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SHORT REPORT

The role of inhibition in young children's altruistic behaviour

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Abstract By behaving altruistically, individuals voluntarily reduce their benefits in order to increase their partners'. This deviation from a self-interest-maximizing function may be cognitively demanding, though. This study investigates whether altruistic sharing in 4- to 6-year-old children, assessed by a dictator game (DG), is related to three measures of executive functioning, that is, inhibitory control, working memory, and cognitive flexibility. We found that children who turned out to be altruistic in the DG performed better on an inhibition task than non-altruists did. This finding lends support to the hypothesis that altruistic sharing might be somewhat constrained by the child's ability to inhibit a natural tendency to preserve his or her own resources. Much research is needed to understand the role of inhibitory control in the development of costly sharing and the consolidation of inequity aversion.

Keywords Altruistic sharing · Inhibitory control · Executive functioning · Dictator game · Young children

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Introduction

Cooperation, broadly defined as behaviour that increases incumbent individuals' welfare, is thought to be a critical component of the scaffolding that supports sociality, a ubiquitous evolved strategy displayed by so many entities of the natural world, from genomes to social groups (Foster 2011; Novak 2006). However, cooperation may come in a variety of forms and may also be driven by a variety of cognitive systems (Warneken and Tomasello 2009a). A critical challenge to be addressed is to elucidate the nature of the cognitive drivers that underpin different forms of cooperation and to establish its emergence in development and in evolution (Brosnan et al. 2010; Cheney 2011; Hauser et al. 2009; Silk and House 2011; Warneken and Tomasello 2009b).

Human prosociality can be expressed through *mutualism or cooperation*, when both partners increase their immediate benefits; *altruism*, when the recipient obtains a benefit at a cost to the actor; and *altruistic punishment*, when the actor's behaviour is detrimental to both the actor and the recipient, but increases third-parties' payoffs (Fehr and Fischbacher 2003). In humans, prosocial behaviour in general and altruism in particular may be expressed through a variety of activities including collaboration (Brownell et al. 2006), sharing resources (Blake and Rand 2010), giving instrumental help (Warneken and Tomasello 2007), providing comfort (Jackson and Tisak 2001), and providing information (Liszkowski et al. 2008). In recent years, there has been a flurry of experimental studies aimed to test whether and when children deploy different forms of prosocial behaviour. These studies have implemented a large array of experimental set-ups including face-to-face interactions between children or between children and adult experimenters, third-person tasks with puppets or dolls, and scenarios in which children are asked to make decisions regarding the sharing of resources with hypothetical partners (Silk and House 2011; Warneken and Tomasello 2009a, b). One of the approaches adopted in the study of resource allocation decisions consists in asking children to distribute actual resources between themselves or between themselves and others. The latter may be other children or adult experimenters that are present (Blake and McAuliffe 2011; Brownell et al. 2009) or hypothetical (and usually) anonymous partners that are absent (Benenson et al. 2007; Fehr et al. 2008). The latter set-up is typical of economic games such as the ultimatum game and the dictator game (DG) (Lucas et al. 2008; Kogut 2012).

Of the two categories of prosocial behaviour in which the recipient's payoff is increased, namely mutualism and altruism, only the latter entails a cost to the actor. And giving something away (to others) at a cost to oneself would appear to be cognitively demanding. Perhaps this is why children's altruistic giving takes some time to develop (e.g. Blake and Rand 2010; Kogut 2012; see Hay et al. 1999; House et al. 2012, however), and perhaps this is because it requires the ability to inhibit the natural desire to maximize one's own profits, which also takes time to develop. Along with working memory and cognitive flexibility, among others, inhibitory control is one of the foundational components of executive functioning (Best and Miller 2010; Carlson 2005). Although the ability to inhibit prepotent responses or to activate alternative responses is known to improve with age and although its developmental timeline often varies as a function of the task used to assess it, there is reasonable consensus as to when children first start to master it. Thus, by 3–4 years of age, children may already perform well on several inhibition tasks and, as already mentioned, the skill improves with increasing age (Best and Miller 2010; Wiebe et al. 2011).

