

Does group size matter? Cheating and cooperation in Brazilian school children[☆]

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Abstract

Cooperation between individuals is an important requisite for the maintenance of social relationships. The purpose of this study was to investigate cooperation in children in the school environment, where individuals could cooperate or not with their classmates in a public goods game. We investigated which of the following variables influenced cooperation in children: sex, group size, and information on the number of sessions. Group size was the only factor to significantly affect cooperation, with small-group children cooperating significantly more than those in large groups. Both sex and information had no effect on cooperation. We suggest that these results reflect the fact that, in small groups, individuals were more efficient in controlling and retaliating their peers than in large groups.

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1. Introduction

Cooperation between individuals is an important requisite for the maintenance of social relationships. On the other hand, noncooperative behaviors benefit the individual at the expense of the group. Therefore, mechanisms that enhance cooperation and inhibit free-riding are fundamental in human populations. These are social mechanisms which discourage free-riding, such as fees, social disapproval, and group alienation, or which stimulate cooperation, such as approval, reciprocity, and praise (Nowak & Sigmund 1998; Wedekind, 2000; Wedekind & Milinski, 1996).

Traditionally, most developmental studies indicate that children behave selfishly toward unrelated individuals. However, a few studies report the development of altruistic behavior during childhood. Very young children (2–3 years old) may display cooperative activities when interacting with peers, involving mainly imitative games and simple routines

(Brownell, Ramani & Zerwas, 2006). Older children display more complex cooperative actions, and studies using economic games report small increases in altruistic behaviors with age (Benenson, Pascoe & Radmore, 2007; Harbaugh, Krause & Liday, 2003) and an average donation in proportion to their assets that matches the number donated in studies with adults. Benenson et al. (2007) suggest that humans may have, from an early age, biologically based mechanisms that encourage altruistic acts under appropriate conditions. Which are these conditions and how do children learn the specific conditions under which they should cooperate or compete? Socialization practices affect explicit human altruistic and competitive behaviors, but their impact may be stronger from 9 years of age, as suggested by Benenson et al. (2007).

Some other variables seem to influence the propensity to cooperate, such as sex. Results of studies with children are mixed: Harbaugh et al. (2003) report a slight tendency for girls to behave more prosocially than boys; Banco and Mettel (1984) suggest that boys cooperate more than girls; Markovits, Benenson and Kramer (2003), on the other hand, report that girls share their food more than boys do, except between siblings, when sharing is equivalent for both sexes. In adults, results of economic games are also mixed:

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Table 1

Composition by age and sex of public school children's groups in Natal, RN, Brazil. Groups 1–10 were considered large and, 11–6, small

Group	Composition	Group mean age (and SE)	Mean age (and S.E.) by group and sex	
			♀	♂
1	n=17 (♀=8 ♂=9)	10.8 (±0.8)	♀ 10.9 (±0.8)	♂ 10.7 (±0.8)
2	n=22 (♀=10 ♂=12)	9.6 (±0.5)	♀ 9.6 (±0.5)	♂ 9.6 (±0.5)
3	n=22 (♀=14 ♂=8)	9.1 (±0.7)	♀ 9.2 (±0.6)	♂ 9.0 (±0.7)
4	n=20 (♀=12 ♂=8)	8.3 (±0.7)	♀ 7.9 (±0.6)	♂ 9.0 (±0.5)
5	n=24 (♀=18 ♂=6)	8.6 (±1.1)	♀ 8.8 (±1.0)	♂ 8.3 (±1.3)
6	n=18 (♀=7 ♂=11)	7.2 (±0.8)	♀ 7.3 (±0.4)	♂ 7.1 (±0.7)
7	n=16 (♀=2 ♂=14)	7.4 (±0.5)	♀ 7.3 (±0.4)	♂ 7.4 (±0.5)
8	n=24 (♀=17 ♂=7)	8.7 (±1.0)	♀ 8.3 (±0.6)	♂ 9.6 (±1)
9	n=13 (♀=3 ♂=10)	8.2 (±0.6)	♀ 8.2 (±0.03)	♂ 8.2 (±0.7)
10	n=19 (♀=9 ♂=10)	7.6 (±0.6)	♀ 7.5 (±0.5)	♂ 7.6 (±0.6)
11	n=7 (♀=4 ♂=3)	8.9 (±0.9)	♀ 8.6 (±0.8)	♂ 9.3 (±0.7)
12	n=7 (♀=4 ♂=3)	9.6 (±0.4)	♀ 9.5 (±0.5)	♂ 9.7 (±0.1)
13	n=7 (♀=2 ♂=5)	9.3 (±0.4)	♀ 9.7 (±0.8)	♂ 9.2 (±0.3)
14	n=6 (♀=3 ♂=3)	7.5 (±0.4)	♀ 7.5 (±0.4)	♂ 7.5 (±0.4)
15	n=6 (♀=3 ♂=3)	7.4 (±0.9)	♀ 7.1 (±0.2)	♂ 7.6 (±1.4)
16	n=7 (♀=4 ♂=3)	7.7 (±0.1)	♀ 7.7 (±0.2)	♂ 7.7 (±0.1)

