Young children's flexible partner choice for cooperation and competition

Supplementary information

1. Task descriptions

Children were presented with a series of tasks (see Fig. S1), for each of which they could recruit one partner. Children were told that in the tasks they would have the chance to win some coins and that, the more coins they collect, the nicer the prize will be they get at the end. The tasks were explained using a combination of pictures and verbal instructions and varied in the qualities required for successful performance. In the cooperation condition, children always picked a partner for their team and thus benefited from picking the partner in possession of task-relevant qualities. In one task, players raced to collect balls in a field as quickly as possible (thus requiring speed), in another, players jointly participated in a quiz (thus requiring knowledge). Both tasks were framed such that participants and their partners would play against another team of two. The third task was a dictator game (Forsythe et al., 1994): children decided which partner could divide a resource between themselves and the child (thus revolving around generosity).

In the competition condition, children faced analogous tasks but now picked a competitor. That is, they raced or played a quiz against the selected partner, and, in the third task, both received a resource to share with a third child who could subsequently pick the child or the partner to take part in a fun activity (this task corresponds to 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).
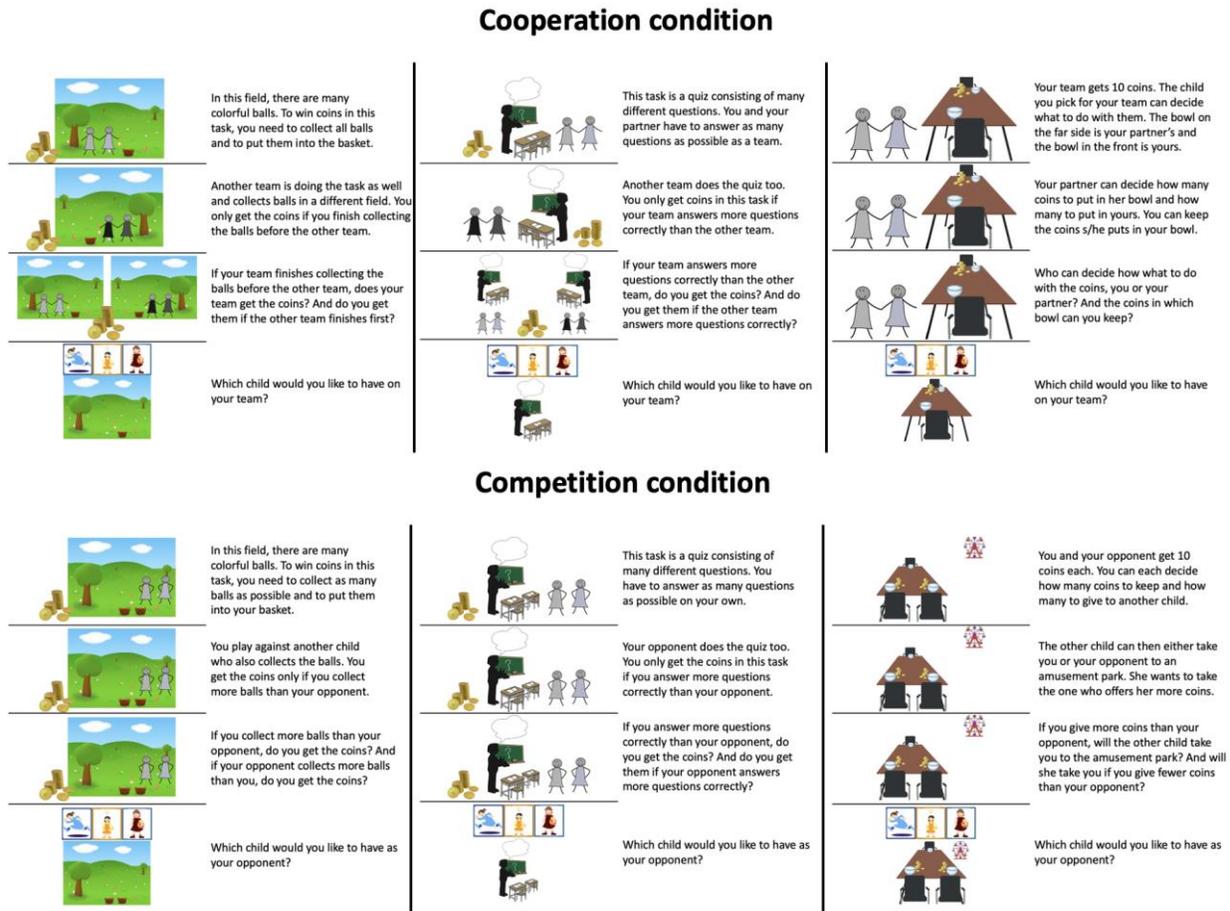
Cooperation condition

In this field, there are many colorful balls. To win coins in this task, you need to collect all balls and to put them into the basket.