The goal of the present study was to investigate whether altruistic sharing in children aged 4–6 was related to executive functioning. We were particularly interested to determine whether altruistic responding was positively associated with inhibitory control in young children. To our knowledge, nobody has so far addressed this issue empirically. Whereas there are several studies that have documented the occurrence and developmental course of sharing in young children (see House et al. 2012; Silk and House 2011, for reviews), only one has explored the relation between collaboration and inhibitory control (Giannotta et al. 2011) and another has investigated the relation between mentalizing (theory-of-mind) skills and prosocial offers in several classes of economic games (Sally and Hill 2006). The one study more closely related to ours, that is, Giannotta et al.'s, however, tested 8- to 10-year-olds and used a structured puzzle task to measure collaboration-based prosocial behaviours and a Stroop task to measure inhibitory control.

In the present research, we used a resource allocation paradigm and a DG to assess altruistic sharing. Participants received 10 candies and they were asked whether they wanted to donate any of them to an anonymous partner in a one-shot interaction. Proposers (dictators) were also told that their choice would remain confidential both to their imaginary partner and to the experimenter. The child's choice was considered altruistic sharing if she donated at least one candy, as it implied for the child to voluntarily deviate from the maximum profit she could otherwise gain, that is, 10 candies. We assumed that altruistic sharing engages the ability to restrain the child's natural tendency towards self-interest maximizing and thus predicted that altruistic sharing would be more likely among children scoring high on inhibitory control.

Methods

Participants

A total of seventy-two 56- to 79-month-old (mean age = 67.2 months, SD = 5.9) children (32 girls and 40 boys), recruited from a school in Bogotá, Colombia, participated in this study. Only pre-kinder (mean age = 63.0 months, SD = 4.1) and kinder (mean age = 71.7 months, SD = 4.1) children who were willing to participate and whose parents had given their informed consent were finally selected for the study.

Procedure and measures

All of the children were tested individually in a quiet room by a single experimenter. All the data for each child were collected over two sessions in 2 consecutive days. On the first day, participants were tested on two executive function tasks, that is, a test of inhibitory control and a test of working memory. On the second day, participants were administered a third executive function task, that is, a test of cognitive flexibility, and finally they played a DG. A brief description of the tests follows.

Inhibitory control

We administered the day/night task (Gerstadt et al. 1994). The experimenter first made sure that children understood that the sun comes up in the day and the moon comes out in the night. He then instructed them to say *night* when presented with a card with a sun drawing on it and to say *day* when presented with a card with a moon drawing on it. Before starting the test, the children first had to get at least 3 correct answers out of 4 practice trials. The test itself comprised 16 trials, with eight sun cards and eight moon cards, shown in a fixed random order. Scores were the number of correct trials (out of 16).

Working memory

We administered the eight boxes task (Oh and Lewis 2008). In this test, the children were first shown a row of eight boxes of various patterns and colours. The experimenter then placed a sticker in one of them and asked the children to remember which box the sticker was put into. While the children were looking away, the boxes were then scrambled. Ten seconds later, the children were asked to pick the correct box. This experiment was then repeated once with each box, following a pre-established random order. The pattern of each scrambled row was also pre-established randomly. In other words, after each consecutive move, the positions occupied by the boxes were always the same. Scores were the number of correct trials (out of 8).

