($F(1,29) = .844$, $p = .366$, $\eta_p^2 = .03$). Thus, at this age, the presence of siblings did not relate to fairness expectations.

Relations between infants' VOE performance and sharing behavior—Next we examined whether infants' sharing behavior is related to their performance on the VOE. Parents' reports of their infant's sharing were classified into one of three groups: no sharing (n = 7), sharing with primary caregiver only (n = 8), or sharing with primary caregiver and other individuals (n = 13). Responses for 4 participants were missing.

An ANOVA with Condition (Experimental/Control) as a within-subjects factor and Sharing Status (yes/no) as a between-subjects factor showed that the Condition by Sharing Status interaction did not reach traditional levels of significance but the effect size was medium to large (F(1,26) = 2.431, p = .131, η_p^2 = .09). The between-subjects effect of Sharing Status showed a similar trend (F(1,26) = 2.507, p = .125, η_p^2 = .09). Analyzing only infants who have begun to share, either with a parent or more broadly (n = 21), showed a marginally greater proportion of looking toward the unfair (M = .56) relative to the unequal (M = .50) outcome, with an effect size close to medium (t(20) = 1.870, p = .076, d = .41). In contrast, babies who have not yet begun to share (n = 7), showed no differences in their proportion of looking across conditions ($M_{experimental}$ = .47, $M_{control}$ = .50; t(6) = 1.205, p = .274, d = .46).

Critically, as Figure 4 and Table 1 indicate, whereas sharing infants' attention to the unfair outcome was significantly above chance, non-sharing infants' attention to the unfair outcome was not; neither group differed from chance for the unequal outcome. These findings show that only sharing infants have formed expectations of fairness.

Finally, in order to determine whether there was a continuous relation between infants' sharing status (no sharing = 0, sharing with primary caregiver only = 1, and sharing with primary caregiver and other individuals = 2) and their proportion of looking at the unfair outcome, we examined the correlation between these two variables. Infants' sharing status was significantly related to their proportion of looking at the unfair outcome in the experimental condition of the VOE (r_s = .43, p = .022), suggesting that fairness expectations increase linearly as experience with spontaneous sharing interactions increases. Infants' proportion of looking at the unequal outcome in the control condition was unrelated to their sharing status (r_s = .049, p = .806).

Examining relations with motor and language development—To ensure that sharing behavior is not merely a reflection of overall development, we next examined whether infants who do not share at all differ from those who share in some capacity on the other developmental measures we collected. Vocabulary information for one participant was missing. No differences between the two groups in motor abilities ($M_{sharers}$ = 11.81, $M_{non\text{-}sharers}$ = 9.14; t(26) = 1.230, p = .230) or vocabulary size were found (receptive: $M_{sharers}$ = 5.25, $M_{non\text{-}sharers}$ = 1.86; t(25) = 1.626, p = .117, expressive: $M_{sharers}$ = .75, $M_{non\text{-}sharers}$ = .57; t(25) = .388, p = .701), and there were no correlations between these measures and performance on the experimental condition of the VOE (motor: r = .131, p = .475, receptive vocabulary: r = .298, p = .104, expressive vocabulary: r = .082, p = .663). Thus, any differences in babies' sharing behavior, as reported by parents, cannot be attributed to general differences in development. Moreover, similar to the findings of Experiment 1, fairness expectations were uniquely related to babies' sharing status.

Comparing VOE performance across age groups—In order to directly examine developmental differences in infants' fairness expectations, the 9-month-old participants in the current experiment were compared to the 12-month-old participants of Experiment 1 (n = 26). An independent-samples t-test indicated that the proportion of looking toward the unfair outcome in the experimental condition did not differ across the two age groups ($t(56) = .65$, $p = .518$).

Experiment 3

Although the 9-month-old participants in Experiment 2 looked numerically longer to the unfair outcome, this effect did not reach statistical significance. Furthermore, the proportion of looking toward the unfair outcome did not significantly differ when comparing the 9-month-olds in Experiment 2 and the 12-month-olds in Experiment 1. These findings, in combination, suggest that 9 months might be a transitional age for the development of fairness expectations.

