

Supplemental Information

Additional methods and results

The total joint success rate in the rope-pulling task was 61% with 131 successful trials over 215 total trials performed by 145 different pairs of 290 children. Only 14 dyads of children did not succeed after the three attempts. Since we children were allowed to perform up to 3 attempts, we also looked at the effect of partner relationship on the number of trials before success using an ordered logistic regression (“polr” function) with ordered responses (1: success after 1 trial; 2: success after 2 trials, 3: success after 3 trials). We built a full model that included fixed effects of dyad relationship (kin, friend, non-friend), average age of partners, age difference between the partners and sex of the dyad (male-male, female-female, male-female). Kin dyads required more trials to succeed on average compared to friends’ dyads while controlling for mean age, age difference and sex of dyads.

Table S1. Effect of dyad characteristics (partner status: Kin, Friends, Non-Friends, sex: Female-Female, Male-Male, Female-Male, mean Age, age difference) on the number of trials before success (ordered LM).

Number of trials before joint success			
<i>Predictors</i>	<i>Odds Ratios</i>	<i>CI</i>	<i>p</i>
Partner: Friend vs. Kin	0.23	0.08 – 0.65	0.007
Partner: Non Friend vs. Kin	0.30	0.11 – 0.80	0.019
Partner: Non Friend vs. Friend	1.28	0.50 – 3.30	0.608
Dyad mean age	0.80	0.52 – 1.23	0.311
Dyad age difference	0.66	0.41 – 1.03	0.079
Dyad sex	0.92	0.62 – 1.36	0.685
Observations	131		
R ² Nagelkerke	0.102		

Note. The second category corresponds to the reference category.

Table S2. Effect of dyad characteristics (partner status: Kin, Friends, Non-Friends, sex: Female-Female, Male-Male, Female-Male, mean Age, age difference) on performance in the first trials (binomial GLM).

<i>Predictors</i>	Performance during first trials				
	<i>Odds Ratios</i>	<i>std. Error</i>	<i>CI</i>	<i>Statistic</i>	<i>p</i>
(Intercept)	0.79	0.38	0.31 – 2.02	-0.50	0.619
Dyad age difference	1.45	0.32	0.95 – 2.27	1.70	0.090
Partner: Friend vs. Kin	4.08	2.19	1.46 – 12.10	2.62	0.009
Partner: Non friend vs. Kin	3.10	1.53	1.20 – 8.41	2.29	0.022
Partner: Non friend vs. Friend	0.76	0.34	0.31 – 1.83	-0.61	0.542
Dyad mean age	1.68	0.33	1.15 – 2.51	2.64	0.008
Dyad sex: FM vs. FF	0.73	0.35	0.28 – 1.87	-0.65	0.513
Dyad sex: MM vs. FF	0.84	0.38	0.35 – 2.02	-0.38	0.704
Dyad sex: MM vs. FM	1.15	0.52	0.47 – 2.81	0.32	0.752
Observations	145				
R ² Tjur	0.127				
AIC	187.393				

Note. The second category corresponds to the reference category.

Table S3. Effect of demographic variables on performance during first trials with “participant” as a random factor and Age in months, sex, number of siblings, parents’ income, and living area (urban vs rural) as fixed factors using binomial GLMM.

Performance during first trials					
<i>Predictors</i>	<i>Odds Ratios</i>	<i>std. Error</i>	<i>CI</i>	<i>Statistic</i>	<i>p</i>
(Intercept)	1.88	0.39	1.26 – 2.82	3.07	0.002
Age in months	2.07	0.47	1.32 – 3.24	3.19	0.001
Sex: M vs. F	1.02	0.18	0.72 – 1.44	0.10	0.922
Parents’ income	0.75	0.14	0.53 – 1.08	-1.55	0.122
Living area (rural=1)	1.30	0.26	0.88 – 1.92	1.32	0.186
Nb. Of Siblings	0.73	0.20	0.43 – 1.23	-1.18	0.239
Random Effects					
σ^2	3.29				
τ_{00} Subject	0.15				
ICC	0.04				
N _{Subject}	171				
Observations	172				
Marginal R ² / Conditional R ²	0.133 / 0.171				
AIC	219.348				

