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Not just what you did, but how: Children see distributors that count as more fair than distributors who don't

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ABSTRACT

To distribute resources in a fair way, identifying an appropriate outcome is not enough: We must also find a way to produce it. To solve this problem, young children spontaneously use number words and counting in fairness tasks. We hypothesized that children are also sensitive to other people's use of counting, as it reveals that the distributor was motivated to produce the outcome they believed was fair. Across four experiments, we show that U.S. children (*N* = 184 from the New Haven area; ages four to six; Approximately 58% White, 16% Black, 18% Hispanic, 4% Asian, and 4% other) believe that agents who count when distributing resources are more fair than agents who produce the same outcome without counting, even when both agents invest the same amount of effort. And vice versa, when the same two agents produce an unfair outcome, children now condemn the agent who counted. Our findings suggest that, from childhood, people understand that counting reflects a motivation to be precise and use this to evaluate other people's behavior in fairness contexts.

1. Introduction

There are often multiple ways to be fair. Imagine that three children worked together to pick six apples from a tree, and then needed to decide how to divide the spoils among themselves. Suppose that the first child found the apple tree, the second child climbed the tree to get the apples, and the third child hadn't eaten anything all day. The most straightforward approach to distributing these apples fairly would be to simply give two to each child—an approach called *equality*. Alternatively, we might decide that each child's role should influence the final distribution—an approach called *equity*. For instance, we might decide that merit matters and give four apples to the child who worked the hardest (leaving one apple for each of the other two children); we might decide that need matters and give the lion's share to the hungry child; or we might even decide that whoever found the apple tree should get all six apples, allowing her to decide how to share them with her friends. To complicate matters further, we can also combine these principles rather than endorsing a single one. For example, if we decide that need and merit matter, in that order, we might give three apples to the hungry child, two apples to the main contributor, and one apple to the child who found the tree.

A vast literature has sought to uncover what fairness considerations guide children's behavior in resource-distribution tasks. In third-person looking time paradigms, even infants have intuitions about what it is to be fair. They expect distributors to produce either equal or equitable distributions (Sommerville, Schmidt, Yun, & Burns, 2013; Geraci & Surian, 2011; Sloane, Baillargeon, & Premack, 2012; Surian & Franchin, 2017; although this expectation has limitations; Dawkins, Sloane, & Baillargeon, 2019). In equality paradigms, 15-month-olds are surprised when distributors split rewards unevenly between two similar characters, and prefer fair over unfair distributors by 16 months (Geraci & Surian, 2011; Sommerville et al., 2013). In equity paradigms, by around 21 months old, children are surprised when rewards are given equally following unequal amounts of work (Sloane et al., 2012; Surian & Franchin, 2017).

In third-party paradigms where children have to create or explicitly judge distributions, young children tend to show a preference for equality (Damon, 1975; Huntsman, 1984; Kenward & Dahl, 2011; Shaw & Olson, 2012; Sigelman & Waitzman, 1991). Until around the age of five, children typically produce equal distributions when possible, even in contexts where recipients clearly differ along dimensions of need or merit (Rizzo & Killen, 2016; Schmidt, Svetlova, Johe, & Tomasello, 2016). In the following years, however, children demonstrate an increasing willingness to produce unequal distributions that are justified by either of these dimensions. Five- to six-year-olds, for example, are willing to distribute more than half to one recipient when they differ

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saliently in merit or need (Essler, Lepach, Petermann, & Paulus, 2020; Leventhal, Popp, & Sawyer, 1973; Noh, D'Esterre, & Killen, 2019; Rizzo & Killen, 2016). Children's tendency to produce fair but inequal distributions increases up to the age of eight, culminating in an ability to distinguish valid from invalid reasons for inequality (Schmidt et al., 2016), and to condemn equal distributions when another approach is necessary (Rizzo & Killen, 2016; Wörle and Paulus, 2018).

The work reviewed above points to a potential discrepancy: an understanding of equity (and in particular, a sensitivity to merit) is visible at an earlier age in judgment tasks compared to production tasks. Recent work, however, has begun to close this gap, showing that young children who typically endorse equality (i.e., splitting resources in half) will endorse equity when an equality solution is not possible (e.g., when the child must decide which of two characters should get the larger cookie; Baumard, Mascaro, & Chevallier, 2012; Liénard, Chevallier, Mascaro, Kiura, & Baumard, 2013). These results have led to the hypothesis that previous tasks showing a protracted understanding of merit may only reflect a relative preference for equality. Additionally, though this developmental trajectory has been found across cultures and contexts (Huppert et al., 2019), the endorsement of any particular alternative is influenced by culture and early childhood experience (Elenbaas, 2019a; Engelmann, Zhang, Zeidler, Dunham, & Herrmann, 2021; Schäfer, Haun, & Tomasello, 2015), as well as by group biases (Xiao et al., 2019). Together, these studies indicate that children move from their early preference for equality to more complex, contextual, and culturally based principles of what it means to be fair.

Despite the importance of children's beliefs about *what* is fair, children's behavior is also influenced by a second factor: their knowledge of *how* to be fair. That is, deciding which fairness principles will guide our behavior is only the first step. Returning to the opening example, suppose that the children distributing apples decided to take merit into account. This decision leads to a second question: What kinds of distributions reflect an adequate sensitivity to merit? Would the distribution be fair as long as those who worked harder get more apples (i.e., a rank-based implementation of merit)? Or should the differences in the distribution reflect the differences in merit (i.e., a proportional implementation of merit; Hook, 1978; Hook & Cook, 1979)? Finally, even when these intuitions are clear, children must still solve a third problem: Ensuring that they produce the intended distribution. While these problems might seem trivial for adults, they are likely challenging for young children who have not yet mastered number concepts and counting—an achievement that usually happens around age four; Wynn, 1990; Sarnecka & Lee, 2009; Lee & Sarnecka, 2010; Piantadosi, Jara-Ettinger, & Gibson, 2014)—as children who cannot count have an impoverished ability to create, manipulate, and reason about set distributions (Izard, Streri, & Spelke, 2014; Jara-Ettinger, Piantadosi, Spelke, Levy, & Gibson, 2017).

1.1. An early relationship between number and fairness

Consistent with this analysis, a growing body of work has begun to reveal a deep connection between the development of number cognition and fairness. Children spontaneously invoke number concepts in fairness tasks (and more frequently relative to other conversational contexts; Chernyak, 2020) and they count to ensure that they produce their intended outcome (Chernyak, Harris, & Cordes, 2019; Chernyak, Sandham, Harris, & Cordes, 2016). Indeed, children even use their beliefs about the importance of number to their advantage: In first-person tasks, children will sometimes generate distributions that are numerically matched, but strategically designed so that they can keep the most valuable objects (e.g., keeping two high-value objects and giving the remaining two low-value objects to a recipient; Sheskin et al., 2016).