Experiment 2 also provides evidence that the onset of naturalistic sharing experiences serves as a predictor of fairness expectations within this transitional period, as only infants who had begun to share, according to parental reports, attended to the unfair outcome in the experimental condition at rates higher than chance. After the period of transition, variability in whether infants gave a preferred toy may reflect more enduring individual differences in their fairness concerns, as shown in Experiment 1. Interestingly, unlike the older age groups, at 9 months of age the presence or absence of siblings was unrelated to infants' fairness expectations, suggesting that the effect of siblings becomes pronounced only once these expectations have been fully established.

The goal of Experiment 3 was to further characterize the developmental trajectory of expectations of fairness, and to corroborate the link with sharing behavior. If the findings of Experiments 1 and 2 are indicative of an age-related shift in fairness expectations between 9 to 12 months of age, and if this change is dependent on the ability to actively perform sharing actions, then infants younger than 9 months, who are not yet sharing, should not exhibit fairness expectations. The current study tested this prediction by assessing whether 6-month-old infants expect fair distributions of resources on the VOE.

Method

Participants—Thirty-four full-term 6-month-old infants took part in Experiment 3 (M = 6 months 3 days, range: 5 months 25 days – 6 months 16 days; 16 female, 18 male). Data were collected from August to October 2012. Infants were again recruited via a university database, and were typically developing. Demographic information indicated that our sample's ethnic composition was White (n = 26), Asian/Pacific Islander (n = 1), Mixed race (n = 3), or Other (n = 3). The majority of parents (85%) held a college degree or higher. Parents of one infant declined to provide demographic information.

One participant was excluded after testing for not looking at the monitors at all during 3 out of 4 outcome presentations. Three infants were excluded from analysis due to looking durations of less than 1 second in total summed across both trials toward the fair or unfair

still outcomes in the experimental condition, summed across both trials. Using the same criterion, the results of two participants were removed from the analyses due to less than 1 second of looking in total toward the equal or unequal outcomes across both trials of the control condition, and one additional infant was excluded due to fussiness.

Materials and Procedure—Infants participated in the VOE paradigm described in Experiment 1. Since the motor and vocabulary checklists were not suitable for babies at this young age, we only collected information about whether participants had siblings as a gage to their potential for observing sharing interactions.

Coder Reliability: Infants' looking times toward the outcome images of the VOE were coded by a second observer. Agreement between the observers was high ($r = .98$, $p < .001$).

Results

Infants' attention to the distribution events and outcomes in the VOE paradigm—Raw looking times toward the distribution events and outcomes were converted to proportion scores and averaged for each condition. Examining the sample as a whole revealed that participants' proportion of looking toward the distribution videos did not differ across conditions (Proportion Experimental = 83%, Proportion Control = 83%, $t(27) = .017$, $p = .987$). Two participants were excluded from further analysis upon examination of the difference in their proportion of looking toward the experimental distribution videos compared to their proportion of looking at the control videos, which exceeded 20%. Thus the final sample included 26 infants.

Infants' expectations of equal resource distributions—A one-sample t-test showed that in the experimental condition infants' proportion of looking at the unfair outcome was no different from chance levels ($t(25) = .778$, $p = .444$, $d = .15$). Participants' looking at the unequal outcome in the control condition did not differ from chance either ($t(25) = 1.194$, $p = .244$, $d = .23$; Figure 2(c)). Thus, as a group, 6-month-olds do not expect resources to be distributed equally, even within a social context.

Relations between infants' VOE performance and the presence of siblings—As in previous experiments, we tested whether the presence of siblings influenced infants' fairness expectations. Out of the 26 participants, 17 had no siblings and 9 had at least one sibling. An ANOVA with Condition as a within subjects factor and Sibling Status as a between-subjects factor yielded no main effects or interactions (all ps > .26) Thus, the presence of siblings did not affect infants' fairness expectations.

Comparing VOE performance across age groups—In order to trace the developmental path of infants' fairness expectations, 6-month-olds' responses on the experimental condition of the VOE were compared to the 12-month-olds in Experiment 1. An independent-samples t-test showed a significant difference between the two age groups ($t(50) = 2.137$, $p = .038$, $d = .59$). The difference between 6- and 9-month-olds' responses on the VOE was not significant ($t(56) = 1.632$, $p = .108$, $d = .42$). Finally, a linear regression was calculated on infants' proportion of looking toward the unfair outcome with age as a

continuous predictor (again including infants in the 6- to 12-month-old age groups). A significant model was found ($F(1,82) = 4.52$, $p = .037$, $R^2 = .052$). Participants' proportion of looking at the unfair outcome increased by .011 with every one-month increase in age. Together, these findings suggest that there is a developmental shift in infants' fairness expectations between 6 and 12 months, and these expectations become more pronounced with age.

