Parental Behavior Models Prosocial Behavior in Face-to-Face Interactions
with their School-age Children

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Abstract

This study examined whether kinship and nurture imperatives affect adults and school-age children's prosocial cooperative behaviors. Members of the same family (i.e., parents and children, couples, and siblings) and non-kin participants (i.e., adults and children) were asked to play a face-to-face iterated version of the prisoner's dilemma that emphasized competition. Results showed that parents consistently cooperate with their children and partners, and forgive their children's betrayals. Conversely, adults playing with non-kin children compete with them. All children seek individual gains regardless of who they are playing with. Taken together these results suggests that kin and nurture imperatives have different developmental trajectories in how they affect parental and children behavior. While non-kin adults and children's behavior responds to immediate goals such as winning the game, parents continue to nurture their offspring by modeling prosocial behaviors that promote mutual over individual gains throughout their childhood.

Keywords: Parent-Child Interactions, Kinship, Nurture, Cooperation, Social Cognition, Prisoner Dilemma Game

Statement of Relevance

The study explores outstanding questions about the development of prosocial behaviors: whether parents persist in modeling prosocial behaviors to their children after early childhood and whether prosocial behaviors are reciprocated by their children. The study is unique because it asked kin and non-kin dyads of adults and children to play a face-to-face iterative version of the prisoner's dilemma that emphasized competition over cooperation. Results show that parents cooperate and sacrifice their gains for their children, while children behave in a self-serving fashion even when playing with their siblings. These findings cast doubts on kin selection claims that the degree to which individuals relate to each other influences the likelihood of cooperation. Rather than being guided by an evolutionary imperative to favor kin, parent's behavior seems to indicate an intention to teach prosocial behaviors to the child. These findings are relevant for researchers studying the development and evolution of social behaviors.

Introduction

Family relationships are integral to social development (Atzil et al., 2018; Hegar & Scannapieco, 2009; Salmon & Shackelford, 2007). From infancy onwards, parents help their offspring learn about the world and acquire the cognitive abilities and emotional health to achieve social success (Bisin & Verdier, 2001; Swain et al., 2012) and continue providing emotional and practical support into adulthood (Hämäläinen & Tanskanen, 2019). Within a family, parents serve a primary role in nurturing their offspring and older offspring are often expected to help nurture younger ones (Hrdy, 2004). Nurturing encompasses the transmission of knowledge (Holland, 2012), values, and cultural traits (Cipriani et al., 2013). Some authors have argued that across species parental nurturing responds to an evolutionary imperative to cooperate with genetic relatives (De Waal, 2012; Rand & Nowak, 2013; Swain et al., 2012; Tanskanen & Danielsbacka, 2018). This claim is supported by studies showing that members of the same kin cooperate more than non-kin individuals (Curry et al., 2013; Hämäläinen et al., 2017). Recent findings have suggested that the role of parental nurturing in humans is more complex than the mere favoring of kin over non-kin (Warneken, 2018). The development of basic sharing and helping behaviors in early infancy might be explained by the parents' kin-selection. During childhood, however, the acquisition of more sophisticated cooperation skills is open to influences beyond parental transmission (e.g., peers, educators) (Blake et al., 2015), and might give rise to equally sophisticated parental transmission strategies. The aim of this project was to investigate these strategies and how they change with children's maturation after pre-school.

Many empirical studies have shown that there is a developmental trajectory for the acquisition of cooperative behaviors (Ben-Ner et al., 2017a; Lu & Chang, 2016; Santamaría-García et al., 2018). Parental nurturing is fundamental to the early acquisition of cooperative behaviors (Swain et al., 2012); parents pass-on prosocial behaviors by modeling them on

their own behavior and children identify with them (Eisenberg & Mussen, 1989). Young children are influenced by observing their parents sharing behaviors (Ben-Ner et al., 2017) and this influence increases with children's age (Blake et al., 2016). The effects of parental modeling of pro-social behaviors are nuanced and depend on a number of factors (Rotenberg, 1995). Children's adoption of observed parental behaviors varies depending on parental background (Bauer et al., 2014), parenting style (Mesurado et al., 2014), and culture (Blake et al., 2016). During and after pre-school, parental influence on children's prosocial behaviors decreases as peer influence increases (Berndt, 1979; Rutland, Killen, & Abrams, 2010; Rutland & Killen, 2017). By elementary school, children's cooperation is not always influenced by the behavior they observe in their parents, rather their social preferences can be heavily influenced by exposure to prosocial behaviors modeled by preschool teachers and peers (Cappelen et al., 2016) regardless of their parent's preferences (Cipriani et al., 2013).

