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EMPIRICAL REPORTS

CHILD DEVELOPMENT

Young children's adaptive partner choice in cooperation and competition contexts

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Abstract
Choosing adequate partners is essential for cooperation, but how children calibrate their partner choice to specific social challenges is unknown. In two experiments, 4- to 7-year-olds ($N = 189$, 49% girls, mostly White, data collection: 03.2021–09.2022) were presented with partners in possession of different positive qualities. Children then recruited partners for hypothetical tasks that differed with respect to the quality necessary for success. Children and the selected partner either worked together toward a common goal or competed against each other. From age 5, children selectively chose individuals in possession of task-relevant qualities as cooperative partners while avoiding them as competitors. Younger children chose partners indiscriminately. Children thus learn to strategically adjust their partner choice depending on context-specific task demands and different social goals.

From building pyramids to playing basketball, from running a company to performing an opera, many (good and bad) things can only be achieved by joining forces with others (Tomasello, 2009). To ensure successful cooperation, individuals need to team up with capable, reliable, and trustworthy partners and avoid partners lacking these qualities. This creates a "biological market," where individuals advertise their own qualities to be included in cooperative endeavors while concurrently aiming to select partners displaying traits that support cooperative success (Barclay, 2016; Noë & Hammerstein, 1994).

Young children begin to exhibit their cooperative traits strategically around age five, as they start enacting their skills or engaging in acts of generosity specifically when others are watching (Asaba & Gweon, 2022; Engelmann & Rapp, 2018; Grueneisen & Warneken, 2022). The competencies supporting partner choice are generally thought to develop earlier (Warneken, 2018). Indeed, children show systematic partner preferences already in infancy (Kuhlmeier et al., 2020). For instance, 6-month-olds prefer agents who help over those who hinder others reach their goals (Hamlin et al., 2007), and 13- to 17-month-olds prefer partners who distribute resources equally rather than unequally (Geraci & Surian, 2011; Lucca et al., 2018). From around age two, partner preferences are also evident in children's prosocial behavior, as they preferentially help familiar individuals (Allen et al., 2018) or individuals who intended to share toys with them (Dunfield & Kuhlmeier, 2010), and refrain from helping or interacting with individuals who have been mean to others (Dahl et al., 2013; Tasimi & Wynn, 2016; Vaish et al., 2010). Children also show partner selectivity based on factors such as food preference and physical appearance (Fawcett & Markson, 2010), group membership (Sparks et al., 2017), accent (Kinzler et al., 2007),

Abbreviation: GLMM, Generalized Linear Mixed Model.

and whether or not individuals intended to cause bad outcomes (Martin et al., 2022).

What mechanisms support children's partner preferences is still unclear. Kuhlmeier et al. (2020) proposed that one route to partner choice is *affective tagging*, whereby the valence of an observed behavior (e.g., generosity) or trait (e.g., group membership) is ascribed to the individual displaying it. Based on diffuse, valanced evaluations (e.g., generous or ingroup individuals are nice), individuals show generalized partner preferences such that they indiscriminately choose or treat favorably those positively tagged partners. An alternative route is that individuals make sophisticated inferences about others' traits ("this person is generous", "this person is knowledgeable"). Such dispositional attributions can result in flexible partner choice based on appraisals of traits and context (e.g., preferring generous individuals in helping situations but not in skill contests). Most previous research on early partner selectivity—in which children were shown to preferentially interact, help, or share resources with partners possessing positive traits over those not possessing those traits—cannot distinguish between these two mechanisms.

Research investigating how children allocate tasks to social partners (rather than recruiting partners for collaborative tasks) has shown that 4- and 5-year-olds are able to infer differences in relative ability and, accordingly, assign harder or easier tasks depending on whether they pursue cooperative or competitive goals (Baer & Odic, 2022; Magid et al., 2018). This early flexibility in matching tasks to partners suggests that children might be able to use strategies that go beyond mere affective tagging, but this has hardly been tested directly.