Sell, Griffith and Wilson (1993), Sell (1997), and Andreoni and Vesterlund (2001) suggest that sex differences may or may not occur depending on the kind of game being played. However, studies in more naturalistic conditions report more prosocial behavior in men (Eagly & Crowley, 1986). The controversial results suggest the need for further investigation.

A second variable is iteration, the repetition of the opportunities to play. Results of iterative games in adults suggest that individuals are more cooperative in their first interaction and decrease it over time (Clark & Sefton, 2001). Fan (2000) reported the opposite effect in an investigation with children, which showed that, after repeating a game, cooperation increased. In Fan's study, disclosure of individual choices to the group may have facilitated cooperation. He attributed cooperation to older children (7 and 8 years old) suggesting that younger children do not have a complete understanding of the situation and, therefore, do not change their behavior.

Information regarding the possibility of further cooperation (iteration) may also influence the willingness to cooperate, insofar as it suggests that there will be opportunities for reciprocation. The perspective of single interactions, on the other hand, may favor cheating (Axelrod & Hamilton, 1981).

Group size may also influence cooperation and how much a member of the group is willing to donate in a public goods game. Larger groups present a control problem, and cheaters may increase their odds in such groups, as the chances of being caught are minimal (Kollock, 1998). Suzuki and Akiyama (2005) also suggest that cooperation decreases as group size increases. In natural conditions, social exchanges occur in much larger groups, and it would be interesting to test if that relation persists when groups increase beyond 4 or 5 individuals.

Moreover, most investigations on this subject use computer simulations that test theoretically a proposed model. Empirical investigations focus mostly on laboratory studies with adults (Millinski, Semmann, & Krambeck, 2002; Wedekind & Milinski, 1996). A more naturalistic approach can help to understand the factors that influence behavior in complex situations.

The purpose of this study was to investigate cooperation in children in the school environment, where individuals could cooperate or not with their classmates. Individual choices were undisclosed to the group as a means to ensure a more spontaneous behavioral expression. More specifically, we investigated which of the following variables influenced cooperation in children: sex, group size, and information on the number of sessions. We expected, according to the literature discussed above, that girls would cooperate more than boys and that increase in group size and lack of information about the duration of the game would decrease cooperation. Although a recent revision (Henrich et al., 2005) reports the absence of sex differences in altruistic behaviors, from an evolutionary perspective females, more than males, may benefit from the display of altruism towards nonkin, as it may reduce the probability of conflict (Benenson et al., 2007). Also, women, more than men, are reported to value the development of reciprocal relationship with other people (Geary, 1999), which would predict more cooperation in games like these. As to group size, we expected that, as group size increases and the possibility of control over cheaters decreases, cooperation should decrease in larger groups. Finally, the information on the repetition of the game would allow for the development of strategies and the advantage of cooperating in the long term when information was available. Therefore, we expected that uninformed children would present extreme strategies, such as free-riding, more often than informed children, as the first would not be aware of future possibilities of cooperation and, therefore, future possibilities of benefiting from it.