These results show that children often rely on number and counting when deciding how to apply a fairness principle. Cross-cultural research has found that children's ability to count also affects which fairness principles to they decide to endorse in the first place. Among the Tsimane'—a farming-foraging group living in the Bolivian Amazon—children who can count are more likely to produce merit-based distributions, relative to children who cannot count (Jara-Ettinger, Gibson, Kidd, & Piantadosi, 2015). Critically, Tsimane' children learn to count at radically variable ages (Jara-Ettinger, Piantadosi, et al., 2017; Piantadosi et al., 2014), revealing that this change in fairness behavior reflects counting knowledge, independent of children's age and years in school (which are also highly variable in the Tsimane'). These results suggest that children who cannot count may be reluctant to integrate merit into their distributions because they lack the numerical knowledge needed to derive and produce an appropriate merit-based distribution, therefore defaulting to a simpler egalitarian strategy (see also Hook, 1978; Hook & Cook, 1979).

1.2. The current study

While these previous studies establish an effect of number cognition on fairness, this research has focused on how children act when distributing resources. How do children expect other people to behave in similar tasks? One possibility is that children only consider the value of counting when they are asked to distribute resources, which forces them to consider what actions they'll need to take to ensure that they generate a fair outcome. If so, children may see counting as an optional tool that they find useful, but not a strategy that other people should use when completing the same task. Here, we instead propose that children are sensitive to people's decision to count in resource distribution tasks, and that they use this information when evaluating the fairness of a distributor. Specifically, we hypothesized that children see counting behavior as evidence that a distributor intends to produce a precise distribution that they have in mind. Consequently, if children believe that producing exact (rather than approximate) distributions is important to being fair, they should judge agents who count to produce a fair outcome as more fair than agents who don't count.

This idea is consistent with work showing that children are sensitive to the procedure behind a distribution (rather than attending to outcomes alone). Children prefer impartial procedures (even when they lead to inequality) both when tasked with distributing resources (Shaw & Olson, 2014) and when judging whether a distribution was fair (Grocke, Rossano, & Tomasello, 2015), although this preference develops with age (Dunham, Durkin, & Tyler, 2018). Nonetheless, to our knowledge, no work has explored the role of counting in children's expectations about distributive behavior. If children are sensitive to whether other people count when distributing resources, this would not only advance the idea that young children care about the methodology behind fairness, but it would also provide evidence that children recognize that an intention to produce a precise distribution is an integral part of being fair. This is the focus of our study.

In Experiment 1 we begin with a basic prediction of our account. If children are sensitive to evidence that the distributor aimed to produce a specific distribution, then an agent's level of attention (independent of counting behavior) should influence their fairness judgments. We therefore first test if children believe that an agent who pays attention when they distribute resources is more fair than an agent who is distracted, even when the agents produce identical outcomes. In Experiment 2 we turn to our main question of interest. We test if children believe that an agent who counts as they distribute resources is more fair than an attentive agent who produces the same distribution through an approximate method.

Agents who count to distribute resources usually incur a higher cost in the activity (in terms of time and effort spent). Therefore, it is possible that children may endorse agents who count only because of the effort they invested in distributing resources, and not because of the precision associated with counting (Jara-Ettinger, Gweon, Schulz, & Tenenbaum, 2016; Jara-Ettinger, Schulz, & Tenenbaum, 2020). To test this possibility, in Experiment 3 we contrasted two agents who invested the same time and effort distributing resources, but only one of them counted to produce the outcome. Finally, under our account, counting is not an intrinsically fair activity. Instead, counting provides evidence that the distributor had a precise outcome in mind, and that they were motivated to produce the exact observed outcome. Our account therefore predicts that an agent who counts to produce an unfair outcome should be judged as more unfair than an agent who produces an identical outcome through a rough split. We test this prediction in Experiment 4. Together, these four experiments provide some of the first evidence that young children understand the importance of transforming abstract fairness considerations into concrete action plans, and that they are sensitive to evidence that distributors were motivated to produce the precise outcome that they had in mind.

1.3. General approach

Here, we focused on third-party distributions to ensure that participant judgments were not influenced by their egocentric preferences (Blake, McAuliffe, & Warneken, 2014; Hamann, Bender, & Tomasello, 2014; Kanngiesser & Warneken, 2012; Rochat et al., 2009; Smith, Blake, & Harris, 2013). More specifically, four- to six-year-olds display an appreciation for procedural fairness in a third-party context, but do not consistently endorse procedural fairness in first-person contexts, particularly when such an approach would not favor them (Dunham et al., 2018). A third-party paradigm therefore allows us to probe children's intuitions about the role of precision in fair distributions, without introducing any conflicting self-interest that may affect children's performance. In all tasks, children were introduced to two puppets that helped clean a classroom, with one puppet having worked harder than the other. Next, participants were introduced to two teachers who each distributed ten cookies between the puppets as a reward. The teachers always produced identical resource distributions, varying only in how they produced them.

We began this project by validating that the intuitions motivating this project are shared with US adults. In these studies, we found that adults in the US are sensitive to evidence that a distributor intended to produce an exact outcome, and that their fairness judgments depend on whether the distributor counted or not (see Supplemental Materials for these studies). We then turned to the main focus of our study: How might this intuition emerge in children? A first possibility is that the value of exactness in distributions could be a direct consequence of children's first-hand experience reasoning about number concepts and counting. Under this view, children who do not yet know how to count may have a more ordinal, rank-based, understanding of merit (i.e., those who work harder should get more, but the exact amount is irrelevant; Hook, 1978; Hook & Cook, 1979). Once children learn to count, their developing understanding of cardinalities and exactness may begin to permeate their reasoning about fairness, producing a change to a more quantitative expectation of exactness in fairness. Alternatively, a second possibility is that children have intuitions about the importance of exactness in distributions before they know how to count. If so, then any child who understands the goal of counting should see its value as a tool in fairness tasks, and integrate this understanding when judging other people's distributive behavior.

Our study aimed to provide a first step to address these questions, focusing on four- to six-year-olds. Our lower age boundary was selected because children in the US learn to count at around three-and-a-half (Jacobs, Flowers, & Jara-Ettinger, 2021; Lee & Sarnecka, 2010; Piantadosi et al., 2014; Sarnecka & Lee, 2009; Wynn, 1990). Thus, all participants are likely familiar with the purpose and practice of counting. We set a relatively wide age range to account for the possibility that children may slowly begin to appreciate the importance of counting in fairness after they have learned to count. All stimuli, data, and analyses used in these studies are available at our Open Science Framework repository (See Public Data & Study Materials). Analyses and data visualizations for all experiments were produced in the R programming language, using the tidyverse, PropCI and boot packages (Canty & Ripley, 2017; R Core Team, 2017; Scherer, 2018; Wickham et al., 2019).