One of the shortcomings of studies on parental transmission of cooperative behaviors during pre-school and elementary-school is that they very rarely investigate face-to-face parent-child interactions (e.g., Blake et al., 2016). Studies tend to use designs that correlate the outcome of parent's and child's behavior in individual tasks (e.g., Cipriani et al., 2013) or, in experimental designs, focus on children interactions with their peers (e.g., Lu & Chang, 2016; Moore, 2009). Such studies provide ample information about the development of cooperation and might aid in indicating whether generous parents tend to raise generous children, but do not address whether parents are more generous towards their children than strangers or whether parent or child decision-making is affected by the other's previous behavior. Thus, while it has been established that cooperation skills become more complex with schooling (Moore, 2009; Warneken, 2018) and parental influence on children's behavior decreases around the same time (Berndt, 1979), little is known about how parents behave when interacting with their children in cooperation/competition games. Kin-selection theory

would expect for parents to continue to favor their children irrespective of their age and prior behavior, and for children to reciprocate (Axelrod & Hamilton, 1981; Axelrod, 1984; Hamilton, 1964). Parents might show generous behavior and persist in doing so irrespective of the child's behavior, if their aim is to teach mutual cooperation.

Current Study

The aim of this project was to investigate parent's behavior when playing a competitive economic game with their elementary-school-age children. We expected parents would be more likely to cooperate and engage in more forgiving and less punishing playing strategies than adults playing with non-kin children. Dyads of the same family or that did not know each other previously played a real-life iterated version of the Prisoner's Dilemma (PD) game. This economic game fosters competitive behaviors between partners at the beginning and allows for cooperation to emerge over a long series of rounds (Stewart & Plotkin, 2012). The emergence of cooperation is modulated amongst other factors by the players considering each other's behavior in previous rounds (Press & Dyson, 2012). We implemented a modified version of the game designed to enhance its competitive nature to assess whether kinship is strong enough to overcome the instruction to outperform the other (Segal & Hershberger, 1999). We contrasted joint outcomes over rounds, degree of cooperation, and strategies between kin (parent-child) and non-kin (adult-child) dyads. The expectation was that parents would choose to cooperate in spite of the instructions, while children and non-kin adults would be more likely to make short-term self-serving choices. Alternatively, if children at this age continue to imitate parent's behavior, they would exhibit mutual cooperation towards their kin (Eisenberg & Mussen, 1989).

A second experiment investigated whether parental and partners kin relationships influenced cooperation in the same fashion. We expected that if parent's behavior was guided by kin selection, they would behave similarly towards their children and partners—partner

relationships are considered familiar because both parties have a shared genetic interest in their children (Salmon & Shackelford, 2007). Alternatively, if the parents' aim is to model cooperation behavior to their children, we expected them to show more cooperation when playing with the children compared to the partners. Finally, a third experiment explored the influence of kinship on children's behavior by comparing siblings and non-kin children dyads. Siblings behavior is hard to predict, as players are related by kin but their relationship is ambivalent (Trivers, 1974). We expected children to show either less cooperation towards their siblings compared to strangers (Barragan-Jason et al., 2020) or to show the opposite behavior and favor their sibling more so than a stranger (Tanskanen & Danielsbacka, 2018).

Methods

Participants

A total of 592 participants (296 dyads; 192 adults, female = 102, mean age = 41.23 yrs.; 224 children, female = 92, mean age = 8.6 yrs.) participated in this study. Table 1 shows a description of the age and gender distribution of participants for each experiment and group. The sample size for Experiment 1 was estimated as 120 participants (20 parent-son/daughter dyads and 20 adult-child dyads) with a power of 0.80 based on the effect sizes obtained in previous studies with parents and children using cooperation games (Ben-Ner et al., 2017; Rotenberg, 1995). Sample sizes for each group in Experiments 2 and 3 were estimated based on the results of Experiment 1 and contained a balanced distribution of ages and gender within each group. All participants were recruited at the Science Cultural Center in Buenos Aires, Argentina. Participants provided a verbal and/or written informed consent, and a parent or guardian gave written informed consent on behalf of the child. Consent forms follow the norms of the declaration of Helsinki and were approved along with the project by The Ethics Committee of the Argentinean Society for Clinical Analyses (SAIC).