2. Methods

2.1. Subjects

Our subjects were 232 children (117 girls and 115 boys) from 5 public schools in Natal, Brazil. Children from public schools in Brazil all come from low socioeconomic status (SES). Mean age was 8.7 (±1.34) years for boys and 8.7 (±1.18) years for girls, the oldest of whom was 11.5 and, the youngest, 5.5 years. Each classroom group tested had 5–24 children. Division of the classrooms was accomplished by attributing randomly 5–7 children to the small group and all the remaining to the large group (Table 1). In some cases, the total number of students in the classroom was not large enough to form one small and one large group. In those cases, we worked with the whole classroom as one large group. Mean age for the small groups was 8.5 (±1.30) years and, for the large ones, 8.7 (±1.07) years. All the subjects

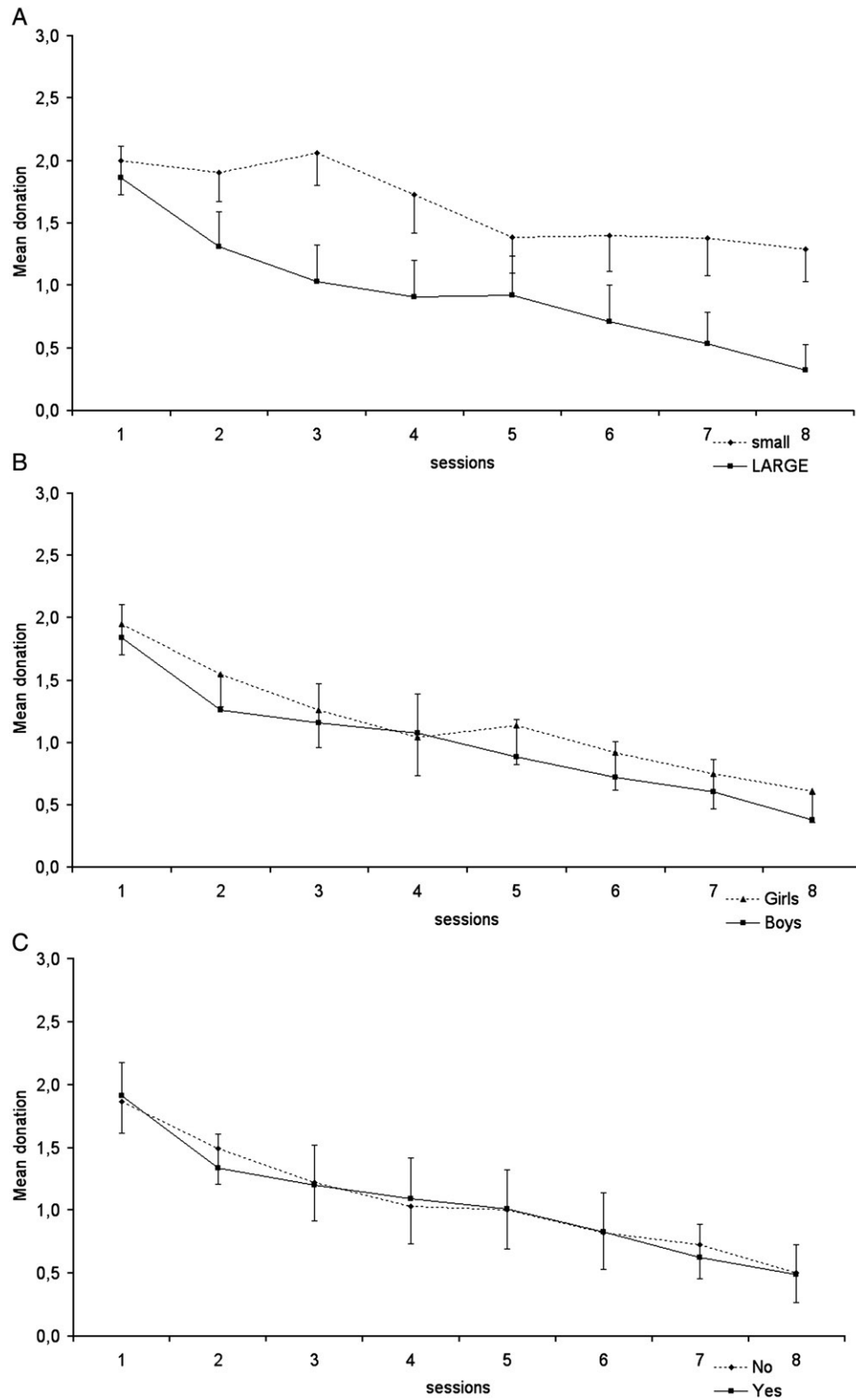


Fig. 1. Mean (and S.E.) donation of candy bars for a public goods fund by children from public schools in Natal at each of eight sessions by (A) group size, (B) sex, and (C) information on the number of sessions.

knew each other for at least 2 months prior to the beginning of this study. Written consent of the parents or legal guardians was obtained before the inclusion of each child in the study.

2.2. Experimental design

The subjects were asked to participate in a public goods game that allowed different degrees of cooperation or free-riding, without the knowledge of other group members. Each group played eight successive sessions, with intervals varying from 1 to 3 days. Each group was classified as either small (between five and seven players) or large (≥ 12 players).

2.3. The game

At the beginning of each session, each child received an envelope and three candy bars (7.5 g each). They were then instructed to take these items behind a partition where they could make a donation to the group in a sealed urn. They could put one, two, or three candy bars (maximum cooperation) or none (free-riding) into the envelope; seal it; and place it into the urn. Retained candy bars could be stored inside purses or pockets (retention) to prevent the other children from knowing how many had been donated. They were also informed that after all the children had taken their turn behind the partition, we would open the envelopes in their presence, and that, for each candy bar donated we would add two more. The total number of bars resulting from donations, plus those that we added, would be equally shared among all the children (return).