Another team is doing the task as well and collects balls in a different field. You only get the coins if you finish collecting the balls before the other team.

If your team finishes collecting the balls before the other team, does your team get the coins? And do you get them if the other team finishes first?

Which child would you like to have on your team?

This task is a quiz consisting of many different questions. You and your partner have to answer as many questions as possible as a team.

Another team does the quiz too. You only get coins in this task if your team answers more questions correctly than the other team.

If your team answers more questions correctly than the other team, do you get the coins? And do you get them if the other team answers more questions correctly?

Which child would you like to have on your team?

Your team gets 10 coins. The child you pick for your team can decide what to do with them. The bowl on the far side is your partner's and the bowl in the front is yours.

Your partner can decide how many coins to put in her bowl and how many to put in yours. You can keep the coins s/he puts in your bowl.

Who can decide how what to do with the coins, you or your partner? And the coins in which bowl can you keep?

Which child would you like to have on your team?

Competition condition

In this field, there are many colorful balls. To win coins in this task, you need to collect as many balls as possible and to put them into your basket.

You play against another child who also collects the balls. You get the coins only if you collect more balls than your opponent.

If you collect more balls than your opponent, do you get the coins? And if your opponent collects more balls than you, do you get the coins?

Which child would you like to have as your opponent?

This task is a quiz consisting of many different questions. You have to answer as many questions as possible on your own.

Your opponent does the quiz too. You only get the coins in this task if you answer more questions correctly than your opponent.

If you answer more questions correctly than your opponent, do you get the coins? And do you get them if your opponent answers more questions correctly?

Which child would you like to have as your opponent?

You and your opponent get 10 coins each. You can each decide how many coins to keep and how many to give to another child.

The other child can then either take you or your opponent to an amusement park. She wants to take the one who offers her more coins.

If you give more coins than your opponent, will the other child take you to the amusement park? And will she take you if you give fewer coins than your opponent?

Which child would you like to have as your opponent?

Figure S1. Tasks used in the Cooperation condition and in the Competition condition.
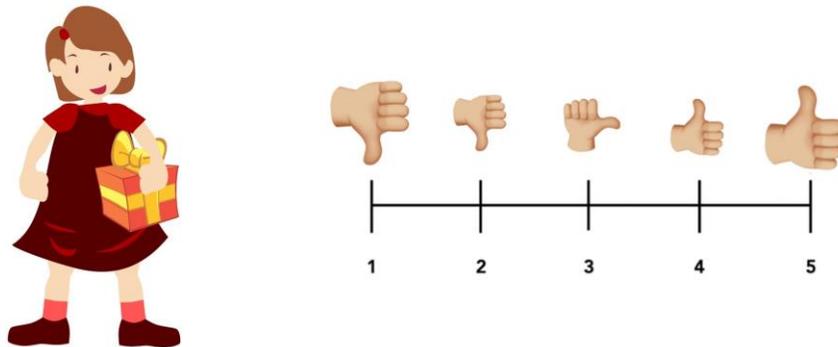
2. Partner ratings

Figure S2. Example of partner rating. Children rated each partner on each quality (i.e., how fast can she run? how much does she know? how much does she share with others?) on a scale from 1 to 5.

3. Analyses

3.1. Study 1

3.1.1 A first GLMM investigated whether the predictors condition, task, and age in months (as well as their interactions) affected whether or not children picked the partner in possession of task-relevant qualities. We included trial number and gender as control predictors, the random effect of participant ID (to account for the fact that children contributed multiple data points), and the random slopes of task nested within participant ID (models with additional random slopes showed convergence issues).

Table S1. Model investigating children's tendency to pick partners in possession of task-relevant qualities (yes/no)

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				33.49	11	$< .001$
condition*age*task (generous)	-0.005	0.055	-0.113, 0.103	1.54	2	.464
condition*age*task (knowl.)	0.060	0.058	-0.053, 0.173			
condition*task (generous)	-0.322	0.549	-1.397, 0.754	0.48	2	.787
condition*task (knowledge)	-0.323	0.535	-1.372, 0.726			
age*task (generous)	0.003	0.031	-0.058, 0.064	1.84	2	.398
age*task (knowledge)	0.034	0.029	-0.021, 0.090			
condition*age	0.074	0.023	0.029, 0.119	11.07	1	$< .001$
task (generous)	-0.192	0.302	-0.784, 0.340	0.45	2	.798
task (knowledge)	-0.040	0.264	-0.558, 0.477			
trial	0.047	0.109	-0.166, 0.260	0.18	1	.669
gender (boy)	-0.439	0.229	-0.889, 0.010	3.63	1	.057

We followed up the significant interaction between condition and age by investigating the condition effect in 4-5-year-olds and 6-7-year-olds separately.