Procedure

An interactive version of the Prisoner's Dilemma (PD) with repeated trials was implemented. Dyads of participants sat across from one another at a small table, while the experimenter stood to the side and tabulated the results obtained in each round of the game on a white board that was clearly visible to both participants. Before the beginning of the study the experimenter explained the rules of the game using paper displays that showed the rules of the game and the consequences of participant's decisions (i.e., cooperate or betray). The rules consisted of: 1) if both participants chose to play, they would each receive three points, 2) if both participants chose not to play, they would each receive one point, and 3) if one participant chose to play and the other not to play, the participant that chose not to play would receive five points, while the participant that chose to play would receive zero points. The experimenter emphasized the competitive nature of the game and that the only reward individuals could possibly obtain was to win over the other. Participants were told that the person that obtained the most points at the end of each round would win the game. The experimenter then asked control questions to determine that both participants had understood the rules and the procedure of the game. The rules were available throughout the study both in paper by the side of the participants and on the whiteboard. Participants played six trials (two rounds of three separated by a short break); after each trial the experimenter gave them feedback on the outcome of the trial, adding up the points obtained by each participant on the board. This feedback was always positive towards the winner of the round in order to maintain sustained engagement with the competitive nature of the game. Participants had available to them cards that were either red or green and a small tray with slots to put the card they chose on each trial within the round. Green cards indicated willingness to play (i.e., cooperate) and red cards unwillingness to play (i.e., betray). On each trial the experimenter positioned a screen between participants so that they could not see the other's choice.

Participants were given ample time to make their choices before the experimenter lifted the board showing the outcome and they were not prevented from talking to each other. During trials the cards chosen by the participants remained visible in the tray. At the end of the study the experimenter debriefed the participants.

Data Reduction and Analyses

Three measures were calculated. The *joint outcome* of each interaction for each individual was coded into four categories: mutual collaboration (MC), mutual defection (MD), when one of the partners (i.e., E1: parent or adult; E2: parent or the elder partners; E3: the elder children or sibling) chose to defect and the other to collaborate (i.e., E1: child or child; E2: child or the youngest partner; E3: the youngest child or sibling) (DC), and when one of the partners chose to cooperate and the other to defect (CD). The number of outcomes obtained on each category for each dyad over the six trials was then calculated. Data was submitted to analysis with group as a between factor (E1: parent-child vs. adult-child; E2: parent-child vs. partners; E3: children vs. siblings). In Experiment 1, a second between factor age group (i.e., adult vs. child) was also included in the analysis. A second measure, overall *degree of cooperation*, was obtained from the individual total of cooperation over the six trials. Similar analyses to those performed for *joint outcome* were carried out for the *degree of cooperation*. Finally, a third measure was obtained for the *strategy* used by each individual proportionally over trials two to six: 1) *tit-for-tat*: the participant copied the behavior of their partner in the previous trial, 2) *forgiving*: the participant chose to cooperate when in the previous trial their partner had chosen to defect, and 3) *betraying*: the participant chose to defect when in the previous trial their partner had chosen to cooperate. Because we calculated the proportions for each strategy, their analysis was separated into two parts. First, the use of *tit-for-tat* was submitted to analysis, same as *degree of cooperation*, for all three experiments. Secondly, mixed ANOVAs were performed on the proportion of trials participant's chose

strategies other than *tit-for-tat* with strategy (i.e., forgiving vs. betraying) as a within factor and group (same as for the analyses of degree of cooperation) as a between factor.

Results

General Results and Performance

Regression analysis on children's data from all three experiments found that the degree of cooperation did not change significantly with age ($r^2 = .004$; $\beta = -0.067$, $p = .392$). In addition, *t*-test comparisons for each experiment showed that the age distributions for each age group compared were not different from each other and *chi-square* analyses showed no differences for gender pair constitution between groups (see Table 1).