Table S4. Effect of the number of friends on performance in the first trial (binomial GLM) while controlling for dyad characteristics (sex: Female-Female, Male-Male, Female-Male, mean age, age difference)

<i>Predictors</i>	Performance				
	<i>Odds Ratios</i>	<i>std. Error</i>	<i>CI</i>	<i>Statistic</i>	<i>p</i>
(Intercept)	0.14	0.19	0.01 – 1.96	-1.43	0.154
Dyad Mean Nb. of friends (outdegree)	1.58	0.32	1.08 – 2.40	2.26	0.024
Dyad mean age	2.34	0.67	1.37 – 4.27	2.95	0.003
Dyad age difference	1.69	0.52	0.95 – 3.20	1.70	0.088
Dyad sex: FM vs. FF	0.64	0.42	0.17 – 2.30	-0.68	0.496
Dyad sex: MM vs. FF	1.66	1.08	0.46 – 6.15	0.77	0.439
Dyad sex: MM vs. FM	2.59	1.73	0.72 – 10.13	1.43	0.153
Number of children in the classroom	1.04	0.03	0.97 – 1.11	1.05	0.295
Observations	81				
R ² Tjur	0.203				
AIC	102.662				

Note. The second category corresponds to the reference category.

Table S5. Effect of partner status on the number of gazes per second during the first trial while controlling for dyad characteristics (sex: Female-Female, Male-Male, Female-Male, mean age, age difference; LM).

Number of gazes per second					
<i>Predictors</i>	<i>Estimates std. Error</i>		<i>CI</i>	<i>Statistic</i>	<i>p</i>
(Intercept)	0.23	0.03	0.17 – 0.28	8.41	<0.001
Partner: Friend vs. Kin	0.10	0.03	0.05 – 0.16	3.55	0.001
Partner: Non Friend vs. Kin	0.05	0.03	-0.00 – 0.11	1.93	0.056
Partner: Non-friend vs. Friend	-0.05	0.02	-0.10 – -0.00	-2.09	0.038
Dyad age difference	0.02	0.01	0.00 – 0.05	2.04	0.043
Dyad mean age	0.06	0.01	0.04 – 0.08	5.20	<0.001
Dyad sex: FM vs. FF	0.06	0.03	0.00 – 0.11	2.07	0.041
Dyad sex: MM vs. FF	0.03	0.02	-0.02 – 0.08	1.34	0.182
Dyad sex: MM vs. FM	-0.02	0.03	-0.07 – 0.03	-0.89	0.378
Observations	142				
R ² / R ² adjusted	0.261 / 0.228				
AIC	-188.387				

Note. The second category corresponds to the reference category.

Figure S1.

