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Explaining early moral hypocrisy: Numerical cognition promotes equal sharing behavior in preschool-aged children

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Abstract

Recent work has documented that despite preschool-aged children's understanding of social norms surrounding sharing, they fail to share their resources equally in many contexts. Here we explored two hypotheses for this failure: an *insufficient motivation hypothesis* and an *insufficient cognitive resources hypothesis*. With respect to the latter, we specifically explored whether children's numerical cognition—their understanding of the cardinal principle—might underpin their abilities to share equally. In Experiment 1, preschoolers' numerical cognition fully mediated age-related changes in children's fair sharing. We found little support for the insufficient motivation hypothesis—children stated that they had shared fairly, and failures in sharing fairly were a reflection of their number knowledge. Numerical cognition did not relate to children's knowledge of the norms of equality (Experiment 2). Results suggest that the knowledge–behavior gap in fairness may be partly explained by the differences in cognitive skills required for conceptual and behavioral equality.

1 | INTRODUCTION

Fairness, or the ability to share resources in a way that accords with mutually recognized principles of justice, is a hallmark of human cooperation and a critical cognitive milestone of early childhood. Our ideas about fairness form quite early: young children report that they *ought* to share resources equally with others (Smith, Blake, & Harris, 2013). They are also quick to recognize when others have violated norms of equal sharing behavior (Geraci & Surian, 2011; LoBue, Nishida, Chiong, DeLoache, & Haidt, 2011; Olson & Spelke 2008; Rakoczy, Kaufmann, & Lohse, 2016; Schmidt & Sommerville, 2011; Sloane, Baillargeon, & Premack, 2011; Ziv & Sommerville, 2017). Yet, when given the chance to act on these beliefs, it is striking that young children fail to actually share fairly with others in many contexts (Blake & McAuliffe, 2011; Fehr, Bernardt, & Rockenbach, 2008; Kogut, 2012; McAuliffe, Blake, Kim, Wrangham, & Warneken, 2013; Posid, Fazio, & Cordes, 2015; Shaw et al., 2014). That is, in spite of the importance that children place on equal sharing during the first few years of life, the behavioral manifestation of fairness is a relatively later-developing phenomenon. Thus, young children appear to be moral hypocrites with regard to fairness: a phenomenon that has been referred to as the 'knowledge–behavior gap' (Blake, McAuliffe, & Warneken, 2014; Smith et al., 2013). To date, the knowledge–behavior gap of fairness in early childhood is well documented but its underlying cognitive processes are poorly understood.

In this work, we consider two possibilities for how and why children display such moral hypocrisy. One possibility may be that young children lack the requisite motivational capacity to share their own resources equally (*insufficient motivation hypothesis*), and prior work has tended to explain failures in sharing with respect to this hypothesis. This hypothesis derives from the fact that children are not strangers to fairness. By preschool age, children begin to believe that equal sharing behavior carries normative force (they answer that they 'should' distribute resources equally between others (Rakoczy et al., 2016; Smith et al., 2013) and by late preschool, children tend to split resources equally between two third parties—a situation that is not costly to children and in which their own motivation is not at stake (Chernyak & Sobel, 2016; Chernyak, Sandham, Harris, & Cordes, 2016; Olson & Spelke, 2008). Thus, failures to engage in costly equality may result from a motivation to retain advantages over others (Sheskin, Bloom, & Wynn, 2014; Sheskin et al., 2016), a lack of interest in appeasing the other recipient (e.g. Moore, 2009), or a lack of motivation to appease third-party observers (see Shaw, 2013). On this account, the knowledge–behavior gap appears not because children are incapable of engaging in behavioral fairness, but simply because they do not want to.

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We propose an additional, non-mutually exclusive, hypothesis: the *insufficient cognitive resources hypothesis*, which suggests that young children may lack cognitive prerequisites that would enable them to act in accordance with social norms. Active equal resource distribution, unlike knowledge of social norms, may require the coordination of advanced behavioral and cognitive abilities that children are still developing. Indeed, recent work has indicated that children's sharing behavior might be linked with socio-cognitive abilities that develop during the preschool years, such as theory of mind (Moore & Macgillivray, 2004), self-regulation (Blake, Piovesan, Monitnari, Warneken, & Gino, 2015), cognitive control (Steinbeis, 2018), and prospective reasoning (Sebastián-Enesco & Warneken, 2015). Moreover, prior work has found correlations between such socio-cognitive abilities and moral reasoning more generally (Astington, 2004; Lane, Wellman, Olson, LaBounty, & Kerr, 2010; Smetana, Jambon, Conry-Murray, & Sturge-Apple, 2012).

One important, but relatively underexplored cognitive prerequisite is children's numerical cognition. During the preschool years, children acquire a verbal, integer-based representation of number, namely verbal counting (Le Corre & Carey, 2007; Le Corre, Van de Walle, Brannon, & Carey, 2006; Wynn, 1990, 1992). In particular, they not only gain knowledge of the count list, but also a deeper understanding of counting principles. One critical development is an understanding of the cardinal principle—the rule that the last item in a count list represents the cardinality of the set. Understanding cardinality should be critically linked to the ability to ensure that each recipient has created two equal sets (Izard, Steri, & Spelke, 2014; Muldoon, Lewis, & Francis, 2007; Muldoon, Lewis, & Freeman, 2009; Sarnecka & Wright, 2013). Indeed, prior work suggests that in third-party cases (Chernyak, Sandham et al., 2016; Jara-Ettinger, Gibson, Kidd, & Piantadosi, 2016; Squire & Bryant, 2002a, 2002b), in which children's own motivation is not at stake, number knowledge plays a critical role in shaping children's sharing behavior, and thus might be an important prerequisite for sharing resources fairly (see also Frydman & Bryant, 1988). For example, such prior work finds that the ability to divide resources equally among others is influenced by children's acquisition of the cardinal principle of counting (Chernyak, Sandham et al., 2016), or by the extent to which the division problem resembles prototypical sharing problems (Squire & Bryant, 2002a).

Although these previous studies investigating sharing in third-party contexts are suggestive, they cannot speak to the knowledge–behavior gap. In all of the above-cited cases, the sharing scenarios that children were presented with were not costly to them—that is, creating a fair scenario did not require that children take resources away from themselves—and thus did not require motivational capacity. A critical test of our hypotheses involves using a costly, first-party task in which children's own motivation is at stake. If so-called moral hypocrisy results primarily from insufficient cognitive resources, then we should see links between numerical cognition and sharing behavior even in first-party cases. If, however, moral hypocrisy is *solely* a result of lack of motivation, then we should instead see that young children, regardless of their numerical cognition, are selfish in first-party tasks in which motivation is required.

RESEARCH HIGHLIGHTS

- Prior work finds a knowledge–behavior gap of sharing in early childhood: appreciating norms of equal sharing does not always mean children share equally.
- This study investigated the reasons behind the knowledge–behavior gap and the cognitive mechanisms that develop early sharing behavior.
- Numerical cognition mediated all age-related changes in equal sharing behavior, but was unrelated to endorsing equal sharing as a social norm.
- Results suggest that one reason behind the knowledge–behavior gap is that conceptual and behavioral equality rely on distinct cognitive skillsets.