1.4. Population characteristics

Though we did not collect demographic data for each individual participant, here we provide summary demographic statistics based on publicly available census data or museum specific reports. 40.7% (n = 75) of our participants were recruited and tested at a museum in New Haven where on average 19% of adult visitors are Black, 58% are White, 13% are Hispanic or Latino, 3% are Asian, 1% are Native American, and 6% are two or more races (Peabody Museum of Natural History, Yale University, 2005). Due to the range of visitors at the New Haven museum, we do not report median income for this source, but we include it below for all other testing sites. 38.5% (n = 71) were recruited and tested at schools in the area surrounding New Haven. We analyzed each testing location by census data according to zip code. On average for these areas, the median income is $86,532 and 6.2% of adults are Black, 68.3% are White, 18% are Hispanic or Latino, 5.1% are Asian, 0.1% are Native American, 0.1% are Native Hawaiian or Pacific Islander, and 3% are two or more races. Additionally, 5.9% (n = 11) were recruited and tested at a nearby museum outside of New Haven, where local median income is $85,769 and 14.7% of adults are Black, 50.8% are White, 27.7% are Hispanic or Latino, 5.5% are Asian, 0.4% are Native American, 0.1% are Native Hawaiian or Pacific Islander, and 3% are two or more races. Finally, 14.6% (n = 27) of participants were tested in lab, recruited using a list obtained primarily through public events in the New Haven area. The median income in New Haven is $41,142 and on average 33% of adults are Black, 30.3% are White, 30.5% are Hispanic or Latino, 4.7% are Asian, 0.4% are Native American, and 4.3% are two or more races.

2. Experiment 1

In Experiment 1 we test the first prediction of our account. If children are sensitive to a distributor's motivation to produce the appropriate outcome, then children should believe that attentive distributors are more fair than inattentive ones. Children watched two teachers distribute cookies between two puppets who put a different amount of effort into a task. Both teachers gave seven cookies to the hard-working puppet and three cookies to the non-hard-working puppet. However, one teacher was distracted, distributing cookies while looking at their phone, while the other teacher was attentive, looking at the cookies as they split them (Fig. 1a-b). If children are sensitive to evidence that an agent was motivated to produce a specific outcome, they should judge that the attentive teacher was more fair.

2.1. Methods

2.1.1. Participants

48 participants (mean age 5.43 years, range 4.02–6.79 years) were recruited and tested at a local museum, local schools, and in lab. Eight additional participants were recruited but not included in the study by decision of a coder (see Results). Based on related research (Jara-Ettinger et al., 2015; Kenward & Dahl, 2011), we expected at least 75% of participant to succeed and we set a sample size $N = 48$ participants such that the power to test if chance is outside a 95% bootstrapped confidence interval is above 0.95 (see Supplemental Materials for details).

2.1.2. Stimuli

Stimuli consisted of a short story, a picture of two puppets, and two videos, each showing a teacher distributing ten cookies between the puppets (Fig. 1a-b). The stories and videos were all shown to participants on a computer or iPad.

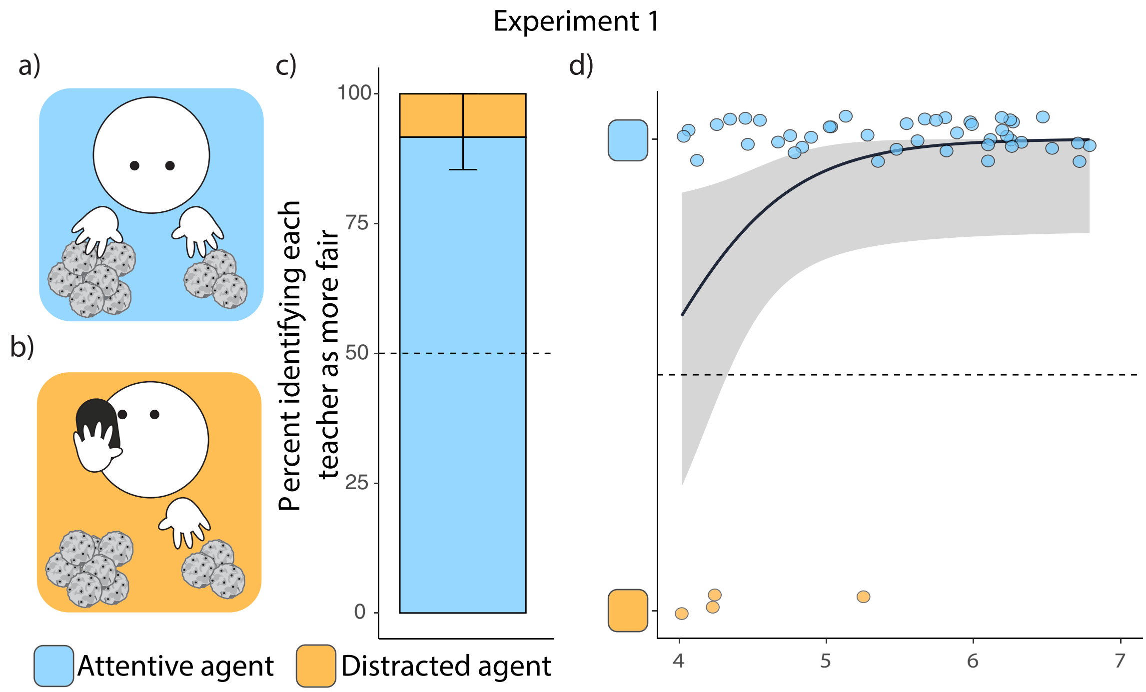

Fig. 1. Distributors used in Experiment 1 and Experiment results. a) Attentive agent. This agent looked at the pile of cookies before reaching in and splitting them in a single motion. b) Distracted agent. This agent distributed cookies while looking at their phone, first moving a pile of cookies towards one agent and then moving the remaining cookies to the second agent. c) Percentage of children identifying each distributor as more fair. Vertical lines show a 95% bootstrapped confidence interval and the horizontal dotted line represents chance. d) Participant responses as a function of age. Each dot represents a participant's answer. The x-axis shows their age, and the y axis shows which teacher they identified as more fair. Data is jittered slightly on the y-axis for visibility purposes but was not jittered on the x-axis. The black line shows a logistic regression fit to the data, with the shaded area indicating standard error.

2.1.3. Procedure

Participants were tested individually in a quiet area, and the child was seated at a table directly across from the experimenter. The experimenter showed the child a picture of the two puppets and introduced them: "Here we have two friends. This is Michael and this is Joey." Children were told that the teachers at school had asked Michael and Joey to help clean the classroom. One puppet had worked very hard and cleaned a lot, while the other puppet did not work very hard and did not clean very much. Introduction order and role of each puppet was counterbalanced across participants. To confirm that participants understood the scenario, participants were asked, "Which friend worked very hard?" and, "Which friend did not work very hard?" If a participant responded incorrectly, the experimenter repeated the story and asked the questions again (no child responded incorrectly more than once). The experimenter then explained that when the friends finished cleaning, the two teachers decided to split a set of cookies between the friends as a reward. The experimenter then showed a video of each teacher distributing cookies between the two puppets (order counterbalanced).

