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Children's and adults' social partner choices are differently affected by statistical information

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ABSTRACT

The current study investigated how U.S. adults (N = 99) and 5- and 6-year-old children (N = 112) use statistical information in their social partner choices. We found that children integrated base rate information (the distribution of traits within groups) and individual-level statistical information (the frequency of an individual's past behaviors) in their partner choices, but adults only relied on the individual-level statistical information and neglected base rate information. In addition, adults and children were affected by non-statistical information: Adults showed risk-seeking and risk-averse tendencies, and children showed only risk-seeking tendencies in their partner choices. These findings provide evidence that both statistical and non-statistical information affect social decisions, and adults and children are influenced by each type of information in distinct ways. The current study suggests future directions to further investigate the role of statistical learning in our social cognition and to develop a unifying account of how non-statistical information interacts with statistical information in our social decisions.

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Introduction

One of the most important aspects of being human is that we form relationships with other non-kin individuals. In many Western societies, as soon as children enter preschools, they start to spend most of their waking hours interacting with their peers, becoming playmates with them and forming friendships. Similarly, adults spend much of their time at work, collaborating with coworkers and forming workplace friendships. How do social interactions emerge? Among the numerous individuals children and adults encounter, whom do they choose to interact with?

Past research has shown that these choices depend on both information about social groups and information about individuals. First, social group membership affects children's and adults' social preferences. Children aged 3 to 5 years choose individuals of the same gender (Shutts et al., 2013) and race (Kinzler et al., 2009) and those who speak the same language or have the same accent (Kinzler et al., 2007, 2009) as their friends. Adults too are more likely to befriend others of the same race or ethnicity (Kao et al., 2019), and they evaluate others who speak the same language or have the same accent more positively (Dailey et al., 2005; Lambert et al., 1960, 1965). Second, children's and adults' social preferences are affected by individual characteristics. Infants and preschoolers prefer prosocial individuals over antisocial individuals (Hamlin, 2013b; Hamlin & Wynn, 2011; Hamlin et al., 2007; Van de Vondervoort & Hamlin, 2017), and they also prefer individuals with positive intentions over individuals with negative intentions regardless of the outcome of their behaviors (Hamlin, 2013a; Heyman & Gelman, 1998). Adults also negatively evaluate antisocial behaviors and motives (Cushman, 2008; Shultz et al., 1981) and prefer prosocial individuals as romantic partners (Fletcher et al., 1999).

Thus, past research on adults' and children's social preferences has focused on categorical information about potential partners (e.g., partners who are from either their own social groups or other social groups, partners who are either prosocial or antisocial). However, social groups are not homogeneous (e.g., an individual from your own social group may be very different from you), and people's behaviors are not monotonic and stable (e.g., a playmate who is generally nice might not always be nice). We therefore ask this question: In addition to relying on categorical information about social groups or individuals, do adults and children also rely on statistical information about groups and individuals when choosing their social partners?

For instance, imagine that you are starting your first day at a new job. Before joining the company, you might hear about the reputation of the company (e.g., most people in the company are friendly or most people are mean). Upon entering the company, you will interact with a few colleagues (e.g., some colleagues will show mostly nice behaviors and some will show mostly mean behaviors). Imagine that you are choosing a partner for your next project; given a choice of either a colleague you are familiar with or a new colleague you have not interacted with, whom would you choose? This decision will likely depend on both the reputation of the company (i.e., base rate information about the distribution of positive vs. negative traits in the group) and the past behaviors of the familiar colleague (i.e., individual-level statistical information about the frequency of positive vs. negative behaviors in the individual). If you are in a company with a good reputation, and you are choosing between a familiar colleague who had showed mostly mean behaviors and a new colleague, you may make your choice by considering the following: The individual-level statistical information indicates that the familiar colleague will likely be mean, whereas the base rate information indicates that the new colleague will likely be nice, and therefore you should choose the new colleague. If you are in the same company but choosing between a nice familiar colleague and a new colleague, the two types of statistical information indicate that both individuals will likely be nice, and therefore you can choose either. Similarly, imagine that it is a child's first day at kindergarten. The reputation of the kindergarten (i.e., base rate information) and the past behaviors of the children she has interacted with on the first day (i.e., individual-level statistical information) would likely affect whom the child would choose as her playmates in the future.

Can adults and children use both base rate information and individual-level statistical information in their social partner choices? A body of research has demonstrated that humans are sophisticated statistical learners in many domains from infancy onward (e.g., Diesendruck et al., 2015; Gopnik

et al., 2004; Jara-Ettinger et al., 2016; Saffran et al., 1996; Xu & Garcia, 2008; for reviews, see Denison & Xu, 2019; Saffran & Kirkham, 2018; Xu, 2019). For example, learners can flexibly use base rate information in their reasoning. Infants expect that a sample randomly drawn from a box containing mostly red balls should contain mostly red balls instead of mostly white balls (e.g., Xu & Garcia, 2008). Similarly, children and adults make rational inferences about the sample given the base rate of the population and vice versa (e.g., Brainerd, 1981; Denison et al., 2006; Girotto & Gonzalez, 2008). Infants and children also use base rates to infer non-randomness in people's behaviors, for example, inferring people's preferences when they violate random sampling (e.g., Heck et al., 2021; Kushnir et al., 2010; Ma & Xu, 2011; Wellman et al., 2016). Adults and older children can correctly use base rates in complex inferences (e.g., inferring the probability that someone who tested positive for a disease actually has the disease) when the problem is framed in appropriate formats – e.g., when participants are given the base rate information as frequencies (e.g., 20 of 100 people have the disease) and how reliable a medical test is in terms of hits and false positives (e.g., Girotto & Gonzalez, 2001; Sloman et al., 2003; Zhu & Gigerenzer, 2006).

In addition, adults and children use individual-level statistical information in their social inferences. Adults readily attribute traits to individuals given just a few trait-relevant behaviors (e.g., Aloise, 1993; Uleman et al., 1996). Children aged 5 and 6 years can make trait inferences when they observe instances of trait-relevant behaviors; for example, they inferred that an individual was mean after the individual showed 5 mean behaviors (e.g., Boseovski & Lee, 2006).

Given children's and adults' sophisticated statistical reasoning abilities, they should be capable of rationally integrating base rate and individual-level statistical information. At the same time, when children and adults make social inferences and decisions, other factors may come into play and their reasoning may deviate from pure statistical calculations. For example, when you are choosing a partner for your next project in a new company, you might think that choosing a familiar colleague would lead to a more successful collaboration because you know what to expect when you work with that individual. You might also believe that choosing a new colleague comes with additional risks (e.g., the new colleague could be one of the few mean people in the company) and additional benefits (e.g., you get to know another colleague in the company). What types of non-statistical factors might affect children's and adults' social inferences and decisions?