We investigated these possibilities by assessing children's sharing behavior in relation to their numerical cognition. We sampled the developmental time period (2.5–5.5 years old) during which children show important changes in both the ability to share resources equally (Posid et al., 2015; Chernyak et al., 2016) as well as in their numerical cognition—namely, their knowledge of the cardinal principle (Gelman & Gallistel, 1986; Le Corre & Carey, 2007; Sarnecka & Carey, 2008; Sarnecka & Lee, 2009; Wynn, 1990, 1992). Importantly, we looked at children's numerical cognition in relation to their first-party resource distribution, a task in which children may be less motivated to share equally and could hoard resources for themselves. In the first experiment, children were endowed with a set of stickers and asked to divide them between themselves and another recipient. Stickers have been used widely in tasks assessing resource distribution and prosocial tendencies towards others, and young children view them as a costly and desirable resource (Blake & Rand, 2010; Engelmann, Herrmann, & Tomasello, 2012; Gummerum, Hanoch, Keller, Parsons, & Hummel, 2010; Leimgruer Shaw, Santos, & Olson, 2012; Posid et al., 2015; see Supplementary Materials and Supplementary Figure 1 for an additional study) while also recognizing that others like and appreciate stickers as well. After the resource distribution tasks, children were asked to complete a version of the Give-N task (Wynn, 1990, 1992) to assess their numerical cognition. In the second experiment, we investigated children's concepts of equality as a social norm in relation to their numerical cognition. Thus, in Experiment 2, we tested whether conceptual fairness, rather than behavioral fairness, was related to numerical cognition.

2 | EXPERIMENT 1

2.1 | Method

2.1.1 | Participants

Ninety-one children (36 male, 55 female) were tested at a local children's museum, local preschool, or in the laboratory (Mean age =

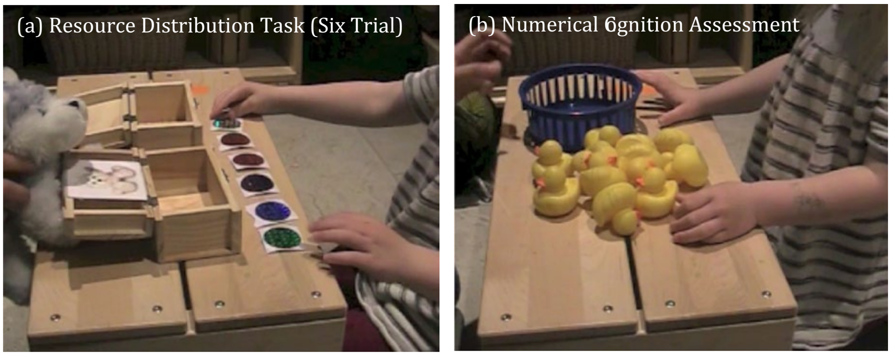

FIGURE 1 Layout of a resource distribution task (a) and the numerical cognition assessment (b) of Experiment 1. The resource distribution task displays the 6-trial

3.84 years; Range = 2.52 – 5.34 years). Three parents declined to provide a date of birth but identified the child as being within the proper age range for the study. These children's data are included in any analyses not requiring age, but by necessity, excluded from average age calculations and any analyses with age. Eighteen additional children were tested but excluded due to equipment failure in recording the session (n = 6), failure to complete the task (n = 9), experimenter error (n = 2), or prior participation in a similar or pilot version of the task (n = 1). In both experiments, we used an a priori sample size stopping rule of N = 80 in keeping with the sample size used in our prior work which had employed a similar paradigm and identical age range (Chernyak, Sandham et al., 2016). In Experiment 1, after achieving this minimum, we continued testing additional children to counteract a later-discovered counterbalancing error. All data and materials are available on: osf.io/xy6ga

2.1.2 | Procedure

All children completed two resource distribution trials: a trial in which they split four resources and a trial in which they split six. After the resource distribution trials, all children completed a numerical cognition assessment (referred to as the 'Give-N task'). The tasks are explained below (see Figure 1 for layout):

Resource distribution task

The paradigm for this task was adapted from prior work (Chernyak & Kushnir, 2013) that has successfully induced sharing behavior in young children. Studies using this methodology have shown that children are motivated to both hoard resources as well as to share them (Chernyak, Trieu, & Kushnir, 2016). In this task, we opted to use puppets to ensure that our stimuli did not inadvertently contain any gender, racial, or socioeconomic cues. Prior work has found that children are willing to engage in a host of behaviors towards puppets, including sharing (Chernyak & Kushnir, 2013), protesting and correcting (Rackozy, Warneken, & Tomasello, 2007), making moral evaluations (Hamlin, 2013), engaging in punishment (Worle & Paulus, 2018), and enforcing norms of fair sharing (Rakoczy et al., 2016).

The adapted task consisted of two trials corresponding to the number of resources children were tasked with sharing (either 4 or 6; order counterbalanced). In each trial, the child was first introduced to either a dog puppet or an elephant puppet (e.g. 'This is Doggie! Do you want to say hi to Doggie?') and encouraged to interact with the puppet for a few seconds. After the initial introduction, the experimenter then stated that the puppet was feeling 'very sad today' and that stickers would make the puppet feel better. Children were not instructed to divide resources in any specific manner.

After being introduced to the puppet, children were then shown two boxes (one that was introduced as 'Doggie's box' and one introduced as the child's box), and a set of stickers (either 4 or 6) that were arranged in a linear array in front of the child and the two boxes. The experimenter then told the child that he or she could decide how to split up the stickers ('whichever stickers you'd like to keep for yourself, you can put in this box' [and pointed to the child's box] 'and whichever stickers you'd like to give to Doggie, you can put in this box' [and pointed to the puppet's box]). At this point, children were encouraged to divide up the stickers and were given no explicit instruction on how to do so. If children left any stickers on the table, they were re-prompted until each of the stickers was placed into a box.

After each trial of the behavioral measure, children were also asked a series of follow-up questions (see our Supplementary Tables 5–7). Boxes were closed and children were asked two *Quantitative Recall Questions* regarding how many stickers they had placed into each of the boxes ('How many stickers did you give to Doggie? How many stickers did you keep for yourself?'), a *Qualitative Recall Question* ('So did you give more to Doggie, keep more for yourself, or give both the same?'), and an *Explanation Question* regarding his/her sharing behavior ('So you gave X stickers to Doggie and kept Y stickers for yourself—why did you do that?' where X and Y reflected the number of stickers the child had actually placed into each of the corresponding boxes). Children were not given corrective feedback during these questions. If children refused to provide an answer, the experimenter re-prompted them once and then proceeded to the next question or trial.

The two trials (4- and 6-trial) were identical other than the number of resources used. The ordering of the two trials (which trial was presented first), which puppet was used in each trial, and whether the puppet's box was placed on the left or right of the child were alternated.

Numerical cognition assessment

Following completion of the resource distribution trials, children were administered the Give-N task to determine their level of counting proficiency. Children were presented a set of approximately 10 ducks and a small basket labeled as a 'pond', and briefly shown how to make 1 duck jump into the pond ('If I want to make 1 duck jump into the pond, I go like this'). Children were then given a series of prompts in which they were asked to place N ducks into the pond, in which N varied from 1 to 6 (e.g. 'Can you make 1 duck jump into the pond?'). The experimenter began with N = 1 and then proceeded to N = 3 if the child was able to do so correctly. After this initial step, the experimenter continued to ask for N + 1 ducks if the child succeeded on N, and N − 1 ducks if the child failed to correctly place N ducks into the pond. For example, if a child was asked for 3 ducks and did so successfully, the experimenter moved onto prompting the child for 4 ducks. If, however, the child failed to place 3 ducks into the pond, she instead prompted the child to place 2 ducks into the pond on the next prompt. For each prompt, after children had placed a set of ducks into the pond, the experimenter asked the child 'Is that N?' and then cleared the ducks out of the pond and moved onto the next prompt if the child answered affirmatively. Children who did not answer affirmatively were prompted to retry ('But can you place N ducks into the pond?') until they confirmed that they believed the number of ducks placed into the pond corresponded to the experimenter's requested number. The experiment continued until children had either: (a) succeeded twice on N and failed twice on N +1, or (b) succeeded twice on N = 6.