At the end of the session, the number of candy bars each child had was the sum of two numbers: the number that each child retained for him or herself (retention), which varied individually, plus the donated candy bars, augmented by those we added (sharing), which did not vary individually.

The resulting amount for each child was the sharing plus retention (which Harbaugh & Krause, 2000 call marginal private return). The sharing plus retention would of course be higher for children who retained more items, since the number resulting from sharing was the same for everyone.

The children were instructed about the rules of the game, which included the material they were receiving (the candy bars, the envelope, and a name tag); the procedure of the game; the fact that donations were undisclosed; and, in the case of the informed group, that they would play eight sessions. In the case of the noninformed group, this information was withheld. At the final session, all the groups were informed that it would be the last day of the game.

2.4. The analyses

Univariate General Linear Model with Repeated Measures (UGLMRM) analysis using SPSS 13 was used to identify which effects had a statistical influence on mean donation, as well as on private return, throughout the eight sessions. The model consisted of three main effects (sex, group size, and information about the number of sessions), their interaction effects up to order 2, and the age as a covariate. We used Spearman's correlations to compare group size and the number of candies donated on each session.

3. Results

Group size was the only factor to significantly affect the mean number of donations (UGLMRM, $F_{3,221}=33.507$, $p=.000$) (Fig. 1A), with the small group children donating significantly more (1.6 candy bars) than those in large groups (0.9 candy bars). Both sex (UGLMRM, $F_{3,221}=1.626$, $p=.184$) (Fig. 1B) and information (UGLMRM, $F_{3,221}=1.401$, $p=.243$) (Fig. 1C) had no effect on mean donations.