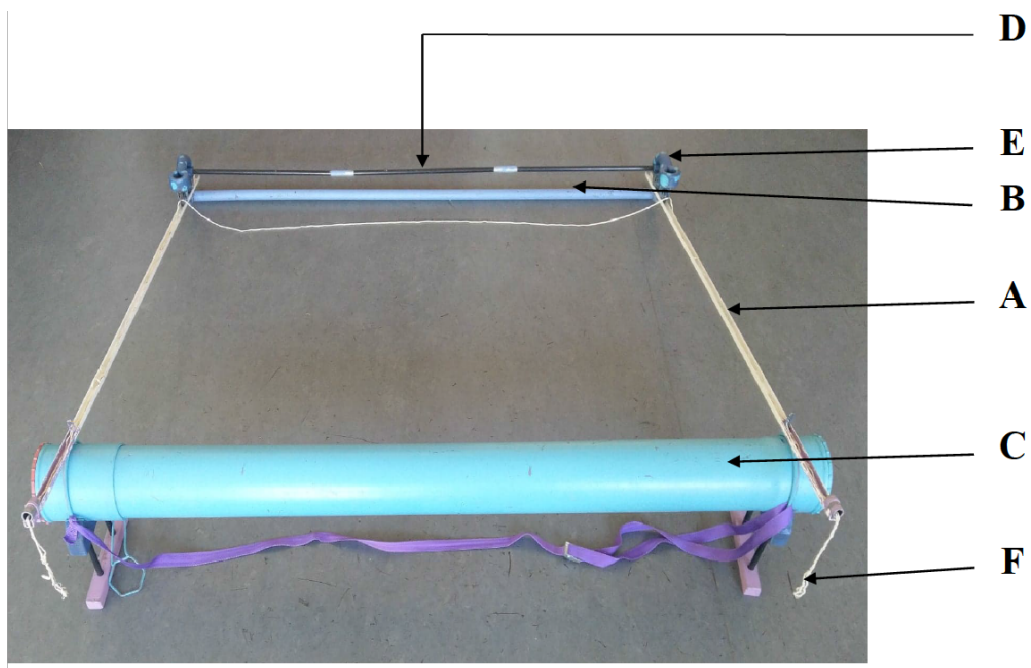


Fig. S1. Photograph of the cooperation apparatus. The "rope pulling game" was adapted from previous studies on chimpanzees and children. It consisted of two rails (A) 150 cm long and spaced 145 cm apart attached to a metal rod (B) and a plastic tube (C). Two small metal trolleys (D) with casters were recessed on each of the rails and were connected to each other by a plastic rod (E). These two carriages had a cavity in which the reward (stickers) was placed. A 480 cm rope was threaded into different notches at the rail and trolleys in such a way that if only one of the children pulled on one end of the rope (F), the other end was automatically pulled in the rail out of reach of the second child. The rope extended the end of the apparatus by only 15 cm on each side so that one child could not pull on both ends alone. At each beginning test, the carriages were positioned on the far side of the metal rod (farthest from children). In order to access the stickers, the children had to simultaneously pull at each of the two ends of the rope and thus roll the carriages towards them to the tube. The rails were inclined at an angle of 30° so that the carriages went back if one of the two children let go of the rope.

Figure S2.

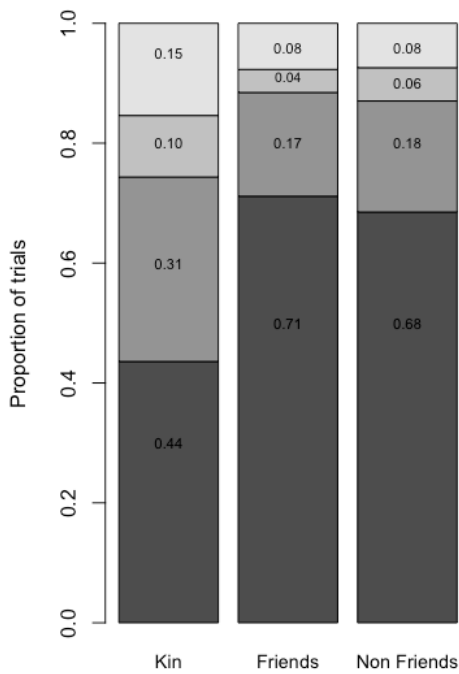


Fig. S2. Proportion of successful attempts during first trials (dark grey), second trials (middle grey), and third trials (light grey) or failure during the third trial (very light grey) by partner status (Kin, Friends, Non-Friends). Kin dyads required more trials to succeed on average compared to friends or non-friend dyads (See Table S1 for detailed statistics).