Past research suggests that one such factor is domain-specific prior knowledge. A study by Eason and colleagues (2019) found that children inferred race-based preferences from statistically non-random friend choices when they conformed with social expectations (e.g., a Black protagonist befriended Black children in a majority White classroom), but they did not make the parallel inference when the statistical non-random friend choices countered social expectations (i.e., when a Black protagonist befriended White children in a majority Black classroom) (Eason et al., 2019). When choosing their social partners, adults and children might rely on domain-specific prior knowledge such as their perceptions about whether individuals in their social environment tend to be nice or mean. For instance, past research suggests that children hold more positive expectations about other individuals than adults (Boseovski & Lee, 2006).

Another factor that may make children's and adults' reasoning diverge from pure statistical reasoning is heuristics and biases. For example, when given base rate information (e.g., an individual is drawn from a group of 70 lawyers and 30 engineers) and individuating information (e.g., a description of the individual that fits the stereotype of an engineer), adults are affected by the representativeness heuristic; they neglect the base rate information and rely entirely on individuating information (Kahneman & Tversky, 1973). Recent studies used modified versions of the lawyer–engineer scenario to examine whether children also use the representativeness heuristic, and these studies showed mixed results. Gualtieri and Denison (2018) found that 5- and 6-year-old children neglected base rates in favor of the representativeness heuristic. However, in Gualtieri and Denison (2021), researchers manipulated the strength of the base rate and individuating information and found that 6-year-olds were sensitive to both types of information and integrated them based on their strengths.

Lastly, when adults and children are making social decisions, risk considerations might come into play given that these decisions often involve risks for the self (e.g., a coworker you collaborate with might be irresponsible, a playmate that a child chooses might be mean to her). According to prospect theory (Kahneman & Tversky, 1979), people do not consider probabilities rationally when they make

decisions that involve risks. Instead, they are affected by gains and losses differently. Specifically, when choosing between a sure gain and an uncertain option with the same expected utilities, adults are risk-averse and prefer the sure gain; but when choosing between a sure loss and an uncertain option with the same expected utilities, they are risk-seeking and prefer the uncertain option (i.e., the framing effect; Tversky & Kahneman, 1986). Some studies with children have found that risk-averse and risk-seeking tendencies do not emerge until at least 10 years of age (Reyna & Ellis, 1994; Weller et al., 2011). However, other studies have found that 5- and 6-year-olds already show risk-seeking behaviors but not risk-averse behaviors (Levin & Hart, 2003; Schlottmann & Tring, 2005).

The current study is the first to investigate whether adults and children would rely on information besides categorical information about potential partners (i.e., their social group memberships and traits) in their social preferences. Specifically, we examined how adults and children use statistical information in their social partner choices as well as how non-statistical information might lead them to deviate from pure statistical reasoning. Given past research (Aloise, 1993; Boseovski & Lee, 2006; Girotto & Gonzalez, 2008; Sloman et al., 2003), our main hypothesis was that adults and children would use base rate information (i.e., the distribution of traits within groups) and individual-level statistical information (i.e., the frequency of an individual's past behaviors) when choosing their own social partners. As an additional and exploratory hypothesis, we examined whether adults' and children's partner choices are also affected by non-statistical information such as heuristics, biases, and domain-specific prior knowledge. We predicted that adults, but not children, might be affected by the representativeness heuristic and ignore base rates (Gualtieri & Denison, 2021; Kahneman & Tversky, 1973). In addition, adults might be affected by risk-averse and risk-seeking tendencies (Tversky & Kahneman, 1986), and children might be affected by risk-seeking tendencies (Levin & Hart, 2003; Schlottmann & Tring, 2005). Our last goal was to explore whether adults and children are more sensitive to statistical information delivered through first-person interactions or third-person observations. Past research suggests that children are similarly affected by social behaviors directed toward themselves (Watson-Jones et al., 2016) or toward a third person (Over & Carpenter, 2009). However, no past studies have directly compared whether adults and children are similarly affected by first-person interactions or third-person observations in the same task. Because this is the first study investigating these questions, we tested at the youngest age that children have been shown to use the base rate and individual-level statistical information in the social domain, 5- and 6-year-olds (Boseovski & Lee, 2006; Gualtieri & Denison, 2021), and we compared their behaviors with those of adults. Testing both adults and children allowed us to examine how the development of heuristics and biases affect human learners' rational statistical reasoning abilities in the social domain.

In our experiments, adults imagined that they joined a new company (Experiment 1), and children imagined that they transferred to a new school (Experiment 2). They were told that a majority of individuals (16 of 20; 80%) in their new company/classroom were either nice or mean, corroborated by the behaviors of a sample of nice and mean individuals (the base rate).[1] An individual from the company/classroom, the "familiar individual," showed either mostly nice or mostly mean behaviors (5 of 6; 83%; the individual-level statistical information).[2] The sample of individuals and the familiar individual showed their behaviors toward the participant (First-Person condition) or another colleague/classmate (Third-Person condition). Then, adults were asked to choose a partner for their next project, and children were asked to choose a playmate, from two options: either the "familiar individual" (for whom participants had strong individual-level statistical information) or a "new individual" randomly selected from the company/classroom (for whom participants had the base rate but no individual-level information). Lastly, to examine whether participants use statistical information to infer the traits of their chosen partners, we asked them to predict whether their partners would be nice or mean.

How should adults and children integrate base rate and individual-level statistical information in their partner choices? There are two main possibilities. One possibility is that they will evaluate each

[1] We chose this base rate because past studies showed that infants and children can make correct social inferences given similar base rates (Eason et al., 2019; Wellman et al., 2016).

[2] We chose this individual-level statistical information because past studies showed that children can correctly infer the trait of an individual given 5 of 6 trait-relevant behaviors, and adults can do so with even fewer trait-relevant behaviors (Aloise, 1993; Boseovski & Lee, 2006; Uleman et al., 1996).

potential partner based on the probability of receiving a nice behavior from this individual (*behavior-based hypothesis*). Thus, the behavior-based hypothesis predicts that participants would integrate the base rate of getting a nice vs. mean individual from the group and the probabilities of getting a nice vs. mean behavior from individuals in their partner choices. Another possibility is that they will form general impressions and attribute nice vs. mean traits to each potential partner (*trait-based hypothesis*). For instance, they might think that an individual who showed 83% nice behaviors has a nice trait and will show 100% nice behaviors in the future. Thus, the trait-based hypothesis predicts that participants would integrate the base rate of getting a nice vs. mean individual from the group and the traits of individuals in their partner choices. Table 1 shows the predictions of each hypothesis in terms of the proportions of participants who would choose the familiar individual as their social partner in each scenario (see the online supplementary material for how the predictions were calculated). The behavior-based hypothesis predicts that participants would be less likely to choose the nice familiar individual regardless of base rate and more likely to choose the mean familiar individual regardless of base rate, compared with the trait-based hypothesis (Table 1).