In one of the videos, the teacher held his phone in one hand while pushing seven cookies to the puppet who worked hard, and three cookies to the puppet who did not work hard. Throughout the process, the teacher was clearly looking at his phone and did not look down at the cookies or the puppets (Fig. 1a). When the video ended, the experimenter explained, "This teacher was distracted and not paying attention because he was looking at his phone, and [puppet] got seven cookies and [puppet] got three cookies." In the other video, the teacher split the cookies while looking directly down at them (Fig. 1b). This teacher put his hands in the middle of the pile and split the cookies by spreading his hands. Again, the puppet who worked hard received seven cookies while the puppet who did not work very hard received three cookies. After the video, the experimenter explained that, "This teacher was looking at the cookies and paying attention when he split them up, and [puppet] got seven cookies and [puppet] got three cookies." To control for any actor effects, the identity of each teacher (distracted or attentive) was counterbalanced across participants.

After watching the videos, the experimenter showed participants side-by-side pictures of the two teachers and asked "Which teacher was more fair when he gave the children cookies?" The side each teacher was on (left/right) was counterbalanced across participants. Finally, the experimenter asked a two-part question for inclusion, counterbalancing which question was asked first: "Which teacher was paying attention and when he split the cookies up? And which teacher was distracted?"

2.2. Results

Results were coded by the experimenter immediately after each session. Results were then coded a second time in a two-step process. When parents consented to videotaping ($n = 35$; 72.9% of participants), a coder blind to participant's responses first determined whether the child should be excluded based on the experimental procedure. Once this decision was made, participant's responses to the test and inclusion questions were coded. When parents only consented to audio taping ($n = 1$ participant), coding was analogous to the last case, but using the audio and the experimenter's notes instead. When parents did not consent to audio or video ($n = 12$ participants), the experimenter's notes were used to determine the child's inclusion and performance. Eight participants were excluded and replaced due to experimenter error ($n = 3$) or because they failed an inclusion question ($n = 5$).

Of the 48 participants included in the study, 91.7% ($n = 44$) judged that the attentive teacher was more fair than the distracted teacher (95%

CI, 85.4–100%; See Fig. 1c[1]). We next tested for any developmental change. A logistic regression predicting performance based on age revealed a marginal age difference, with older children more likely to judge that the approximate and attentive teacher was more fair ($\beta = 2.17$; $p = .052$; Fig. 1d). Given this developmental change, we analyzed performance within each age group. 81.25% of four-year-olds ($n = 13$ out of 16; 95% CI: 62.5–100%), 93.75% of five-year-olds ($n = 15$ out of 16; 95% CI: 87.50%–100%), and 100% of six-year-olds ($n = 16$ out of 16) judged that the attentive teacher was more fair. Thus, although children's intuitions became stronger with age, children at all ages were more likely to believe that the attentive teacher was more fair than the distracted one. These results suggest that even four-year-olds believe that an attentive agent is more fair than an inattentive agent, even when both agents produce identical outcomes.

3. Experiment 2

Having established that children are sensitive to a distributor's attention, in Experiment 2 we turn to our main question of interest: Beyond a sensitivity to attention, are children sensitive to an agent's decision to count as they divide resources? The procedure was identical to Experiment 1, but we now contrasted two attentive teachers that produced identical outcomes. The first distributor behaved the same as the attentive teacher we used in Experiment 1, who divided the cookies in a rough split while attending to the task. The second distributor was also attentive, but divided the cookies by counting (Fig. 2a-b). If children see counting as additional evidence that an agent was motivated to produce the exact distribution in mind, they should judge that the agent who counted is more fair than the attentive agent who did not count.

3.1. Methods

3.1.1. Participants

48 participants (mean age 5.49 years, range 4.00–6.93 years) were recruited and tested at a local museum, schools, and in lab. Seven additional participants were recruited but not included in the study by decision of a coder (see Results).

3.1.2. Stimuli

The stimuli were identical to those from Experiment 1, with one exception: Participants saw videos that contrasted a teacher who distributed cookies attentively but in an approximate way (the same agent used in Experiment 1; Fig. 2a) with a teacher who distributed cookies attentively while counting (Fig. 2b). The teacher who counted produced the same distribution as the attentive teacher, giving seven cookies to the child who worked hard and three cookies to the child who did not work hard. To achieve this, however, the agent used their index finger to move the cookies one by one silently.

3.1.3. Procedure

The procedure was identical to Experiment 1 with the difference that the video of the distracted teacher was replaced with a video of a teacher who counted attentively (Fig. 2b). When participants watched the video of the attentive but approximate teacher, they heard an identical explanation to the one in Experiment 1: "This teacher was looking at the cookies and paying attention when he split them up, and [puppet] got seven cookies and [puppet] got three cookies." When participants watched the counting and attentive teacher, the counting was done silently so that both videos would be matched in audio (to avoid low-level differences in attention). After the video, the experimenter explained, "This teacher was paying attention and looking at the cookies and he counted each cookie as he gave them to the children and [puppet] got seven cookies and [puppet] got three cookies." Video order, teacher actors, and hard-working and not hard-working agent were all counterbalanced across trials.

As in Experiment 1, participants were shown side-by-side pictures of the two teachers and asked "Which teacher was more fair when he gave the children the cookies?" Participants were then asked two inclusion questions: "Which teacher just split the cookies up? And which teacher counted each cookie?"

3.2. Results

Results were coded in the same way as Experiment 1 ($n = 47$ from video; $n = 8$ from experimenter notes). Participants who failed to respond correctly to the two inclusion questions were excluded from analysis and replaced ($n = 7$). Of the 48 participants included in the study, 72.92% ($n = 35$) judged that the counting and attentive teacher was more fair (95% CI: 60.42–85.42%; See Fig. 2c). A logistic regression predicting preference for the counting and attentive teacher as a function of age revealed no significant age effects ($\beta = -0.08$; $p = .83$; Fig. 2d).

4. Experiment 3

Our results so far indicate that children's fairness judgments are sensitive to whether distributors count to divide resources. However, it is possible that these judgments reflect a sensitivity to effort alone. That is, children may believe that counting is effortful, and that agents who expend more effort to divide resources must have a stronger desire for the outcome (Jara-Ettinger et al., 2016; Jara-Ettinger et al., 2020). Under our account, however, children are sensitive to counting because it reveals that the distributor wants to ensure that they produce the appropriate outcome. To test if children's sensitivity to counting goes beyond a sensitivity to effort, Experiment 3 contrasted two distributors who put an equal amount of effort into dividing the cookies, with only one of them counting (Fig. 3a-b). If children's previous judgments reflected a sensitivity to effort alone, they should see both agents as equally fair. However, if children were sensitive to an agent's decision to count, they should judge the agent who counted as more fair than the agent who distributed resources in an effortful but approximate manner.