Figure S3

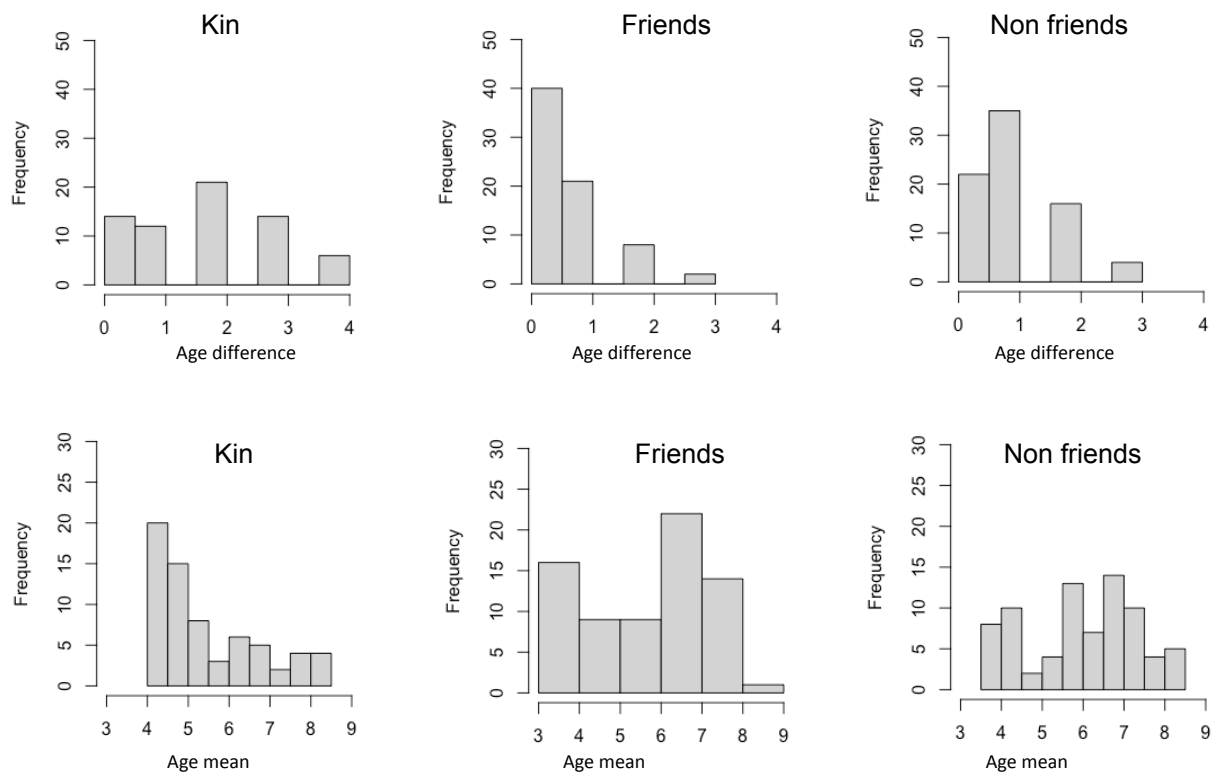


Fig. S3. Histograms of the age difference between members of the dyad (top row) and mean age of dyad members (bottom row) for each dyad status (i.e. Kin, friends and non-friends).

Figure S4.