For partner predictions, we hypothesized that participants' predictions about the new individual would be consistent with the base rate, that is, more likely to predict the new individual from the mostly nice company/classroom to be nice than the new individual from the mostly mean company/classroom. Their predictions about the familiar individual would be consistent with the individual-level statistical information, that is, more likely to predict the familiar individual who showed mostly nice behaviors to be nice than the familiar individual who showed mostly mean behaviors.

Experiment 1

Method

Participants

A total of 99 adults (70 women, 26 men, 2 of non-binary gender, and 1 of unknown gender; mean age = 21.80 years, *SD* = 3.97, range = 18–47) participated on an online research platform at the University of California, Berkeley. Participants were college students enrolled in psychology courses at the university. Participants provided written informed consent prior to the experiment, and they received 0.5 course credit for a 20-min experiment. The study was approved by the institutional review board at the University of California, Berkeley.

Design and procedure

The study employed a 2 (Condition: First-Person vs. Third-Person) × 2 (Base Rate Information: Majority Nice vs. Majority Mean) × 2 (Individual-Level Information: nice familiar individual vs. mean familiar individual) mixed design, with the condition and the base rate information as between-subjects variables and the individual-level information as a within-subjects variable.

A visual schematic of the procedure is shown in Fig. 1 (see supplementary material for the full scripts). Participants were asked to imagine that they just started their first day at a new company. They were randomly assigned to the Majority Nice company or the Majority Mean company. Each participant completed two trials: a nice familiar colleague trial and a mean familiar colleague trial. Each trial consisted of three phases as described below.

Base rate information: The group composition. A group of 20 colleagues was shown on a slide. In the Majority Nice company, participants were told that most colleagues in this company were nice (16 of 20 colleagues were highlighted) and a few colleagues were mean (4 of 20 colleagues were highlighted). In the Majority Mean company, participants were told that most colleagues in this company were mean (16 of 20 colleagues were highlighted) and a few colleagues were nice (4 of 20 colleagues were highlighted). To illustrate the group composition, participants were shown a sample of colleagues from their company, consisting of 4 nice colleagues and 1 mean colleague in the Majority Nice company or 1 nice colleague and 4 mean colleagues in the Majority Mean company.

Table 1
Predicted proportion of participants who would choose the familiar individual in each scenario.

	Majority Nice–Nice familiar individual	Majority Nice–Mean familiar individual	Majority Mean–Nice familiar individual	Majority Mean–Mean familiar individual
Behavior-based hypothesis	.56	.26	.74	.44
Trait-based bypothesis	.60	.17	.83	.40

The sample of colleagues directed their behaviors toward the participant (First-Person condition) or another colleague (Third-Person condition). A nice colleague showed 5 nice behaviors and 1 mean behavior, and a mean colleague showed 5 mean behaviors and 1 nice behavior. The inconsistent behavior was shown either first or last (counterbalanced across participants). The colleagues showed one of two types of behavior (counterbalanced across trials): for sharing behaviors the colleague shared (nice behaviors) or did not share (mean behaviors) office stationery (e.g., Scotch tape), and for helping behaviors the colleague helped (nice behaviors) or did not help (mean behaviors) the participant or another colleague with a task (e.g., helping the other person to understand a function in Excel). We chose sharing and helping behaviors because these are the most common types of behavior used to demonstrate nice and mean traits in past studies with adults and children (e.g., Boseovski & Lee, 2006; Gualtieri & Denison, 2018; Uleman et al., 1996).

Individual information: The familiar individual. Participants were introduced to another colleague from the company, "the familiar colleague," who was either nice or mean. The nice familiar colleague or the mean familiar colleague showed 6 behaviors in the same way as a nice colleague or a mean colleague from the sample, as described in the previous phase.

Partner choice and prediction. Next, participants were asked to choose a partner for their next project from two options: the familiar colleague or a new colleague randomly selected from the company. Lastly, the experimenter asked participants to predict whether the chosen partner would be nice or mean.

Statistical analysis

To analyze whether adults used base rate and individual-level statistical information in their partner choices, we first used mixed-effects logistic regression to predict adults' partner choice from participants' age (as a continuous variable), participants' gender, the familiar individual's gender (same vs. different as the participant), base rate (Majority Nice vs. Majority Mean), individual-level information (nice familiar individual vs. mean familiar individual), condition (First-Person vs. Third-Person), behavior order (inconsistent first vs. inconsistent last), and the interactions of base rate and individual-level information, base rate and condition, individual-level information and condition, base rate and behavior order, and individual-level information and behavior order, with random intercepts for participant.

Second, we assessed whether the behavior-based hypothesis or the trait-based hypothesis better captures adults' partner choices. We calculated the mean squared error (MSE), the average of the squared differences between the predicted and actual proportions, for each hypothesis. Lower MSE indicates better fit.

Third, we examined whether adults' partner choices deviated from the predictions of statistical information alone. We used exact binomial tests to compare adults' data with the predictions of the best-fitting hypothesis (determined by the previous analysis) in each of the four scenarios.

Lastly, to analyze whether adults' partner predictions were consistent with the base rate and individual-level statistical information, we used mixed-effects logistic regression to predict adults' predictions about their chosen partners from participants' age (as a continuous variable), participants' gender, the interactions of base rate (Majority Nice vs. Majority Mean) and the chosen partner (familiar colleague or new colleague), and the interaction of individual-level information (nice familiar individual vs. mean familiar individual) and the chosen partner, with random intercepts for participant.