Moreover, children in prior studies were not asked to *actively recruit* individuals for specific joint activities differing in their task demands. In real life, a close match between the displayed traits and the partner choice context is likely to be crucial. For example, people might value generosity when choosing friends or romantic partners but prioritize qualities like motivation or athleticism when picking players for their soccer team. Likewise, a university hiring committee recruiting a new colleague will presumably focus on the candidates' academic excellence (i.e., their knowledge and skills) rather than their willingness to bring cake to the faculty meeting (i.e., their generosity). A critical developmental challenge is thus to discern and evaluate potential partners' qualities and then to decide which quality is most relevant for the endeavor at hand. How children come to master this challenge has not been sufficiently explored.

We therefore conducted two experiments in which we presented 4- to 7-year-olds with partners who each possessed a different positive quality. Children could subsequently recruit partners for a series of collaborative tasks, which differed with respect to the quality required to succeed, so that children had to pick partners in possession of task-relevant qualities. To probe the flexibility of children's partner choice, we included a second condition in which children picked partners *to compete against* in analogous tasks, so that they benefited from *avoiding* partners with task-relevant qualities. We measured whether children adapted their partner choice depending on the social context and the qualities required. We predicted that children would be more likely to pick partners possessing task-relevant qualities for cooperative than competitive purposes and that this tendency would increase with age.

EXPERIMENT 1

Method

Participants

Experiment 1 included 69 children (48% girls) aged 4 to 7 years (six 4-year-olds, thirty-three 5-year-olds, twenty-four 6-year-olds, and six 7-year-olds; $M = 71$ months), recruited through the participant database of the Max Planck Institute for Human Development. Two additional children were excluded because age data was missing. No ethnic or socio-economic status data were collected, but the population from which the sample was drawn is approximately 71% ethnic German, 11% other European, 9% Middle Eastern, 3% Asian, 2% Afro-German/Black African, and 4% other/unspecified, and encompasses a wide range of socio-economic backgrounds. Children were tested online, and legal guardians gave written informed consent. Online sessions were videotaped. The study was approved by the institutional ethics committee of the Max Planck Institute for Human Development.

Design

In a 2 × 3-within-subjects design, children chose partners to cooperate with (*cooperation* condition) or compete against (*competition* condition). In each condition, children recruited partners for three tasks, each requiring different qualities (speed, knowledgeability, or generosity). Each participant thus contributed 6 choices. The orders of conditions, tasks, and partner introductions were counterbalanced across participants.

Procedure

Children were tested in a videoconference call using BigBlueButton. After obtaining children's assent, the experimenter shared a PowerPoint presentation containing picture stimuli that were accompanied by the experimenter's verbal instructions. Children were first introduced to three gender-matched partners who were described as being fast, knowledgeable, or generous (Figure 1). Partners differed slightly in appearance,