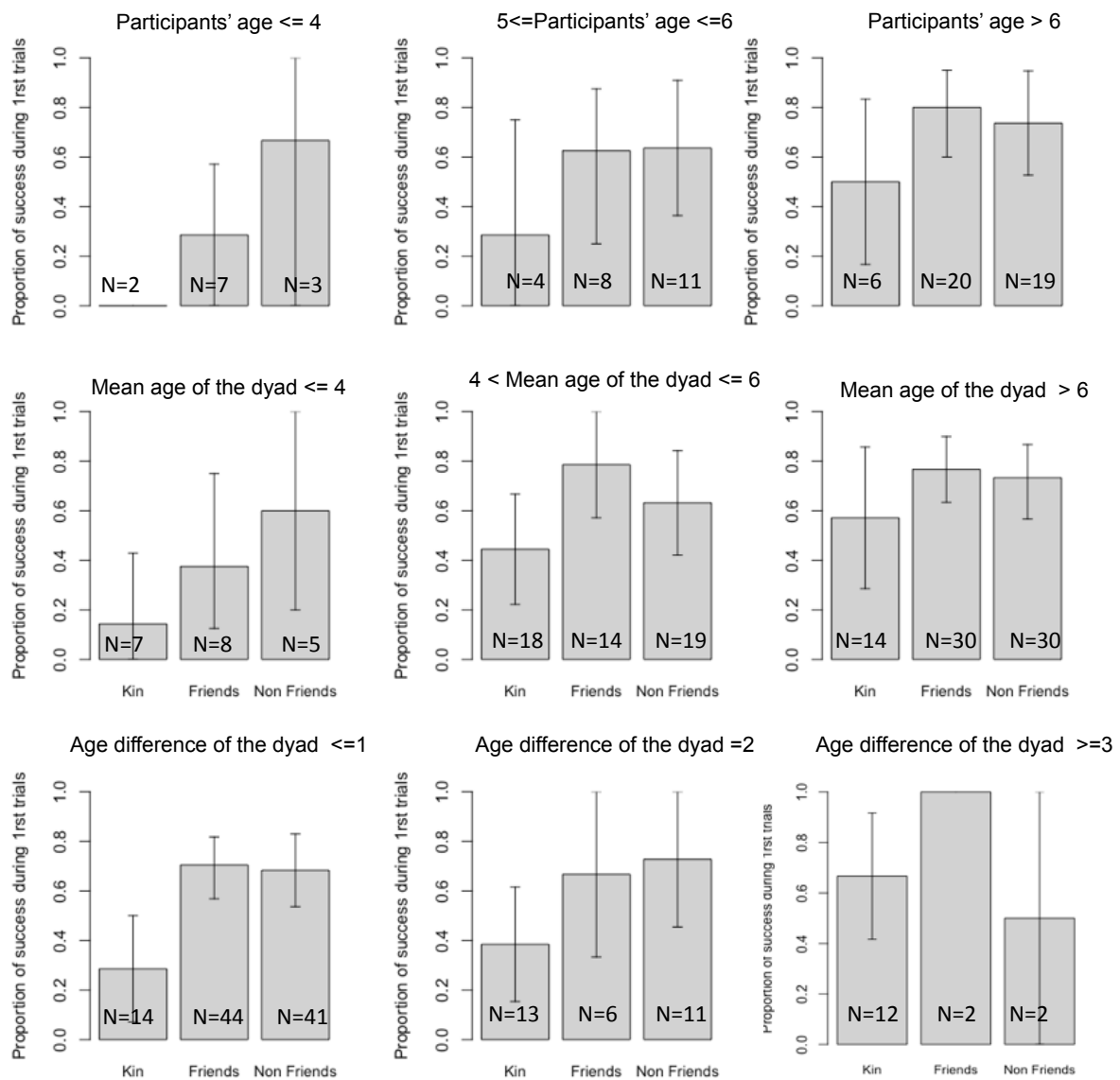


Fig. S4. Proportion of successful first trials by kin (i.e. siblings), non-kin friends, and non-kin non-friend dyads in cooperative rope pulling by age groups (age: ≤ 4 years old; between 4 and 6 years-old; and > 6), mean age of the dyad (≤ 4 ; 5 and 6 and > 6) and age difference (≤ 1 ; 2 or > 3). Error bars indicate 95% bootstrapped confidence interval. N values indicate the number of dyads in each category. When the sample size is sufficient, kin partners are always less successful than non-kin partners (friends or non-friends).

Figure S5.