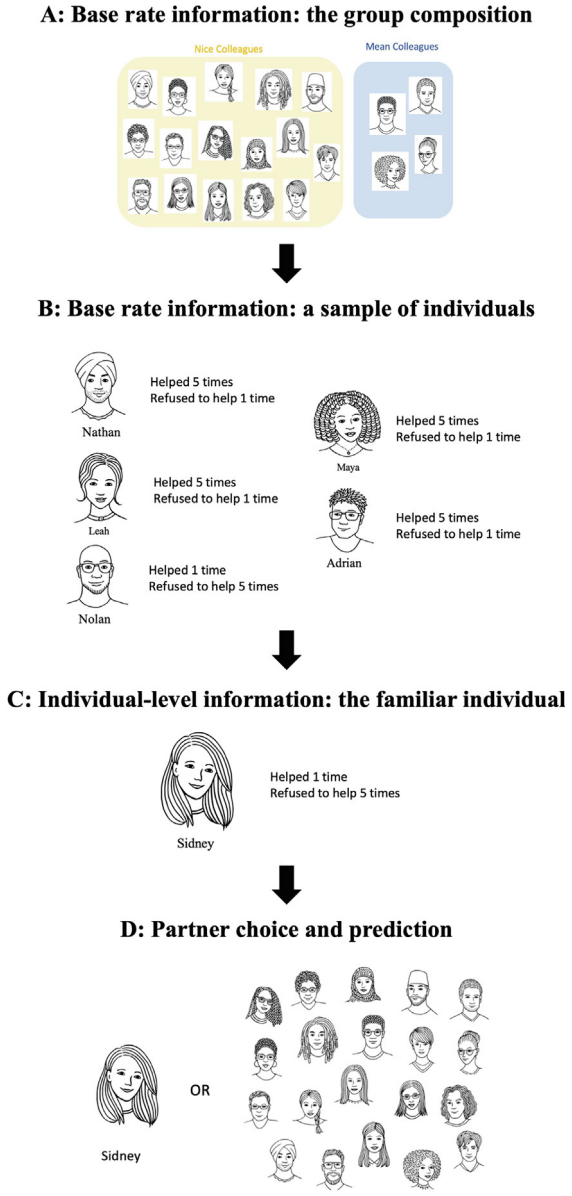


Fig. 1. Visual schematic of the procedure in the First-Person condition in Experiment 1. (A) Participants were shown the composition of nice and mean colleagues in their company. (B) Participants were shown a sample of colleagues from the company, one by one. Each colleague showed 6 behaviors (e.g., 5 of 6 helping behaviors). (C) Participants were shown the descriptions of each of the 6 behaviors that the familiar colleague exhibited. (D) Participants chose as a partner either the familiar colleague or a new colleague from the company and predicted whether their partner would be nice or mean.

All materials, data, and analysis codes are available on the Open Science Framework (https://osf.io/p94bd/?view_only=5e91308ff6df4945aec70b16a37a8900).

Results

Partner choice

Adults' partner choices are shown in Fig. 2. Mixed-effects logistic regression revealed a main effect of individual-level information and an interaction between base rate and condition. The main effect of individual-level information showed that overall participants were more likely to select the nice familiar colleague than the mean familiar colleague as their partner (β = 4.23, *SE* = 0.50, odds ratio [OR] = 68.87, $p < .001$). The interaction revealed that in the third-person condition, participants were less likely to choose the familiar colleague in the Majority Nice company than in the Majority Mean company, compared with in the first-person condition ($\beta = -2.21$, *SE* = 0.95, OR = 0.11, $p = .02$). However, base rate did *not* have a significant effect on participants' partner choices in either the First-Person condition (β = 1.19, *SE* = 0.65, OR = 3.28, $p = .068$) or the Third-Person condition ($\beta = -1.02$, *SE* = 0.64, OR = 0.36, $p = .12$).

Table 2 shows the actual proportions of adults who chose the familiar colleague in the four scenarios, the predicted proportions of each hypothesis,[3] and the MSE for each hypothesis. The predictions of the trait-based hypothesis better fitted adults' data (lower MSE). To further examine whether adults deviated from the predictions of the statistical information alone, we used exact binomial tests to compare adults' data with the predictions of the trait-based hypothesis in each of the four scenarios. Adults' behaviors were consistent with the predictions of the hypothesis when they chose between a mean familiar colleague and a new colleague in the Majority Nice company (P_{familiar} = .20, 95% CI [.10,.34], $P_{\text{trait-based}}$ = .17, $p = .57$). However, their behaviors deviated from the hypothesis in the other three scenarios. When choosing between a nice familiar colleague and a new colleague in both companies, they were more likely to choose the nice familiar colleague than predicted by the hypothesis (Majority Nice company: P_{familiar} = .90 [.78,.97], $P_{\text{trait-based}}$ = .60, $p < .001$; marginally significant in the Majority Mean company: P_{familiar} = .94 [.83,.99], $P_{\text{trait-based}}$ = .83, $p = .054$). When choosing between a mean familiar colleague and a new colleague in the Majority Mean company, they were less likely to choose the mean familiar colleague and therefore more likely to choose the new colleague than predicted by the hypothesis (P_{familiar} = .14 [.06,.27], $P_{\text{trait-based}}$ = .40, $p < .001$).

Partner prediction

Adults' predictions about the chosen partners are shown in Table S2 in the supplementary material. Mixed-effects logistic regression revealed a main effect of base rate and an interaction of the chosen partner and individual-level information. Participants were more likely to predict the partner to be nice in the Majority Nice company than in the Majority Mean company (β = 1.97, *SE* = 0.55, OR = 7.19, $p < .001$). When choosing between a nice familiar colleague and a new colleague, they were more likely to predict the partner to be nice if they chose the familiar colleague (β = 3.95, *SE* = 1.23, OR = 51.74, $p = .001$); when choosing between a mean familiar colleague and a new colleague, their predictions did not differ by the partner they chose (β = 0.42, *SE* = 0.69, OR = 1.52, $p = .54$).

Discussion

In Experiment 1, we found that adults used the frequency of an individual's past behaviors to choose their partners: they were more likely to select an individual who had shown mostly nice behaviors than an individual who had shown mostly mean behaviors. However, adults did not rely on the base rate information in their partner choices. They were slightly more sensitive to the base rate information in the Third-Person condition than in the First-Person condition, but they did not reliably rely on the base rate information in either condition. Indeed, the patterns of adults' partner

[3] The predictions of the behavior-based and trait-based hypotheses in the main text (Tables 1 and 2) were calculated based on the assumption that participants used both base rate and individual-level statistical information in their partner choices. However, because the previous analysis with mixed-effects logistic regression showed that adults did not use base rate information, we also calculated the predictions of the hypotheses assuming that they used individual-level statistical information alone (see online supplementary material), and all the following analyses yielded similar results under this assumption.

