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Science resource inequalities viewed as less wrong when girls are disadvantaged

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Abstract

In response to some resource inequalities, children give priority to moral concerns. Yet, in others, children show ingroup preferences in their evaluations and resource allocations. The present study built upon this knowledge by investigating children's and young adults' (N = 144; 5–6-year-olds, M_{age} = 5.83, SD_{age} = .97; 9–11-year-olds, M_{age} = 10.74, SD_{age} = .68; and young adults, M_{age} = 19.92, SD_{age} = 1.10) evaluations and allocation decisions in a science inequality context. Participants viewed vignettes in which male and female groups received unequal amounts of science supplies, then evaluated the acceptability of the resource inequalities, allocated new boxes of science supplies between the groups, and provided justifications for their choices. Results revealed both children and young adults evaluated inequalities of science resources less negatively when girls were disadvantaged than when boys were disadvantaged. Further, 5- to 6-year-old participants and male participants rectified science resource inequalities to a greater extent when the inequality disadvantaged boys compared to when it disadvantaged girls. Generally, participants who used moral reasoning to justify their responses negatively evaluated and rectified the resource inequalities, whereas participants who used group-focused reasoning positively evaluated and

perpetuated the inequalities, though some age and participant gender findings emerged. Together, these findings reveal subtle gender biases that may contribute to perpetuating gender-based science inequalities both in childhood and adulthood.

KEYWORDS
disadvantaged groups, fairness, gender, resource allocation

1 | INTRODUCTION

Decisions to allocate resources encompass a range of considerations, including moral concerns relating to issues of fairness, others' welfare, equality, and equity (Rizzo et al., 2020). These moral concerns develop early, as children as young as 3 years of age reject unfair resource allocations (Baumard et al., 2012) and with age rectify group-based inequalities (Elenbaas & Killen, 2016). In straightforward contexts, elementary-aged children even discard resources instead of allocating them unequally between recipients (Blake & McAuliffe, 2011; Shaw & Olson, 2012). And yet, in contexts where resource recipients are from different groups (such as different genders, races, or ethnicities), children may also justify unequally distributing resources in order to maintain status hierarchies, give preferentially to those who share similar identities, or adhere to stereotypes about the deservedness of certain groups (Elenbaas et al., 2016; Li et al., 2014; Olson et al., 2011; Renno & Shutts, 2015). These resource allocation decisions remain fundamental issues in adulthood, as the concerns of fairness, equity, and group identity that begin in childhood have implications for moral decisions throughout life. Thus, resource allocations are complex decisions from childhood to adulthood.

While much of the extant research investigates individuals' understanding of how to fairly allocate simple resources like stickers, candy, or tokens, recently, researchers have advocated for examining the development of decisions about broad inequalities of necessary resources, such as medicine, salaries, or school supplies (Corbit et al., 2021; Elenbaas et al., 2016; Rizzo et al., 2016). Previous research shows age-related differences in how individuals consider fairness in some simple contexts while prioritizing their ingroup or the status quo in others. Documenting decisions about inequalities that are precipitated by broad status hierarchies or commonly held stereotypic expectations may help parse apart these two allocation strategies and more directly connect allocation decisions with social inequalities. Further, focusing on the allocation of resources that are meaningful for both children and adults provides a basis for developmental comparisons. Thus, it is important to understand the conditions under which both children and adults rectify and perpetuate these broad, group-based inequalities.

One way to examine the connection between resource allocation decisions and social inequalities is to assess how individuals allocate resources when presented with gender-based inequalities in science resources. These inequalities may highlight both the pro-male biases about science that are held by children and adults and the existing gender imbalances in science engagement. Though boys and girls demonstrate equivalent math and science proficiencies in the elementary, middle school, and high school years, more men than women earn undergraduate degrees within the sciences and participate in science-related fields (National Center for Science & Engineering Statistics, 2017; National Girls Collaborative Project, 2016; Noonan, 2017). In other words, though there is equivalent aptitude among boys and girls in science, there is still unequal representation in science between men and women. Moreover, children and adults associate science with men more than women (Guimond & Roussel, 2001; Kurtz-Costes et al., 2008; Miller et al., 2018; Nosek et al., 2009). Given these connections to real societal level inequalities, investigating age-related differences in decisions to rectify or perpetuate gender-based science inequalities is particularly important.

Thus, the present study aimed to assess both children's and young adults' evaluations, resource allocation decisions, and reasoning surrounding science resource inequalities between groups of boys and girls. This design assessed whether children and young adults support or reject disparities in access to science resources based on gender, and the extent to which children and adults prioritize moral or group identity concerns when justifying their evaluations and allocations.

1.1 | Theoretical framework

The present study was motivated by the social reasoning developmental (SRD) model, which proposes that considerations of equality and fairness need to be understood in the context of group identity (Killen & Rutland, 2011). SRD draws on social identity theory (SIT) (Tajfel & Turner, 1986) and developmental theories of SIT (Nesdale, 2004; Nesdale & Lawson, 2011) that show that children develop group preferences for individuals that share their social identities (such as race, gender, or ethnicity). Yet these ingroup biases often decrease from 6 to 10 years of age (McGlothlin & Killen, 2006; Nesdale & Lawson, 2011), likely due to both an increase in fairness judgments as well as self-presentation awareness.

SRD also draws on social domain theory (Turiel, 2002) for hypotheses regarding how contextual factors guide decision-making and different forms of social reasoning. Individuals engage in both moral reasoning about equality, fairness, and others' welfare and group-based reasoning, often focused on ingroup and outgroup preferences or maintaining the status quo. The core assumptions of SRD are that, with age, individuals view unequal treatment of others as wrong, and increasingly reference concerns for fairness, equality, and others' welfare in justifying such evaluations (McGuire et al., 2019). Yet, at the same time, group identity and group dynamics remain salient influences on both children's and adults' decision-making.

Children acquire concepts of fairness as early as the preschool years (Smetana et al., 2014). With age, children balance concerns for equality with concerns for equity and merit (Rizzo et al., 2016) and rectify inequalities for disadvantaged groups (Elenbaas et al., 2016). In the current study, children's and young adults' decisions to rectify gender inequalities may be rooted in concerns for fairness. And yet, group identity is a salient factor that children and adults alike consider in morally relevant situations. The salience of gender group membership and gender ingroup preferences may prompt individuals to perpetuate inequalities that favor their gender ingroup (Renno & Shutts, 2015). Taken a step further, contexts that tap into group-focused preferences, such as gender stereotypic expectations and existing gender-based status disparities, may lead individuals to allocate in favor of the high-status gender (often the male) group, regardless of the participant's own gender group membership (Horwitz et al., 2014). These conflicting desires may complicate individuals' allocations when presented with unfair inequalities favoring certain gender groups.

The ability to coordinate judgments with reasoning, both within and across domains, continues to refine with age. For example, SRD predicts that young children often prioritize concerns for strict equality, while concerns for equity emerge around 10 years of age (Killen et al., 2015; Rutland et al., 2010). Additionally, SRD predicts that children in early childhood are more susceptible to ingroup bias (in their evaluations and allocations, e.g.), whereas older children and adolescents increasingly prioritize moral concerns over group identity (Elenbaas et al., 2016; Rutland & Killen, 2017). Thus, SRD predicts that young children would exhibit more ingroup preferences in their resource allocation decisions, whereas older children and adolescents would rectify inequalities to benefit the disadvantaged group regardless of the group's membership. Coupled with shifts from prioritizing one's ingroup to rectifying inequalities, SRD also predicts that children coordinate their judgments and reasoning, such that equitable allocations are most often coupled with moral reasoning and allocations that perpetuate inequalities are often coupled with group-focused reasoning (Rutland et al., 2010).