4.1. Methods

4.1.1. Participants

40 participants (mean age 5.48 years, range 4.17–6.90 years) were recruited and tested at a local museum, schools, and in lab. We did not achieve our pre-registered target sample size of 48 participants due to the COVID-19 pandemic. A post-hoc power analysis revealed that the sample size of $n = 40$ was appropriately powered (power = 0.81; see Supplemental Materials). 22 additional participants were recruited but not included in the study by decision of a coder (see Results).

4.1.2. Stimuli

The stimuli in Experiment 3 were identical to Experiments 1–2, with the difference that the cookies were now initially positioned underneath a small cardboard box, and the scene included a stack of ten notebooks. In one of the videos (effortful agent), the ten notebooks were resting on top of the box. To distribute the cookies, the agent began by moving the notebooks out of the way one by one (for a total of ten actions). The agent then removed the box from the cookies and divided them through a rough split (Fig. 3a). In the other video (counting agent), the ten notebooks were underneath the cookie box, such that the agent had direct access to the cookies. The agent removed the box from the cookies and divided them by counting in the same way as the counting agent from Experiment 2 (for a total of ten actions; Fig. 3b).

[1] All reported intervals are 95% bootstrapped confidence intervals using 10,000 samples. Due to limitations of null-hypothesis significance testing (Cohen, 1994; Cumming, 2014) we avoid computing p-values whenever possible.

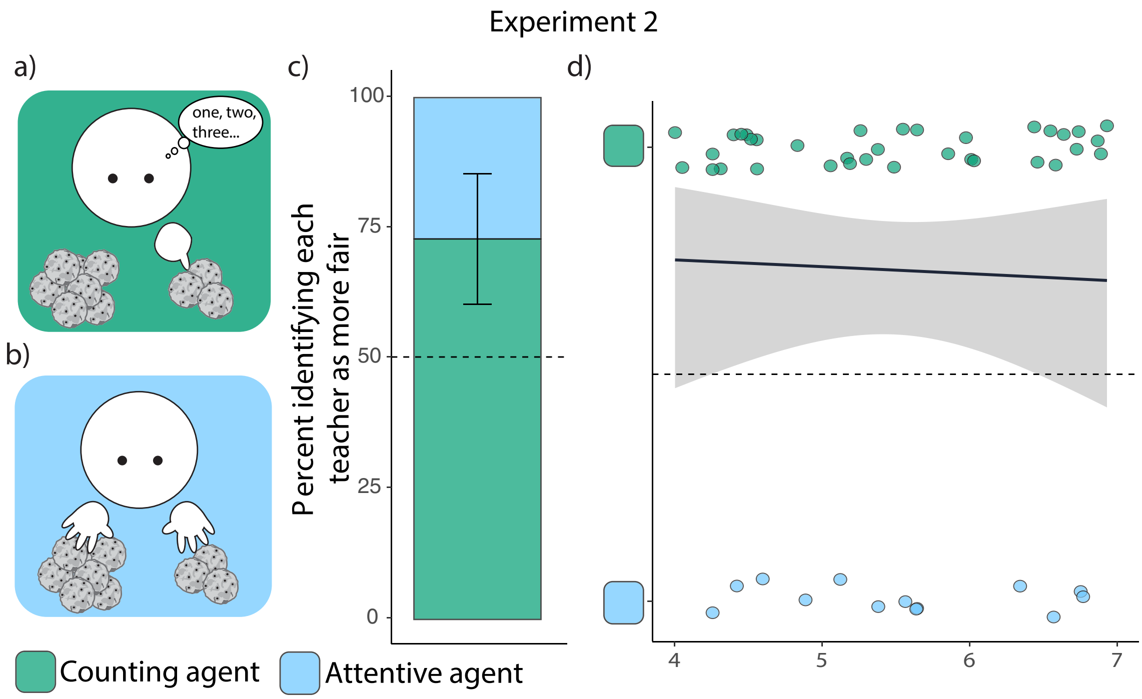

Fig. 2. Distributors used in Experiment 2 and Experiment results. a) Counting agent. This agent counted to distribute the cookies. b) Same attentive agent used in Experiment 1. This agent looked at the pile of cookies before reaching in and splitting them in a single motion. c) Percentage of children identifying each distributor as more fair. Vertical lines show 95% bootstrapped confidence intervals and the horizontal dotted line represents chance. d) Participant responses as a function of age. Each dot represents a participant's answer. The x-axis shows their age, and the y axis shows which teacher they identified as more fair. Data is jittered slightly on the y-axis for visibility purposes but was not jittered on the x-axis. The black line shows a logistic regression fit to the data, with the shaded area indicating standard error.

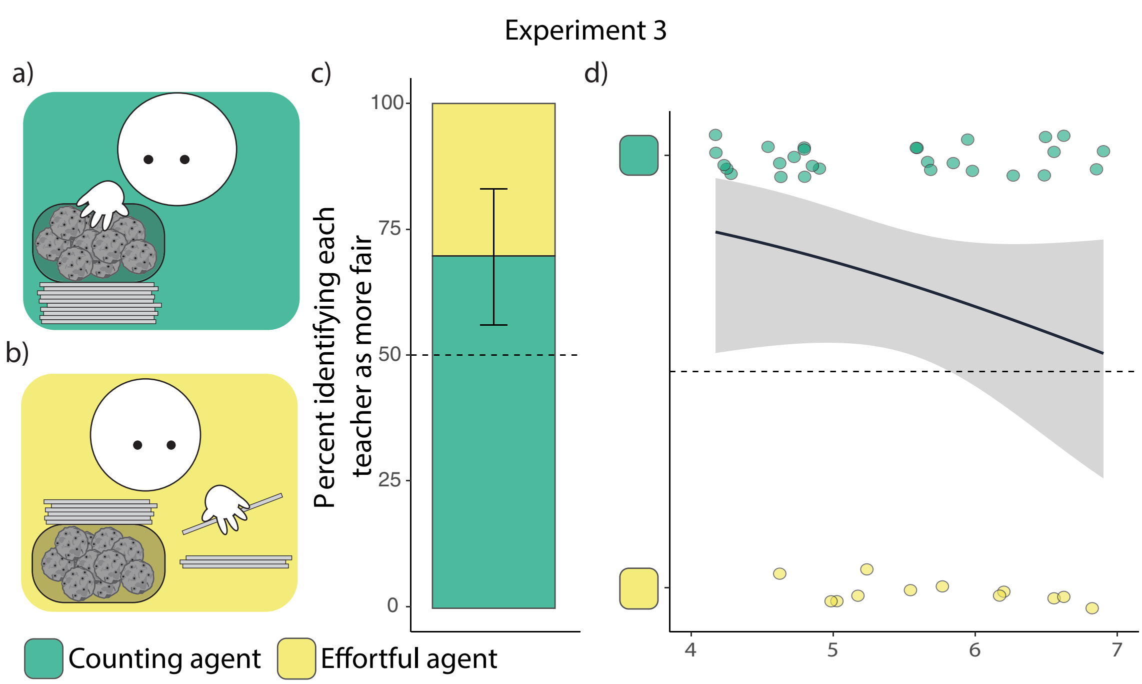

Fig. 3. Distributors used in Experiment 3 and Experiment results. a) Counting agent. This agent counted to distribute the cookies in the same way as the counting agent from Experiment 2. b) Effortful agent. This agent moved each book from on top of the box of cookies individually, before looking at the pile of cookies and splitting them in a single motion (in a similar way to the Attentive agent in Experiments 1 and 2). c) Percentage of children identifying each distributor as more fair. Vertical lines show 95% bootstrapped confidence intervals and the horizontal dotted line represents chance. d) Participant responses as a function of age. Each dot represents a participant's answer. The x-axis shows their age, and the y axis shows which teacher they identified as more fair. Data is jittered slightly on the y-axis for visibility purposes but was not jittered on the x-axis. The black line shows a logistic regression fit to the data, with the shaded area indicating standard error.