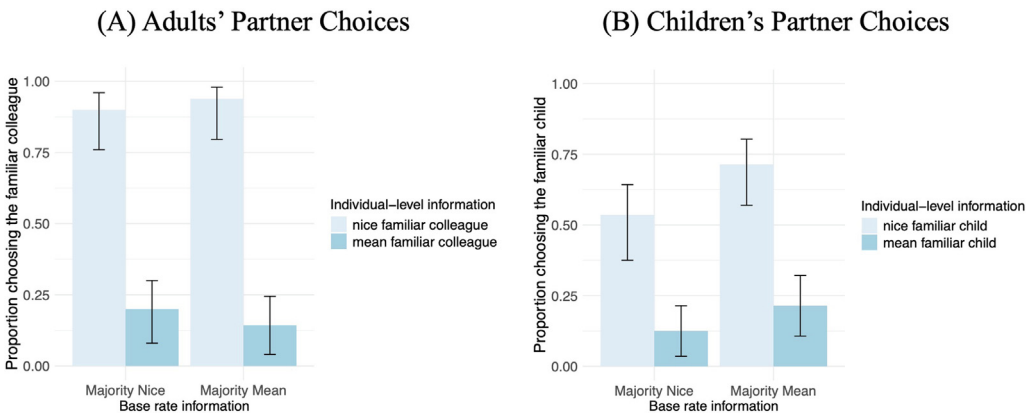


Fig. 2. Partner choice results in Experiments 1 and 2. (A) Proportion of adults who chose the familiar colleague as a partner by base rate information and individual-level information. (B) Proportion of children who chose the familiar child as a playmate by base rate information and individual-level information. The error bars indicate bootstrapped 95% confidence intervals.

Table 2
Actual proportion of adults and children who chose the familiar individual, the predicted proportion for each hypothesis, and MSEs.

	Majority Nice–Nice familiar individual	Majority Nice–Mean familiar individual	Majority Mean–Nice familiar individual	Majority Mean–Mean familiar individual	MSEs for adults' results	MSEs for children's results
Adults' results	.9	.2	.94	.14		
Children's results	.54	.13	.71	.21		
Behavior-based hypothesis	.56	.26	.74	.44	.062	.018
Trait-based hypothesis	.60	.17	.83	.40	.043	.014

Note. MSE, mean squared error.

choices were highly similar in the Majority Nice company and the Majority Mean company (see Fig. 2 and Table 2).

The trait-based hypothesis better captured adults' partner choices than the behavior-based hypothesis, suggesting that adults evaluated potential partners based on the traits they attributed to each individual. Moreover, adults' partner choices deviated from the predictions of statistical information alone in three of the four scenarios. It is particularly striking to compare the scenarios of (a) choosing between a nice familiar colleague and a new colleague in a Majority Nice company and (b) choosing between a mean familiar colleague and a new colleague in a Majority Mean company. In both scenarios, the expected utilities of the two options were similar, and the predictions from statistical information alone suggest a slight preference for the nice familiar individual (choosing that individual 60% of the time) in the first scenario and a slight preference for the new individual (choosing that individual 60% of the time) in the second scenario. However, adults' actual behaviors exaggerated these preferences: They were much more likely to choose the nice familiar individual (90% of the time) in the first scenario, suggesting that adults might be risk-averse when one of the options involved a sure gain—a familiar individual known to be nice—and therefore more likely to avoid the risky option (the new individual) and stick with the sure gain (the nice familiar individual). They were much more likely to choose the new individual (85% of the time) in the second scenario, suggesting that adults might be risk-seeking when one of the options involved a sure loss—a familiar individual

known to be mean—and therefore more likely to gamble or take a risk to sample a completely new individual from the group. Thus, in addition to statistical information, adults' partner choices might also be affected by risk considerations. This finding is reminiscent of the findings of prospect theory and the framing effect (Kahneman & Tversky, 1979; Tversky & Kahneman, 1986), although the methodologies we used in the current experiment were somewhat different given that we did not ask participants to choose between two options with the exact same utilities.

Adults' predictions about their chosen partners were affected by the base rate and the individual-level information. Consistent with the base rate, adults predicted that a partner from the Majority Nice company was more likely to be nice than a partner from the Majority Mean company. We hypothesized that the base rate information would affect adults' predictions only if they chose the new individual. However, we did not find an interaction of base rate and the partner they chose (the familiar individual vs. the new individual), potentially because we did not have enough power to detect such an effect. Consistent with the individual-level information, participants were more likely to predict the partner to be nice if they chose the nice familiar colleague over the new colleague, but their predictions did not differ when they chose the mean familiar colleague over the new colleague.

In Experiment 1, we found that adults did not rationally integrate the two types of statistical information in their partner choices: they neglected the base rate and only used individual-level statistical information. Moreover, their partner choices seem to have been affected by risk considerations, similar to the predictions of prospect theory. In the next experiment, we examined children's partner choices in a similar context. Past research suggests that, compared with adults, children may be more sensitive to base rate information and more likely to integrate the base rate with individual-level information (Gualtieri & Denison, 2021). In addition, past studies found that children did not consistently show risk-seeking and risk-averse tendencies until 10 years of age (Levin & Hart, 2003; Reyna & Ellis, 1994; Schlottmann & Tring, 2005; Weller et al., 2011). Thus, we predicted that children may be more rational in integrating the two types of statistical information and less affected by risk considerations than adults.

Experiment 2

Method

Participants

A total of 112 5- and 6-year-old children (54 girls, 56 boys, and 2 of unknown gender; mean age = 5.76 years, *SD* = 0.56, range = 5.00–6.92) participated in the experiment.[4] Children were tested in the lab, at local public schools, and children's museums (48 children were tested in-person) or online via Zoom (due to the COVID-19 pandemic, 64 children were tested online). Parents of the participants provided written informed consent prior to testing. The study was approved by the institutional review board at the University of California, Berkeley.

Design and procedure

The design of Experiment 2 was the same as the design of Experiment 1. The procedure of Experiment 2 was similar to the procedure of Experiment 1 except that participants reasoned about classmates in a new classroom, and these individuals engaged in sharing and helping behaviors appropriate for children (e.g., sharing stickers or toys, helping classmates with a puzzle). Past research suggests that children at this age prefer children of their own gender in their friendship choices (Shutts et al., 2013). Thus, we only showed children of the same gender in each trial (one trial consisted of all girls, and the other trial consisted of all boys; the gender of the Majority Nice group vs. the Majority Mean group was counterbalanced across participants) so that children would not be influenced by

[4] This sample size provided us with at least 85% power (at α =.05) to detect the small effect sizes observed in a previous study (Gualtieri & Denison, 2021). We recruited children in counties with a diverse racial and ethnic population (County A: 47.8% White, 33.8% Asian, 22.4% Hispanic or Latino, 10.7% Black, 5.6% mixed race, 1.0% American Indian and Alaska Native; County B: 77.5% White, 6.3% Hispanic or Latino, 7.9% Asian, 1.9% Black, 11.7% mixed race) (U.S. Census Bureau, 2020).

their gender-based preference in their playmate choice. A visual schematic of the procedure is shown in Fig. 3.