Research using the SRD framework has recently examined how social identity and moral decision-making relate to issues of fairness in science contexts (McGuire et al., 2020; Mulvey & Irvin, 2018). For instance, McGuire et al. (2020) and colleagues have investigated whether and how group identity and group loyalty is related to preferences for

engagement in science activities. As one example, they found that boys (the ages of 8–10 years) negatively evaluated a peer who wanted to change the boys' group activity (computer programming) to one that was less male-stereotypic (biology). Boys also expected that the group would negatively evaluate the peer's preference to change the activity from computer programming to biology (McGuire et al., 2020). Mulvey and Irvin (2018) found that young children (the ages of three to eight) judged counter-stereotypic STEM career choices as less acceptable than did older children indicating that group norms related to identity emerge early. Thus, there is evidence that group dynamics are relevant in children's decision-making involving science activities. Nonetheless, there is a paucity of research investigating children's and adults' viewpoints about whether gender inequalities regarding science materials should be rectified or perpetuated.

1.2 | Gender stereotypes and science

Implicit and explicit gender stereotypes regarding science and math abilities are present from early childhood throughout the lifespan (Cvencek et al., 2011; Liben & Bigler, 2002; Mulvey & Irvin, 2018). By 7–8 years of age, children are more likely to draw a male scientist than a female scientist (Miller et al., 2018). This may be driven by children's implicit attitudes about who can do science or due to children seeing more men as scientists than women. Indeed, children's educational resources feature more men than women in science professions (Kerkhoven et al., 2016), which may influence young girls' perceptions about who can be scientists and thus contribute to the low representation of women in science-related majors and fields.

Young adults hold similar gender stereotypes and biases in relation to science (Eccles et al., 1990; Gunderson et al., 2012; Nosek et al., 2009; Shapiro & Williams, 2012; Smeding, 2012). Adults associate men with science more than women in both implicit and explicit association tasks (Guimond & Roussel, 2001; Nosek et al., 2009), and female young adults even rate academic subjects of math, physics, and chemistry as masculine professions (Makarova et al., 2019). Because gender stereotypes associating men with science more than women are so widespread in childhood and adulthood, the current study assessed whether children and adults alike perpetuate science inequalities in a manner that is consistent with gender stereotypes.

1.3 | Resource allocation and gender stereotypes

In some cases, young children exhibit gender stereotypes in their resource allocations (Rizzo & Killen, 2018). For instance, 4–6-year-olds gave more stickers as a r reward to boys when children made toy trucks and more stickers to girls when children made toy dolls (Rizzo & Killen, 2018), showing biases in allocating rewards for completing activities consistent with gender stereotypes. Other studies have documented biased allocations when the resources themselves are associated with gender stereotypes, such as giving more butterfly stickers to girls and pirate stickers to boys (Conry-Murray, 2017), or expecting parents to allocate toys and costumes stereotypically (e.g., giving a toy truck to a boy and a toy doll to a girl) (Conry-Murray & Turiel, 2012). Gender stereotypes, therefore, influence children's resource allocation decisions.

Assessing adults' resource allocation evaluations and decisions in gender stereotypic contexts is insightful, as adults are often the gatekeepers to resources. Yet, few studies have investigated both children's and adults' resource allocation decisions. In one study, young adults negatively evaluated a third party's decision to allocate resources based on gender when the resources were related to gender stereotypes (e.g., robotics kits for boys and card games for girls) (Conry-Murray, 2015). In another study, young adults negatively evaluated unequal allocations both of gender-stereotyped toys and of neutral items to boys and girls, whereas younger children (e.g., 7- and 9-year-olds) were more accepting of gendered allocations (Conry-Murray, 2019). These findings suggest that young adults may hold a more egalitarian orientation than children when it comes to resource allocation decisions in gender stereotypic

contexts. An informative next step, however, is assessing how young adults themselves allocate resources in such contexts, and whether children and adults use different strategies in gender stereotypic contexts involving science resources.

1.4 | Rectifying and perpetuating inequalities

Previous research investigating children's decisions to rectify or perpetuate resource inequalities reveals a mixed picture (Elenbaas & Killen, 2016; Elenbaas et al., 2016; Li et al., 2014; Olson et al., 2011). In the context of luxury resources (e.g., playdough, cookies), children rectify resource inequalities in some contexts (Li et al., 2014) and perpetuate resource inequalities in others (Olson et al., 2011). Other research has documented age-related changes in children's decisions to rectify necessary resource inequalities (e.g., hospital supplies, school supplies) (Elenbaas & Killen, 2016; Elenbaas et al., 2016). For instance, Elenbaas et al. (2016) showed 5–6-year-olds and 10–11-year-olds an inequality of school supplies between racial groups. Younger White and Black children (e.g., 5–6-year-olds) viewed the resource inequality as being more wrong when their racial ingroup was disadvantaged than when the inequality disadvantaged their racial outgroup (Elenbaas et al., 2016). Additionally, younger children demonstrated racial ingroup preferences in their resource allocation decisions, allocating more resources to the disadvantaged group when their racial ingroup was disadvantaged compared to when their racial outgroup was disadvantaged. Notably, this was true for both younger Black and White participants. Older participants (e.g., 10–11-year-olds), in contrast, evaluated pre-existing inequalities of school supplies between racial groups as being equally wrong and rectified the resource inequalities to the same extent regardless of the racial group membership of the disadvantaged group (Elenbaas et al., 2016).

In line with predictions from SRD, which state that children coordinate their judgments and reasoning (Rutland et al., 2010), children who positively evaluated the inequality used group-focused reasoning (e.g., maintaining the status quo), whereas children who negatively evaluated the inequality made references to equality and equity (Elenbaas et al., 2016). In short, there is preliminary evidence that in the context of pre-existing inequalities of school supplies, 5–6-year-olds demonstrate ingroup preferences in their evaluations of, and decisions to rectify, such inequalities, and that these ingroup preferences decrease by 10–11 years of age.

However, it remains less clear how children and adults weigh fairness concerns with ingroup preferences in their resource allocations involving inequalities between gender groups. Unlike race, gender is a commonly accepted social category marker used by adults for grouping individuals (e.g., "…line up boys and girls") and for assigning play activities (e.g., dolls for girls and trucks for boys; softball for girls and baseball for boys) (Liben & Bigler, 2002). In one study, American and Peruvian children (e.g., 4–9-year-olds) viewed vignettes featuring unequal allocations of pay between boys and girls (Corbit et al., 2021). Both samples of children allocated resources to correct the unequal pay, thus rectifying the inequality. Notably, these findings held both when girls were the disadvantaged group and when boys were the disadvantaged group. Nonetheless, it remains an open question if a similar pattern would emerge for a context that generates gender-based stereotypes, such as science resource inequalities between gender groups, and how children's responses might compare to those of young adults.