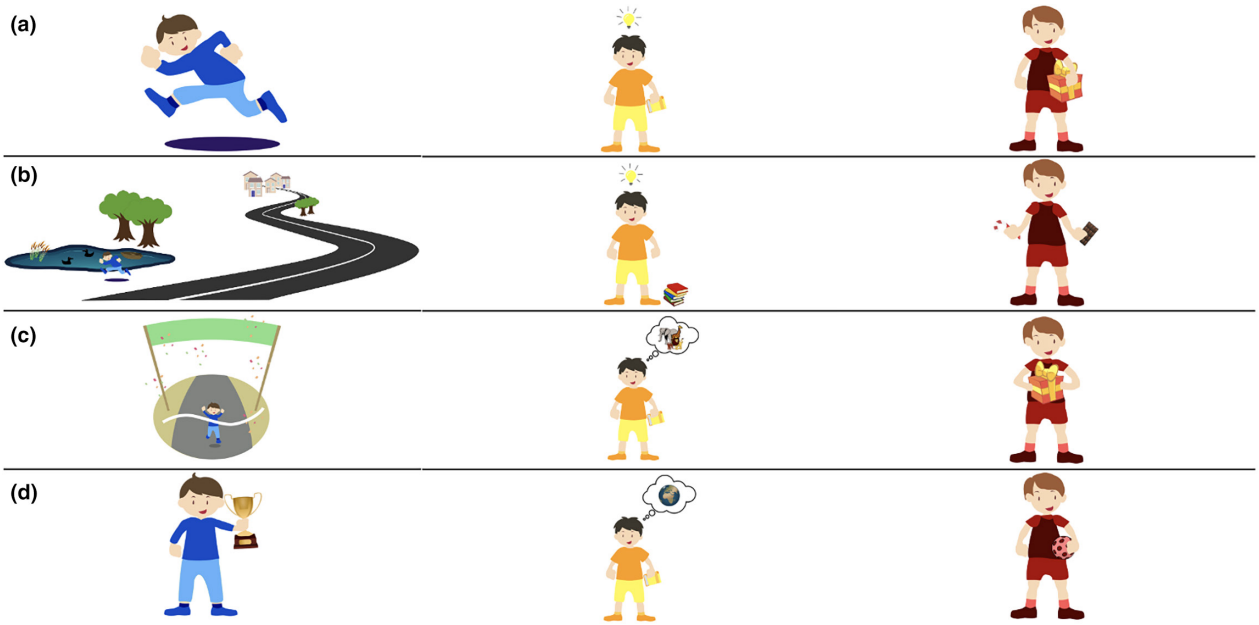

FIGURE 1 Partner introduction: Partners are described using picture stimuli and text narrated by the experimenter.

but which quality they possessed was counterbalanced across participants.

In a subsequent test phase, children were asked to select partners for a series of hypothetical tasks, which were explained using a combination of pictures and verbal instructions and which varied in the qualities required for success. In the cooperation condition, children picked partners for their team, and therefore benefited from picking the partner in possession of task-relevant qualities. In the *speed-relevant* task, players had to collect more balls in a field than an opposing team of two in a given time; in the *knowledge-relevant* task, players had to win against an opposing team in a quiz; the *generosity-relevant* task was a dictator game (Forsythe et al., 1994), where children had to decide which partner would be given resources and the power to decide how to share them with the participant.

In the competition condition, children faced analogous tasks, but now had to pick a competitor, against which to race or play a quiz. The competition version of the *generosity-relevant* task involved both the participant and the partner receiving a resource to share with a third child, who could subsequently pick the participant or the partner to take part in a fun activity. This task taps into the concept of *competitive altruism*, where individuals aim to surpass others' generosity to elicit favors from third parties (Barclay & Willer, 2007; Herrmann et al., 2019). For details on all tasks, see Figure 2 and Figure S1.

In a final phase, children rated the three partners on their speed, knowledgeability, and generosity using five-point scales (Figure S2) and indicated which partner they liked the most.

Analysis

To investigate whether children adjusted their choices to the social context and task demands, we ran a binomial Generalized Linear Mixed Model (GLMM; Baayen, 2008). The dependent variable was whether or not children chose the partner in possession of task-relevant qualities. The test predictors were condition (cooperation, condition), task (speed, knowledge, and generosity), age in months, and their interactions. We included trial number and gender as control predictors, the random effect of participant ID, and the random slopes of task nested within participant ID.

To examine how well children performed in the different conditions and across tasks we ran an identical GLMM, except that the dependent variable was whether or not children chose correctly (i.e., partners possessing

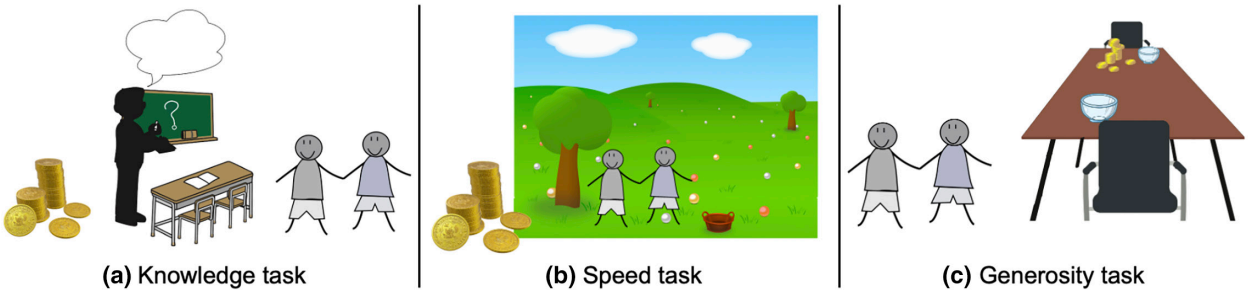

FIGURE 2 Tasks differing with regards to the qualities required for success. For each task, children selected a partner to cooperate with or compete against. (a) knowledge task, (b) speed task, and (c) generosity task.

task-relevant qualities in the cooperation condition, partners *not* possessing task-relevant qualities in the competition condition).