Joint Conditional Outcome

The joint outcome of each trial was coded depending on the combined choices made by participants into four categories: MC, MD, CD, or DC (see Methods). The number of trials for each of these four outcomes were counted and submitted for analyses (Figure 1).

			Gender Distribution				
			Age	Both Female	Both Male	Mixed Gender	Statistical comparison
Experiment 1 (n= 120)	Parent-Son/Daughter	42.5 (7.8) 8.1 (1.7)	12	13	6	$X^2_{(2, N = 120)} = .08$ $p = .78$	
	Adult-Child	43.2 (8.7) 8.7 (2.2)	11	9	9		
Experiment 2 (n= 102)	Parent-Son/Daughter	43.4 (6.7) 8.1 (1.7)	1	3	21	$X^2_{(2, N = 96)} = .00$ $p = .99$	
	Partners	40.8 (11.2)	1	3	22		
Experiment 3 (n= 80)	Children	8.6 (2.2)	8	5	7	$X^2_{(2, N = 80)} = 1.50$ $p = .47$	
	Siblings	9.2 (2.0)	8	3	9		

Table 1: Demographics of the samples included on each experiment. Statistical results are also presented for comparison between groups for the gender distribution of dyads

Data from Experiment 1 was analyzed via mixed ANOVA with outcome as a within-subject factor and dyad (kin vs. non-kin) as a between-subject factor. Results showed a significant main effect of outcome [$F_{(3, 174)} = 1.771, p < .0001, \eta_p^2 = .234$] and non-significant main effect of dyad. But the interaction between both factors was significant [$F_{(3, 174)} = 5.915, p < .001, \eta_p^2 = .092$] (see Figure 2, left panel). *LSD post hoc* test ($MS = 1.051, df = 174.00$) indicated that parent-child dyads choose significantly more MC ($p = .043$) and CD ($p = .007$), and significantly less MD ($p = .003$) than adult-child dyads (see Figure 2, left panel). A trend towards significance was observed between kin and non-kin dyads for DC outcomes ($p = .075$). These findings suggest that kinship has an effect of participant's choices pushing them towards more cooperation and less defection in general.

Fig. 1: Mean number of trials for the four possible outcomes shown by each group in all three experiments. Bars show SEMs.

A second experiment explored in more detail the effect of type of kin relationship on participant's behavior. Data was submitted to the same analysis as Experiment 1 with outcome and dyad (parent-child vs. partners). Results showed no significant main effects and a tendency towards significance for the interaction between outcome and trials [$F_{(3, 138)} = 2.188, p = .092, \eta_p^2 = .045$]. *LSD post hoc* test ($MS = 1.453, df = 138.00$) indicated that parents choose significantly more CD ($p = .024$) than other strategies and a tendency for parents to choose less DC ($p = .079$) than partners (see Figure 2, middle panel). All other comparisons were not significant. These results replicate and provide further evidence of the effect of the type of kin relationship in kin relation on participant's choices.

Finally, a third experiment sought to further investigate the effect of kinship on children's choices by comparing siblings and non-kin children dyads. Data showed a significant main effect for type of outcome [$F_{(3, 114)} = 3.054, p < .0001, \eta_p^2 = .045$]. Follow-up a *LSD post hoc* test ($MS = 1.791, df = 114.00$) showed that in both types of dyads MD was significantly higher than MC ($p < .001$), CD ($p < .001$), and DC ($p < .001$) (see Figure 2, right panel). No significant main effect of dyad (sibling vs. non-kin children) and no significant interaction between dyad and outcome were found. These results suggest that children might have played the game as a competitive game choosing to defect more often than to cooperate in detriment of potential mutual gains.

Degree of Cooperation

ANOVA performed on the data obtained in Experiment 1 with participants age (child vs. adult) and dyad (kin vs. non-kin) found main significant effects for participants age [$F_{(1, 116)} = 7.001, p = .018, \eta_p^2 = .046$] and dyad [$F_{(1, 116)} = 9.961, p = .002, \eta_p^2 = .079$], and a significant interaction between both factors [$F_{(1, 116)} = 6.489, p = .012, \eta_p^2 = .052$]. *LSD post hoc* test ($MS = 387.29, df = 116.00$) indicated that parents cooperated more than their children ($p < .001$); this difference was not observed for non-kin dyads. Parents also

cooperated more than non-kin adults ($p < .001$) and non-kin children ($p < .001$; see Figure 2, left panel). These results are in line with those found for outcomes. They show that kinship affects the degree of cooperation of individual players with parents being more cooperative than non-kin adults. Children's behavior was not affected by kinship which might indicate that their choices respond to the competitive nature of the game.