Following prior procedures (Le Corre & Carey, 2007), children were classified as either Cardinal Principle Knowers (CP Knowers; proficient counters) who had succeeded twice on the highest-numbered prompt (N = 6), or as Subset Knowers (non-proficient counters) who failed at least twice on one of the prompts. Subset Knowers were further classified according to the highest number that they could produce: For example, children who succeeded in producing up to 3 ducks, but could not produce 4 ducks were labeled as '3-knowers'. (See Table 1.)

2.1.3 | Coding

All children were videotaped for later coding with the exception of one child whose parents did not provide video consent and whose answers were instead transcribed by a research assistant. The first author coded all videos. Two research assistants then coded the data: one research assistant coded the resource distribution tasks (number of stickers given, sharing strategy, and all of the child's responses to follow-up questions) and stayed blind to the child's performance on the numerical cognition assessment; another coded the child's numerical cognition assessment and stayed blind to the child's resource distribution task performance. Inter-rater reliability was 99.5% and 96.7%, respectively.

2.2 | Results

Initial analyses showed no main effects of gender on equal sharing or on numerical cognition. Therefore, we present data collapsed across genders.

Children succeeded in sharing resources equally on 102/182 trials (56%). They shared resources equally on 59/91 (65%) of the 4-trials and 43/91 (47%) of the 6-trials.

2.2.1 | Does numerical cognition explain age-related changes in sharing behavior?

Our primary research question was whether numerical cognition might serve as a cognitive prerequisite to equal sharing behavior. Accordingly, we examined whether number knowledge might help explain age-related changes in equal sharing behavior. Figure 2 shows the raw proportions of trials on which children accomplished fairness. We first looked at age-related changes in children's propensity to engage in equal sharing (Model 1; see Table 2). We ran a binary regression, using likelihood of Equal Sharing (coded 1 for yes and 0 for no) as the response variable and Age and Trial Type (dummy coded as 1 for the 4-trial and 0 for the 6-trial) as the predictors.[1]

There was a significant effect of Age, 95% CI = 0.33 – 1.33, Wald $\chi^2(1)$ = 10.57, p = 0.001 and a significant effect of Trial Type, 95% CI = 0.31 – 1.35, Wald $\chi^2(1)$ = 9.74, p = 0.002. Confirming prior work displaying age-related changes in sharing behavior, as children got older, they became more likely to share their resources equally.

TABLE 1 Descriptives of the numerical cognition assessment in Experiment 1

Give-N classification	Number of children	Mean age (*SE* in parentheses)	Gender distribution (females/males)
Subset Knowers	47	3.36 (0.08)	31/16
1-knowers	3	2.84 (0.24)	1/2
2-knowers	8	2.98 (0.15)	4/4
3-knowers	10	3.40 (0.24)	8/2
4-knowers	17	3.53 (0.10)	13/4
5-knowers	6	3.64 (0.29)	4/2
unclassified	3	3.10 (0.21)	1/2
CP Knowers	44	4.40 (0.10)	24/20

Note. Three children could be classified as Subset Knowers, but due to a minor experimental error (experimenter skipped administering a prompt of 2 ducks) their subset knower level was unclear. Because our focal analyses look at Subset vs. CP Knowers, they are included in the dataset.

Additionally, children were more likely to succeed in sharing their resources equally on the 4-trial than the 6-trial.

We then checked whether numerical cognition mediated any age-related changes in sharing behavior. To do so, we first confirmed that age was related to number knowledge. A binary regression using Age and Trial Type as predictors and CP Knowledge (dummy coded as 1 for CP Knower and 0 for Subset Knower) as the response variable confirmed that Age was significantly related to cardinal principle knowledge, $B = 2.50$, $SE(B) = 0.50$, 95% CI = 4.60 – 32.59, Wald $\chi^2(1) = 25.30$, $p < 0.001$. We then ran a second model (Model 2) using CP knowledge, instead of age, as a predictor. We ran a binary logistic regression using likelihood of Equal Sharing as the response variable, and CP Knowledge and Trial Type as predictors (Model 2). There was a significant effect of Trial Type, Wald $\chi^2(1) = 9.72$, $p = 0.002$, with children being more likely to share equally on the 4-trial, and a significant effect of CP Knowledge, Wald $\chi^2(1) = 14.03$, $p < 0.001$.[2,3,4]

Finally, we combined Models 1 and 2 and included both Age and CP Knowledge as predictors (Model 3). We ran a binary regression using Age, CP Knowledge, and Trial Type as predictors and likelihood of Equal Sharing as a response. As in the first model, there was a significant effect of Trial Type, with children being more likely to share resources equally on the 4- trial, Wald $\chi^2(1) = 9.50$, $p = 0.002$. Most critically, there was also a significant effect of CP knowledge, with CP Knowers being more likely to share resources equally than Subset Knowers, Wald $\chi^2(1) = 8.94$, $p = 0.003$, but no longer any significant effect of Age, Wald $\chi^2(1) = 0.39$, $p = 0.53$. Therefore, CP knowledge, but not age, explained children's abilities to share their resources equally. A formal Sobel mediation test confirmed that numerical cognition fully explained age-related changes in equal sharing behavior, Sobel test $z = 2.56$, $p = 0.01$.

As another test of whether counting might explain the relationship between age and equal sharing, we also looked at children's responses to our Quantitative Recall Question, in which boxes were closed and children were asked to recall how many stickers they had placed in each box (e.g. 'How many stickers did you give to Doggie?';

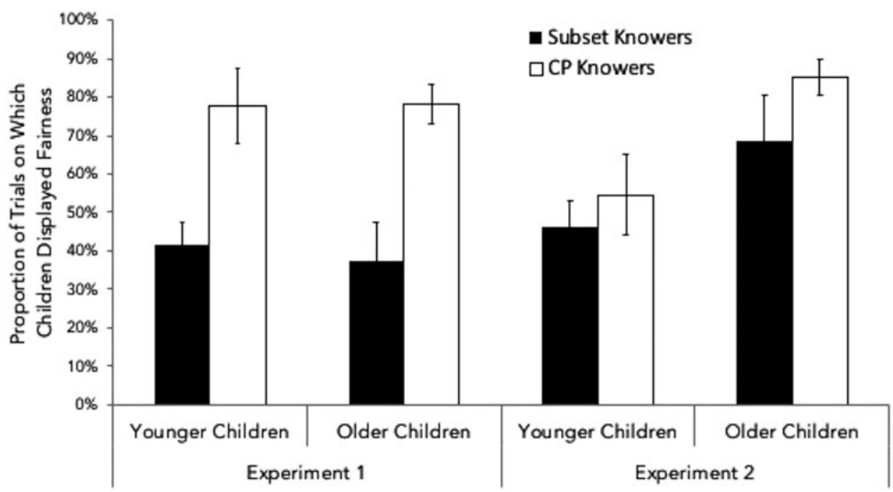

FIGURE 2 Proportion of trials on which children either shared resources equally (experiment 1) or chose the equal split (experiment 2) as a function of age and CP knowledge. *Note*: Bars represent standard errors. For the purposes of presenting this dataset, 'Younger' and 'Older' children were defined via a median split of all children within that experiment (Experiment 1 *median* = 3.68 years; Experiment 2 *median* = 3.85). Unless otherwise stated, age is used continuously in all reported models. For Experiment 1, chance levels were between 31.25% (6-trial) and 37.5% (4-trial). In Experiment 2, chance levels were 50%