A Poisson GLMM examined children's post-test partner ratings. The test predictors were age in months, the quality to be rated (speed, knowledge, and generosity), and whether or not the partner had been described as possessing that quality. We included gender as a control predictor, the random effect of participant ID, and the random slopes of rated quality and quality possession nested within participant ID.

Analyses were conducted in R (R Core Team, 2021) using the function "glmer" of the R-package lme4 (Bates et al., 2014). We first compared the described full models with respective null models not including the test predictors but retaining all control predictors, random effects, and random slopes using likelihood ratio tests. We ran hypotheses-driven tests of individual predictors only after this full-null model comparison revealed a significant effect of the test predictors combined (this approach reduces Type 1 error rates by preventing multiple testing issues; Forstmeier & Schielzeth, 2011). All reported analyses are confirmatory.

Results

A model including condition order, task order, and order of partner introduction did not improve model fit compared to a null model ($\chi^2(11)=12.87$, $p=.302$). These factors were thus dropped. Condition, age, and task combined significantly affected whether children chose the partner in possession of task-relevant qualities (full-null-model comparison, $\chi^2(11)=33.49$, $p<.001$). Following up a significant interaction between age and condition ($\chi^2(1)=11.07$, $p<.001$), we found that 6- to 7-year-olds picked the partner in possession of task-relevant qualities more often in the cooperation condition than in the competition condition (61% and 31%, respectively, $\chi^2(1)=18.70$, $p<.001$). Condition had no significant effect in 4- to 5-year-olds ($\chi^2(1)=1.15$, $p=.283$). There was no significant effect of task type and no other 2-way or 3-way-interactions.

Children rated partners significantly higher on those qualities they were initially described as possessing ($\chi^2(1)=63.97$, $p<.001$). This effect was consistent across qualities (interaction between quality and quality possession, $\chi^2(2)=1.45$, $p=.485$) and ages (interaction between age and quality possession, $\chi^2(1)=0.01$, $p=.931$). The effect also holds when analyzing the 4- to 5-year-olds separately ($\chi^2(1)=80.04$, $p<.001$), suggesting that younger children's indiscriminate partner choice cannot be explained by their failure to understand or memorize the partner descriptions.

In the post-test preference question, more children preferred the generous (44%) to the knowledgeable partner (20%) with the fast partner being intermediate (36%), $\chi^2(2)=6.09$, $p=.048$. However, children's partner preference did not affect whether they picked the partner with task-relevant qualities ($\chi^2(2)=1.68$, $p=.432$), and all main findings hold when we include children's partner preference as a control predictor.

The predictors age, condition, and task also affected whether or not children chose correctly (full-null model comparison, $\chi^2(11)=36.37$, $p<.001$). We found a significant interaction between age and condition ($\chi^2(1)=4.65$, $p=.031$): Whereas condition had no effect in 6- to 7-year-olds ($\chi^2(1)=1.62$, $p=.203$), 4- to 5-year-olds made more correct choices in the competition than in the cooperation condition ($\chi^2(1)=20.14$, $p<.001$; Figure 3). However, different chance levels in the cooperation ($p=1/3$) and competition conditions ($p=2/3$) make the interpretation difficult. Indeed, 6- to 7-year-olds were more likely than chance to choose correctly in the cooperation condition ($p<.001$), but not in the competition condition ($p=.690$), whereas 4- to 5-year-olds did not differ from chance in either condition (cooperation: $p=.324$, competition: $p=.812$). No other two-way or three-way interactions were significant (see Tables S1–S6 for model summaries).