1.5 | The current study

The current study investigated 5–6-year-olds', 9–11-year-olds', and young adults' evaluations, resource allocations, and reasoning in a task involving a gender-based inequality of science supplies. Investigating participants' science resource evaluations and allocations in a morally relevant context allowed us to examine whether children and adults alike endorse and perpetuate science inequalities that advantage boys over girls. For the resource allocation task, we

showed participants two conditions. In one condition, a school serving girls was disadvantaged by receiving one box of science supplies while a school serving boys was advantaged by receiving six boxes of science supplies. In the other condition, the boy's school was disadvantaged with one box of science supplies and the girl's school was advantaged with six boxes of science supplies. Participants evaluated the inequality, allocated science supplies between gender groups, and provided reasoning for their evaluations and allocations. This allowed us to assess children's and adults' allocations in the context of systemic access to educational opportunities that also might relate to held gender stereotypes. These measures were modeled after previous research on resource allocation decisions in the context of pre-existing inequality (Elenbaas et al., 2016; Olson et al., 2011).

We chose to investigate 5–6-year-olds, 9–11-year-olds, and young adults, given previous research documenting shifts in resource allocation decisions at these ages. For example, young children (e.g., 5–6-year-olds) exhibit ingroup biases in their resource allocation decisions that decrease by middle childhood (e.g., 10–11-year-olds) (Elenbaas & Killen, 2016; Elenbaas et al., 2016; Li et al., 2014; Olson et al., 2011). Additionally, children become less rigid in their gender stereotype enforcement with age (Ruble et al., 2006). We chose to also investigate young adults' resource allocation decisions because little research has investigated how resource allocation evaluations and decisions continue to change with age past adolescence (for exceptions, see Conry-Murray, 2015, 2019). We, therefore, aimed to assess the extent to which gender biases emerge in childhood and persist into adulthood in a science resource allocation task.

1.6 | Hypotheses

Based on a review of the literature and the theoretical model (SRD) guiding the study, we made the following predictions:

1.6.1 | Evaluations of inequality

We expected that participants would more readily condone the science inequality when girls were disadvantaged (had fewer resources) than when boys were disadvantaged (H1). Motivated by previous research on resource allocation decisions (Elenbaas & Killen, 2016; Elenbaas et al., 2016; Renno & Shutts, 2015), we hypothesized that younger children would evaluate the inequality more negatively when their gender ingroup was disadvantaged compared to older children and adults, and that this would be particularly true for male participants given that prior research suggests boys demonstrate more ingroup preferences in their resource allocation decisions than do girls (Benozio & Diesendruck, 2015) (H2).

1.6.2 | Allocation of resources

We predicted that younger participants would allocate more boxes of science supplies to the boys' disadvantaged group than to the girls' disadvantaged group, as previous research has documented young children prefer and perpetuate status inequalities in favor of high-status groups (Horwitz et al., 2014; Olson et al., 2011), but that this allocation strategy would decrease with age (Elenbaas et al., 2016; Olson et al., 2011) (H3). We also hypothesized that male participants would allocate more boxes of science supplies to the boys' disadvantaged group than to the girls' disadvantaged group (H4), given previous research on gender differences in resource allocation decisions (Benozio & Diesendruck, 2015; Leman et al., 2009) and gender stereotypes associating science with men more than women (McGuire et al., 2020; Nosek et al., 2009).

1.6.3 | Reasoning about inequality and allocation of resources

We expected that participants who negatively evaluated the resource inequality and rectified the inequality would use moral reasoning more than group-focused reasoning, whereas participants who positively evaluated the inequality and perpetuated the inequality would use group-focused reasoning more than moral reasoning (H5). It was an open question whether reasoning would differ as a function of age and gender, given that some studies find differences in reasoning by age and gender and other studies do not (e.g., Rizzo et al., 2016; Theimer et al., 2001).

2 | METHOD

2.1 | Participants

Participants ($N = 144$) were 5–6-year-olds ($n = 49$; 24 girls; $M_{age} = 5.83$ years, $SD_{age} = .97$ years), 9–11-year-olds ($n = 47$: 24 girls; $M_{age} = 10.74$ years, $SD_{age} = .68$ years), and young adults ($n = 48$; 24 girls; $M_{age} = 19.92$ years, $SD_{age} = 1.10$ years). Motivated by previous research with similar sample sizes (e.g., Elenbaas & Killen, 2016; Elenbaas et al., 2016), we conducted a priori power analyses using G*Power (Faul et al., 2009), which revealed that for an ANOVA with fixed effects, special, main effects, and interactions, a medium effect size ($f = .27$) with power (.8) and $\alpha = .05$, a minimum of 136 participants would be appropriate to test for medium effects. Participant race and ethnicity was 52% European American, 15% African American, 10% Asian American, 7% Latinx, and 11% Mixed or Other, with 5% who declined to report, with no differences in participant race/ethnicity by age group (see Table S1). Reported parental income of participants on average was between $120,000 and $150,000, and was significantly higher for 5–6-year-old participants compared to the reported parental income for young adult participants (see Table S2). Consent forms were distributed to parents of age-eligible children (5–6-year-olds and 9–11-year-olds) who were recruited from local elementary schools, after school care programs, and summer programs in the Mid-Atlantic region of the United States. Parents who were interested in having their child participate signed and returned consent forms, and child verbal assent was obtained in addition to written parental consent. Young adults were recruited through an undergraduate participant pool at a large public research university in the Mid-Atlantic region of the United States and provided written consent and verbal assent. Young adults also self-reported on all items, including those on the consent form (e.g., parental income). The protocol was identical for all participants. The data were collected between April of 2018 and June of 2019. The Institutional Review Board at the University of Maryland approved this study. Children received a small prize (e.g., an eraser) and young adults received SONA research credits as compensation for their participation.

2.2 | Procedure and assessments

2.2.1 | Procedure

Participants received hard-copy printed surveys depicting brightly colored pictures of children, schools, science materials, and smiley faces that accompanied Likert-type scales (see Figure 1). To account for reading ability differences between age groups, a trained research assistant read the questions individually in a quiet room at their school or care facility to the youngest age group (5–6-year-olds), and their reasoning responses were audio-recorded and transcribed. Older children (9–11-year-olds) and adults completed the same paper protocol independently with experimenters sitting nearby to answer any questions. All participants were trained on how to use the Likert-type scales depicted in the protocols. In total, each interview took approximately 25 min to complete.