Discussion

The first question addressed in the current study was whether expectations of fairness in resource distributions change, or are continuous, across the course of development. In asking this question we sought to uncover the earliest evidence for fairness expectations, to follow their developmental trajectory, and to contribute to the understanding of their developmental origins. Our findings demonstrated group-level transitions from 6 to 12 months of age. At 12 to 15 months of age, as a group, infants looked longer at the unfair distribution outcome relative to the fair outcome in the VOE (but showed no preference for unequal over equal outcomes in the control condition), suggesting that infants at this age expect fair outcomes. Nine-month-old infants did not show group-level fairness expectations, and nor did 6-month-old infants. Importantly, a separate experiment confirmed that the null findings of the experimental condition of Experiment 3 were not due to 6-month-olds' inability to discriminate the outcome images. Infants were habituated to either the fair or unfair static outcome image, and during test trials they were shown both images in alternation. Infants looked longer at the novel image, suggesting that they could tell the two images apart (see Online Supplementary Materials for additional details).

Furthermore, when directly comparing VOE performance across ages, 6-month-olds were significantly different from the 12-month-olds and no different from 9-month-olds in their proportion of looking toward the unfair outcome, yet there was no significant difference when comparing the 9-month-old to the 12-month-old participants. These age trends were further confirmed by a regression analysis. Together, these findings suggest that 9 months of age represents a transitional period in infants' fairness expectations.

A second major question was whether the onset of fairness expectations at 9 months of age is associated with the onset of infants' spontaneous sharing behavior (as assessed by parental reports of naturalistic sharing). We hypothesized that the unique experiences afforded by producing and participating in sharing exchanges might promote the development of fairness expectation. More generally, by examining variability in sharing at this transitional age we sought to identify mechanisms that spur the developmental shift in infants' fairness expectations. Our findings revealed that the proportion of looking toward the unfair outcome was marginally greater than the proportion of looking at the unequal outcome only in the group of babies who had spontaneously began to share, whether with their primary caregiver or more broadly. Sharers' attention toward the unfair outcome was also significantly greater than chance, while their attention to the unequal outcome did not differ from chance. Conversely, babies who were not yet sharing looked at the unfair and unequal outcomes equivalently, and at rates no different from chance levels.

Our findings also revealed age-related predictors of individual differences in infants' fairness expectations at 12 and 15 months of age. First, consistent with past work (Schmidt & Sommerville, 2011; Sommerville et al., 2013), we found that the nature of infants' prompted giving behavior predicted their fairness expectations: infants who gave a preferred toy were more sensitive to violations of fairness than infants who gave a non-preferred toy. These finding suggest that beyond the point of developmental transition in infants' fairness expectations, infants' prompted giving behavior might index meaningful dispositional differences in their altruistic tendencies, which influence how much they care about the effects of unfair distributions. Second, we found that at 12 to 15 months the presence or absence of siblings predicted infants' fairness expectations. Infants with siblings showed enhanced attention to unfair outcomes relative to unequal outcomes whereas those without siblings did not. Interestingly, the presence of siblings was not linked to infants' behavior in the prompted giving task, suggesting that these are two independent predictors of infants' fairness concerns.

Overall, these findings have exposed a developmental transition in the acquisition of fairness expectations that are tied to the experience of sharing. Furthermore, they point to the proliferation of stable individual differences at 12 to 15 months of age that are reflected in infants' prompted giving behavior and predict their fairness expectations.