EXPERIMENT 2

Experiment 1 indicates that, at least by age 6, children develop considerable flexibility in choosing partners for a range of cooperative tasks. The competition condition, in which older children avoided partners in possession of

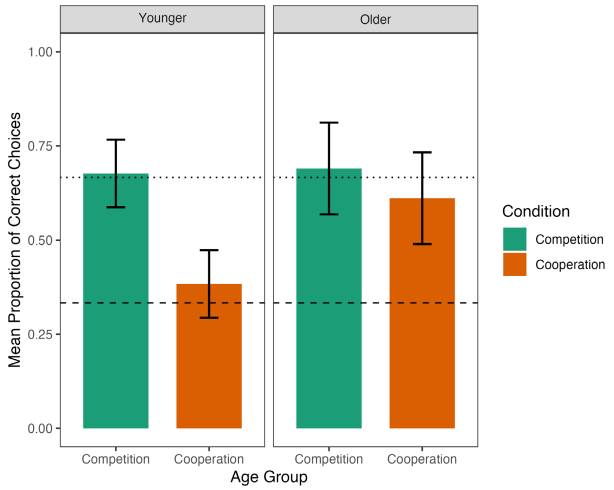

FIGURE 3 Mean proportion of correct partner choices in Experiment 1, displayed by age group and condition. Error bars represent 95% confidence intervals, horizontal lines indicate chance levels in the cooperation condition (1/3, dashed), and the competition condition (2/3, dotted).

task-relevant qualities, suggests that they did not simply match qualities with tasks but rather considered the task characteristics in combination with the social context.

The chance comparisons point to the possibility that children might be better at picking partners for cooperation than for competition, but the divergent chance levels render it difficult to draw strong conclusions. We therefore ran an additional preregistered experiment (https://aspredicted.org/MVM_22K) in which, on each trial, children picked between two partners, one of whom possessed task-relevant qualities while the other did not. The chance probability of choosing correctly was thus .5 in both conditions. Using this simplified design, we also sought to replicate the findings of Experiment 1 with a larger and more balanced sample, with the goal to identify the age at which children begin to show context-specific partner choice. All reported analyses are confirmatory.

Method

Participants

Experiment 2 included 120 children (50% girls) aged 4–7 years (twenty-nine 4-year-olds, thirty-two 5-year-olds, thirty 6-year-olds, and twenty-nine 7-year-olds; $M = 71$ months) from the same population as in Experiment 1. Sample size was determined prior to data collection using a simulation-based power analysis based on the condition effect of Experiment 1 at $\alpha = .05$ with 90% power. The data were collected in person at public locations (zoo, museum, leisure center; $n = 63$) and online ($n = 57$; the testing strategy was adjusted due to the Covid-19 pandemic; for all age groups, the percentage of children tested online was between 51% and 54%).

Design and procedure

The design, procedure, and analysis approach were identical to Experiment 1 except that, at the test, children were presented with two partners to choose from, one possessing task-relevant qualities and one who did not. Which pairings children were presented with (e.g., the fast partner vs. the knowledgeable partner or the fast partner vs. the generous partner) and whether the task-relevant partner appeared on the right or the left were counterbalanced between participants.

Results

The test location and order of condition, partner introduction, and task did not affect the results ($p > .1$). These factors were thus dropped. Condition, age, and task combined significantly affected whether children selected the partner with task-relevant qualities (full-null-model comparison, $\chi^2(11) = 55.74$, $p < .001$). Follow-up analyses revealed significant interactions between condition and task ($\chi^2(2) = 9.44$, $p = .009$) and between age and condition ($\chi^2(1) = 8.37$, $p = .004$). Replicating the results of Experiment 1, 6- to 7-year-olds picked the partner in possession of task-relevant qualities more often in the cooperation condition than in the competition condition ($\chi^2(1) = 31.60$, $p < .001$). Four to five-year-olds did not clearly discriminate between conditions ($\chi^2(1) = 3.04$, $p = .081$). Figure 4 indicates that children adjusted their partner choice to the social context at 63 months of age. Indeed, when fitting models for 4- and 5-year-olds separately, we found that 5-year-olds already distinguished between conditions, $\chi^2(1) = 10.07$, $p = .002$, whereas 4-year-olds did not, $\chi^2(1) = 0.00$, $p = .952$.