Fig. 2: Mean degree of cooperation for all three Experiments in each group.

Bars show SEMs.

Strategies

Results showed that *tit-for-tat* was by far the predominant strategy chosen by individuals in all three experiments, while forgiving and betraying were chosen in smaller and varying proportion (see Figure 3, A, B, and C panels). A very small percentage of participants in all experiments chose always to cooperate or to defect (see Appendix). We analyzed the proportion of trials in which *tit-for-tat* was used separately from betraying and forgiving. Analyses of *tit-for-tat* showed no group differences for any of the experiments (See Figure in Supplementary Materials).

For Experiment 1, the proportion of use of *betraying* and *forgiving* was analyzed using ANOVA with participants age (child vs. adult) and dyad (kin vs. non-kin) as between

factors, and type of strategy (betraying vs. forgiving) as within factor. Results showed a significant three-way interaction [$F_{(1, 115)} = 13.64, p < .0001, \eta_p^2 = .106$] and no significant main effects (see Figure 3, A panel). In order to tease out the interaction, first, we studied the relationship between dyad and strategy by conducting separate analyses for the kin and non-kin dyads. For kin dyads follow-up ANOVA found a significant interaction between strategy and participants age [$F_{(1, 60)} = 18.926, p < .0001, \eta_p^2 = .239$] (see Figure 3, D panel). *LSD post hoc* test ($MS = 346.67, df = 117.92$) indicated that parents showed significantly more forgiving than their children ($p = .005$) and children showed significantly more betraying than their parents ($p < .0001$). In addition, parents showed more forgiving than betraying ($p = .013$) and children showed more betraying than forgiving ($p < .0001$). No significant effects were found for non-kinship dyads. A second set of follow-ups studied the relationship between participants' age and strategy by running two separate Mixed ANOVAs for adult and children data. While no significant effects were found for the adult data, children showed a significant main effect of strategy [$F_{(1, 58)} = 6.039, p = .017, \eta_p^2 = .094$] and a significant two-way interaction between kinship and strategy [$F_{(1, 58)} = 13.084, p < .0001, \eta_p^2 = .184$] (see Figure 3, D panel). *LSD post hoc* test ($MS = 274.43, df = 115.86$) indicated that children showed significantly more betraying playing with their parents than children playing with non-kin adults ($p < .0001$) and that children playing with their parents showed significantly more betraying than forgiving ($p < .0001$). Taken together these results indicate that parents forgive children more than non-kin adults and that children betray their parents more than they do non-kin adults.

Fig. 3: Mean proportion of trials for the betraying and forgiving strategies for Experiments 1 (left panel), 2 (middle panel), and 3 (right panel). Bars show SEMs.

For Experiment 2, we compared the proportion of betraying and forgiving for parents, children, and partners (for this measure the average of both members of the pair was used). Mixed ANOVA with dyad (parents vs. children vs. partners) as a between factor and strategy as a within factor showed a significant interaction between dyad and strategy [$F_{(1, 70)} = 6.866$, $p = .002$, $\eta_p^2 = .164$] (see Figure 3, E panel). *LSD post hoc* test ($MS = 302.19$, $df = 139.97$) indicated that, as in Experiment 1, parents showed more forgiving than their children ($p = .001$) and more forgiving than betraying ($p = .039$). Parents also used more forgiving than partners ($p = .036$) and partners used more betraying than forgiving ($p = .047$). This later finding suggests that the type of kin relationship affects directly adult decisions to cooperate; parents forgive more their offspring than they do their partners who have a symmetric status within the family. Data from Experiment 3, submitted to ANOVA with dyad (siblings vs. children) as a between factor and strategy as a within factor, showed no significant main effects.