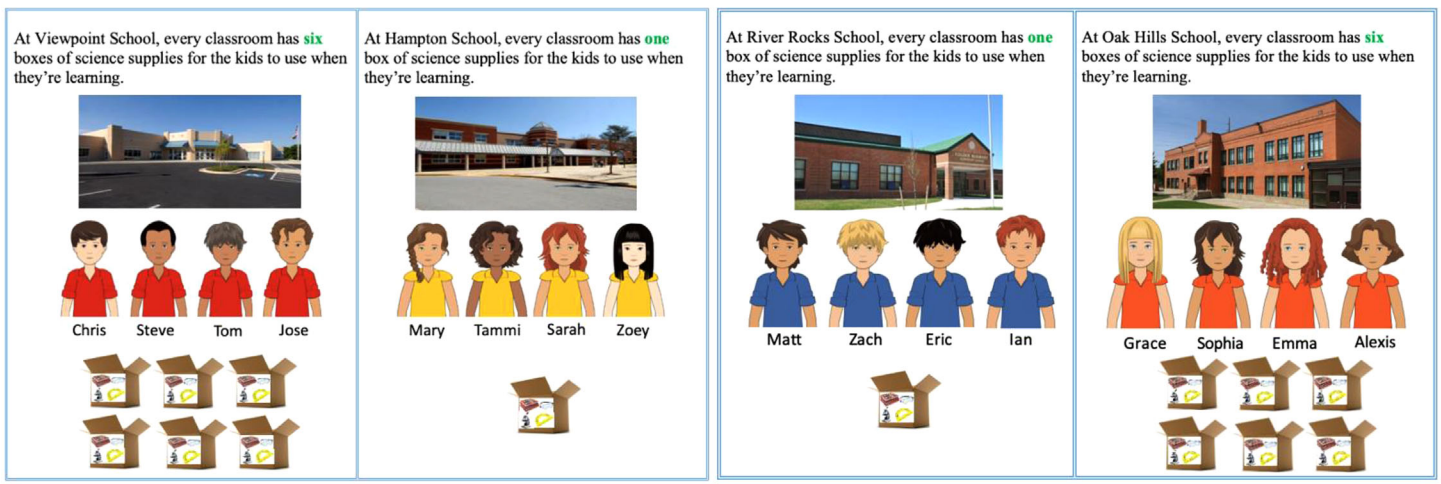

FIGURE 1 Presentation of the pre-existing gender inequality in the resource allocation vignette. *Note*: This figure depicts the within-subjects science resource inequality, with the Girls Disadvantaged Condition on the left, and the Boys Disadvantaged Condition on the right.

2.2.2 | Resource allocation vignette

To assess age-related differences in children's and adults' preferences to rectify or perpetuate an inequality of science supplies in a gendered context, we administered a script modified from Elenbaas and Killen (2016). All participants witnessed two vignettes where one group of children (e.g., boys) had six boxes of science supplies while another group of children (e.g., girls) had one box of science supplies. Participants were shown pictures of each group of children and a picture of the school each group attended with the following text to denote the equal need and merit between the two groups:

> "These are two schools in the same city. There are the same number of kids who go to both schools. Here are some kids who go to [School A]. Here are some kids who go to [School B]."
>
> When kids at [School A] have science class, they study a lot and love to learn about different areas of science, such as how plants grow and the different clouds in the sky. For example, when kids at [School A] go home, they study a lot and do all of their science homework. Here they are doing their science homework.
>
> "When kids at [School B] have science class, they study a lot and love to learn about different areas of science, such as how plants grow and the different clouds in the sky. For example, when kids at [School B] go home, they study a lot and do all of their science homework. Here they are doing their science homework."

Next, participants were shown the resource inequality. The study included two within-subjects conditions that varied the disadvantaged gender group (see Figure 1). The two vignettes included identical scripts but varied the images of the kids that were in each group and the names and pictures of each school. In one vignette boys were advantaged (e.g., had six boxes of science supplies) and girls were disadvantaged (e.g., had one box of science supplies), and in another vignette girls were advantaged, and boys were disadvantaged. Younger participants (e.g., 5- to 6-year-olds) received tangible figures of the science boxes to indicate their distribution preferences. In contrast, older participants (e.g., 9- to 11-year-olds and young adults) viewed and indicated their distribution preferences of figures of science boxes on the printed survey.

Evaluations of inequality

To assess the acceptability of the resource inequality between the two groups, participants were asked, "How okay or not okay is it that [School A] has more boxes of science supplies than [School B]?" using a six-point Likert-type scale ranging from 1 = "*really not okay*" to 6 = "*really okay*." Participants provided their evaluations of the permissibility of the resource inequality both when girls were the disadvantaged group and when boys were the disadvantaged group.

Participant resource allocation decisions

To assess the degree to which participants rectified or perpetuated the resource inequality, participants were given seven boxes of science supplies and were asked, "How should you give out these seven boxes of science supplies between these two schools?" The number of boxes allocated to the disadvantaged group was recorded, ranging from 0 to 7 boxes. Participants allocated resources both when girls were disadvantaged and when boys were disadvantaged. We conceptualized rectifying the inequality as an allocation in which participants gave a majority (i.e., 4 or more) of boxes of science supplies to the previously disadvantaged group. We conceptualized perpetuating the inequality as an allocation in which participants gave a majority of boxes of science supplies to the previously advantaged group.

Reasoning

Participants justified their evaluations and their resource allocation decisions. Based upon previous research (Cooley & Killen, 2015; Elenbaas et al., 2016; Rizzo et al., 2016), the transcripts from the audio recordings for the youngest children and the written responses on the protocol for the older children and adults were coded into the following two categories: (1) *Moral*: others' welfare, equality, and rights for resources and opportunities (e.g., "All children should have the same access to education, including supplies") and fairness (e.g., "Because they both study a lot and they only have one box that is not fair"); (2) *Group-focused*: status quo (e.g., "The boys' school originally had more boxes so they get the extra one") and gender stereotypes (e.g., "Boys are smarter than girls in science. They need more resources to develop"). Status quo reasoning and reasoning related to gender stereotypes were used less than 10% of the time each as independent codes, and thus were collapsed into a single "group-focused" code given that both codes refer to group-based concerns related to societal issues (Smetana et al., 2014). A third category was for *Uncodable* statements ("I don't know"). Participants who referenced two categories were given double codes (.5 for each category). Two independent coders who were blind to the hypotheses of the study coded 25% of the data ($n = 36$) and reached an inter-rater reliability of Cohen's $\kappa = .85$. In total, 8% of our sample referenced both the moral and group-focused concerns in their responses, 11% of responses were "uncodable" (referenced something other than moral and group-focused reasoning), and 9% did not provide reasoning for at least one reasoning response.

For reasoning analyses, participants' evaluations and allocations were dichotomized in order to test if participants' reasoning differed based on whether they endorsed or rejected, and whether participants themselves rectified or perpetuated, the inequality. Participants' responses of "really not okay," "not okay," or "a little not okay" were collapsed into a "not okay" code, and participant responses of "a little okay," "okay," or "really okay" were collapsed into an "okay" code. This procedure is standard with SRD research (see Elenbaas & Killen, 2016 for an example).

2.3 | Data analytic plan

This section outlines the data analytic plan for each analysis. The de-identified data and the measures may be available upon request. This study was not pre-registered.

2.3.1 | Evaluations of inequality and reasoning

To test our hypothesis that participants would more negatively evaluate an inequality of science supplies that disadvantaged boys over one that disadvantaged girls (H1), we conducted a 3 (age group: 5–6-years-old, 9–11-years-old, young adults) by 2 (participant gender: male, female) by 2 (disadvantaged gender group: girls disadvantaged, boys disadvantaged) ANOVA with repeated measures on the last factor. To test our hypothesis that moral reasoning would accompany negative evaluations of the inequality and group-focused reasoning would accompany positive evaluations of the inequality when girls were disadvantaged and when boys were disadvantaged (H5), we conducted separate 3 (age group: 5–6-years-old, 9–11-years-old, young adults) by 2 (participant gender: male, female) by 2 (inequality evaluation: okay, not okay) by 2 (reasoning: moral, group-focused) ANOVAs with repeated measures on the last factor. Bonferroni-adjusted pairwise comparisons were conducted to explain significant interactions.