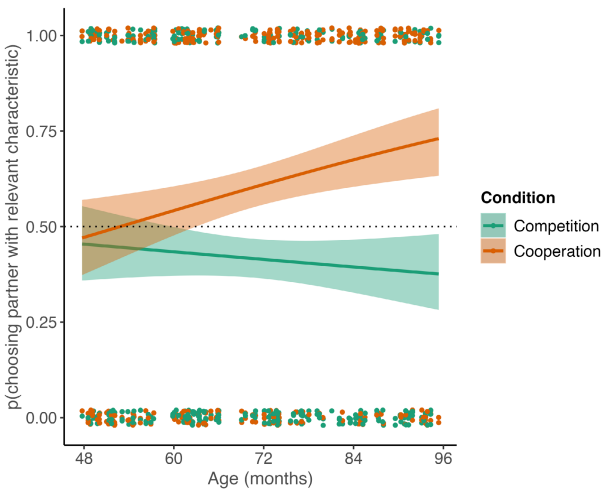

FIGURE 4 Probability of participants selecting partners possessing task-relevant qualities in Experiment 2. Dots represent individual decisions, the dotted horizontal line the 0.5 chance level. Solid lines are fitted regression lines (binomial logistic regressions), shaded regions indicate 95% confidence intervals.

The interaction between condition and task indicates that, while condition affected children's choices in the knowledge task ($\chi^2(1)=13.62$, $p<.001$) and the speed task ($\chi^2(1)=21.06$, $p<.001$), there was no condition effect in the generosity task ($\chi^2(1)=0.14$, $p=.709$): Children, especially older ones, tended to pick the generous partner in both the cooperation and competition conditions (Figure 5).

Children did not show a preference for any of the partners in the post-test preference test ($\chi^2(2)=2.15$, $p=.341$) and their partner preference did not affect whether they picked the partner with task-relevant qualities ($\chi^2(2)=3.15$, $p=.207$). All significant effects remain when we include children's partner preference (as recorded post-test) as a control predictor.

Children rated partners significantly higher on those qualities they were described as possessing, and this effect was larger in older children (interaction between age and quality possession, $\chi^2(1)=8.83$, $p=.003$). Importantly, the effect holds when analyzing the 4- to 5-year-olds ($\chi^2(1)=82.99$, $p<.001$) or only the 4-year-olds separately ($\chi^2(1)=37.40$, $p<.001$). Younger children's indiscriminate partner choice thus cannot be explained by their failure to understand or memorize the partner descriptions.

The analysis investigating correct choices revealed a significant three-way interaction between condition, task, and age ($\chi^2(2)=6.07$, $p=.048$). There were no significant effects of condition and task in 4- to 5-year-olds ($\chi^2(5)=5.66$, $p=.341$). Younger children were not more effective at choosing partners for cooperation or competition, or for a particular task, and they did not pick the correct option above chance in