4.1.3. Procedure

The procedure was the same as Experiments 1–2. Children were introduced to two puppets, learned about their relative contribution towards cleaning their classroom, and then learned that two teachers would each distribute ten cookies. Participants then watched the videos of the teachers distributing cookies (presentation order counterbalanced). After watching the agent who first moved the notebooks and split the cookies approximately (see Stimuli), the experimenter explained: "This teacher was paying attention and she was looking at the cookies and she had to move each book from the box, then she just split them up." Similarly, after watching the agent who counted to distribute the cookies (but did not have to move the notebooks; see Stimuli), the experimenter explained: "This teacher was paying attention and looking at the cookies and she counted each cookie as she split them up." Both videos ended with the hard-working puppet receiving seven cookies while the not hard-working puppet received three cookies. Participants were then shown side-by-side pictures of the two teachers and asked the test question: "Which teacher was more fair when she gave the children the cookies?" Children were then asked the inclusion questions: "Which teacher had to move each book, then just split the cookies up? And which teacher counted each cookie?"

4.2. Results

Results were coded in the same way as Experiments 1–2 ($n = 48$ from video; $n = 9$ from audio; $n = 5$ from experimenter notes). Twenty participants were excluded from analysis and replaced because they failed to respond correctly to the two inclusion questions, and two additional participants were excluded because of family interruption during the testing session. Of the 40 participants included in the study, 70% (95% CI: 57.5–85.0%; $n = 28$; See Fig. 3c) responded that the counting teacher was more fair. A logistic regression predicting preference for the counting teacher as a function of age revealed no significant age effects ($\beta = -0.5$; $p = .228$; Fig. 3d).

5. Experiment 4

Experiments 1–3 show that children believe that an agent who counts when distributing resources is more fair than an agent who produces an identical outcome through a rough split. Under our account, this is because counting reveals that the distributor was motivated to ensure that they produced a precise outcome. If this is the case, then a distributor who counts to produce an *unfair* outcome should be perceived as less fair than an agent who does not count. We test this prediction in Experiment 4.

5.1. Methods

5.1.1. Participants

48 participants (mean age 5.50 years, range 4.03–6.93 years) were recruited and tested at a local museum, schools, and in lab. 15 additional participants were recruited but not included in the study by decision of a coder (see Results).

5.1.2. Stimuli

The stimuli in were identical to the stimuli used in Experiment 2 with the difference that the teachers now gave seven of the ten cookies to the agent who worked less hard and only three cookies to the agent who worked hard.

5.1.3. Procedure

Experiment 4 was identical to Experiment 2, except that the child who worked harder received three cookies in both videos, and the child who did not work hard received seven cookies in both videos. Participants were then shown side-by-side pictures of the two teachers and asked the test question: "Which teacher was very unfair when he gave the children the cookies?" Children were then asked the inclusion questions: "Which teacher just split the cookies up? And which teacher counted each cookie?"

5.2. Results

Results were coded in the same way as Experiments 1–3 ($n = 48$ from video; $n = 5$ from audio; $n = 10$ from experimenter notes). Fourteen participants were excluded from analysis and replaced because they failed to respond correctly to the two inclusion questions, and one additional participant was excluded because the child did not speak English. Of the 48 participants included in the study, 68.75% (95% CI: 56.25–83.28%; $n = 33$; see Fig. 4c) judged the counting teacher was very unfair. A logistic regression predicting preference for the counting and attentive teacher as a function of age revealed no significant age effects ($\beta = 0.45$; $p = .24$; Fig. 4d).

6. General discussion

To distribute resources in a fair way, people must decide what outcome to produce and ensure that they implement it correctly. Reflecting the difficulty of implementation, even young children spontaneously rely on their ability to count when tasked with distributing resources (Chernyak et al., 2019). Here we proposed that, when judging other people's distributive behavior, children are also sensitive to how the distributor acts to guarantee that they produce their intended outcome. Consistent with this proposal, Experiment 1 showed that four- to six-year-olds believe that agents who pay attention while they distribute resources are more fair than those who are distracted. Experiment 2 next showed that children of the same age believe that agents who count are more fair than those who distribute resources in an approximate manner. Experiment 3 revealed that this effect was not due to a simple sensitivity to effort (i.e., the belief that counting is effortful, and effort reveals motivation; Jara-Ettinger et al., 2016; Jara-Ettinger, Floyd, Tenenbaum and Schulz, 2017). Finally, Experiment 4 showed that children condemn agents who count to produce unfair outcomes, revealing that children do not see counting as intrinsically fair, but rather as evidence that the agent intended to produce precisely the observed outcome.

While our results suggest that children's judgments go beyond a sensitivity to effort, a wealth of evidence shows that even young children and infants understand that the costs that agents incur reveal their desire for the outcome (Aboody, Zhou, & Jara-Ettinger, 2021; Jara-Ettinger et al., 2015; Jara-Ettinger et al., 2016; Liu, Ullman, Tenenbaum, & Spelke, 2017; Lucas et al., 2014). Our results do not suggest that children are insensitive to effort, but show that the value that children place on counting goes beyond the effort that it demonstrates.

Our findings add to a growing body of work showing that children's judgments about fairness are not focused on outcome alone, and are also sensitive to the underlying distributive procedure (Dunham et al., 2018; Grocke et al., 2015; Shaw & Olson, 2014). Our study goes beyond this past work by showing that children are sensitive to an agent's motivation to ensure that they produce the intended outcome. These results are consistent with children's propensity to count when they distribute resources (Chernyak et al., 2016; Jara-Ettinger et al., 2015), but go beyond this work by suggesting that children do not conceptualize counting as an optional tool that only comes to mind when they are asked to distribute resources. Instead, children understand that other agents also confront the problem of how to implement a fair outcome and are sensitive to evidence that distributors are motivated to solve this problem.