2.3.2 | Resource allocation decisions and reasoning

To test our hypothesis that young children would perpetuate resource inequalities that advantaged boys compared to older participants (H3), and that male participants would show an ingroup bias in their allocations (H4), we conducted a 3 (age group: 5–6-year-olds, 9–11-year-olds, young adults) by 2 (participant gender: male, female) by 2 (allocations

to disadvantaged gender group: girls disadvantaged, boys disadvantaged) ANOVA with repeated measures on the last factor. To test our hypothesis that participants who rectified the inequality would use moral reasoning and that participants who perpetuated the inequality would use group-focused reasoning when girls were disadvantaged and when boys were disadvantaged (H5), we conducted separate 3 (age group: 5–6-year-olds, 9–11-year-olds, young adults) by 2 (participant gender: male, female) by 2 (resource allocation: more to disadvantaged, more to advantaged) by 2 (reasoning: moral, group-focused) ANOVAs with repeated measures on the last factor. Bonferroni-adjusted pairwise comparisons were conducted to explain significant interactions.

3 | RESULTS

3.1 | Evaluations of inequality

Supporting our hypothesis (H1), participants evaluated the resource inequality as less wrong when girls were disadvantaged ($M = 2.45$, $SD = 1.62$) than when boys were disadvantaged ($M = 2.04$, $SD = 1.28$) ($F(1, 138) = 10.81$, $p = .001$, $\eta_p^2 = .07$). Contrary to our hypothesis (H2), however, there were no significant interactions between the disadvantaged gender group and age group ($F(2, 138) = 2.79$, $p = .07$, $\eta_p^2 = .04$) or the disadvantaged gender group and participant gender ($F(1, 138) = 1.32$, $p = .25$, $\eta_p^2 = .009$). Lastly, there was a marginally significant interaction for the disadvantaged gender group by age group by participant gender ($F(1, 138) = 3.01$, $p = .053$, $\eta_p^2 = .04$).

While marginally significant interactions are typically not reported, we conducted Bonferroni-adjusted pairwise comparisons on the marginal interaction given that these comparisons were related to our central hypotheses, and we found significant difference based on participant gender and age. Results revealed 5–6-year-old male participants ($p < .001$) and 9–11-year-old female participants ($p = .003$) evaluated the inequality more negatively when boys were disadvantaged than when girls were disadvantaged. Young adult female participants evaluated both the girls-disadvantaged ($p = .01$) and boys-disadvantaged ($p = .009$) inequalities more negatively than did 5–6-year-old female participants, and more negatively than 9–11-year-old female participants only when girls were disadvantaged ($p = .003$). Additionally, 9–11-year-old male participants ($p = .017$), young adult male participants ($p = .001$), and 5–6-year-old female participants ($p = .030$) evaluated the girls-disadvantaged inequality more negatively than did 5- to 6-year-old male participants. Thus, female young adults judged the inequalities to be more wrong than did younger female participants, while 5–6-year-old male participants viewed the inequality where girls were disadvantaged more positively than did their older male counterparts.

3.2 | Reasoning for evaluations of inequality

We tested our hypothesis that moral reasoning would accompany negative evaluations of the inequality and group-focused reasoning would accompany positive evaluations of the inequality (H5).

3.2.1 | Girls disadvantaged condition

When girls were disadvantaged, there was a significant main effect of reasoning ($F(1, 128) = 17.77$, $p < .001$, $\eta_p^2 = .12$). This main effect was qualified by a significant reasoning by inequality evaluation interaction ($F(1, 128) = 115.94$, $p < .001$, $\eta_p^2 = .48$) (see Figure 2). Supporting our hypothesis (H5), Bonferroni-adjusted pairwise comparisons on the interaction revealed that participants who negatively evaluated the inequality used moral reasoning significantly more than group-focused reasoning ($p < .001$). In contrast, participants who positively evaluated the inequality used group-focused reasoning significantly more than moral reasoning ($p < .001$).

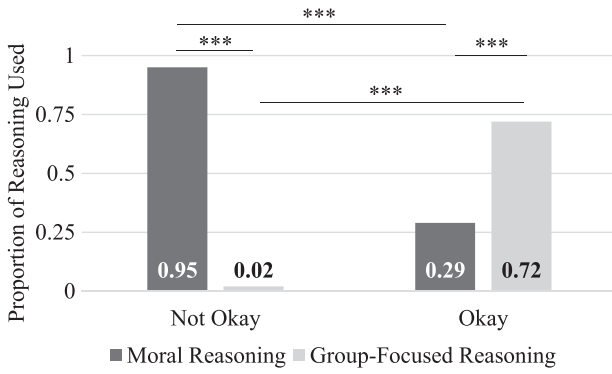

FIGURE 2 Proportion of reasoning used in the girls disadvantaged condition by inequality evaluation. *Note*: ***$p < .001$

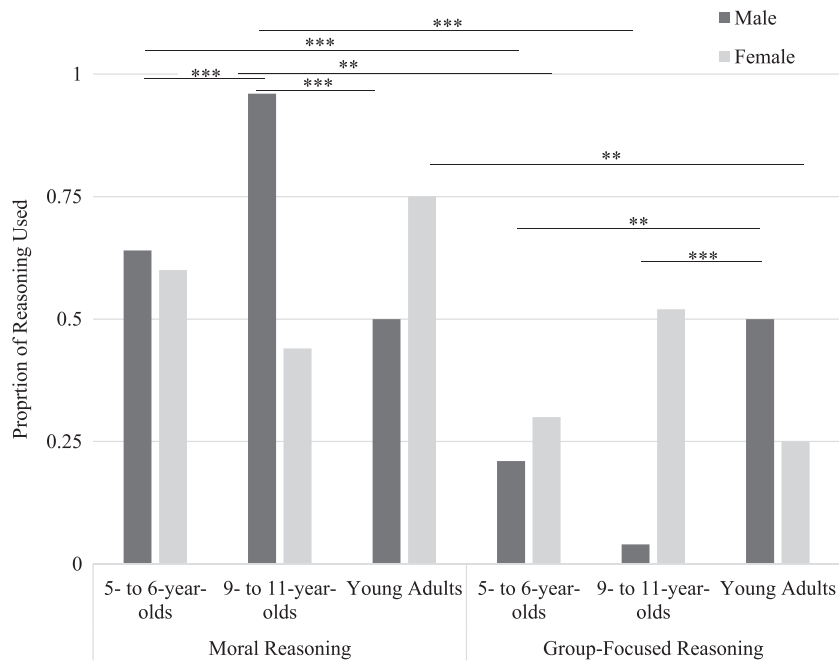

FIGURE 3 Proportion of reasoning used in the boys disadvantaged condition by age group and participant gender. *Note*: ***$p < .001$; **$p < .01$

3.2.2 | Boys disadvantaged condition

When boys were disadvantaged, there was a significant main effect of reasoning ($F(1, 128) = 9.95$, $p = .002$, $\eta_p^2 = .07$). This main effect was qualified by several significant interactions. Supporting our hypothesis (H5), we found a significant reasoning by inequality evaluation interaction ($F(1, 128) = 129.39$, $p < .001$, $\eta_p^2 = .50$), as well as a significant reasoning by age group interaction ($F(2, 128) = 3.56$, $p = .03$, $\eta_p^2 = .05$). These two-way interactions were qualified by a significant reasoning by age group by participant gender interaction ($F(2, 124) = 3.12$, $p = .048$, $\eta_p^2 = .05$), which we interpret below.