Table S2. Condition effect for different age groups

Age group tested	Estimate	St. Error	95% CI	χ^2	DF	p
5-year-olds	0.303	0.295	-0.275, 0.881	1.15	1	.283
6-7-year-olds	1.432	0.350	0.746, 2.118	18.70	1	$< .001$

3.1.2 A second GLMM investigated whether the predictors condition, task, and age in months (as well as their interactions) affected whether or not children chose correctly (i.e., whether or not they chose the partner possessing the relevant characteristic in cooperation condition and a partner not possessing the relevant characteristic in the competition condition). We included trial number and gender as control predictors, the random effect of participant ID (to account for the fact that children contributed multiple data points), and the random slopes of task nested within participant ID.

Table S3. Model investigating children's tendency to choose correctly (yes/no)

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				36.37	11	$< .001$
condition* age*task (generous)	0.000	0.053	-0.104, 0.104	2.01	2	.365
condition* age*task (knowl.)	0.069	0.056	-0.0420, 0.179			
condition*task (generous)	-0.185	0.529	-1.221, 0.851	0.16	2	923.
condition*task (knowledge)	-0.011	0.535	-1.060, 1.037			

	Estimate	St. Error	95% CI	χ^2	DF	p
age*task (generous)	-0.005	0.028	-0.060, 0.049	1.20	2	.548
age*task (knowledge)	0.023	0.028	-0.032, 0.079			
condition*age	0.047	0.022	0.004, 0.091	4.65	1	.031
task (generous)	-0.241	0.270	-0.771, 0.289	0.96	2	.619
task (knowledge)	-0.217	0.270	-0.746, 0.313			
trial	0.181	0.107	-0.0297, 0.391	2.87	1	.090
gender (boy)	0.094	0.229	-0.356, 0.543	0.17	1	.683

We followed up the significant interaction between condition and age by investigating the effect of condition in 4-5-year-olds and 6-7-year-olds separately.

Table S4. Condition effect for different age groups

Age group tested	Estimate	St. Error	95% CI	χ^2	DF	p
5-year-olds	-1.215	0.281	-1.765, -0.664	20.14	1	$< .001$
6-7-year-olds	-0.427	0.337	-1.087, 0.233	1.62	1	.203

3.1.3 A third GLMM (with poisson error structure) investigated children's post-test partner ratings. Children rated each partner on the three qualities of interest (i.e., speed, knowledgeability, generosity) on five-point scales. This served as a manipulation check to make sure children understood and could remember the information provided about the three partners. We tested if the quality to be rated (speed, knowledge, generosity), whether or not the partner had been described as possessing that quality (yes/no), and children's age (as well as their interactions) affected children's ratings. 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.

Table S5. Model investigating children's partner ratings (1-5)

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				73.94	11	$< .001$
quality (generous)*qual. possession (yes)*age	0.001	0.011	-0.020, 0.022	3.59	2	.166
quality (knowl.)*qual. possession (yes)*age	0.018	0.011	-0.003, 0.040			
quality possession (yes)*age	0.000	0.006	-0.011, 0.011	0.01	1	.931
quality (generous)*age	0.003	0.005	-0.008, 0.013	0.44	2	.802
quality (knowledge)*age	0.000	0.005	-0.011, 0.010			
quality (generous)*quality possession (yes)	0.082	0.109	-0.131, 0.295	1.45	2	.485
quality (knowledge)*quality possession (yes)	-0.048	0.108	-0.261, 0.163			
quality (generous)	-0.067	0.054	-0.001, 0.009	1.50	1	.473
quality (knowledge)	-0.038	0.054	0.434, 0.655			
quality possession (yes)	0.545	0.056	-0.173, 0.039	63.97	1	$< .001$
age	0.004	0.003	-0.143, 0.067	2.35	1	.136
gender (boy)	-0.013	0.052	-0.114, 0.089	0.06	1	.803

Although we did not find an interaction between age and quality possession, we examined the effect of quality possession on partner ratings in 4-5-year-olds separately as an additional robustness check. This analysis tests whether 4-5-year-olds rated partners higher on those qualities they had initially been described as possessing.