There are several alternative interpretations to our study that we hope to address here and in future research. One possibility is that children's fairness judgments are driven by beliefs about competence. Related research has shown that competence produces a *halo effect*, such that people use a single positive characteristic to make global and unrelated positive judgments (Brosseau-Liard & Birch, 2010; Fusaro,

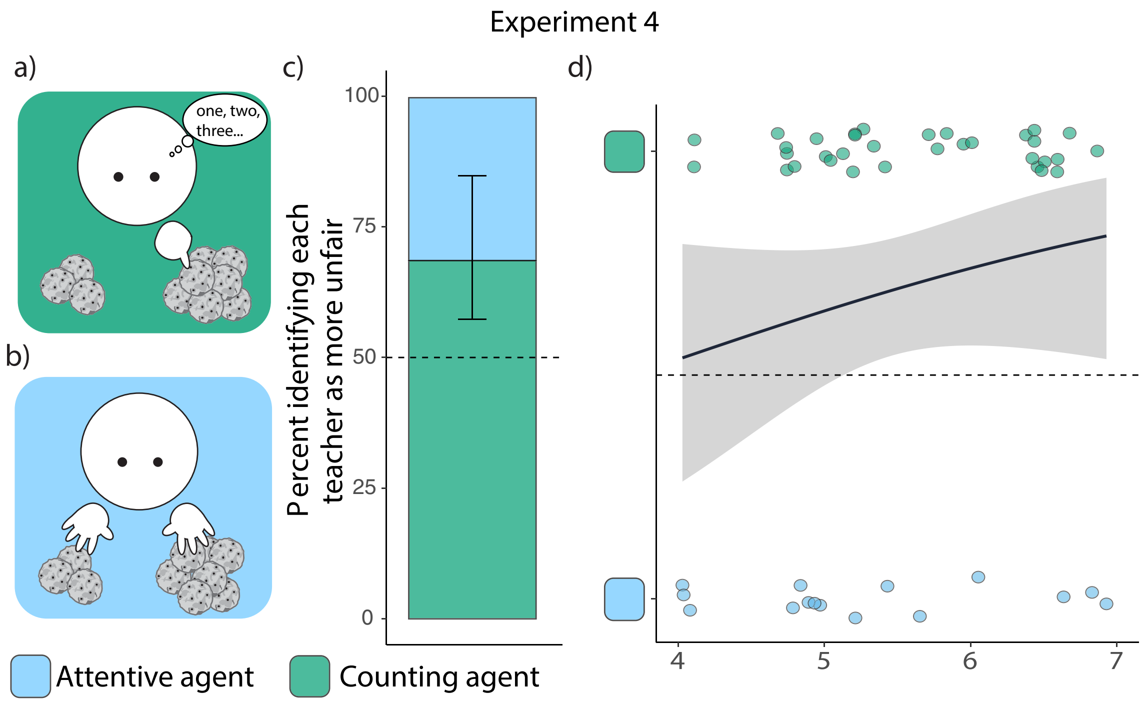

Fig. 4. Distributors used in Experiment 4 and Experiment results. a-b) The same counting agent and attentive agent used in Experiment 2, with the difference that the agents now produced identical unfair outcomes, giving fewer cookies to the harder-working child. c) Percentage of children identifying each distributor as more unfair. Vertical lines show 95% bootstrapped confidence intervals and the horizontal dotted line represents chance. d) Participant responses as a function of age. Each dot represents a participant's answer. The x-axis shows their age, and the y axis shows which teacher they identified as more unfair. Data is jittered slightly on the y-axis for visibility purposes but was not jittered on the x-axis. The black line shows a logistic regression fit to the data, with the shaded area indicating standard error.

Corriveau, & Harris, 2011; Landrum, Pflaum, & Mills, 2016; Nisbett & Wilson, 1977). Under this view, children may have believed that the teacher who counted was more competent, and therefore concluded that she was also more fair. Though this effect is well-founded in prior literature, we believe it to be an unlikely explanation of children's judgments here for two reasons. First, children in Experiment 4 judged the agent who counted (to produce an unfair distribution) more negatively than the agent who did not count. If children were making broad positive attributions towards the agent who counted, they should judge the counting agent more positively than the approximate one. This is the opposite of what we found. Moreover, it is not clear if children perceive counting as the most competent distribution procedure in our task. Considering that the approximate agent spent less time and effort to create the same outcome in Experiment 2, they may just as reasonably infer that the approximate agent is more competent than the counting agent. Nonetheless, our study is limited in that our results focused on a single dependent variable and children were not asked to explain their decisions. We therefore do not know how much competence children attributed to each agent (as well as other attributions they might have made for each agent). This is a direction that we hope to explore in future work.

Another related possibility is that children in our task were not sensitive to counting per se, and they were instead sensitive to a behavioral feature that correlates with counting, such as time or carefulness distributing resources.[2] Experiment 3 provides some initial evidence against these possibilities. In this experiment, the approximate agent spent more time distributing resources, but children nonetheless judged the counting agent as more fair (see Supplemental Materials for timing details). Similarly, the two distributors took the same number of actions and they put an in equal amount of overall effort, but children did not perform at chance. This being said, it is possible that children make fine-grained distinctions between effort and care dedicated to accessing resources (such as moving objects out of the way in Experiment 3), and the effort and care dedicated to splitting up the resources afterwards. If children disregard all actions prior to touching the resource pile, they may rate our counting agent as more fair due to the additional caution they demonstrate while distributing resources.

Such explanation would raise an interesting question: Why would children believe that people who are more careful when they distribute resources are also more fair? One possible explanation is that children believe that agents that are more careful must have a stronger motivation to be fair. This explanation is similar to ours, with the difference that our account posits that what matters is the care invested into producing a specific and precise distribution, as opposed to carefulness applied to any dimension of a resource distribution. Nonetheless, it is also possible that children have a more general association between fairness and carefulness that is unrelated to exactness and precision. These two accounts make different predictions. For instance, imagine an agent who distributes resources in an approximate way and a second agent who puts a lot of care into placing the resources in a very specific spatial pattern (e.g., placing them in a happy face pattern), but both produce the same numerical outcome. According to the general carefulness account, children should judge the distributor who made a happy face with cookies as more fair. By contrast, our account predicts that this type of carefulness towards spatial order is irrelevant. This is an open

[2] This concern would be even more serious if children did not realize that one of the agents was counting, as counting was performed silently (with the goal of matching the videos auditorily). Note, however, that the experimenter always explained that the teacher was counting, and our task included an inclusion question that ensured children could recall which distributor had counted ("can you remind me, which teacher counted each cookie as they split them up?").

question that we hope to explore in future work.[3]

That being said, it is possible that children in our task were inferring that an agent was fair not from the physical act of counting, but from other cues to intentionality (beyond effort, care, or time, discussed above), such as spending more time staring at the distribution, or physically interacting with the objects.[4] We believe this is a concern that can only be addressed with new data. For instance, future research should test a case where two agents take visually identical actions, giving the impression that they are counting, but children are told that one of them was counting, while the other was touching the cookies to feel their texture.