The experimenter asked participants to imagine that they had just transferred to a new school. They were randomly assigned to the Majority Nice classroom or the Majority Mean classroom. Each participant completed two trials in counterbalanced order: a nice familiar child trial and a mean familiar child trial. Each trial consisted of the same phases as in Experiment 1. In the partner choice phase, children were asked to choose a playmate from two options: the familiar individual or a new individual randomly selected from the classroom. If children answered "both," the experimenter asked a follow-up question: "If you can only choose one child to be your playmate, which child would you choose?" All children were able to choose one option after being asked this follow-up question. In the partner prediction phase, children were asked to predict whether the chosen playmate would be nice or mean (see supplementary material for the full scripts).

Statistical analysis

We conducted the same statistical analyses as in Experiment 1.

Results

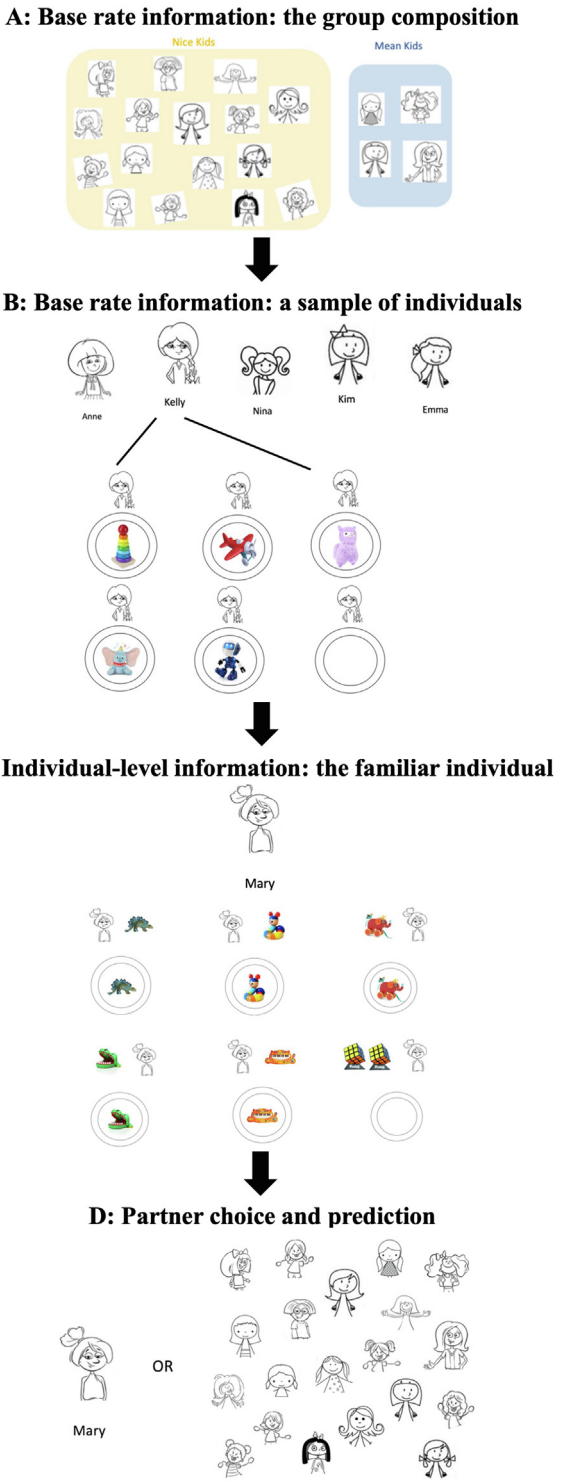
Partner choice

Children's playmate choices are shown in Fig. 2. Mixed-effects logistic regression revealed a main effect of base rate and an interaction between individual-level information and behavioral order. The main effect of base rate showed that overall children were less likely to select the familiar child in the Majority Nice classroom than in the Majority Mean classroom (β = − 1.00, SE = 0.50, OR = 0.37, p = .044). The interaction revealed that children were more likely to select the nice familiar child than the mean familiar child, both when the inconsistent behavior was shown first (β = 4.36, SE = 0.97, OR = 78.52, p < .001) and when it was shown last (β = 1.95, SE = 0.66, OR = 7.01, p = .003), but the effect was stronger when the inconsistent behavior was shown first (β = 2.42, SE = 0.91 OR = 11.29, p = .008). This effect of behavioral order can be explained by a recency effect: the last behavior of the familiar child had a disproportionate effect on children's choices. We did not find an interaction between base rate and individual-level information or any effect of condition (First-Person vs. Third-Person).

Table 2 shows the actual proportions of children who chose the familiar child in the four scenarios, the predicted proportions of each hypothesis, and the MSE for each hypothesis. The predictions of the trait-based hypothesis better fitted children's data, but the behavior-based hypothesis also provided relatively good fits (the MSE of the behavior-based hypothesis was only slightly higher than the MSE of the trait-based hypothesis; see Table 2). To further examine whether children deviated from the predictions of the statistical information alone, we used exact binomial tests to compare children's data with the predictions of the trait-based hypothesis in each of the four scenarios. Children's behaviors were consistent with the predictions of the hypothesis in the Majority Nice classroom, both when they chose between a nice familiar child and a new child (P_{familiar} = .54 [.40,.67], $P_{\text{trait-based}}$ = .60, p = .34) and when they chose between a mean familiar child and a new child (P_{familiar} = .13 [.05,.24], $P_{\text{trait-based}}$ = .17, p = .48). However, their behaviors deviated from the predictions of the hypothesis in the Majority Mean classroom. They were less likely to choose the familiar child, and therefore were more likely to choose the new child than predicted by the hypothesis, both when choosing between a nice familiar child and a new child (P_{familiar} = .71 [.58,.83], $P_{\text{trait-based}}$ = .83, p = .03) and when choosing between a mean familiar child and a new child (P_{familiar} = .21 [.12,.34], $P_{\text{trait-based}}$ = .40, p = .004).

Partner prediction

Children's predictions about the chosen playmates are shown in Table S3 in the supplementary material. Mixed-effects logistic regression did not reveal any significant effects (ps > .05). Overall, children predicted the chosen playmate to be nice above chance (exact binomial test: P = .84 [.78,.88], p < .001). More specifically, if children chose the familiar child, they predicted the nice familiar child to be nice above chance (Majority Nice classroom: P = .93 [.78,.99], p < .001; Majority Mean classroom: P = .95 [.83,.99], p < .001) and the mean familiar child to be nice at chance (Majority Nice classroom: P = .57 [.18,.90], p = 1; Majority Mean classroom: P = .58 [.28,.85], p = .77). If they chose the new child,


A: Base rate information: the group composition
Nice Kids
Mean Kids
B: Base rate information: a sample of individuals
Anne
Kelly
Nina
Kim
Emma
C: Individual-level information: the familiar individual
Mary
D: Partner choice and prediction
Mary
OR

they predicted both the new child from the Majority Nice classroom (nice familiar child vs. new child: P = .81 [.61,.93], p = .002; mean familiar child vs. new child: P = .76 [.61,.87], p < .001) and the new child from the Majority Mean classroom (nice familiar child vs. new child: P = .88 [.62,.98], p = .004; mean familiar child vs. new child: P = .80 [.65,.90], p < .001) to be nice above chance.