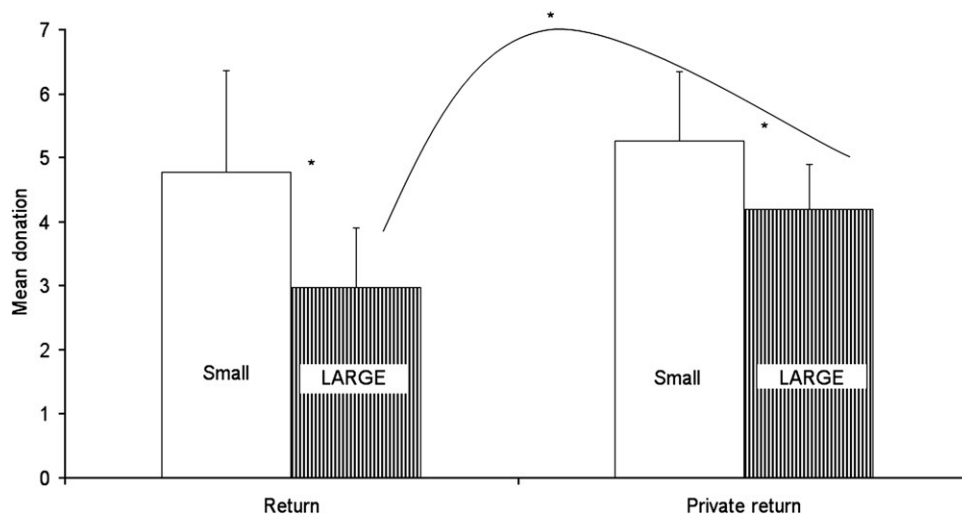


Fig. 2. Mean (and S.E.) candy bars received from sharing (return) and from sharing plus retention (private return) for small and large groups. See text for details. * $p < .05$.

Mean donation decreased significantly across the sessions. Although this is true for all conditions pooled, when we analyzed the data by factor, the only significant difference was, once again, for group size, with small groups showing a slower decrease than large groups (Fig. 1A). Both male and female children (Fig. 1B) and informed and noninformed groups (Fig. 1C) showed statistically similar decreases in mean donation. The main effect, group size, was the only variable to affect cooperation according to Bonferroni's significance level (UGLMRM, $F_{1,53}=7.668$, $p<.01$), i.e., mean donation throughout the sessions was statistically larger or equal in small groups when compared to large groups. Since sex and information did not affect cooperation, all further analysis refers to group size only.

Both sharing and sharing plus retention were significantly larger in small groups when compared to the large ones (UGLMRM, $F_{1,226}=51.651$, $p<.001$), as children donated and received more candy bars. Consequently, there were no statistical differences between sharing and sharing plus retention (private return) for small groups (repeated-measures analysis of variance, $F_{1,100}=221.24$, $p=.000$; Tukey, $p=.9011$). On the other hand, for large groups, most of the candy bars were obtained by retention, since these children donated less. Accordingly, return was significantly lower than sharing plus retention (Tukey, $p=.0001$) (Fig. 2).

A decrease in mean donation was associated with (i) an increase in the proportion of children that acted as free

Table 2

Spearman's correlations between group size and mean donation on each testing day

Session	Spearman's ρ	p
Day 1	-0.063	.338
Day 2	-0.212	.004
Day 3	-0.324	.000
Day 4	-0.324	.000
Day 5	-0.188	.012
Day 6	-0.286	.000
Day 7	-0.329	.000
Day 8	-0.509	.000

riders (no donations) (Fig. 3A) but also with (ii) a decrease in the percentage of children that donated three candy bars (maximum cooperators) (Fig. 3D). Both options were significantly affected by the number of sessions in both small and large groups. In small groups, the proportion of maximum cooperators declined more slowly than in large groups. However, at the last session, none of the children, both from large and small groups, donated three candy bars. In large groups, moreover, the proportion of free-riders was high from the third session on, while in small groups, free-riding levels remained very low for most sessions, with the exception of Session 5 when free-riding peaked. Partial donation was also different in small and large groups: in the latter, it decreased to very low levels