TABLE 2 Parameter estimates (and standard errors) of models used in Experiment 1

	Model 1	Model 2	Model 3	Model 4	Model 5
Trial Type (1 = 4-trial)	**0.83 (0.27)****** ***0.31 – 1.35***	**0.81 (0.26)**** ***0.30 – 1.32***	**0.90 (0.29)**** ***0.33 – 1.47***	0.58 (0.31) *−0.36 – 1.19*	0.59 (0.32) *1.23 – 3.24*
Age	**0.83 (0.25)***** ***0.33 – 1.33***	–	0.20 (0.32) *−0.43 – 0.84*	0.45 (0.28) *0.04 – 1.27*	0.03 (0.36) *−0.64 – 0.73*
CP Knowledge (1 = CP Knower)	–	**1.43 (0.38)***** ***0.68 – 2.17***	**1.52 (0.51)**** ***0.52 – 2.52***	–	**1.06 (0.55)*** ***0.02 – 3.71***
Quantitative recall score	–	–	–	**1.14 (0.23)***** ***0.69 – 1.58***	**1.08 (0.23)***** ***0.62 – 1.54***

Note. DV = Likelihood of equal sharing. Significant effects are in bold. **p* ≤ 0.05; ***p* ≤ 0.01; ****p* ≤ 0.001. Italicized range represents 95% CI of the parameter estimate.

'And how many did you keep for yourself?'). This test provided a more task-specific counting measure, rather than the general counting measure. If children had accurately counted stickers during the sharing task, they should be more likely to answer correctly in these cases. Each trial was given a Quantitative Recall Score of 0–2 corresponding to the number of questions answered correctly (1 question was asked for each box). We first checked for predictors of Quantitative Recall. An ordinal linear regression using Quantitative Recall Score (0–2) as the response variable and Age, Trial Type, and CP knowledge as the predictors showed a significant effect of Age, $B = 0.61$, $SE(B) = 0.29$, 95% CI = 0.05 – 1.17, Wald $\chi^2(1) = 4.49$, $p = 0.03$, with older children having higher recall scores, a significant effect of Trial Type, $B = 0.84$, $SE(B) = 027$, 95% CI = 0.31 – 1.37, Wald $\chi^2(1) = 9.58$, $p = 0.002$, with children having higher recall scores when numbers were smaller (as on the 4-trial), and most critically, a significant effect of CP knowledge, $B = 1.22$, $SE(B) = 0.44$, 95% CI = 0.36 – 2.08, Wald $\chi^2(1) = 7.68$, $p = 0.006$.

We then re-ran Model 3, but used Accurate Quantitative Recall score rather than CP Knowledge as our measure of number knowledge (Model 4). Results are consistent with Model 3: there was a marginal effect of Trial Type, Wald $\chi^2(1) = 3.41$, $p = 0.07$, a significant effect of Accurate Qualitative Recall Score, Wald $\chi^2(1) = 25.23$, $p < 0.001$, and no longer any significant effect of Age, Wald $\chi^2(1) = 2.55$, $p = 0.11$. A formal Sobel mediation test confirmed that correctly having counted the stickers fully explained age-related changes in equal sharing behavior, Sobel test $z = 2.42$, $p = 0.02$.

Our task-specific Accurate Quantitative Recall continued to predict equal sharing behavior even when adding CP knowledge to our model. We re-ran our Model 4 above, but re-introduced CP knowledge as a predictor. There was a significant effect of Accurate Quantitative Recall Score, Wald $\chi^2(1) = 21.41$, $p < 0.001$. Consistent with Model 3, there was a marginal effect of Trial Type, Wald $\chi^2(1) = 3.24$, $p = 0.07$, a significant effect of CP Knowledge, Wald $\chi^2(1) = 3.71$, $p = 0.05$, and no effect of Age, Wald $\chi^2(1) = 0.006$, $p = 0.94$. These analyses confirm our earlier analyses showing that age-related changes in equal sharing behavior are explained by the extent to which children are able to count the items presented to them. Therefore, using both a task-specific counting measure (Quantitative Recall) as well as a task-independent measure (Give-N), we find that counting proficiency mediates age-related changes in sharing fairly.

2.2.2 | Does numerical cognition predict the likelihood of children stating that they had shared resources equally?

Although Experiment 1 was not designed to test children's beliefs about social norms, we did probe children's beliefs about their own sharing behavior in our Qualitative Recall question ('Did you give more to Doggie, keep more for yourself, or give both the same?'). We reasoned that if number knowledge changed children's knowledge of social norms, it would predict their propensity to state that they had shared their stickers equally. Accordingly, we analyzed children's responses to this question. Children provided a codable answer on 168 of the 182 total trials (92%), and children stated that they had shared their resources equally on a very high proportion of these codable trials (123 of 168; 73%). A formal Binomial test (assuming a conservative criterion of chance levels of 50%) confirmed that children stated that they had shared resources equally at above chance levels both in the 4-trial (66/83; 80%; Binomial $p < 0.001$) and the 6-trial (57/85; 68%; Binomial $p = 0.002$). Children were more likely to state that they had shared resources equally than to actually have done so: a McNemar's test revealed that 38 children stated they had shared resources equally without having done so, whereas only 13 did the reverse, $p = 0.001$, suggesting a bias to claim equal sharing without actually having do so.

We looked at whether numerical cognition might explain children's propensity to state that they had shared resources equally. We ran a binary regression using Age, Trial Type, and CP Knowledge as predictors and the likelihood of children stating that they had shared resources equally as a response. There was a marginally significant effect of Trial Type, $B = 0.64$, $SE(B) = 0.37$, 95% CI = 0.08 – 1.36, Wald $\chi^2(1) = 3.06$, $p = 0.08$, with children being more likely to state they had shared resources equally on the 4-trials, and no other significant effect (both $ps > 0.25$).

Therefore, in line with work suggesting that social norms develop earlier than equal sharing behaviors (Smith et al., 2013), children across ages stated that they had shared resources equally. There was also a dissociation between the two abilities (endorsement of their own sharing behavior and actual sharing behavior) with respect to their relationship to CP knowledge: whereas CP knowledge predicted equal sharing behavior, it failed to predict the likelihood of children stating that they had shared their own resources fairly, suggesting that CP knowledge may not predict the acquisition of sharing norms, only the behavioral execution of these norms. Overall, while CP knowledge predicted behavioral equality, it failed to predict conceptual equality.

2.2.3 | Does selfishness explain age-related changes in equal sharing?