Across Experiments 1-3 we sought to investigate whether developmental and individual differences in infants' fairness expectations could be explained by general development. To do so, we collected measures of infants' language and motor skills, and related these measures to infants' performance on the VOE. We found that a) individual differences in infants' fairness expectations were not predicted by individual differences in language and motor development and b) there were no differences in performance on these measures as a product of which toy infants gave (Experiment 1), or whether infants were engaging in spontaneous sharing (Experiment 2). Thus, the observed differences between groups as a function of giving status and sharing onset cannot be attributed to broader developmental differences. Importantly, each of these measures predicts specific outcomes in other topic areas. For example, the Motor Abilities Checklist correlates with infants' grip strength (Upshaw, Bernier, & Sommerville, 2016), and infants' receptive vocabulary predicts their ability to generalize an actor's goal across contexts when the goal is verbalized as a preference (Martin & Sommerville, 2015). Such findings lend credence to the use of these measures as developmental indices, and rule out the possibility that a failure to find associations between performance on these measures and infants' fairness expectations and sharing behavior are simply due to the poor predictive value of such measures.

Implications for the role of experience in the development of fairness expectations—Our findings suggest a transition in the development of infants' fairness expectations, which is associated with experience producing sharing actions. Six-month-olds, who have not yet begun to share, did not expect resources to be distributed fairly, at 9 months of age only infants whose parents reported sharing behavior displayed fairness expectations, and 12-15-month-olds were sensitive to fairness as a group. In considering the origin of moral intuitions more broadly and the role of experience in their development it is interesting to compare this trajectory to other domains of morality. For example, it has been

shown that sensitivity to help versus harm arises early, regardless of experience and is continuous across ages. In particular, a consistent preference for helpful individuals has been observed from 3 months of age (Hamlin, Wynn, & Bloom, 2010) to later in toddlerhood (Hamlin, Wynn, Bloom, & Mahajan, 2011). Based on these findings it has been argued that moral intuitions are innate (Hamlin, 2013, Hamlin, Wynn, & Bloom, 2007), however, the current results paint a different picture. Thus, different domains of morality might follow different developmental paths for various reasons. For instance, sensitivity to help and harm might be present early or innate due to its functional importance for survival. Since the fact that 6-month-olds do not expect resources to be distributed fairly does not in itself provide evidence against innateness, and given that the development of fairness expectations seems more protracted and relates to acts of sharing, the model that best fits our findings currently is one of an interaction between innate predispositions and environmental experiences (see Prinz, 2008 for a discussion of how innate foundations and the environment might interact).

Why sharing interactions might matter—Our findings showed that infants' emerging sense of fairness is related to their sharing capabilities. How might performing sharing actions contribute to an understanding of fairness? One idea is that the emerging capacity to share may enhance infants' attention toward similar actions performed by others. It has been shown that after manipulating an object themselves, infants prefer to observe others acting on that same object as opposed to a novel object (Hauf, Aschersleben, & Prinz, 2007). Perhaps then, when babies start to share they become more interested in how others distribute resources and in the outcomes of such events. This heightened attention may result in a qualitative change in how infants perceive these actions, and may aid them in developing an expectation of fair allocations based on such observations.

Alternately or additionally, active participation in sharing exchanges may affect infants' understanding of fairness through their subjective experiences as both the agents and recipients of fair and unfair behavior, which cannot be extracted merely by observation. In the context of causality, it has been suggested that infants' own sense of effort in their causal interventions could contribute to a causal analysis of events involving other agents (Carey, 2009), and similarly, knowledge of their own intentions through active experience could contribute to infants' understanding of other's goals (Sommerville et al., 2005). Thus, by actively sharing, infants might tie their feelings about being the recipients of others' fair and unfair behavior with their own ability to produce fair and unfair outcomes, and through this process they might prefer and expect fair allocations.

A final possibility is that babies already possess intuitions regarding the equal distribution of resources, however, sharing behavior triggers said knowledge and allows babies to express it. Recent evidence in the domain of action understanding demonstrates the potentially broad implications of active experience. In particular, 3-month-old infants were trained to reach for objects, and their responses to an actor's reach over a barrier were subsequently examined. Importantly, during the training period no obstacles obstructed infants' path of motion toward the objects. Results showed that action experience not only enhanced participants' ability to understand the actor's goals, but it also uncovered their preexisting expectation that goal directed actions will be guided by a principle of efficiency (Skerry, Carey, & Spelke, 2013). Similarly, gaining experience in producing sharing acts might "switch on" infants'

preexisting expectation for fairness. One challenge for this perspective, however, is in explaining why observation alone is insufficient for the activation of fairness (or efficiency) concepts.