We conducted Bonferroni-adjusted pairwise comparisons to interpret the reasoning by age group by participant gender interaction (see Figure 3). Results revealed both 5–6-year-old females ($p = .002$) and males ($ps < .001$), 9- to

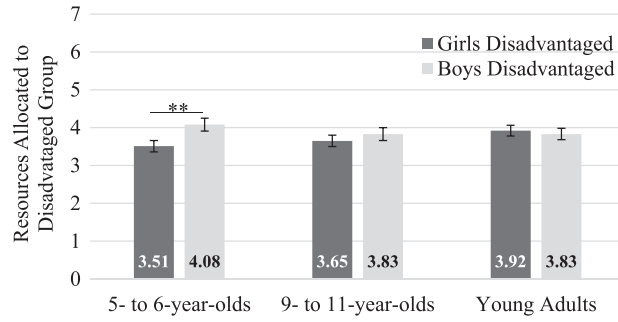

FIGURE 4 Resources allocated to the disadvantaged group by age group. *Note*: $^{**}p < .01$

11-year-old males ($p < .001$), and young adult females ($p = .009$) used moral reasoning significantly more than group-focused reasoning.

More specifically, 9–11-year-old males used *moral* reasoning significantly more than 5–6-year-old males ($p < .001$), young adult males ($p < .001$), and 9- to 11-year old females ($p < .001$), and used *group-focused* reasoning significantly less than did 9- to 11-year old females ($p < .001$). Young adult males used group-focused reasoning significantly more than 5–6-year-old males ($p = .003$), 9- to 11-year-old males ($p < .001$), and young adult females ($p = .04$). Thus, male participants in middle childhood used moral reasoning significantly more than younger and older male participants and their female counterparts when reasoning about inequalities that disadvantaged boys. In contrast, young adult male participants used group-focused reasoning significantly more than male participants from the other age groups and their female counterparts.

3.3 | Participant resource allocation decisions

Testing our hypothesis that young children would perpetuate resource inequalities that advantaged boys compared to older participants (H3) and that male participants would show an ingroup bias in their allocations (H4) revealed a significant main effect of disadvantaged gender group ($F(1, 137) = 4.75, p = .03, \eta_p^2 = .03$). The main effect was qualified by a significant disadvantaged gender group by age group interaction ($F(2, 137) = 3.39, p = .04, \eta_p^2 = .05$) (see Figure 4).

Supporting our hypothesis regarding age-related differences (H3), Bonferroni-adjusted pairwise comparisons revealed that 5- to 6-year-olds gave significantly more boxes of science supplies to the disadvantaged group when boys were disadvantaged than when girls were disadvantaged ($p = .002$), whereas the other age groups did not significantly differ in their resource allocation decisions based on the gender of the disadvantaged group ($ps > .05$).

Our hypothesis regarding participant gender differences (H4) was also supported: there was a significant disadvantaged gender group by participant gender interaction ($F(1, 137) = 9.78$, $p = .002$, $\eta_p^2 = .07$) (see Figure 5). Bonferroni-adjusted pairwise comparisons revealed that male participants allocated more boxes of science supplies to the disadvantaged group when boys were disadvantaged than when girls were disadvantaged ($p < .001$) while female participants did not allocate significantly differently based on the gender of the disadvantaged group ($p = .50$). However, female participants allocated significantly more boxes to the disadvantaged girl group than did male participants ($p = .01$). In other words, male participants demonstrated an ingroup bias in their resource allocation decisions when boys were disadvantaged, whereas female participants did not demonstrate an ingroup bias when girls were disadvantaged. For visual representations of participants' allocation strategies, please see supplemental materials (Figures S1 and S2).

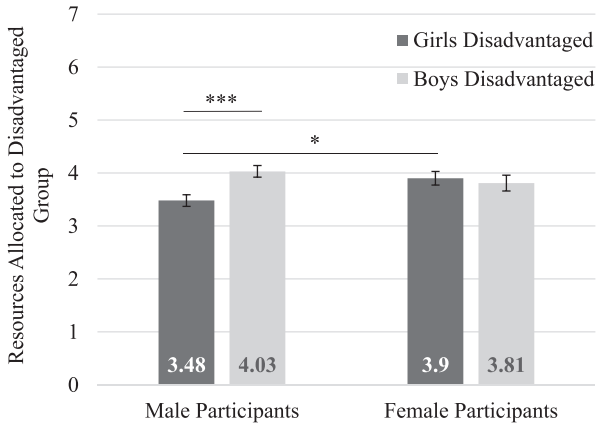

FIGURE 5 Resources allocated to the disadvantaged group by participant gender. *Note*: ***$p < .001$, *$p < .05$

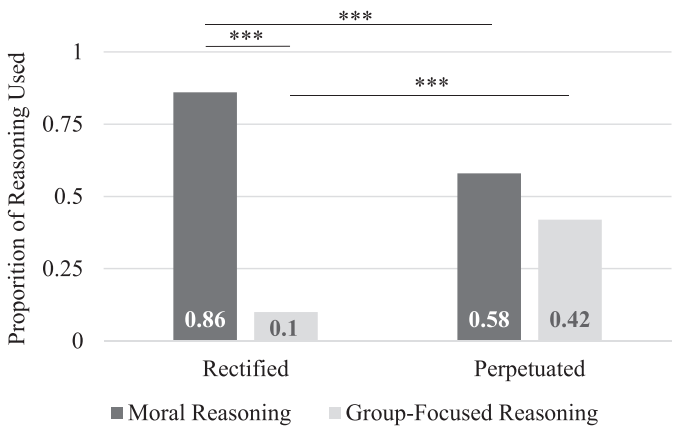

FIGURE 6 Reasoning proportions by allocation strategy in the girls disadvantaged condition. *Note*: ***$p < .001$

3.4 | Reasoning for resource allocation decisions

We tested our hypothesis that participants who rectified the inequality would use moral reasoning and that participants who perpetuated the inequality would use group-focused reasoning (H5).

3.4.1 | Girls disadvantaged condition

When girls were disadvantaged, there was a significant main effect of reasoning ($F(1, 125) = 40.39$, $p < .001$, $\eta_p^2 = .24$). The main effect was qualified by a significant reasoning by resource allocation interaction ($F(1, 125) = 21.24$, $p < .001$, $\eta_p^2 = .15$) (see Figure 6).

Partially supporting our hypothesis (H5), Bonferroni-adjusted pairwise comparisons revealed that participants who rectified the resource inequality used moral reasoning significantly more than group-focused reasoning ($p < .001$). Counter to our hypothesis (H5) and theorizing under the SRD model more generally which asserts that perpetuating inequality is more often related to social conventional and group-focused reasoning (Rutland et al., 2010), participants who perpetuated the inequality did not significantly differ in their use of moral or group-focused reasoning ($p = .27$).