We then considered whether selfish motivations might be a concurrent factor in children's errors in sharing resources equally in our task. To do this, we focused on the trials in which children had *not* shared fairly ($n = 80$ of a total of 182 trials across the 91 participants). If selfishness caused unequal sharing, we would expect that children strategically default to selfishness (i.e. giving themselves more). If, however, cognitive prerequisites solely drove sharing behavior in our task, we would expect children to be just as likely to share generously (give more than half of their resources to the puppet) as selfishly (keep more than half for themselves). Confirming the latter possibility, children did not strategically default to selfishness: of the 80 trials on which children did not share resources equally, 52.5% showed generous sharing (sharing over half of their resources; $n = 42$) and 47.5% showed selfish sharing (sharing less than half of their resources, $n = 38$). Figure 3 shows the distributions of stickers given. Follow-up analyses revealed that CP

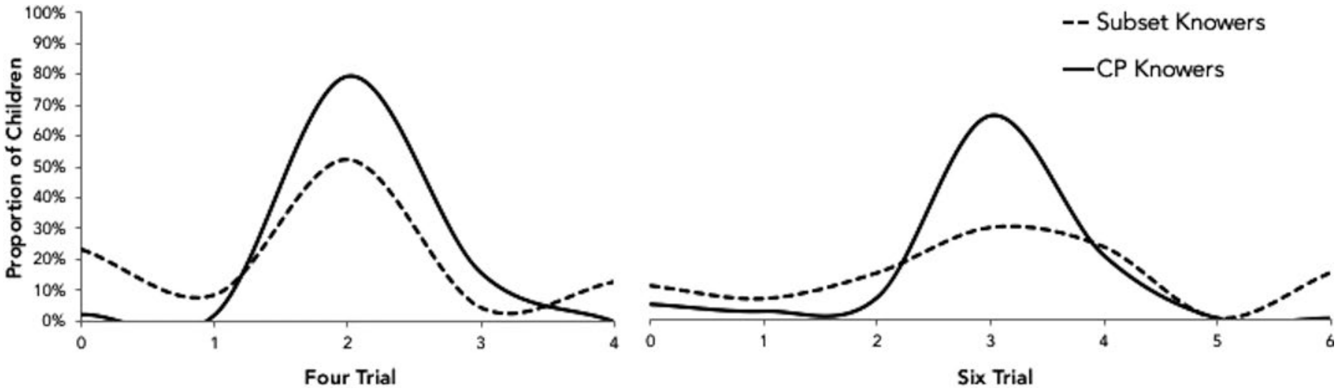

FIGURE 3 Distribution of stickers given to the puppet as a function of number knowledge and Trial Type

knowledge, but not Age, predicted a *lower* likelihood of sharing either selfishly, $B = -1.28$, $SE(B) = 0.63$, 95% CI = −0.05 – −2.52, Wald $\chi^2(1) = 4.17$, $p = 0.04$, or generously, $B = -1.03$, $SE(B) = 0.57$, 95% CI = 0.09 – 2.15, Wald $\chi^2(1) = 3.22$, $p = 0.07$, although the latter was marginally significant.

To more formally capture children's approximations towards equality, we also looked at whether CP knowledge predicted how close children's errors were to equal sharing behavior. We reasoned that as children gain numeracy skills, they will better approximate equal sharing behavior. We thus calculated a Percent Deviation from Fairness Score (% DFS) reflecting the absolute magnitude of the deviation of children's sharing behavior from equality:

$$\%DFS = \frac{|\ \#\text{ of stickers child gave away } - \#\text{ of stickers reflecting equality}\ |}{\#\text{ of stickers reflecting equality}}$$

Note that the number of stickers reflecting equality was 3 in the 6-trial, and 2 in the 4-trial. Thus, a child who shared either 4 or 2 stickers in the 6-trial showed 33% error in achieving perfect equality (i.e. 3 stickers), whereas a child who shared either 0 or 6 stickers in the 6-trial showed 100% error. Lower DFS scores thus reflected better approximations to fair sharing behavior.

We looked at the trials during which children had failed to share resources equally (see Supplementary Table 4 for full sample analyses). A linear regression using %DFS as the response variable and Age, CP Knowledge, and Trial Type as the predictors revealed a significant effect of Trial Type, with children showing greater error on the 4-trial, $B = 0.20$, $SE(B) = 0.05$, 95% CI = 0.10 – 0.31, Wald $\chi^2(1) = 13.90$, $p < 0.001$, compared to the 6-trial, as well as a significant effect of CP Knowledge, with CP Knowers showing a smaller deviation from equality than Subset Knowers, $B = -0.21$, $SE(B) = 0.09$, 95% CI = −0.39 – −0.03, Wald $\chi^2(1) = 5.05$, $p = 0.025$. Greater errors on the 4-trial were likely a reflection of the fact that there were fewer possibilities for small errors on that trial (i.e. a result of the fact that our coding scheme defined a deviation of 1 sticker as a greater percent deviation on the 4-trial than on the 6-trial). Thus, even among children who did not share resources equally, numerical cognition predicted how far children were from equal sharing behavior.

2.3 | Discussion

In Experiment 1, children's numerical cognition fully explained age-related changes in equal sharing behavior. Consistent with prior work showing that children have already acquired a norm of equality by the preschool age (Rakoczy et al., 2016; Smith et al., 2013), the majority of children, even without having acquired the cardinal principle, stated they gave both agents 'the same' amount, suggesting a dissociation between conceptual and behavioral equality. We saw no evidence for decreasing selfishness across ages or numerical cognition levels. In Experiment 2, we more directly tested whether children's numerical cognition is related to their receptive understanding of the equality norm. We presented children with hypothetical splits (either equal or unequal) and asked how they 'should' share. We once again tested children's numerical cognition using the Give-N task.

3 | EXPERIMENT 2

3.1 | Method

3.1.1 | Participants

Eighty separate children (37 male, 43 female) were tested at a local children's museum, local preschool, or in the laboratory (Mean age = 3.92 years; Range = 2.27 – 5.52 years). Three parents declined to provide a date of birth but identified the child as being within the proper age range for the study. These children's data are included in any analyses not requiring age, but by necessity, excluded from average age calculations and any analyses with age. Sixteen additional children were tested but excluded due to experimenter error ($n = 6$), failure to complete the entire task ($n = 5$), parental interference ($n = 2$), equipment failure ($n = 2$), or prior participation ($n = 1$).

3.1.2 | Procedure

As in Experiment 1, all children completed two trials in which they were asked questions about the norm of sharing (referred to as the