Due to the correlational nature of our results it is impossible to determine whether participation in sharing interactions drives the changes in fairness expectations that start to emerge at 9 months of age. The possibility that a developing understanding of fairness enhances acts of sharing has not been ruled out, nor has the possibility that a third variable might promote the onset of both fairness expectations and sharing behavior. For example, a shift in infants' level of cooperativeness and sociality at 9 months of age could explain both increased sharing and increased attention to fairness, indeed, it has been suggested that between 9-12 months there are remarkable advances in infants' understanding of others as intentional agents, which manifests in increased participation in social interactions involving joint attention (the so-called "nine-month revolution"; Tomasello, 1999). A stronger test of the direction of the relation between spontaneous sharing and fairness expectations would entail a sharing intervention in which pre-sharing infants have active training in sharing exchanges. If sharing plays a causal role in the emergence of fairness expectations, infants who undergo a sharing intervention should expect resources to be divided up equally.

Processes underlying reactions to fairness violations across development— Our findings show both a group-level transition in infants' fairness expectations in the VOE task, followed by individual variability in responses on the same task at later ages. At both 9 and 12-15 months of age we measured prosocial behavior, that is, infants' willingness to act to benefit another person, and found that two distinct factors contribute to their fairness responses at the different ages: in the younger age group the presence or absence of experience with naturalistic sharing drives the development of fairness expectations, and older infants' degree of altruism, indexed by the relative personal cost they are willing to incur in order to act prosocially, is related to subsequent variability in fairness concerns. Recent work is consistent with the idea that different forms of prosocial behavior may rely on different processes: in older children the number of participants who decide to allocate resources to an anonymous peer increases with age, yet the average amount of resources allocated remains stable across development (Blake & Rand, 2010). The authors suggest these trends point to separate cognitive processes underlying the decision whether to give or not, and the decision how much to give.

We propose that the participation in spontaneous sharing exchanges, and individual dispositional tendencies each play complementary but potentially separable roles in infants' fairness concerns. Critically, in the VOE task infants' attention to an unequal outcome could measure mere detection of a violation of the norm of fair resource distribution and/or could gauge their concerns with such norms, that is, the degree to which infants evaluate adherence to or violations of the norm. Thus, prior to 12 months of age enhanced attention to the unfair outcome may capture infants' ability to *detect* fairness violations. In contrast, at 12-15 months of age the task may tap infants' *evaluation* of such violations. We are suggesting that the underlying processes invoked in response to equal and unequal resource distributions change across these developmental time points. It has recently been shown that already by 13 months of age infants negatively evaluate unfair distributors as evidenced by increased

visual attention toward an image of a previously unfair distributor (versus a fair distributor) when sentences of admonishment were heard in the background, but not when sentences of praise were heard (DesChamps, Eason, & Sommerville, 2015). These findings suggest that in the second year of life infants move beyond mere detection of fairness violations and attach valence to individuals performing fair and unfair actions. If our interpretation of the VOE is accurate, it leads to the testable hypothesis that infants who show increased attention to the unfair outcome will also differentially evaluate fair and unfair distributors only at 12-15 months of age, but not at 9 months of age.

Moreover, if the mechanisms underlying infants' preferential attention on the VOE are different across ages, moving from experiential to dispositional factors, then individual variability in the older age groups should be more predictive of infants' performance in future tasks than individual variability at 9 months of age. This hypothesis could be examined in future research. More generally, the question of whether and how experiential and dispositional factors interact would be interesting to explore. For example, infants who show early naturalistic sharing might also hold more pronounced fairness concerns at 15 months of age, however, this is yet to be determined.