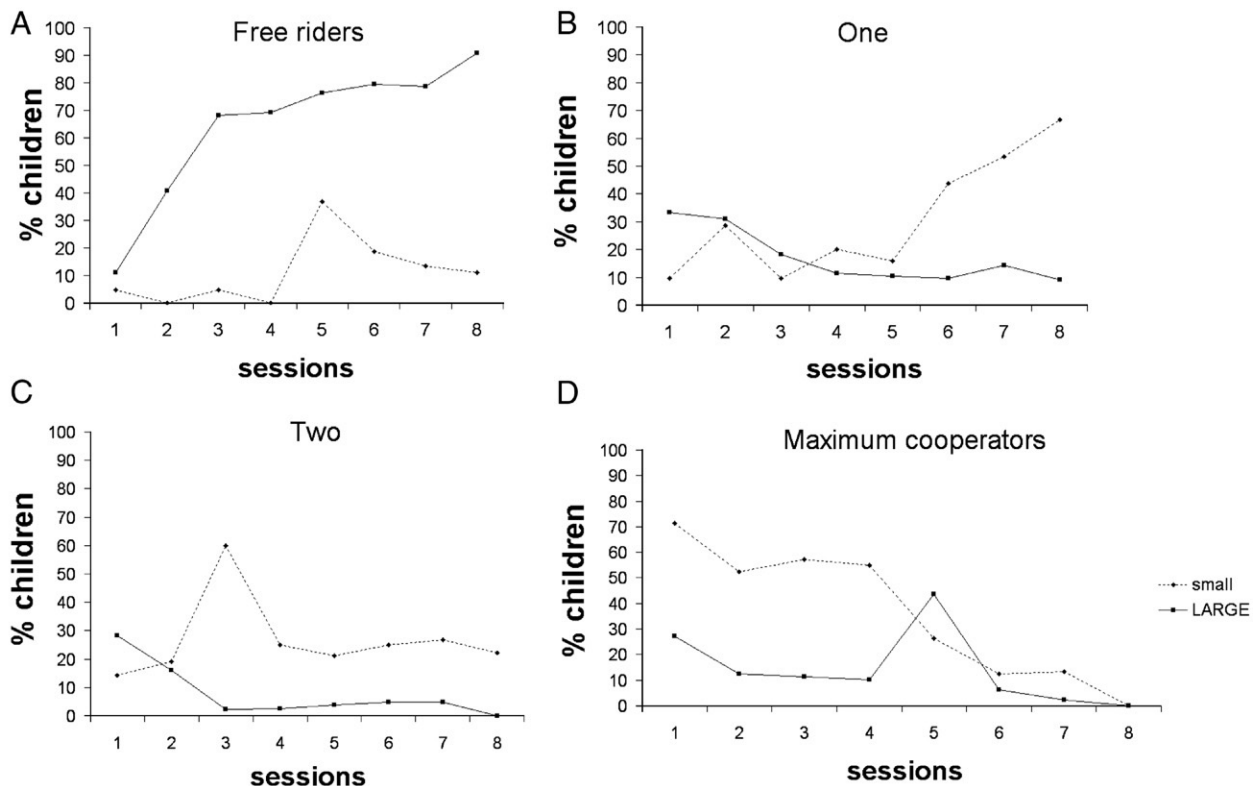


Fig. 3. Percentage of children from public schools in Natal at each of eight sessions that donated no candies (A, free-riders); one candy (B); two candies (C); and three candies (D, maximum cooperators).

quickly; in the former, donation of two candy bars was stable throughout the sessions (with the exception of Session 3), and donation of one candy bar actually increased from Session 6 on. In both groups, there was a change of strategy: both started the game as maximum cooperators. However, in large groups, there was a shift for free-riding as the most frequent strategy (Fig. 3A and D), while in small groups, the most frequent strategy was moderate donation (Fig 3B and D). Significant negative correlations were found between group size and mean donation on all sessions but the first (Table 2).

4. Discussion

This investigation showed that group size was the key factor in promoting cooperation among school children. Neither sex nor information about the duration of the experiment significantly influenced the behavior of the subjects.

Our first hypothesis was that girls would display more prosocial behavior as they are more empathic from an early age (Geary, 1999) and, therefore, more responsive to social stimuli. We did observe a slight tendency for girls to behave more prosocially than boys, but that did not achieve statistical significance. Two studies that reported that girls display more prosocial behavior (Banco & Mettel, 1984; Markovits et al., 2003) had adults (the researchers) openly watching the children, and this has probably acted as a powerful social influence, particularly on girls. However, in our study, we avoided to provide such influences by favoring anonymity. In such conditions, there is no evolutionary or psychological reason for females to display greater altruism, as the social consequences of their prosocial behavior are lost (Benenson et al., 2007).