Our results open several additional questions for future work. First, our task focused on situations where recipients differed in merit. This was a practical choice, as our task required introducing agents that used an approximate method to produce fair outcomes. If the two recipients did not differ along any meaningful dimension, then only an equal resource split could be considered fair. In this case, children might find it surprising that a distributor who split things in a rough manner managed to produce an exactly equal split, as people perceive exact divisions as non-random (Griffiths & Tenenbaum, 2001). Confronted with this, children might infer that this agent was highly competent and able to produce any precise split without counting. By introducing a merit difference, we were able to create situations with fair, unequal outcomes which could be more reasonably generated by agents who did not count. In future work we hope to explore how children react to agents who do not count, but nonetheless produce an outcome that implies attention to precision.

Our focus on merit and our sample population also raises questions about how our results may apply to other contexts or cultures. While we focused on merit here for practical reasons, the appreciation of merit as a fairness principle varies across cultures (as part of a broader set of variable intuitions in fairness; Schäfer et al., 2015; House et al., 2020; Huppert et al., 2019). Regardless of which societal norm informs the ideal outcome, however, counting and other indicators of precision may continue to play a role in fairness judgments. Procedural precision indicates attention to evaluating what each person deserves, and a dedication to producing exactly the desired outcome. That said, it is possible that intuitions about the importance of precision, and counting as a signal thereof, are heightened by a cultural emphasis on merit as a fairness principle. Additionally, research indicates demographic differences, such as gender or SES, can have an effect on children's fairness behaviors (Cowell et al., 2017; Benenson, Pascoe, & Radmore, 2007; Fehr, Bernhard, & Rockenbach, 2008). As we did not collect participant specific demographics, and only tested within WEIRD populations (i.e., Western, educated, industrialized, rich, and democratic), our study is limited in its ability assess how these factors influence the generalizability of our findings (Henrich, Heine, & Norenzayan, 2010). Future work may explore how children's intuitions about precision and fairness vary by culture or individual demographics, and how they may apply to fairness norms other than merit.

Our work also opens the question of whether children can infer merit differences by watching agents distribute resources. If children trust that the outcome produced by a counting agent reflects the agent's beliefs about what each party deserves, then this outcome can reveal differences between the recipients. For instance, children might be more likely to infer a difference in merit if they see an agent produce an unequal outcome through counting, than if they watch an agent produce an unequal outcome in an approximate manner (provided that children believe that neither agent intended to be unfair). Future work may explore this possibility.

Finally, our results raise questions about how the development of number cognition affects children's reasoning about resource distributions. Our task focused on four- to six-year-olds, such that all of our participants were most likely able to count (an achievement that usually happens at around age three-and-a-half in the US, and in particular in the New Haven area; Jacobs et al., 2021). Would children who cannot yet count also appreciate the value of counting in fairness tasks? This question is particularly important when considering that counting is not culturally universal (Frank, Everett, Fedorenko, & Gibson, 2008) and that its acquisition timeline can vary greatly across cultures (Piantadosi et al., 2014). While past work has found that children's behavior in fairness tasks changes when they learn to count (independent of the age when they learn it; Jara-Ettinger et al., 2015), we do not know whether children's expectations about others also change when they learn to count. We hope to explore this question in future work.

Relatedly, children in our study succeeded on all experiments, independent of age (with only Experiment 1 showing a marginal age effect, but capturing only an age-related improvement, rather than a switch from failure to success). The lack of developmental effects suggests that children's intuitions about the role of counting in fairness might emerge at an earlier age than we tested. Specifically, children may understand the purpose of counting before they can count themselves (Gelman & Gallistel, 1986). If children already believe that precision is an important aspect of being a fair distributor before knowing how to count, then even younger children might show the same intuitions that we documented here. Alternatively, it is also possible that children undergo a conceptual shift once they learn to count, producing a similar expectation rather abruptly. If this is the case, then we would expect a sharp transition in sensitivity to counting as a distributive procedure when comparing children who cannot count with children who can count. As we did not measure participants counting abilities directly, our work leaves open the question of whether this intuition emerges gradually, or if it undergoes a sharp change when children master the logic of counting.

In line with prior research, these potential explanations also raise the question of how understanding of available procedures may influence what children believe to be the most fair outcome (Jara-Ettinger et al., 2015). For instance, younger children may initially have an ordinal understanding of fairness, which does not capture an expectation that differences in resources should be proportional to differences in merit. Then, as children come to recognize counting as a reliable method for others to create exactly proportional divisions, and develop abilities to evaluate what these proportions should be, they may develop a preference for these outcomes (Hook & Cook, 1979). This possibility points to a broader question relevant to our work here: Given that children care about procedure when judging fairness and when creating distributions themselves, to what extent do distributive procedures constrain and reinforce particular fairness ideals throughout development? For example, children may never come to expect exactly proportional divisions in a culture without a system of integers, as they lack the tools to create or evaluate this distribution precisely. In other words, our understanding of how to be fair and to implement resource divisions may in turn influence what we believe to be fair. We hope to explore this more in future research.

Finally, it is worth noting that Experiments 1 through 3 asked participants to answer relative fairness judgments (who was more fair?) rather than absolute ones (was this fair?). This enabled us to elicit children's transitive judgments across experiments, showing that children prefer an attentive but approximate distributor over a distracted one (Experiment 1), and a counting distributor over the attentive but approximate distributor (Experiment 2). These results raise the possibility that, like adults, young children already see different agents' fairness as a continuum rather than as categorical (see also Elenbaas, 2019b). Note, however, that Experiment 4 did not use a relative question

[3] A parallel argument and prediction can be made about time. If children believe that time spent distributing resources means an agent is more fair, then the slower an agent moves as they distribute resources, the more fair they should be perceived relative to an agent who takes the same actions in a swifter manner. This is also an open question.

[4] We are grateful to an anonymous reviewer for raising this possibility.

("which teacher was very unfair") and we therefore do not know if these relative judgments extend to judgments of unfairness. In future work we hope to explore how graded judgments of fairness are influenced by a distributor's method in a within-subjects design.

Altogether, our work adds to literature showing that even young children make nuanced judgments of fairness that go beyond a sensitivity to outcomes. Instead, four- to six-year-olds believe that methodology matters in distributive tasks, and they expect fair agents to act to ensure they produce their intended outcome. These results show an early appreciation of algorithmic fairness, and emphasize the need for more work which explores the rich connection between children's abstract beliefs about fairness and their understanding that these abstract ideals must ultimately be grounded in concrete action plans.

Public data & study materials

For all study materials and public data please see our OSF repository: https://osf.io/2kp9e/

Credit_author_statement

MF, RA, and JJE conceptualized experiments 1, 2, and 4. CJ and JJE conceptualized experiment 3. MM, MF, and JJE conceptualized studies in supplemental materials. CJ and MF led data collection with help from RA and MM. CJ analyzed the data and generated the figs. CJ and JJE wrote the manuscript.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cognition.2022.105128.

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