Relations between fairness expectations and siblings—Our results revealed a relation between fairness expectations and the presence of siblings. Daily interactions with siblings could provide infants with richer opportunities for observing and participating in sharing and resource distribution, and with more opportunities to experience fair and unfair outcomes first hand. Indeed, sibling conflict is prevalent in early childhood (Dunn, 1987), primarily revolves around disputes of rights, property, and possession (Dunn & Munn 1987; McGuire et al., 2000), and may be one of the first contexts in which concepts of morality are applied (Smetana, 1997). Our findings show that the presence of siblings was related to infants' fairness expectations only in the older age group such that infants who had siblings looked proportionally longer at the unfair relative to the unequal outcome, yet infants who did not have siblings looked at the two outcomes equally. Only infants with siblings attended to the unfair outcomes at rates higher than chance at these ages. In the 6- and 9-month-old age groups, no differences in looking toward the experimental and control outcomes were observed based on whether infants had siblings or not. These results could be interpreted in at least two ways. First, it is possible that only the oldest age groups accumulated enough experience with sharing exchanges related to the presence siblings, which contributed to the development of fairness expectations. Specifically, with age and increased mobility infants might become more active participants in sharing interactions with siblings, rather than purely observers. Second, perhaps any sibling effects on fairness concerns arise only past the point of developmental transition. That is, the presence of siblings might not contribute to the development of fairness expectations beyond what infants are gaining from their own experiences producing sharing actions, however, once fairness expectations have developed sibling interactions may serve to enhance infants' concern with fairness violations.

We found that the presence of siblings was not linked to infants' performance on the prompted giving task at 12-15 months of age. Since interactions with siblings are an experiential factor whereas infants' prompted giving behavior marks dispositional altruistic tendencies, this finding raises questions regarding the independent role each of these two

factors plays in advancing the development of fairness concerns within a single age group, and how they might interact. Perhaps future studies could shed some light on these questions by exploring the influence of these factors also later in development.

Strengths and Limitations—A notable strength of our study is its within-subjects design, and use of a single task across a wide range of ages. Indeed, the advantage of looking time tasks (the most common measure used in infancy research; Aslin, 2007) is that they overcome the limits of young infants response modalities, and thus facilitate a streamlined comparison across age groups. Furthermore, the VOE task in particular, allowed us to make testable predictions regarding infants' looking patterns assuming fairness expectations are in place. However, we recognize that this task is not without its limitations, as it cannot specify the underlying nature of the psychological process it detects: is it merely expectation or is it the degree to which infants care about the depicted events that drives their attention? In response to such limitations, new methods have been developed with the aim of providing a richer understanding of the root of infants' looking responses (e.g., DesChamps et al., 2015).

Despite the scope of this research, we acknowledge that our participants came from middle to high SES families living in an urban region in the US, and may not represent the fairness expectations of infants from other backgrounds. As previously mentioned, there are marked cultural differences in adults' and children's commitment to equality in resource distribution (Henrich et al., 2005; Schäfer, et al., 2015). Testing babies from diverse backgrounds at different time points could help identify the culture-specific practices that shape later equality expectations.

Though in the current work a relatively large number of participants did not respond in the prompted giving task of Experiment 1, we were able to improve on prior work by identifying the reasons for their lack of response. Based on infants' reactions to the experimenter's prompts, we identified a group of infants who were unwilling to share since they wanted to keep both toys to themselves. Adding this group to the analyses ultimately led to further confirmation of our hypotheses regarding the link between early altruistic dispositions and fairness concerns. As in a previous study using the same task (Schmidt & Sommerville, 2011) we also found evidence of stranger anxiety in a subset of infants who did not respond. Thus, in the future, reducing stranger anxiety by familiarizing infants with the actor in advance might elicit greater response rates and allow us to tap altruistic tendencies in more of the wary infants.

Related to the previous point, we acknowledge that some of our inferences are limited by small sample sizes, and would benefit from replication. Similarly, though our age range is considered quite broad for infant research, examining older infants or tracking infants' performance longitudinally could, for example, uncover whether the individual differences in sharing at 12-15 months are related to other dispositional differences in prosocial tendencies later in life.

Finally, in future research it might be informative to inquire about infants' other social experiences outside of the family, such as attending daycare. Such settings could provide a

rich ground for sharing interactions with peers, which could be an additional or complementary source of individual difference that drives the emergence of fairness sensitivities at a young age.