Prior information on the number of sessions had no effect on cooperation. We predicted that having the information that the game would be repeated could induce a long-term strategy, which usually favors cooperation, as there are more opportunities for retribution and retaliation, and more radical strategies, such as free-riding, are less frequent. However, this information may have been discarded, since this group had been together for some time and probably had previous alliances and antagonisms. As a regular classroom, they would also remain together at least for the remainder of the academic year, so the opportunities for reciprocity were present independent of the duration of the game. All these variables were likely more relevant to the children than the duration of the experiment, and reciprocity patterns were probably already established between the children. Information on the duration of the game could also favor cooperation through indirect reciprocity. Again, anonymity may have prevented indirect reciprocity, as it cannot take place when players are not identified.

Despite the precautions and instructions given by the experimenters, the children tried to monitor the behavior of the group members checking how many candies the other

children were retaining or counting the number of candies at the end of the session. Incidental observations suggest that vigilance was more efficient in small groups, since individuals could be more easily controlled and retaliated when they did not cooperate. Vigilance usually occurred after the session when we instructed the children to put away their candies, and other children tried to spot how many candies they had kept. This could also take place when children left the classroom for lunch break. In large groups, children did not seem able to monitor or control other children as effectively. Again, incidental observations suggest that, in these groups, children were aware of the cooperative behavior of close friends only. The increase in the number of free-riders across the sessions is similar to the results reported by Clark and Sefton (2001) in adults. This same tendency was observed in Brazilian undergraduate students (Lopes, personal communication) in a dictator game, suggesting that it does not depend on age or educational level.

The model used in this study was that of the public goods game and was designed so that cooperative behavior would maximize individual benefits. In other words, if all children donated the maximum (three candy bars), the private return (sharing plus retention) would be maximal. Free-riding would be the best choice if there was only one free-rider, as determined by the Nash equilibrium for this type of game (Fort & Viola, 2004). These calculations are difficult for an adult, let alone children. However, according to Axelrod and Hamilton (1981), individuals do not have to make calculations to choose an advantageous strategy. Opting for the less advantageous strategy is probably related to the more immediate and safer benefits, as opposed to the dubious return.

Apparently, individuals weigh investment against return. In this game, if all children acted as maximum cooperators, the private return would be nine candy bars. Donations of one or two items would secure a benefit (the items retained) and would still yield a return from the public goods. However, even this strategy, although used in the first sessions, did not endure for large groups. In small groups, a strategy of moderate donation developed along the sessions, probably consequent to the behavior of other children in the group. The fact that this behavior is influenced by some environmental variables (in this case, group size) and not by others (in this case, sex and information), and that children act very much as adults under the same conditions, suggests a biologically based mechanism that encourages both cooperation as well as cheating under specific circumstances. Vigilance in small groups and the impossibility of building a reputation on both small and large groups, given the anonymity of donations, favored a moderate cooperation in small groups and free-riding in large groups (Benenson et al., 2007). Boyd and Richerson (1988), in accordance with our results, report that the conditions that allow the evolution of reciprocal cooperation become extremely restrictive as group size increases.

The mechanism for such decrease could include imitation of other players (Hauert, Monte, Hofbauer & Sigmund, 2002), as free-riding in large groups and moderate donation in small groups.

Children learned, along sessions, which was the best strategy given the specific conditions of the group they belong, as described above. The lack of trust or control of the cooperative behavior of other group members have probably increased free-riding in large groups and moderation in small groups, in response to the behavior of other members of the group. Studies by Benenson et al. (2007) and Knight and Kagan (1977) with children from high and low SES conclude that both prosocial as well as competitive behaviors are different for the two groups. Both studies suggest that this derives from socialization practices and represent a modulation of a biologically based mechanism that encourages altruistic acts, but only under appropriate conditions. As suggested by Benenson et al. (2007), altruistic and competitive behaviors cannot be viewed as mutually exclusive. Children learn, as they age, the specific conditions under which each should be displayed. However, children from this study were from the same SES, and this could not be, therefore, a significant variable here. In this study, children adjusted their behavior to that of the group, which was mainly affected by group size and the conditions of anonymity. These results stress the plasticity of prosocial behavior in children and suggest that socialization practices and favorable conditions can promote cooperation in children.

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