Discussion

In Experiment 2, we found that children used both the base rate of the trait distribution in a group and the frequency of an individual's past behaviors to choose their playmates. They were more likely to choose a new individual from the mostly nice group than a new individual from the mostly mean group, consistent with the base rate. Across groups, they were more likely to select an individual who had shown mostly nice behaviors than an individual who had shown mostly mean behaviors, consistent with the individual-level statistical information.

The trait-based hypothesis captured children's partner choices slightly better than the behavior-based hypothesis, suggesting that children, like adults, were also more likely to evaluate partners based on the traits they attributed to each individual rather than the probability of receiving a nice behavior from each individual. In addition, children's partner choices deviated from the predictions of statistical information alone in some scenarios. When children were in a Majority Mean classroom, regardless of whether the familiar child was nice or mean, children were more likely to choose the new child than predicted by the trait-based hypothesis. Given that the new child from the Majority Mean classroom was likely to be mean, this suggests that in both scenarios children were more risk-seeking than predicted by pure statistical reasoning. We discuss the possible explanations for children's risk-seeking tendencies in the General Discussion.

Children's predictions about their chosen playmates were overwhelmingly positive and unaffected by the classroom composition or the familiar child's trait. These results could be explained by children's positivity bias (Boseovski, 2010): for instance, a past study showed that 5- and 6-year-olds more readily attribute positive traits than negative traits to individuals (Boseovski & Lee, 2006). An additional explanation is that predicting their playmate to be mean *after* they had committed to being playmates with this child would lead to cognitive dissonance (Festinger, 1957; see also Benozio & Diesendruck, 2015; Egan et al., 2007, 2010). To reduce such dissonance, children predicted that their playmate would be nice even when the playmate was mean before or when the playmate was randomly selected from a mostly mean classroom.

General discussion

The primary goal of the current study was to examine whether children and adults can use base rate and individual-level statistical information in their own partner choices. We found that although children used both the base rate of the trait distribution in a group and the frequency of an individual's past behaviors to choose their partners, adults neglected the base rate and only relied on the frequency of an individual's past behaviors. Thus, children were more rational than adults in integrating the two types of statistical information. Past research shows that when asked to integrate base rate

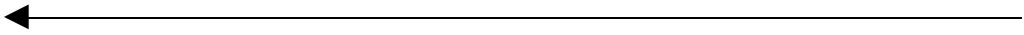


Fig. 3. Visual schematic of the procedure in the First-Person condition in Experiment 2. (A) Participants were shown the composition of nice and mean children in their classroom. (B) Participants were shown a sample of children from the classroom, one by one. Each child showed 6 behaviors. In this example, the child showed sharing behaviors. The items in the circles represent what the child was willing to give (e.g., if there is a toy in the circle, that means the child was willing to share a toy with the participants; if the circle is empty, that means the child was not willing to share with the participants). (C) Participants were shown the 6 behaviors that the familiar child exhibited. (D) Participants chose as a playmate either the familiar child or a new child from the classroom and predicted whether their playmate would be nice or mean.

and individuating information to make inferences about an individual, adults neglect the base rate and rely excessively on individuating information (Kahneman & Tversky, 1973), whereas children are sensitive to base rate and integrate the two types of information (Gualtieri & Denison, 2021). The current study extends this literature by showing that the developmental difference in sensitivity to base rates also emerges when adults and children are asked to integrate base rate and individual-level statistical information to choose a social partner from a known individual (for which they have the individual-level statistical information) and from an unknown individual (for which they have the base rate information).

We also examined how adults and children evaluated their potential partners by comparing their behaviors with the predictions of two hypotheses. The results suggested that both adults and children were more likely to evaluate their partners based on the traits attributed to the partners, instead of the probability of receiving a nice behavior from the partners. This finding might be due to the specific method used in the current study. First, adults were asked to choose a partner for their next project, and children were asked to choose a playmate. In both cases, the assumption might be that they would engage in multiple behaviors, rather than a single behavior, with their chosen partners. Therefore, it is reasonable for them to evaluate the individuals based on global traits instead of the probability of a single nice behavior. Second, even though the behavioral frequencies of a potential partner were probabilistic, the majority of the behaviors were consistent with the trait (e.g., a nice individual showed 5 nice behaviors and 1 mean behavior). Therefore, participants might have ignored the one trait-inconsistent behavior and thought the individual was nice in general. Future research should investigate whether adults and children would be more likely to evaluate potential partners based on the probability of receiving a nice behavior when they were only expected to interact with the partner once or when the probabilistic information was more moderate (e.g., an individual showing 3 nice behaviors and 2 mean behaviors).

Furthermore, we found that adults and children deviated from pure statistical reasoning in distinct ways. First of all, we compare the scenarios of (1) choosing between a nice familiar individual and a new individual in a Majority Nice group and (2) choosing between a mean familiar individual and a new individual in a Majority Mean group. Whereas adults were risk-averse in the first scenario and risk-seeking in the second scenario (as we discussed in Experiment 1), children showed risk-seeking tendency only in the second scenario and instead behaved in accordance with the statistical information in the first scenario. Moreover, in the scenario of (3) choosing between a nice familiar individual and a new individual in the Majority Mean group, adults were more risk-averse than predicted by statistical information, and children were more risk-seeking. Overall, these findings suggest that children were more risk-seeking than adults, consistent with other findings indicating that risk-seeking tendencies might develop earlier than risk-averse tendencies (Levin & Hart, 2003; Schlottmann & Tring, 2005).

What might explain this developmental difference? One possibility is that children's and adults' statistical reasoning were affected by domain-specific prior knowledge, specifically their perceptions about whether other individuals in their social environments tend to be nice or mean. Children hold more positive views about others and are more likely to attribute positive traits to individuals than adults (the positivity bias; Boseovski & Lee, 2006). Therefore, children in our study might have been more likely than adults to think that the new individual would be nice and thus more likely to choose the new individual in the first and third scenarios described above. The partner prediction results support this possibility: children were overwhelmingly positive in their predictions of partners from both mostly nice and mostly mean groups, but adults' predictions varied based on base rate and individual-level statistical information. A second possibility is that children and adults differ in their subjective utilities of rewards and losses. For instance, children might think that the reward of getting to know a new individual outweighs the potential loss of interacting with a mean individual. Future research could test the latter possibility by measuring children's and adults' subjective utilities.