Conclusion

Our study was the first to test sensitivity to fairness in resource distribution at 6 and 9 months of age, providing a more comprehensive characterization of the developmental trajectory of infants' fairness expectations, and showing that expectations of fairness in resource distribution emerge between 6 to 12 months of age. Moreover, these findings add to previous research by confirming that fairness expectations are in place at 12 months of age, and by demonstrating a link between the onset of sharing and fairness expectations at 9 months. Finally, these results have uncovered that an additional aspect of infants' experience, namely the presence of siblings, relates to fairness expectations at 12-15 months of age. Most generally, our findings shed light on the developmental arc of fairness expectations and by extension perhaps other socio-cognitive or socio-moral sensitivities by showing that a period of developmental transition can be followed by the entrenchment of individual differences, and at each of these phases different factors, dispositional and experiential, could be of influence.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Schematic depiction of the experimental condition (a), and control condition (b) of the VOE paradigm used in Experiments 1-3.

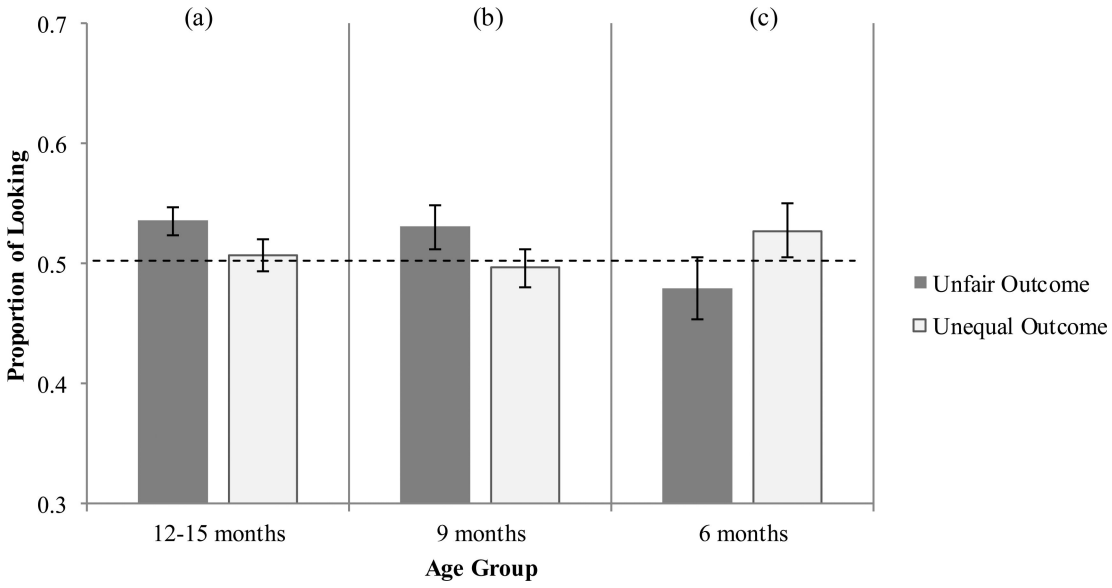

Figure 2.

Proportion of looking toward the unfair outcome in the experimental condition, and the unequal outcome in the control condition of the VOE across age groups. Error bars represent standard errors.

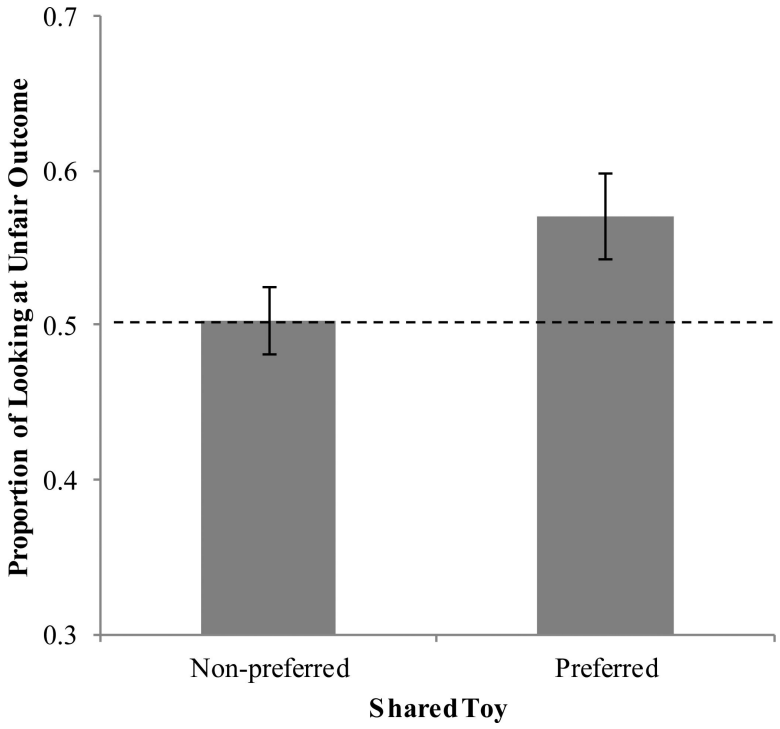

Figure 3.