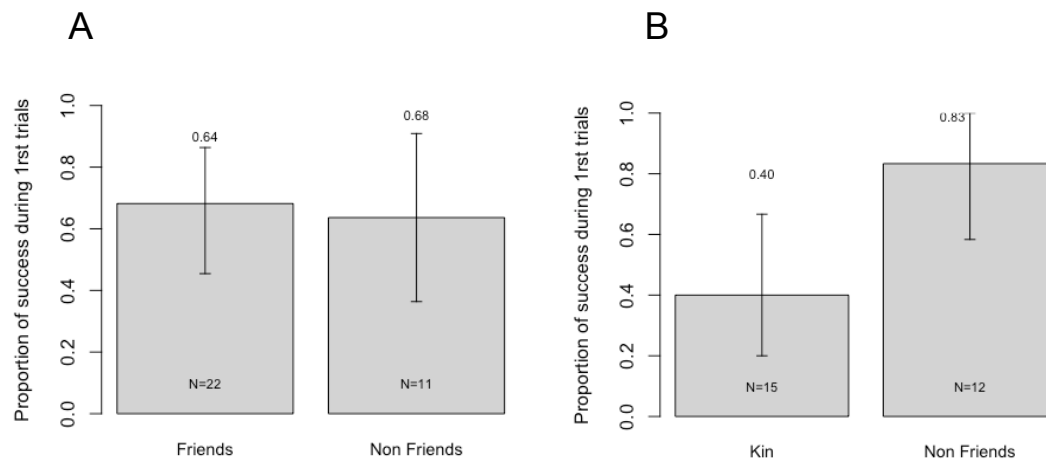


Fig. S5. Proportion of successful first trials in the rope pulling task using data restricted to groups that have similar age and gender profiles. A) Contrast between dyads that include friends or non-friends including only dyads composed of same-age (age difference <1) and same-sex (Female-Female and Male-Male) individuals. Performance during first trials of the friend and non-friend dyads do not differ (Odds ratios: 1.75; CI: [0.25-5.59]; $z=0.26$; $P=0.80$) as in the overall analysis presented in the main text (see also Table S2). B) Contrast between kin and non-friend dyads where ages are different (age difference ≥ 1 since kin are more often more than one year apart) and different-sex (Female-Male). As friend dyads were nearly always the same age, we only contrasted non-friends with kin to keep the age difference similar. Kin dyads performed less well than non-friends in the different age different, gender group (Odds ratios: 0.13; CI: [0.02-0.73], $z=-2.15$; $P=0.032$) as was observed in the overall results presented in the main text (see also Table S2). Figures show means and error bars indicate 95% bootstrapped confidence interval. N values indicate the number of dyads in each category.

Figure S6.