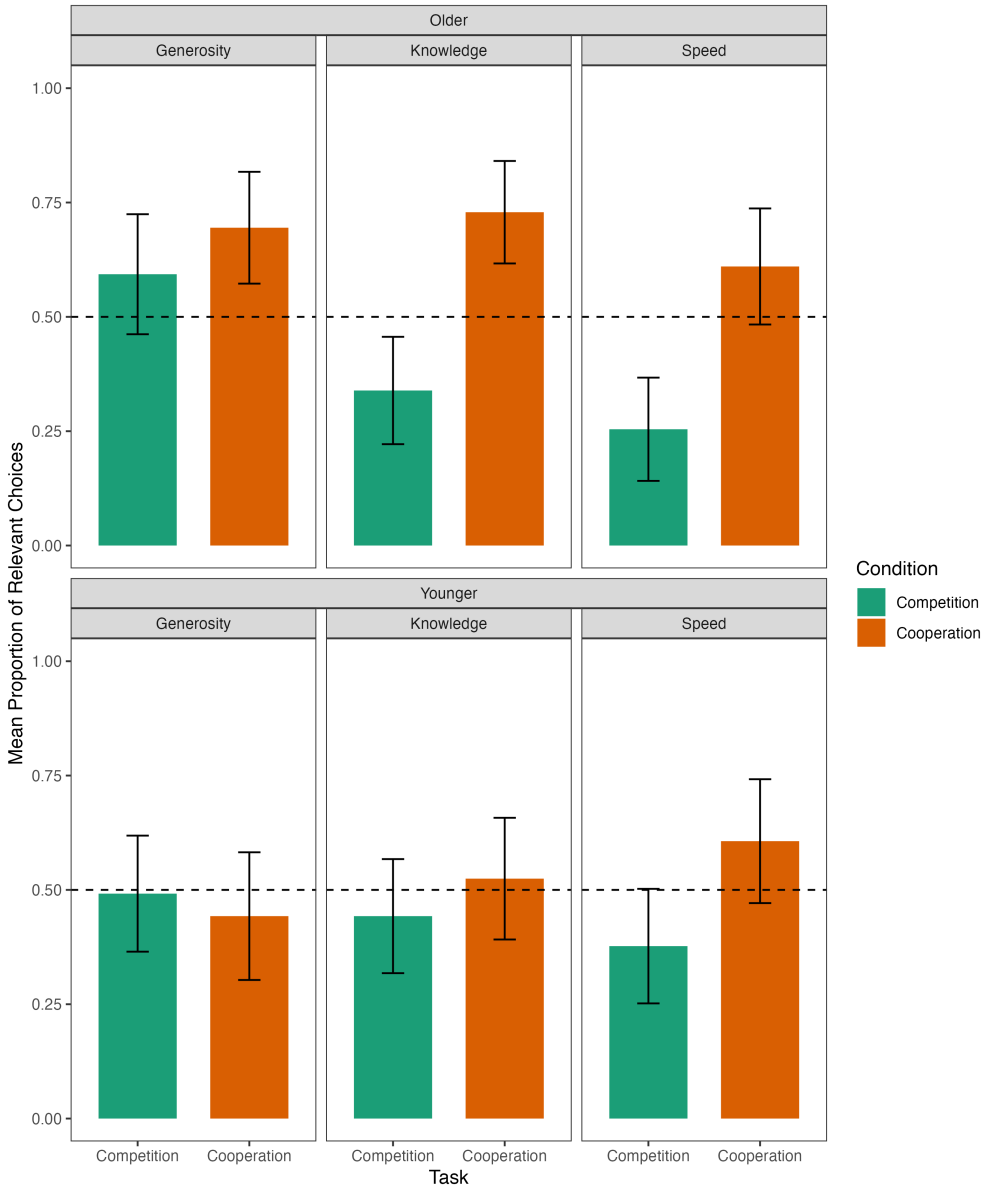

FIGURE 5 Mean proportion of 6- to 7-year-old (top) and 4- to 5-year-old (bottom) children's selection of partners with task-relevant qualities in Experiment 2. Error bars represent 95% confidence intervals, horizontal dotted lines indicate the 0.5 chance level.

either condition ($p > .1$). In 6- to 7-year-olds, we found a significant interaction between condition and task ($\chi^2(2) = 11.97$, $p = .003$): In the knowledge and speed task, children chose correctly at high levels and condition had no significant effect (knowledge: $\chi^2(1) = 0.63$, $p = .428$; speed: $\chi^2(1) = 2.63$, $p = .105$). In the generosity task, 6- to 7-year-olds tended to choose the generous partner irrespective of condition, resulting in fewer correct choices in the competition condition ($\chi^2(1) = 10.05$, $p = .002$). Overall, however, children chose the correct option above chance in both conditions (cooperation: $p < .001$, competition: $p = .008$; see Tables S7–S17 for model summaries).

DISCUSSION

The findings demonstrate that children's partner choice substantially gains in flexibility around age 5–6, as they start selecting partners depending on their qualities, as well as on the characteristics of the task at hand. Children did not prioritize specific qualities over others, their choices were not guided by their general partner preferences, and older children systematically avoided partners possessing task-relevant qualities as competitors, suggesting that they did not use a simple matching rule (e.g., knowledge goes with quiz). The results indicate instead that children strategically adjusted their decisions based on an assessment of the social context and the quality necessary for success.

Previous research has documented that partner selectivity develops remarkably early. Even infants and toddlers systematically evaluate, prefer to interact with, and direct their prosocial actions toward specific individuals based on their prior behavior, their cooperative intentions, or their group membership (Dunfield & Kuhlmeier, 2010; Sparks et al., 2017; Tasimi & Wynn, 2016), a pattern consistent with affective-tagging strategies (Kuhlmeier et al., 2020). Building on this work, the current experiments show that capacities for more complex partner choice become more sophisticated over the school years.