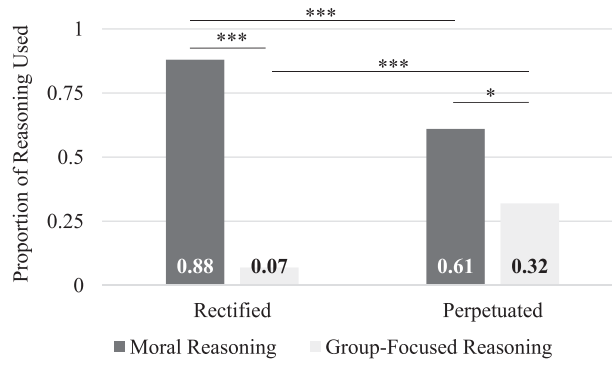

FIGURE 7 Reasoning proportions by resource allocation strategy in the boys disadvantaged condition. *Note*: ***$p < .001$, **$p = .001$, *$p = .012$

3.4.2 | Boys disadvantaged condition

When boys were disadvantaged, there was a significant main effect of reasoning ($F(1, 129) = 70.27$, $p < .001$, $\eta_p^2 = .35$). This main effect was qualified by a significant reasoning by resource allocation interaction ($F(1, 129) = 16.19$, $p < .001$, $\eta_p^2 = .11$) (see Figure 7).

Bonferroni-adjusted pairwise comparisons on the two-way interaction revealed that our hypothesis (H5) was partially supported. Participants who rectified the resource inequality when boys were disadvantaged used moral reasoning significantly more than group-focused reasoning ($p < .001$). Counter to our hypothesis, however, participants who perpetuated the inequality when boys were disadvantaged also used moral reasoning significantly more than group-focused reasoning ($p = .012$).

4 | DISCUSSION

How to allocate resources amongst those who need them is a fundamental human concern involving considerations of fairness, equity, and group identity (Rutland & Killen, 2017). Denying a group resource based on gender, specifically, may motivate children's and adults' recognition of social inequalities, concerns for others' welfare, and confrontation of stereotypic expectations (Smetana et al., 2014). The current study revealed novel findings regarding children's and adults' evaluations and resource allocations in response to a gender-based inequality of science supplies. First, participants in the current study evaluated science resource inequalities less negatively when girls were disadvantaged than when boys were disadvantaged. In other words, though participants negatively evaluated science resource inequalities in both contexts, they did so to a greater extent when boys were disadvantaged than when girls were disadvantaged. This aligns with previous research documenting a pro-male bias in relation to beliefs about science-related competencies (Guimond & Roussel, 2001; Liben & Bigler, 2002; Mulvey & Irvin, 2018; Nosek et al., 2009).

Second, younger participants (e.g., 5–6-year-olds) and male participants rectified the inequality of science supplies to a greater extent when boys were disadvantaged than when girls were disadvantaged. This reflects not only a gender disparity in resource allocation decisions, but may also be related to underlying assumptions that boys are more qualified and deserving of science resources than are girls. This is also counter to other research documenting that children rectify unequal gender-based pay to the same extent regardless of the gender of the disadvantaged group (Corbit et al., 2021). Third, as with many assessments of bias, these differences were subtle (see Dunham et al., 2011). That is, the magnitude of the difference in allocations to disadvantaged girls and to disadvantaged boys was small, but still significant nonetheless, indicating a gender-stereotypic bias that participants may not be fully aware they hold (Smeding, 2012). These findings add to a growing body of literature on perceptions of fairness and group bias in resource allocation tasks.

Our findings differ with previous research on race-based findings (Elenbaas & Killen, 2016; Elenbaas et al., 2016). Unlike evaluations of race-based inequalities of resources in which young children presented an ingroup bias (Elenbaas & Killen, 2016; Elenbaas et al., 2016), younger children in the present study did not evaluate their own group being disadvantaged more negatively than did older children. Instead, across age and participant gender, participants in the current study evaluated science resource inequalities disadvantaging boys more negatively than when such disparities disadvantaged girls. These findings are in line with previous literature associating science with men more than women (Nosek et al., 2009), and speak to the importance of addressing gender stereotypes as they relate to science early in development.

Participants' reasoning related to their evaluations and resource allocation decisions. In line with SRD's predictions that children coordinate their judgments and reasoning (Killen & Rutland, 2011), we found that participants who negatively evaluated and rectified resource inequalities primarily used moral reasoning rather than group-focused reasoning. Notably, however, there were some participants who used moral reasoning even when perpetuating science inequalities. For example, there were no significant differences for references to moral reasoning and group-focused reasoning for participants who perpetuated the resource inequality when girls were disadvantaged, counter to our predictions.

Under the SRD perspective, it is unusual for participants to perpetuate an inequality while also justifying their choice with moral reasoning. This suggests that these participants did not view perpetuating an inequality that disadvantaged girls as problematic, but rather justified this decision through a moral lens. This may be because participants who perpetuated the inequality when girls were disadvantaged viewed boys as having more claim to science materials than girls due to gender stereotypes about merit in science. Merit is a moral concern, yet in this case may have been tarnished by held stereotypes associating boys and men with more competency in science than girls and women (Nosek et al., 2009). That is, it is possible that participants thought that boys had a stronger claim to science resources because males fit the status quo given their higher rates of science-related workforce participation (National Center for Science & Engineering Statistics, 2017; National Girls Collaborative Project, 2016; Noonan, 2017) and broader societal stereotypes associating them with science (Nosek et al., 2009). Such associations may explain why these participants viewed resource allocations that further perpetuated inequality when girls were disadvantaged as having a meritorious basis. In other words, if participants believed the boys would use (or deserved) the resources more than the girls, then choosing to further perpetuate the inequality, in this case, could be justified through moral appeals to rights to resources and claims to merit, even if such associations were based on stereotypes. Future research should further delve into this line of reasoning to determine the underlying motivation for this type of explanation. However, it is possible that other motivations, such as ingroup preferences, were responsible for driving participants' justifications. Ultimately, future research needs to be conducted to understand the underlying motivations of those who perpetuated the inequality while using moral reasoning when girls were disadvantaged.

We also found some age-related changes in participants' evaluations of the inequality when girls were disadvantaged. That is, female young adults judged the inequality more negatively than did younger female participants (e.g., 5–6-year-olds and 9–11-year-olds). This suggests that understanding of the wrongness of gender-based inequalities increases with age, at least among females who are more often disadvantaged in science contexts. Notably, it is possible that this finding was driven by age-related increases in the awareness that stereotypic beliefs surrounding science exist but are not necessarily accurate, or that our older sample of female participants may have experienced similar disadvantages themselves. Our data do not speak to this possibility, however, and this is an area for future research to address.

Findings from the current study also make significant contributions to the broader literature on resource allocation and moral development in childhood and adulthood. Previous research has found that in some contexts children hold ingroup preferences in their resource allocations (Dunham et al., 2011; Renno & Shutts, 2015) and perpetuate status-based resource inequalities between racial and novel groups (Olson et al., 2011), yet in other contexts rectify race-based inequalities of medical and school resources (Elenbaas & Killen, 2016; Elenbaas et al., 2016). Concerns for fairness are prevalent in the early childhood years (Blake & McAuliffe, 2011; Li et al., 2014; Mulvey et al., 2014),

with evidence that children as young as 3 years of age reject unfair resource allocations (Baumard et al., 2012). In line with the SRD model, children often reason about issues of fairness, equality, and others' welfare in contexts involving inequality (Rutland & Killen, 2015).