Cognitive flexibility

We administered the Dimensional Change Card Sort (DCCS) (Zelazo et al. 1996). In this task, the children were presented with two vertical target cards, one with a red triangle and the other one with a blue circle. They were then instructed to play a game called the colour game, whereby cards have to be grouped according to the colour of their symbols: the cards with blue symbols must be placed into a box facing the blue circle card, while the cards with the red symbols must go into a box facing the red triangle card. For rehearsal, two blue squares and two red squares were used. After that, the children were told that the rule had changed and that the cards would now have to be sorted according to the shapes of the symbols, instead of their colours. For the rehearsal of that task, two yellow triangles and two yellow circles were used. In order to pass the rehearsal test, the children had to get at least three-fourths of the answers right (for both the colour and the shape games), which they all did. Next, the children were asked to take the trial tests: sorting four blue triangles and four red circles according to shape and then according to colour. During both the rehearsal and the test trials, the cards were presented in the same order, which had previously been randomly established, under the constraint that a card could not be presented more than twice in a row. The children were told to always place the cards face down in the boxes, and for both the rehearsal and the trial tests, a written protocol based on Kirkham et al. (2003) was followed. Scoring reflected the number of correct trials (out of 16).

Dictator game

To assess children's altruistic sharing, we made them play a DG. This is an economic game in which two players unknown to each other are involved. One of them, the proposer or dictator, receives all the tokens and has to decide whether she wants to give any of them away to her partner. In this game, the second player has a passive role and cannot influence the dictator's decisions. Dictator games involving children use candies or stickers (Benenson et al. 2007; Gummerum et al. 2010; Lucas et al. 2008) instead of money, which is the usual currency when run on adults (Camerer 2003). In the present study, candies were used. Before starting the game, all the children were asked whether they liked candies, a question they all answered affirmatively. Next, they were told that they would be given ten candies as a reward for having participated in the previous games and to count them. They were then explained that they were free to either hold on to them all or give away as many of them as they wanted, to a child from another school they had never met. Each participant was then told to mark an envelope and to place the candies they wanted to keep into it, while the candies to be donated would be placed into an unmarked envelope. The experimenter reminded each child that they were free to give away as many candies as they wanted. Also, the children were told that their decisions would remain anonymous, since the unmarked envelopes would be placed onto a pile of similar-looking ones. Eventually, they were also reminded that the experimenter would leave the room and so would not be able to see them make their decision and place the candies into the envelopes. In order to make sure that they had really understood the rules of the game, the participants were asked whether they were allowed to keep all the candies, keep just a few, or give them all away and also whether someone would look inside the envelopes. Once it was clear that the children had understood the rules, they were left alone in the room with their candies and the two envelopes. After having allocated the candies, they were given a chance to change their decision. Finally, they got to keep the marked envelopes and watch while the unmarked envelopes were being placed onto a pile of identical ones. Two variables were used to assess this task: the number of candies donated (out of 10) and whether any candies were given away or not.

Data analysis

We carried out exploratory data analysis with the procedure EXAMINE from the SPSS, version 19, to compute the descriptive statistics and examine the normality of the distributions. The Shapiro–Wilk's statistic showed lack of normality in all variables related to executive function and in the number of candies donated. Due to the lack of normality, correlations were computed using the Spearman's nonparametric procedure. Finally, to examine the effect of variables related to executive function on altruistic sharing, we conducted a binary logistic regression analysis with a hierarchical approach with two blocks of predictor variables. The first block consisted of two socio-demographic variables (sex and grade). We used grade (i.e. pre-kinder and kinder) instead of age because we found no correlation between age and the other variables. In this sample, however, the age distribution of children was not clearly associated with their grade. The second block was composed of the executive function variables (inhibitory control, working memory, and cognitive flexibility). In this analysis, the dependent variable (altruistic sharing) was established by dividing the children in two groups: altruists, who offered at least one candy (44 %), and non-altruists, who did not give away any candy (56 %).

Results

Neither the executive function variables nor the number of candies donated was normally distributed (Table 1). Inhibitory control correlated positively with cognitive flexibility and with number of candies donated ($p < .05$, $r^2 = 0.1$, in both cases, Table 2). Although statistically significant and definite, these correlations were medium, though (i.e. 0.3–0.1, Cohen 1988; Sprinthall 2003). In fact, the Spearman's correlation coefficient between inhibitory control and number of candies offered turned non-significant when the analysis was run only on the 32 children who donated at least one candy ($rs = -0.143$, $n = 32$; N.S.). Overall, children in this study offered an average of 1.46 candies (out of 10) to their anonymous partner (Table 1). Of the 32 (i.e. 44 %) children who did donate at least one candy, their average level of donation was 3.3 (range = 1–6 candies).