Experiment 1. Proportion of looking toward the unfair outcome in the experimental condition of the VOE, as a function of whether infants shared their preferred or non-preferred toy in the prompted giving task. Error bars represent standard errors.

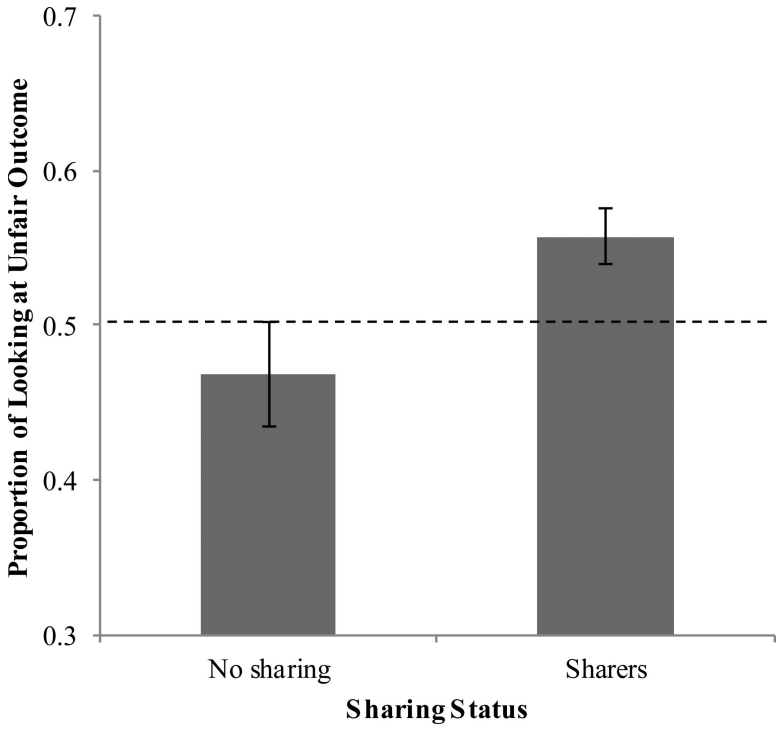

Figure 4.

Experiment 2. Proportion of looking toward the unfair outcome in the experimental condition of the VOE as a function of infants' sharing status. Error bars represent standard errors.

Table 1

Mean proportion of looking at the unfair and unequal outcomes compared to chance level (0.5).

	Condition	Proportion	*p*	*d*
12-15-month-olds				
With siblings (*n* = 25)	Unfair	*M* = .59	*p* < .001*	*d* = .99
	Unequal	*M* = .51	*p* = .68	*d* = .08
Without siblings (*n* = 32)	Unfair	*M* = .49	*p* = .47	*d* = .13
	Unequal	*M* = .51	*p* = .77	*d* = .05
Gave preferred toy (*n* = 14)	Unfair	*M* = .57	*p* = .03*	*d* = .67
	Unequal	*M* = .48	*p* = .63	*d* = .13
Gave non-preferred toy (*n* = 13)	Unfair	*M* = .50	*p* = .90	*d* = .04
	Unequal	*M* = .53	*p* = .08	*d* = .52
Gave non-preferred toy + Kept both toys (*n* = 24)	Unfair	*M* = .51	*p* = .47	*d* = .15
	Unequal	*M* = .52	*p* = .21	*d* = .26
9-month-olds				
Sharers (*n* = 21)	Unfair	*M* = .56	*p* = .005*	*d* = .68
	Unequal	*M* = .50	*p* = .92	*d* = .02
Non-sharers (*n* = 7)	Unfair	*M* = .47	*p* = .38	*d* = .36
	Unequal	*M* = .50	*p* = .96	*d* = .02

*Significantly different from chance