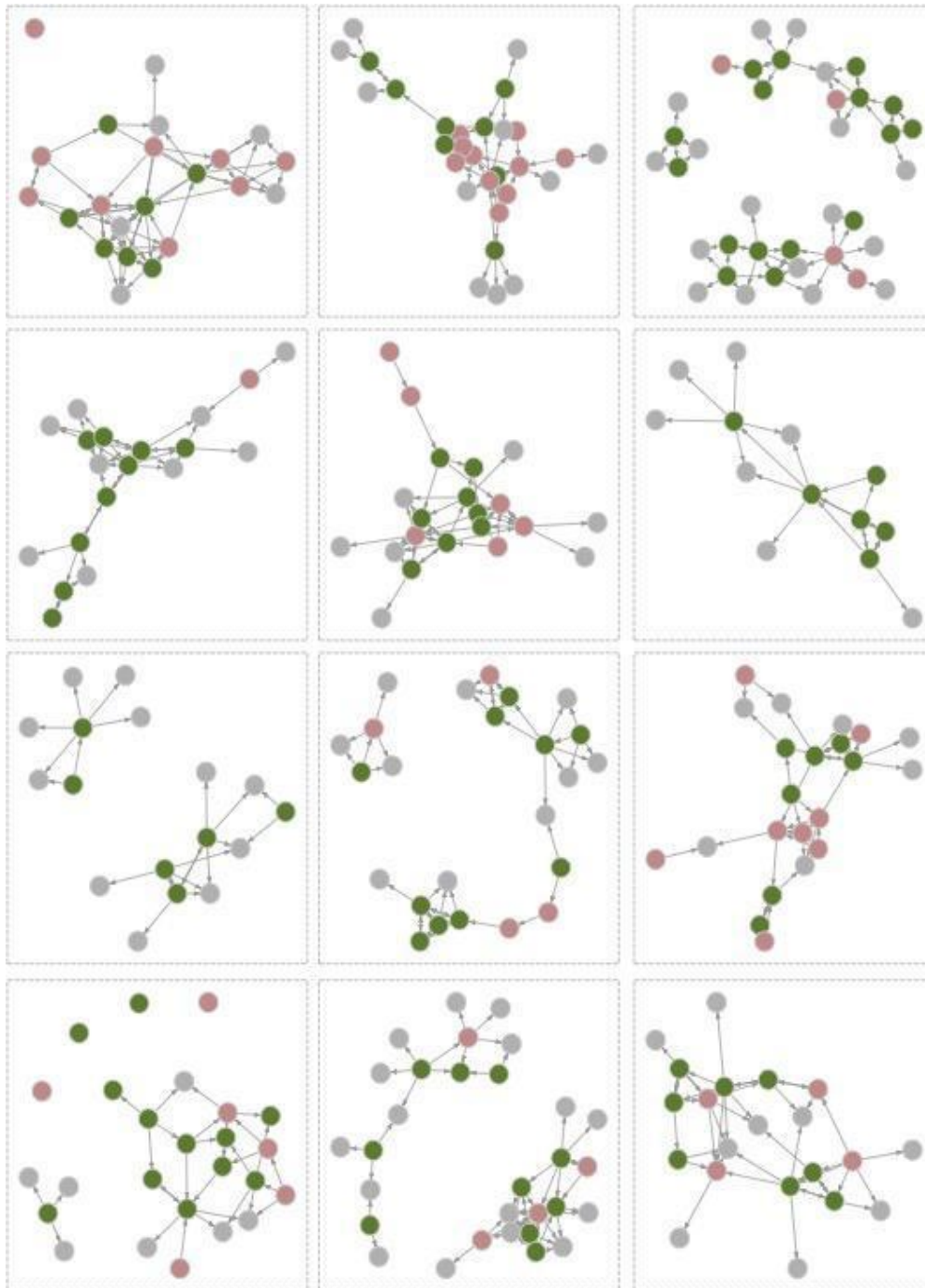


Fig. S6. Network graphs representing relationships between children in 10 schools (12 classrooms) where data was available based on questionnaire data from children who participated in the task. Individuals who were successful in the first trial are shown in green while those who failed in the first trial are shown in red. Children who did not participate but who participants named as friends appear in grey. Arrows represent friendship between children such that bi-directional arrows represent pairs of individuals who each listed the other as a friend whereas single headed arrows represent cases where one individual considered the other a friend while the second individual did not list the first as a friend.

Figure S7.

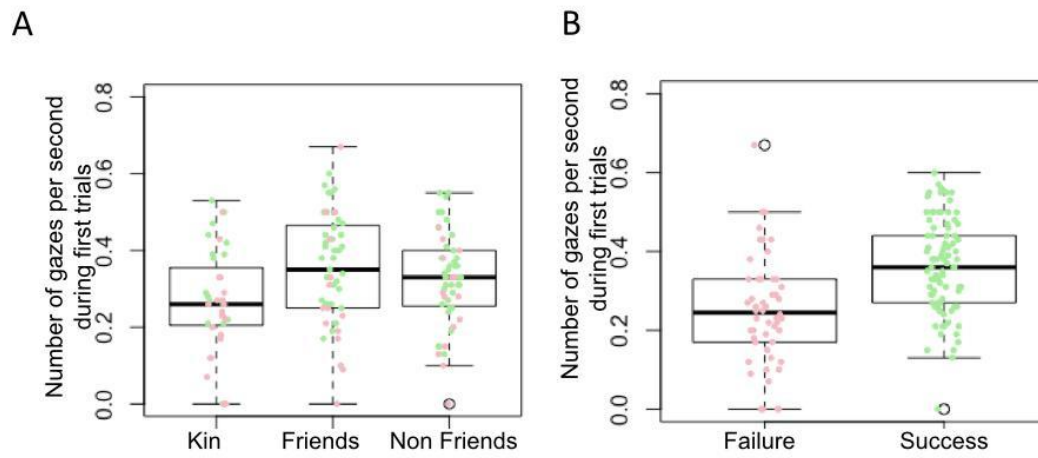


Fig. S7. Number of gazes displayed during the first trials. A) Boxplots represent the number of gazes per second for each dyad category (i.e. Kin, friends and non-friends). Each dot represents a dyad with red dots associated with failure and green dots associated with joint success.