The logistic regression revealed that the contribution of the first block (sex and grade) was not statistically significant (χ^2 (2), 72 = 2.70, $p = .26$). A test of the full model with all five predictors against the first block model was statistically significant (χ^2 (3), 72 = 11.64, $p < .01$). According to the Wald criterion, only inhibitory control predicted altruistic sharing ($p = .008$; Table 3). When inhibitory control is raised by one unit, the odds ratio is 1.73 times as large, and therefore, children are 1.73 times more likely to belong to the altruist group (Table 3). There was also an effect of sex on altruistic sharing, although this was only marginally statistically significant ($p = .054$; Table 3); thus, girls were more likely than boys to be in the altruist group. The pseudo-R-square of Nagelkerke was .24, and the Hosmer–Lemeshow statistic showed a good fit ($p = .39$). Classification was adequate, with 71.9 % of the altruistic children and 75.0 % of the non-altruistic children correctly predicted and an overall success rate of 73.6 %.

Discussion

Our prediction that levels of altruism and inhibitory control in 4- to 6-year-old children would be positively associated was borne out by the results of the analysis. Nevertheless, this relationship did not show up in the correlational analysis when this was run only on the sample of children who donated at least one candy. The inability to detect a significant relationship between number of candies donated and inhibitory function (and the other executive function variables) may well have been constrained due to the lack of variability in how many candies children donated. Our assessment of altruism in young children was based on their performance in a DG. Therefore, our measure of prosociality represents costly (or altruistic) sharing: every candy the "dictator" gave away represented both a benefit conferred on the recipient and a cost incurred by the donor. Although the number of children who donated nothing and the overall average number of resources donated in the DG were close to those reported in other DG studies (Benenson et al. 2007; Blake and Rand 2010; Gummerum et al. 2010; Lucas et al. 2008), the children in this study turned out to be stingier both in terms of percentage of non-altruists (i.e. 56 %) and in terms of the overall mean number of resources donated (i.e. 1.46). We found no effect of age (see also Gummerum et al. 2010), but a marginal effect of sex in the direction that has most often been reported in the literature, that is, girls were more generous than boys (e.g. Benenson et al. 2007; Blake and Rand 2010; Gummerum et al. 2008, 2010). Resource allocation studies using other paradigms such as the Prosocial Choice Test in which children are forced to choose between two alternative discrete payoffs have reported that young children under 7–8 years of age do not tend to choose altruistic options in a costly sharing game if they play with anonymous partners

Table 1 Descriptive statistics and normality tests

Variables	Mean	SD	Asymmetry	Kurtosis	Shapiro–Wilk's test
Age	4.70	0.49	0.08	−0.56	0.98
Inhibitory control	14.30	1.81	−1.43	2.75	0.84***
Working memory	7.14	0.79	−0.43	−0.76	0.82***
Cognitive flexibility	9.64	3.23	1.47	0.24	0.52***
Number of candies	1.46	1.87	0.79	−0.94	0.75***

*** $p < .001$

Table 2 Spearman's correlation coefficients among age, executive function variables, and number of candies donated in the dictator game ($N = 72$)

	Age	Inhibitory control	Working memory	Cognitive flexibility	Number of candies
Age	–	–			
Inhibitory control	−0.003	–			
Working memory	0.210	0.206	–	–	
Cognitive flexibility	−0.036	0.280*	0.186		
Number of candies	0.007	0.276*	−0.008	0.056	–

* $p < .05$

Table 3 Results from the logistic regression on altruistic sharing in dictator game

	B	SE	Wald	*df*	*p* value	Exp (*B*) (Odds ratios)	CI 95 % (odds)
Sex	−1.08	0.56	3.72	1	0.054	0.34	0.11–1.02
Grade	−0.57	0.54	1.12	1	0.292	0.56	0.19–1.64
Inhibitory control	0.55	0.21	7.13	1	0.008	1.73	1.16–2.58
Working memory	−0.50	0.37	1.80	1	0.179	0.61	0.29–1.26
Cognitive flexibility	0.04	0.08	0.24	1	0.626	1.04	0.88–1.23
Constant	−4.18	3.26	1.64	1	0.200	0.02	

(Fehr et al. 2008); however, this age-related effect vanishes or reverses if children play this game in face-to-face contexts with other children (House et al. 2012).