It should also be noted, however, that though we conceptualized rectifying the inequality as giving a majority of boxes of science supplies to the disadvantaged group, participants often did not rectify the inequality enough to achieve true equity. That is, children and adults in the current study allocated resources closer to an even split and on average avoided more extreme allocations that would have resulted in the most equitable outcomes (e.g., six boxes to the disadvantaged group and one box to the advantaged group). There are numerous reasons why this finding may have emerged. One perspective is that this type of allocation strategy more closely mirrors allocation decisions made in everyday life; when disparities exist, resources are rarely stripped from individuals in order to allocate more fairly to other individuals. Instead, supplies are often allocated to all parties, with a slight majority going to the less advantaged group. Additionally, given that participants allocated necessary resources, there may have been more justification needed to deny necessary resources (in this case science supplies) to one group over the other, even when one group had more resources to begin with. In other words, the advantaged group was not portrayed as having done anything wrong, nor was the disadvantaged group portrayed as being more deserving or worthy of resources aside from the sheer inequality presented. In this way, our findings differ from previous research showing that children fully rectify inequalities of pay between gender groups (Corbit et al., 2021), but that is not to say that children and adults alike are not thinking about issues of equality and equity when it comes to science supplies. Indeed, taken as a whole, participants gave more resources to the disadvantaged group, though younger participants (e.g., 5–6-year-olds) and male participants allocated more resources to the disadvantaged group when boys were disadvantaged than when girls were disadvantaged.

Bridging these findings under the SRD perspective, our study revealed both the presence and extent of gender biases for children's and adults' moral decision-making in response to a gender-based science inequality. On average, children and adults negatively evaluated science resource disparities between groups, rectified inequalities in their resource allocation decisions, and used moral reasoning to explain their responses. Yet, some pro-boy gender biases were evident for both children and adults in the context of science resource inequalities, supporting the societal status quo as it relates to gender and science.

4.1 | Limitations and future directions

There were several limitations of the present study. First, we did not include a comparison condition to the presented science inequality paradigm. Therefore, we cannot determine whether the current findings are specific to science resource inequalities or if similar findings may emerge if participants were asked to allocate other resources (e.g., candy) between gender groups. We recommend that future research use an identical paradigm to what was used in the present research, but in a non-science context (e.g., giving out seven boxes of art supplies between the schools). Future research could include multiple comparison conditions to directly test this assumption.

Further, our study was designed to specifically address how societal stereotypes about science and gender contribute to judgments about gender-based science inequalities. Yet, it is possible that participants could derive status from which group has more resources rather than getting cues about status from the gender of the groups as we intended. Future research should directly explore these possibilities.

Additionally, participants were given an odd number of resources to allocate, thus not allowing participants to make equal allocations. It is possible that equal allocations would have been the most popular choice had participants been given that option, and we do not know how the current findings would have differed if participants had the opportunity to allocate resources equally. Future research should include both even and odd amounts of resources to test whether allocations differ in these contexts, and possibly reduce the participants' cognitive load by including smaller amounts

of resources and visual cues reminding participants which allocations would rectify the inequality and which would perpetuate the inequality.

In the current study, we presented groups of boys and girls as working equally hard at science and enjoying science activities equally to control for participant inferences about the groups' desires for access to science resources. As a next step, it would be informative to manipulate the extent to which each group utilized the science resources and how merit relates to children's and adults' decisions to rectify science resource inequalities. Future research might also examine the anticipated emotions of the recipients, and how this varies by the gender of the disadvantaged group. In this way, future research could assess how considerations of care (e.g., empathy) bear on moral decision-making in inequality contexts. Future research should also counterbalance the allocation of resources by participants' own gender to test if order effects emerge when witnessing one's gender ingroup at a disadvantage compared to one's gender outgroup, as well as investigate children's and adults' resource allocation decisions in stereotypic and non-stereotypic contexts.

The current study depicted boxes of science supplies given its generalizability across age groups, but it is an open question if similar results would emerge if participants allocated different types of science resources (e.g., biology equipment vs. engineering equipment). In addition to varying the type of supplies depicted, future research could also vary the presentation of the inequality whereby access to science resources could be depicted at the group level compared to the school level (as done in the current study). Additionally, young adults reasoned about inequalities among children. It is an open question if young adults' evaluations, allocations, and reasoning would differ in inequality contexts with adults instead of children. Furthermore, future research can also adopt an individual differences analytical perspective in order to unpack the most common distribution strategies among younger and older age groups.

We did not expect the socioeconomic status (SES) of our sample to skew our findings, but this is an area for future research to explore. It is not only possible that differences may emerge among low SES and high SES samples in terms of resource allocation of science supplies between gender groups, but it is also possible that differences in SES among the target groups may also sway participants' resource allocation decisions. For instance, research by Elenbaas and Mistry (2021) indicates that children's and adolescents' perceptions of wealth inequality inform their resource allocation decisions. Thus, how wealth status informs resource allocation decisions in the context of science and gender is an area for future research to address.

Lastly, resource allocation decisions are only one means to investigate children's conceptions of inequality. Other social cognitive measures, such as inclusion and exclusion decisions, are informative for providing a broader understanding of science biases as they relate to gender and racial group membership. In some cases, children endorse a child's gender counter-stereotypic science-related career choices and negatively evaluate exclusion from such careers (Mulvey & Irvin, 2018). Yet, other research has found that boys negatively evaluate a group deviant who prefers a biology activity over a programming activity and expect the group to negatively evaluate the group deviant (McGuire et al., 2020). Extending this research and findings from the current study, future research should investigate whether gender differences emerge in children's and adults' own inclusion and exclusion selections in a variety of science contexts.

5 | CONCLUSION

Overall, children and adults negatively evaluated and rectified science inequalities between gender groups. The extent to which they did so differed, however, based upon the gender of the disadvantaged group. Across age and gender, both children and adults held more negative attitudes towards science resource inequalities that disadvantaged boys over those that disadvantaged girls. Furthermore, 5–6-year-olds and male participants rectified resource inequalities to a greater extent when boys were disadvantaged than when girls were disadvantaged. The results of the present study aid our understanding of the developmental trajectory of resource allocation decisions from childhood to adulthood. On the one hand, the findings are encouraging, as participants in many cases prioritized fairness and equality and reduced science resource inequalities. However, the findings also revealed that both children and

adults perpetuated the status quo in relation to gender and science. Research on the development of children's understanding about gender-based inequalities in science, and particularly where issues of fairness and biases about gender intersect, have implications for addressing gender stereotypes regarding science aptitude and participation in childhood and adulthood. This line of work should be extended to promote targeted discussions about the implications of rectifying and perpetuating bias-based inequalities, particularly as they relate to equal access and opportunity for all individuals. Our findings thus provide a foundation for future research to explore the factors that promote fair and just science participation in childhood and adulthood.

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CONFLICT OF INTEREST

None.

DATA AVAILABILITY STATEMENT

Study materials may be available upon request.

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