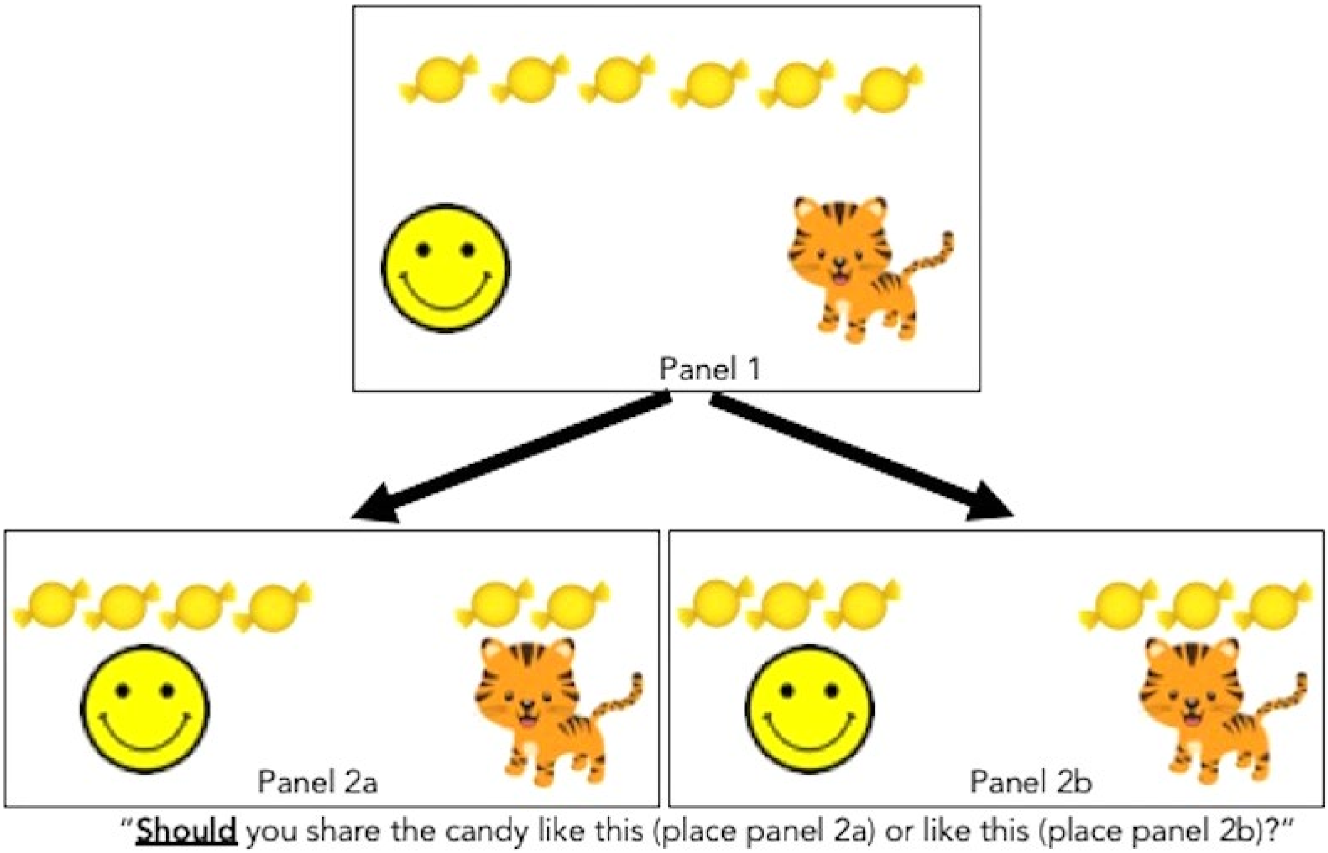

FIGURE 4 Schematic of sharing norm task in Experiment 1. 6-Trial is displayed. Note: Panel labels (e.g., 'Panel 1') were added for clarity

sharing norm task): a 4-trial and a 6-trial. Also as in Experiment 1, after the sharing norm tasks, all children completed a numerical cognition assessment.

Sharing norm task

We used a non-costly task in which children had to choose between two potential splits. Splits were presented as hypothetical (children were not allocated the candy). In each trial, the child was first shown an introductory panel (Figure 4) depicting an animal (either a giraffe or a tiger; counterbalanced across trials) and a smiley face on opposite sides of the panel with a set of candies (either 4 or 6 depending on the trial type between them). They were introduced to the panel: 'This is Giraffe [point to animal] and we're going to pretend this is you [point to smiley face]. And here is some candy [point to candy]. You and Giraffe can share it.' The first panel was put away, and children were then shown two panels depicting two potential hypothetical splits: one equal and one unequal. Unequal splits were always advantageous to the child and reflected the closest possible split to equality (i.e. a 4/2 split in the 6-trial or a 3/1 split in the 4-trial). Children were then asked a *Normative Sharing Question* reflecting their beliefs about the norm of equality: 'Should you share the candy like this [point to split 1] or like this [point to split 2]?' After indicating their choice, children were asked to justify their choice via an *Explanation Question* ('And why should you share it like this?'). Children who refused to provide an answer to the Explanation Question were re-prompted once and then proceeded to the next trial. Conceptually, this task followed prior work (Smith et al., 2013), in that it asked children about sharing norms in a non-costly manner and was therefore devoid of motivational constraints.

Explanations were coded for containing *References to Fairness*, defined as references to either the welfare of others (e.g. 'because I think Giraffe wants some') or to fairness/moral norms ('because tiger needs the same number as me'; 'because then it would be fair'), and *References to Personal Desires*, defined as references to the child's own needs (e.g. 'I'm still hungry'). The two categories were not mutually exclusive. In order to avoid biasing results towards finding age-related trends due to the limited verbal capacities of young children, explanations that were uncodable (e.g, 'I don't know') were not included in this coding, resulting in a total of n = 104 codable trials.

The ordering of the two trials (4 and 6), animals used in each trial, placement of the animal vs. child in the pictures, and left/right placement of the equal split were counterbalanced.

Numerical cognition assessment

The numerical cognition assessment was identical to that of Experiment 1. We once again classified children as either Cardinal Principle Knowers or Subset Knowers (see Table 3).

TABLE 3 Descriptives of the numerical cognition assessment in Experiment 2

Give-N classification	Number of children	Mean age (*SE* in parentheses)	Gender distribution (females/males)
Subset Knowers	37	3.42 (0.10)	17/20
1-knower	7	3.22 (0.15)	4/3
2-knower	10	3.18 (0.17)	4/6
3-knower	7	3.52 (0.35)	4/3
4-knowers	6	3.56 (0.15)	1/5
5-knowers	6	3.75 (0.33)	4/2
unclassified	1	4.11 (0)	0/1
CP Knowers	43	4.35 (0.10)	26/17

Note. One child could be classified as subset knower, but due to a minor experimental error (experimenter skipped administering a prompt of 2 ducks) their subset knower level was unclear. Because our focal analyses look at subset vs. CP knowers, they are included in the dataset.

TABLE 4 Parameter estimates (and standard errors) of models used in Experiment 2

	Model 1	Model 2	Model 3
Trial Type (1 = 4-trial)	0.13 (0.36) *−0.57 – 0.83*	0.13 (0.34) *−0.54 – 0.79*	0.13 (0.36) *−0.57 – 0.84*
Age	**0.98 (0.27)***** ***0.45 – 1.50***	–	**0.83 (0.32)**** ***0.21 – 1.46***
Gender (1=Female)	**0.79 (0.37)*** *0.06 – 1.52*	**0.77 (0.37)*** ***0.04 – 1.50***	**0.76 (0.38)*** ***0.03 – 1.50***
CP Knowledge (1 = CP Knower)	–	**1.07 (0.37)**** *0.34 – 1.07*	0.36 (0.45) *−0.52 – 1.25*

Note. DV = Likelihood of Choosing the Equal Split. Significant effects are in bold. $^*p \le 0.05$; $^{**}p \le 0.01$; $^{***}p \le 0.001$. Italicized range represents 95% CI of the parameter estimate.

3.1.3 | Coding

All children were videotaped for later coding with the exception of three children whose parents did not provide video consent but whose answers were transcribed by a research assistant. An additional four children's Give-N data were not caught on video but transcribed by a research assistant. One of ten researchers coded all available videos. Three additional hypothesis-blind research assistants then coded all available videos: one research assistant coded the sharing norm task and stayed blind to the child's performance on the numerical cognition assessment; a second coder coded the child's numerical cognition assessment and stayed blind to the child's sharing norm task; a third coder categorized explanations. Inter-rater reliability was 93%, 97%, and 90%, respectively.