The current study has a few limitations. First, the binary nature of the dependent variables might be insufficient to fully reflect participants' understanding of probabilities in this context. For instance, participants could not say that they were equally likely to choose the familiar individual and the new individual as their partner. Future studies should better tap into children's and adults' understanding of probability in their social partner choices by asking participants to rate their certainty for their

choices or asking them to explain why they made their choices. Second, the comparison between adults' and children's behaviors in the two experiments should be interpreted with caution. Although we closely matched most aspects of the stimuli in the two experiments, there were a few procedural differences that could have contributed to adults' and children's different behaviors. For instance, adults chose a work partner, whereas children chose a playmate; adults were introduced to a group with both male and female individuals, whereas children were introduced to a group of children of the same gender. Future studies should use more closely matched stimuli to further explore the developmental differences in adults' and children's use of statistical information in partner choices. Third, we tested only one particular base rate (16 of 20; 80%) and one particular individual-level statistical information (5 of 6; 83%) in our study. Future studies can examine whether changing the total number of individuals or behaviors as well as the proportion of trait-relevant individuals or behaviors would affect adults' and children's sensitivity to the two types of information. Lastly, although we found that adults' and children's social partner choices were affected by both statistical and non-statistical information, only statistical information was experimentally manipulated in the current study. Future studies could try to manipulate non-statistical information such as sensitivity to risk and perceptions of other people by priming adults and children with information about the riskiness of their social environment and whether individuals in their social environment tend to be nice or mean.

Despite these limitations, our findings have important implications for children's and adults' social preferences and how heuristics and biases affect rational statistical inferences. First, these findings inform the literature on children's and adults' social preferences. Past research suggests that children and adults focus on individuals' particular characteristics in their social preferences: prosociality (Fletcher et al., 1999; Hamlin, 2013a; Hamlin & Wynn, 2011; Hamlin et al., 2007; Van de Vondervoort & Hamlin, 2017), similarity, and loyalty (Bigelow, 1977; Bigelow & la Gaipa, 1975; Hayes, 1978; Kandel, 1978; Mollgaard et al., 2016; Shaw et al., 2017). Our findings showed that in addition to relying on categorical information about individuals when choosing social partners, children and adults also rely on statistical information about individuals. Relatedly, past research suggests that children and adults prefer individuals who belong to the same social groups as themselves (e.g., Dailey et al., 2005; Dunham et al., 2006, 2016; Kao et al., 2019; Kinzler et al., 2007; Lambert et al., 1960, 1965; Yee & Brown, 1994). These are examples of base rate preferences. Our findings showed that individual-level information can sometimes override the base rate (e.g., adults and children chose a nice individual from a mostly mean group to be their partner). One interesting avenue to pursue in future research is to investigate whether individual-level information (e.g., an outgroup individual who shares similar interests as the participant) could override children's group biases (e.g., ingroup preference) in their social preferences.

The current study also revealed interesting developmental differences between 5- and 6-year-old children and adults that warrant further investigation. Future studies could examine the developmental changes that might occur between 6 years of age and adulthood. For instance, at what age do humans start ignoring base rates and only relying on individual-level statistical information in their social partner choices? To our knowledge, no past studies have investigated older children's and adolescents' ability to integrate these two types of statistical information in their social decisions. Given past research showing that 5- and 6-year-olds already ignored base rate in favor of the representativeness heuristic in their social inferences about others (Gualtieri & Denison, 2018), we predict that children slightly older than 6 years might start neglecting base rate and rely more on individual-level statistical information in our playmate choice task as well. In addition, people's sensitivities to risk and perceptions of other people also undergo substantial developmental changes. Past research found that risk-seeking tendencies declined linearly from childhood to adulthood (Paulsen et al., 2012; Weller et al., 2011). Relatedly, older children are less positively biased in their perceptions of other people than younger children (Boseovski, 2010; Lockhart et al., 2002). Therefore, we predict that older children would gradually become less risk-seeking (e.g., less likely to choose a new individual from the mostly mean classroom) and less positively biased (e.g., more likely to predict that a partner from a mostly mean group is mean), and adolescents might start showing more adult-like behaviors in their partner choices and predictions.

The current study examined children's and adults' social partner choices given statistical information about individuals' niceness. We chose the trait nice because niceness or warmth is one of the key

dimensions that children and adults use to evaluate others (Fiske et al., 2018). However, other traits (e.g., competence, loyalty) may also be relevant in their evaluation of potential playmates or work partners. Future studies can examine whether children and adults can integrate statistical information about multiple traits in their social partner choices. Furthermore, some playmates and work partners turn into friends over time (Howes & Lee, 2006; Rath, 2006). How do playmates and partners become friends? We hypothesize that statistical information about prosociality, similarity, and loyalty gathered over time plays a role in this process (Liberman & Shaw, 2019). Future studies can provide participants with statistical information about a variety of characteristics of potential social partners and ask participants to repeatedly choose from these individuals to probe the friendship formation process.

Another implication from the current study relates to the demonstration that children's and adults' social reasoning can deviate from the predictions of statistical information alone (e.g., Eason et al., 2019) and can be influenced by heuristics and biases (Gualtieri & Denison, 2018; Kahneman & Tversky, 1973). A broad question these findings raise is why adults and children sometimes deviate from rational statistical reasoning and rely on heuristics and biases when they make risky decisions in the social domain. One conceptual framework that may provide a comprehensive answer to this question is the resource-rational framework (Lieder & Griffiths, 2020). According to this framework, biases and heuristics allow the human mind to make good decisions quickly by rationally using its limited cognitive resources (e.g., attention, working memory). For instance, adults and children in our study might have shown risk-seeking tendencies because they rationally allocated their attention to the best possible outcome: the randomly drawn new individual from the mostly mean company would be one of the few nice individuals. Future research should systematically examine whether the resource-rational framework can explain how the development of different heuristics and biases (e.g., representativeness heuristics, availability heuristics, anchoring effect) affect rational statistical reasoning. More broadly, an important future direction is to develop a unifying account of when and how non-statistical information (e.g., domain-specific prior knowledge, heuristics and biases) affects how we learn from statistical information.

Taken together, these findings show that both statistical and non-statistical information play important roles in our social decisions, and adults and children are affected by each type of information in unique ways. The current study paves the way for future research to systematically investigate how statistical and non-statistical information interact to shape our social decisions.

CRediT authorship contribution statement

Rongzhi Liu: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Gil Diesendruck:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. **Fei Xu:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization.

Data availability

All materials, data, and analysis codes are available on the Open Science Framework (https://osf.io/p94bd/?view_only=5e91308ff6df4945aec70b16a37a8900).

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jecp.2025.106260.

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