One-shot DGs played between anonymous partners offer the opportunity to test for altruistic prosocial responding while controlling for the effects of reputation and fear of recipient's retaliation (or spite) (e.g. Benenson et al. 2007; Warneken et al. 2011). In this regard, DGs may indeed help to detect an individual's genuinely altruistic prosociality in sharing (Benenson et al. 2007). Results in the DG and in its predefined two-option version, that is, the Prosocial Choice Test (cf. Silk and House 2011), have also been interpreted in terms of the proposer's sensitivity to unfair allocations of resources (e.g. Fehr et al. 2008; Geraci and Surian 2011). And our prediction was premised on the assumption that altruistic prosociality or fairness requires the ability to overcome an arguably natural tendency towards self-maximizing outcomes. As mentioned above, studies on the development of prosociality have yielded mixed results regarding the relationship between age and prosocial responding (Hay and Cook 2007; Silk and House 2011; House et al. 2012), and at least some of the inconsistencies may reflect differences in the prosocial measures analysed and in the methods used to assess them (Jackson and Tisak 2001). If our assumption turns out to be well grounded, then the prediction we formulated and subjected to test was justified. And, finally, the results obtained confirm that variation in performance on a task which measures inhibitory control, that is, an individual's ability to refrain from maximizing his or her own gains or from proposing unfair resource allocations, is associated with variation in altruistic sharing as measured in a DG.

We did not find any significant relationship between the children's altruistic sharing and their performance on the tasks used to measure two other executive functions, that is, working memory and cognitive flexibility. This comes as no surprise, though, as it has been established that different executive function components somewhat follow different developmental trajectories, engage different neural systems, and are affected by diverse experiential factors (see Best and Miller 2010, for a review). Furthermore, performance in one-shot DGs with anonymous partners does not require sophisticated working memory skills or advanced cognitive flexibility especially if, like in this study, "dictators" make their choice quickly and they are not challenged to behave strategically. In effect, a number of studies have shown that prosocial responding is higher when individuals make quicker decisions (Rand et al. 2012; Schulz et al. 2011; this is so even when cooperation is achieved via altruistic punishment, see Smith and Silberberg 2010). It is also thought that interactive settings in which players have repeated encounters with each other so that they are forced to make strategic decisions based on contingent prior interactions are more cognitively demanding. As a matter fact, some comparative psychologists have argued that non-human animals are unable to exhibit the patterns of reciprocation or retaliation so characteristic of human cooperation because they lack the cognitive skills to act contingently (e.g. Hauser et al. 2009; see, however, Cheney 2011).

We are well aware that human prosociality can be deployed through different behavioural actions (e.g. collaborating to reach a goal, sharing resources, giving instrumental help, comforting others in distress, providing information; see Warneken and Tomasello 2009a, b) and that they are supported by a variety of motivational, emotional, and cognitive drivers that follow different developmental trajectories (Hay and Cook 2007; Warneken and Tomasello 2009b). The goal of the present study was to investigate one particularly simple, but natural (and frequently occurring) context in which conflicting tendencies may arise: when individuals have to decide between maximizing their personal gains or to forego their own interests in order to benefit others. The results found in this study add to the growing body of data on the development of human cooperation by documenting a positive relationship between altruistic sharing in a DG and performance on an inhibitory control task in 4- to 6-year-olds. We have assumed that self-maximizing is a natural tendency that conflicts with costly prosociality and that it needs to be tamed or inhibited in order to deploy altruistic sharing.

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