3.2 | Results

Initial analyses showed that girls were more likely to choose the equal split than boys, consistent with prior work finding that girls show a greater aversion to inequity (Chernyak et al., 2016; McAuliffe et al., 2013). Therefore, we control for gender in all of our subsequent models.

In general, children chose the equal split on 104 of the 160 trials (65%): 53/80 (66%) of the 4-trials (Binomial $p = 0.005$) and 51/80 (64%) of the 6-trials (Binomial $p = 0.02$).

3.2.1 | Does numerical cognition explain age-related changes in endorsing equality as a social norm?

Our primary research question was whether numerical cognition influences children's endorsement of equality as a social norm. We first looked at age-related changes in children's propensity to choose the equal split (Model 1; see Table 4). We ran a binary regression using likelihood of choosing the equal split (coded 1 for yes and 0 for no) as the response variable and Age, Trial Type (dummy coded as 1 for the 4-trial and 0 for the 6-trial), and Gender (dummy coded as 1 for female) as predictors. There was a significant effect of Age, Wald $\chi^2(1) = 13.35$, $p < 0.001$, a significant effect of Gender, Wald $\chi^2(1) = 4.41$, $p = 0.04$, and no significant effect of Trial Type, Wald $\chi^2(1) = 0.14$, $p = 0.71$. Therefore, as children got older, they became more likely to choose an equal distribution of resources.

We then checked whether number knowledge might mediate any age-related changes in children's sharing choice. To do so, we first confirmed that age was related to number knowledge. A binary regression using Age and Gender as predictors and CP Knowledge (dummy coded as 1 for CP Knower and 0 for Subset Knower) as the response variable confirmed that Age was significantly related to number knowledge (being classified as a Cardinal Principle Knower), $B = 2.26$, $SE(B) = 0.54$, 95% CI = 1.19 – 3.32, Wald $\chi^2(1) = 17.22$, $p < 0.001$. We then ran a second model using CP knowledge, instead of age, as a predictor. We ran a binary logistic regression using likelihood of choosing the equal split as the response variable, and CP Knowledge and Trial Type as predictors (Model 2). There was a significant effect of CP Knowledge, Wald $\chi^2(1) = 8.22$, $p = 0.004$, with CP Knowers being more likely to select the equal split, a significant effect of Gender, Wald $\chi^2(1) = 4.24$, $p = 0.04$ and no significant effect of Trial Type, Wald $\chi^2(1) = 0.14$, $p = 0.71$.

Finally, we combined Models 1 and 2 and looked at both Age and CP Knowledge as predictors (Model 3). We ran a binary regression using Age, Gender, CP Knowledge, and Trial Type as predictors and likelihood of choosing the equal split as the response. There was a significant effect of Age, Wald $\chi^2(1) = 6.84$, $p = 0.009$ and Gender, Wald $\chi^2(1) = 4.10$, $p = 0.04$, but no significant effect of Trial Type, Wald $\chi^2(1) = 0.14$, $p = 0.71$ or, most critically, of CP Knowledge, Wald $\chi^2(1) = 0.65$, $p = 0.42$. Together, these results suggest that age, but not knowledge of the cardinal principle, helped children endorse equal splits as social norms.

We also looked at whether younger children were consistently choosing the selfish split, which would give more credence to selfish motivations. For this analysis, we divided children into two groups based on a median split of ages, resulting in a Younger Age Group ($n = 39$, *Mean age* = 3.30, *SE* = 0.07) and an Older Age Group ($n = 38$, *Mean age* = 4.56, *SE* = 0.09). As expected, older children systematically chose the equal split on 62/76 (82%) trials. This was different from chance levels on both the 4-trial in which children chose the equal split on 34/38 (89%) trials (Binomial $p < 0.001$) and on the 6-trial, in which children chose the equal split on 28/38 (74%) trials (Binomial $p = 0.005$). Younger children were less likely than older children to choose the equal split, but younger children did not strategically default to selfishness: they chose the equal split on 38 (49%) of the 78 trials. This was not different from chance levels on either the 4-trial, in which younger children chose the equal split on 17/39 (44%) trials, or on the 6-trial, in which younger children chose the equal split on 21/39 (54%), both Binomial $ps > 0.25$. Thus, although the younger children were less likely than their older counterparts to choose the equal split, these children were not necessarily motivated by selfishness given that they chose the equal split at chance levels.

Finally, our explanation data confirm children's judgment data. As noted in our coding section above, explanations were coded for references to fairness and references to personal desires. We employed binary regression using Age, CP Knowledge, and Trial Type as predictors and likelihood of referencing fairness as the response. The results revealed a significant effect of Gender, with girls being more likely to reference fairness, $B = 1.30$ $SE(B) = 0.58$, 95% CI = 0.16 – 2.44, Wald $\chi^2(1) = 5.01$, $p = 0.03$, and no effect of Trial Type ($p > 0.15$). There was an effect of Age, $B = 1.42$, $SE(B) = 0.51$, 95% CI = 0.42 – 2.41, Wald $\chi^2(1) = 7.75$, $p = 0.005$, and no effect of CP knowledge ($p > 0.15$), suggesting once again, that Age, but not CP knowledge predicted conceptual equality. A similar result was found for children's references to personal desires. There was a marginal effect of Age, $B = -0.96$ $SE(B) = 0.51$, 95% CI = −1.94 – 0.03, Wald $\chi^2(1) = 3.62$, $p = 0.06$, and no other significant effects (all $ps > 0.15$). Therefore, with age, children became more likely to reference fairness/moral considerations and less likely to reference personal desires. CP knowledge played no role in this change.

3.3 | Discussion

The results of Experiment 2 show that numerical cognition, as indexed by CP Knowledge, explains behavioral equality, but not children's acquisition and endorsement of it as a social norm. Thus, unlike behavioral equality, conceptual equality may rely on a different skillset and is not underpinned by number knowledge, but by other age-related changes. We thus propose that one reason why children's knowledge and behavior surrounding fairness appear dissociable may be that conceptual and behavioral equality are underpinned by different cognitive prerequisites, and thus may undergo different developmental trajectories.

4 | GENERAL DISCUSSION

We began this work with an investigation of the previously documented knowledge–behavior gap of fairness (Smith et al., 2013). We documented further evidence of this gap by finding important dissociations between what children did and what they stated they *should* do, as well as between what they did and what they stated they had done, further suggesting that children acquire norms of equal sharing before they are able to implement them. Our results suggest that this gap may be derived from the fact that different cognitive resources are recruited for conceptual and behavioral equality. In particular, we find evidence for the insufficient cognitive resources hypothesis: children's cognitive skills (their numerical cognition, as measured both by a task-general test of cardinality, as well as a task-specific measure of numerical memory in our Quantitative Recall Score) fully explain age-related changes in sharing behavior; numerical cognition does not, however, explain age-related changes in children's acquisition of the social norm of equality.