A recent study by Dunfield et al. (2023) suggested that even 6-year-olds' partner choice is best explained by affective tagging. When choosing between partners who each possessed a different positive trait (helpful vs. polite, or helpful vs. attractive), children did not show consistent preferences, irrespective of whether they were deciding whom to help or play with. Children did, however, prefer helpful, polite, and attractive partners over partners lacking these qualities. Hence, they generally preferred others with positive traits but were insensitive to the nature of the trait or the context under consideration. In our study, children aged 5 to 6 already showed clear specificity in their partner choice depending on task and context. This finding is inconsistent with affective tagging and, on a cognitive level, likely requires children to make dispositional attributions to effectively predict others' actions (e.g., knowledgeable partners will do well in a quiz).

One explanation for the discrepancy in our findings might be that the task used by Dunfield et al. (2023) was more complex, as evidenced by the high rate of 4-year-olds who did not pass the comprehension checks (children in our study did not show such difficulties). Additionally, the choice contexts in our paradigm may have been more clear, so that children were better able to derive precise partner-specific behavioral predictions.

Another capacity supporting flexible partner choice might be *prospection*—the ability to mentally simulate future events to guide actions in the present (Gilbert & Wilson, 2007; Suddendorf et al., 2011)—which improves markedly over the studied age range (Atance & Jackson, 2009; Coughlin et al., 2019) and is related to the emergence of strategic cooperative decision-making (Grueneisen et al., 2023). Prospection capacities would have enabled children to mentally project themselves into various task situations, anticipate their respective needs, and select partners with whom those needs could best be met. These substantial cognitive demands might explain why children under 5 struggled to select partners adaptively. Future research could test these explanations directly by investigating whether children's developing capacities for prospection and for making dispositional inferences predict the emergence of flexible partner choice.

The fact that even 4-year-olds rated partners significantly higher on those qualities they were described as possessing suggests that task comprehension is unlikely to account for their poor performance. Moreover, 4- to 5-year-olds have previously been shown to attribute specialized knowledge to specific experts (e.g., doctors know more about biology, car mechanics know more about physical mechanics; Lutz & Kail, 2002). What younger children seemed to struggle with, then, is not to attribute expertise itself, but to use this information effectively when choosing partners or when inferring what qualities are required for success.

Another open question is why children selected the generous partner in the competitive version of the generosity task. This tendency increased with age, making task-comprehension issues unlikely (see Herrmann et al., 2019, for a similar competitive altruism paradigm with 5- to 8-year-olds). Perhaps children did not fully perceive this task as competitive and wanted the third-party recipient to be met with generosity, or they assumed that the generous partner would let them join the activity despite not being selected. Note that children did not generally prefer generous partners in the knowledge or speed task or in the post-test preference test. This finding is interesting in light of recent work suggesting that adults place greater value on the willingness to provide benefits than on factors like competence or a partners' access to resources (Dhaliwal et al., 2022; Eisenbruch &

Roney, 2017; Raihani & Barclay, 2016). This tendency is thought to reflect a partner-choice strategy tailored to the conditions that were characteristic of the ecologies in which human social cognition evolved, where generosity varied more than competence between partners (Eisenbruch & Krasnow, 2022). However, in most studies providing the basis for this theorizing, generosity was directly relevant to the tasks participants had to recruit partners for—typically some type of economic game—while other qualities such as knowledgeability, intelligence, or physical prowess were not. Indeed, in real-life settings, people often consider multiple traits (Smith & Apicella, 2020), although generosity might well be of special importance in many contexts (see Barclay, 2016; Bird & Power, 2015).

In summary, the current study found that, between ages 5 and 6, children begin to strategically team up with individuals who are most likely to contribute to cooperative success while avoiding skilled individuals as competitors. This represents an important building block for the facility to enter effective partnerships and thus meet the great variety of cooperative challenges characteristic of human social life.

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DATA AVAILABILITY STATEMENT

The data and analytic code necessary to reproduce the analyses presented here are available from the first author upon request. The analyses of Experiment 2 were preregistered. The materials necessary to attempt to replicate the findings presented here are included in Supporting Information and available from the first author.

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