Table S6. Effect of quality possession on partner ratings in 4-5-year-olds

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
quality possession (yes)	0.542	0.060	0.425, 0.659	80.04	1	$< .001$

The results show that 4-5-year-olds rated partners significantly higher on those qualities they were initially described as possessing.

3.2. Study 2

3.2.1 A first GLMM investigated whether the predictors condition, task, and age in months (as well as their interactions) affected whether or not children picked the partner in possession of task-relevant qualities. Trial and gender were included as control predictors. We included trial number and gender as control predictors, the random effect of participant ID (to account for the fact that children contributed multiple data points), and the random slopes of task nested within participant ID (models without random slopes or additional ones led to some convergence issues).

Table S7. Model investigating children's tendency to pick partners in possession of task-relevant qualities (yes/no)

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				55.74	11	$< .001$
condition*age*task (generous)	-0.015	0.028	-0.070, 0.040	1.09	2	.582
condition*age*task (knowl.)	0.015	0.029	-0.041, 0.071			
condition*task (generous)	-1.144	0.395	-1.918, -0.371	9.44	2	.009
condition*task (knowledge)	-0.233	0.406	-1.028, 0.562			
age*task (generous)	0.035	0.015	0.005, 0.065	5.22	2	.073
age*task (knowledge)	0.016	0.014	-0.011, 0.044			
condition*age	0.033	0.011	0.010, 0.055	8.37	1	.004
trial	-0.105	0.081	-0.265, 0.054	1.69	1	.194
gender (boy)	0.159	0.163	-0.160, 0.477	0.95	1	.329

We followed up the significant interaction between condition and age by investigating the effect of condition in younger children (4-5-year-olds) and older children (6-7-year-olds) separately. Given the non-significant trend in 4-5-year-olds, we also inspected the effect of condition in 4-year-olds and 5-year-olds separately.

Table S8. Condition effect for different age groups

Age group tested	Estimate	St. Error	95% CI	χ^2	DF	p
4-5-year-olds	0.390	0.225	-0.051, 0.831	3.04	1	.081
4-year-olds	-0.021	0.336	-0.679, 0.638	0.00	1	.952
5-year-olds	1.083	0.359	0.380, 1.786	10.07	1	.002
6-7-year-olds	1.316	0.250	0.825, 1.807	31.60	1	$< .001$

This analysis suggests that from around age 5 children start choosing partners possessing task-relevant qualities as cooperators while avoiding them as competitors (see also Fig. 4 of the main text).

We followed up the significant interaction between condition and task by looking at the effect of condition in the three tasks separately.

Table S9. Condition effect in the three tasks

Task	Estimate	St. Error	95% CI	χ^2	DF	p
knowledge task	1.012	0.289	0.445, 1.578	13.62	1	< .001
speed task	1.128	0.274	0.690, 1.765	21.06	1	< .001
generosity task	0.100	0.268	-0.425, 0.626	0.14	1	.709

3.2.2 A second GLMM investigated whether the predictors condition, task, and age in months (as well as their interactions) affected whether or not children chose correctly (i.e., whether or not they chose the partner possessing the relevant characteristic in cooperation condition and a partner not possessing the relevant characteristic in the competition condition). We included trial number and gender as control predictors, the random effect of participant ID (to account for the fact that children contributed multiple data points), and the random slopes of task nested within participant ID (again, not including the random slopes led to convergence issues).

Table S10. Model investigating children's tendency to choose correctly (yes/no)

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				30.36	11	.001
condition* age*task (generous)	0.068	0.028	0.013, 0.123	6.07	2	.048
condition* age*task (smart)	0.034	0.028	-0.021, 0.089			
trial	0.151	0.080	-0.005, 0.307	3.66	1	.056
gender (boy)	0.126	0.174	-0.216, 0.468	0.52	1	.470

We followed up the significant three-way-interaction between condition, task, and age by examining the effects of condition, task, and their interaction in 4-5-year-olds and 6-7-year-olds separately.

Table S11. Effects of condition and task in 4-5-year-olds

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				5.66	5	.341
condition*task (generous)	-0.203	0.532	-1.245, 0.840	0.15	2	.926
condition*task (smart)	-0.063	0.529	-1.010 0.975			
condition	-0.135	0.216	-0.558, 0.289	0.39	1	.533
task (generous)	-0.600	0.268	-1.125, -0.074	5.12	2	.077
task (smart)	-0.335	0.268	-0.859, 0.190			
trial	0.192	0.109	-0.021, 0.405	3.15	1	.076
gender (boy)	0265	0.234	-0.193, 0.723	1.27	1	.259

Condition, task, and their interaction did not affect 4-5-year-olds's tendency to choose correctly.