We propose that understanding cardinality is more important for active counting of the type required in costly resource distribution tasks than for mental division and approximation of the type required in tasks that assess fairness norms. Prior work points to several correlates of cardinality that may be most relevant to active resource distribution: acquiring knowledge of the cardinal principle may increase the precision through which children perform intuitive division operations on the resources (McCrink & Spelke, 2016), provide a tool through which children can count out equal sets (Sarnecka & Wright, 2013) or help participants identify when sharing errors occur (Muldoon, Lewis, & Berridge, 2007). Consistent with our findings, in the latter two cases, cardinality, rather than subitizing or knower-level knowledge, relates to these developments (see also Chernyak et al., 2016; Jara-Ettinger et al., 2016; Moore, vanMarle, & Geary, 2016).

In contrast, tasks that assess fairness norms are likely to rely on semantic memory of fairness norms, or in the case of our task in Experiment 2, on approximation abilities, which allow children to quickly mentally divide resources without employing deliberate counting strategies to ensure cardinal equivalence (although, of course, such strategies can promote performance in children if they should choose to use them). The latter possibility is consistent with the fact that children who employed deliberate turn-taking strategies (i.e. taking turns distributing resources among recipients) rather than quick, division strategies (i.e. immediately grabbing a set of resources and placing them accordingly) were also more likely to succeed in behavioral fairness in Experiment 1 (see Supplementary Table 8).

The effect of numerical cognition appeared despite potential individual differences in motivation and even when motivational constraints were held constant. With that said, it is important to note that several features of our task have been shown to increase equal sharing in prior research; more specifically, we used a motivating task in which children distributed discrete countable resources that could be distributed via one-to-one correspondence (Frydman & Bryant, 1988), resources were distributed in the presence of the experimenter (Engelmann et al., 2012; Leimgruber et al., 2012), and children distributed after having had the chance to interact with the recipient (Chernyak & Kushnir, 2013; Hamann, Warneken, Greenberg, & Tomsello, 2011; Warneken, Lohse, Melis, & Tomasello, 2011) and sympathize with the recipient's distress (Vaish, Carpenter, & Tomasello, 2009). Moreover, children were tested in a culture in which children are known to care about fairness and even sacrifice resources in order to achieve it (Blake et al., 2015; Shaw & Olson, 2012). Each of these motivational and situational factors may have played a role in inspiring children to be generous towards the puppet in spite of their self-interest. One concern may be that our method induced generosity, rather than equality: However, the high rates of equality, both in the context of our study as well as in prior work using a similar method (Chernyak, Trieu et al., 2016), suggest that neither selfishness nor generosity are the sole motivations. Indeed, the high rates of sticker hoarding in our supplementary study, as well as prior work using dictator game paradigms, suggest that children also have the countervailing motivation to keep stickers. We suggest that children trend towards fairness norms when attempting to balance the needs of others with their own personal desires—the extent to which each child is successfully able to reach a fair compromise depends on his or her level of numerical competency.

To be clear, our work is not intended to explain all instances of moral hypocrisy: A continually growing body of work finds that there are many contexts in which young children are systematically selfish and lack motivation to share resources equally despite recognizing the norm of equality (Blake & McAuliffe, 2011; Fehr et al., 2008; Posid et al., 2015; Sheskin et al., 2016; Smith et al., 2013). Moreover, not all resource distribution contexts involve the use of discrete, countable items, although such items (e.g. cookies, toys) are frequent in children's day-to-day lives. Prior work also finds that discrete items such as the ones we used may also be distributed without any understanding of the numerical nature of sharing (Frydman & Bryant, 1988)—although our work finds that numerical cognition plays an important role, this prior finding accords with ours in that we find that there is a substantial portion of Subset Knowers that are still capable of accomplishing equal sharing. We instead propose that cognitive constraints such as number knowledge play an additional, and critical, role in limiting children's abilities to accord with social norms. We encourage future work to carefully consider multiple constraints (motivational and cognitive) when interpreting the behavior of young children.

It is also important for future work to carefully address other types of cognitive constraints that may be related to the acquisition of equality. Given that attention, working memory, cognitive control, and vocabulary (e.g. Gray & Reeve, 2016; Mou, Berteletti, & Hyde, 2018; Negen & Sarnecka, 2012; Steele, Karmiloff-Smith, Cornish, & Scerif, 2012) are also associated with numerical cognition, it is important to directly address how each of these domain-general skills might also interact with equal resource distribution. Several indirect pieces of evidence from our work suggest that there may be a unique impact of number knowledge, however: First, if other cognitive developments accounted for numerical cognition, we would expect to see a continued effect of age, after controlling for number knowledge. Second, smaller set sizes increased the rates of equal sharing behavior, showing that sharing behavior is affected by the inherent numerosity of the task (see Posid et al., 2015), even when other features of the task (e.g. vocabulary demands) were equivalent across trials. Finally, our recall measure in Experiment 1, which presumably demands slightly different (albeit, overlapping) cognitive skills than the Give-N task, was also highly related to equal sharing above and beyond age. Nonetheless, it is important for future work to more directly assess the unique contribution of numerical cognition, as well as potential interactions with other domain-general skills, to equal sharing in order to paint a more complete picture of how cognitive constraints play a role in social behavior.

We conclude by outlining several important implications for future research on the development of fairness. Our findings suggest that young children's behavior ought not to be circularly confused with their motivation. When children display 'failures' in sharing resources, it is important not to presuppose underlying selfish motivations. Contrary to beliefs that acting fairly only requires knowledge of social norms and sufficient motivation to accord with them, our work speaks to the idea that certain cognitive underpinnings underlie children's social abilities and that limitations in those cognitive underpinnings may restrict children's ability to follow social norms. Thus, our findings highlight the fact that children's behaviors ought to be interpreted in light of their conceptual knowledge of the world. Finally, our findings imply a strong link between children's social and cognitive competencies. Future work may capitalize on this by considering whether sharing contexts also serve as ripe opportunities for children to acquire numerical cognition. By studying the connection between the cognitive and social domain, we may better understand mechanisms that build and sustain morality throughout development.

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ENDNOTES

[1] All models were run using the Generalized Estimating Equations (GEE) procedure using Trial Type as a within-subjects predictor and assuming an exchangeable correlation structure. We used a criterion of $p = 0.05$, two-tailed, for significance testing. For all models, we also checked for potential interactions with our main variables of interest (age and CP knowledge) and removed them if non-significant.

[2] We present alternative models in our Supplementary Analyses (Supplementary Tables 1 and 2), which analyze Give-N continuously (i.e. through giving a child a score of 1–6 corresponding to his/her Subset Knower level or 6 if the child was a CP Knower). Results remain consistent with what is reported in the main text. We chose to present the binary coding scheme because additional analyses revealed no differences among Subset Knowers, which is consistent with prior work showing that cardinality, rather than knower-level, is required for equal sharing (Chernyak et al., 2016; Jara-Ettinger et al., 2016).

[3] Results also remain consistent when restricted to trials in which children had stated they had shared equally. Thus, as might be expected, numerical cognition, not age, plays a role for children who are explicit that equality was their goal. (See Supplementary Table 3.)

[4] For an analysis of children's sharing strategies, see Supplementary Table 8 and Supplementary Figure 5.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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Graphical Abstract

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BLURB: In spite of early understanding of fairness, young children fail to behave fairly towards others in many contexts. We demonstrate that children's developing numerical cognition explains their abilities to split resources equally between themselves and others, but not their understanding of fairness norms. Our work suggests that one of the reasons for documented asymmetries between what children know and what they do may be the different cognitive abilities required for conceptual and behavioral fairness.