Table S12. Effects of condition and task in 6-7-year-olds

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				20.51	5	.001
condition*task (generous)	2.000	0.599	0.826, 3.175	11.97	2	.003
condition*task (smart)	1.027	0.598	-0.145, 2.198			
trial	0.099	0.121	-0.137, 0.336	0.68	1	.411
gender	0.005	0.267	-0.518, 0.528	0.00	1	.985

We followed up the significant interaction between condition and task in 6-7-year-olds by examining the effect of condition in the three tasks separately.

Table S13. Condition effect in three tasks (6-7-year-olds only)

Task	Estimate	St. Error	95% CI	χ^2	DF	p
knowledge task	0.319	0.404	-0.472, 1.110	0.63	1	.428
speed task	-0.668	0.421	-1.494, 0.157	2.63	1	.105
generosity task	1.210	0.391	0.444, 1.976	10.05	1	.002

3.3.3 A third GLMM (with poisson error structure) investigated children's post-test partner ratings. Children rated each partner on the three qualities of interest (i.e., speed, knowledgeability, generosity) on five-point scales. This served as a manipulation check to make sure children understood and could remember the information provided about the three partners. We tested if the quality to be rated (speed, knowledge, generosity), whether or not the partner had been described as possessing that quality (yes/no), and children's age (as well as their interactions) affected children's ratings. 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.

Table S14. Model investigating children's partner ratings (1-5)

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
full-null comparison				265.79	11	< .001
age*quality possession (yes)*quality (generous)	-0.026	0.075	-0.173, 0.120	1.20	2	.550
age*quality possession (yes)*quality (knowl.)	0.054	0.074	-0.091, 0.198			
age*quality possession (yes)	0.090	0030	0.031, 0.150	8.83	1	.003
age*quality (generous)	0.020	0.037	-0.053, 0.093	0.60	2	.739
age*quality (knowl.)	0.027	0.037	-0.044, 0.099			
quality possession (yes)*quality (generous)	0.010	0.082	-0.152, 0.171	6.99	2	.030
quality possession (yes)*quality (knowl.)	-0.182	0.081	-0.340, -0.023			
gender (boy)	-0.031	0.033	-0.097, 0.034	0.88	1	.347

We followed up the significant interaction between age and quality possession by looking at the effect of quality possession in 4-5-year-olds and 6-7-year-olds separately. Both older and younger children rated partners higher on the qualities they were initially described as possessing. As an additional robustness check, we examined the effect of quality possession on partner ratings in 4-year-olds separately.

Table S15. Effect of quality possession on partner ratings for different age groups

Age group tested	Estimate	St. Error	95% CI	χ^2	DF	p
4-5-year-olds	0.434	0.047	0.342, 0.526	82.98	1	< .001
4-year-olds only	0.433	0.070	0.296, 0.570	37.40	1	< .001
6-7-year-olds	0.625	0.048	0.532, 0.719	168.92	1	< .001

The results show that even the 4-year-olds rated partners higher on the qualities they were initially described as possessing. Younger children's indiscriminate partner choice thus cannot be explained by their failure to understand or memorize the partner descriptions.

We followed up the interaction between quality (i.e., the quality to be rated) and quality possession (whether the rated partner had been described as possessing that quality) by looking at the effect of quality possession for the three qualities separately.

Table S16. Effect of quality possession on partner ratings in the three tasks

Task	Estimate	St. Error	95% CI	χ^2	DF	p
knowledge task	0.406	0.057	0.293, 0.518	48.63	1	< .001
speed task	0.587	0.057	0.475, 0.699	102.91	1	< .001
generosity task	0.597	0.059	0.481, 0.713	102.91	1	< .001

3.3.5 Additional analyses.

We tested whether children's partner preference predicted whether or not children chose the partner in possession of task-relevant qualities and whether the main findings hold when we control for children's partner preference.

To do this, we reran Analysis 3.2.1 while including children's partner preference (as indicated by the post-test preference test) as a control predictor.

Table S17.

Predictor	Estimate	St. Error	95% CI	χ^2	DF	p
condition*age	0.036	0.011	0.014, 0.058	10.16	1	.001
condition*task (generous)	-1.104	0.328	-1.853, -0.355	9.47	1	.009
condition*task (knowl.)	-0.228	0.387	-0.986, 0.530			
partner preference (generous)	0.316	0.187	-0.050, 0.682	3.15	2	.207
partner preference (knowl.)	0.061	0.200	-0.332, 0.453			