General Discussion

This study explored how the evolutionary imperatives to favor kin and nurture offspring affect adult and child cooperative behaviors. Parents and their children, partners, and siblings played a competitive iterative version of the PD game. Three aspects of dyad's behavior were studied: the joint outcome on each trial conditional on the previous trial, the degree of cooperation shown by partners, and the strategies individuals used. Results showed that kinship led to increased cooperation in parents, who were prone to persist in modeling cooperative behaviors and choose a forgiving strategy when playing with their children. Children's behavior was consistently self-serving throughout childhood, similarly to the behavior shown by non-kin adults. Conversely, parents continue to nurture their children into late childhood. Overall, these findings suggest that the evolutionary imperatives to favor kin and nurture offspring have distinct effects on adult and child behaviors.

The imperative to favor kin and overwrite the competitive nature of the game was evidenced in kin dyads choosing mutual cooperation significantly more and mutual defection significantly less than non-kin dyads. This effect was largely driven by differences in adult behavior in the first two experiments: parents consistently chose to cooperate with their children and partners, while non-kin adults displayed competitive behaviors towards children. In line with previous findings (Cipriani et al., 2013), children ignored parental behavior and choose to compete in spite of having a familiar relationship to their partners both when playing against parents and siblings. These results support the notion that kinship affects the degree of cooperation adults show towards one another and their offspring, while children choices might be determined by other factors (Cappelen et al., 2016).

Contrary to previous work (Burnstein et al., 1994; Candelo et al., 2018; Hamilton, 1964) the degree of closeness between individuals of the same kin did not affect cooperation; parents exhibited a similar degree of cooperation towards offspring and partner. This suggests

that the imperative to favor kin might underlay parental choices to some extent when playing with their children. However, results from the analyses of playing strategies suggest that, in line with Warneken (2018) proposal, parental transmission behaviors might be modulated by factors beyond kinship. This modulation can be observed in how adults and children choose to either forgive or betray their partners after they had betrayed them on a previous trial. Parents chose to forgive their children even though their children reciprocated by betraying. In turn, parents did not show an equivalent propensity to forgive partners and children engaged in less betraying when playing with non-kin adults. This later result lends further evidence that children choices are determined factors other than evolutionary imperatives (Cappelen et al., 2016). Taken together, these findings suggest that there is a propensity in parents towards modeling cooperative behaviors exclusively to their children but children, instead of imitating their parents, tend to produce the opposite response.

Children's behavior in our study shows that the emergence of prosocial behaviors follows a more nuanced trajectory than increased cooperation and can be affected by external constraints (Berndt, 1979; Cappelen et al., 2016; Rutland, Killen, & Abrams, 2010; Rutland & Killen, 2017). The emphasis on competition might have led children to behave in a consistently non-cooperative fashion, though it is possible that the small number of trials did not allow for children to show direct reciprocity, which tends to emerge in longer versions of the game. It is also possible that parents and children might have had a different understanding of the game. Press and Dyson (2012) proposed in their modelling of PD behavior that the strategy players choose might vary depending on how they understand the game and consider their partner's intention, which can change the evolution of cooperation within the game away from mutual cooperation and towards self-serving strategies. This might have been the case for children in our study. Future studies that compare siblings and

children in competitive versus traditional versions of the game and include more trials are necessary to disentangle this issue.

In sum, parent's behavior supports the notion that parents might have adapted their choices when playing with their children to suit a nurturing goal. During parent-child interactions mutual cooperation outcomes were higher than during adult-child interactions. In contrast, mutual defection was the predominant outcome of non-kin adult and children's interactions (siblings and children who did not know each other). In all, these results suggest that parent's cooperation increases mutual cooperation and reduces mutual defection in parent-child interactions. This finding challenges the claim made by kin selection theories that the degree to which individuals relate to each other influences the likelihood of cooperation. Parental behavior indicates the persistent effect of the imperative to nurture their offspring, which manifests in the modeling of prosocial behaviors to the child.

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Appendix

Table: Percentage of trials where individuals chose to either always cooperate or always defect.

		N	% Always Cooperate	% Always Defect
Experiment 1	Parent-Son/Daughter	62	1.6	3.2
	Adult-Child	58	0.0	6.9
Experiment 2	Parent-Son/Daughter	50	0.0	6.0
	Partners	46	4.3	6.5
Experiment 3	Children	40	0.0	27.5
	Siblings	40	0.0	20.0

Figure: Mean proportion of trials for all three strategies for Experiments 1 (left panel), 2 (middle panel), and 3 (right panel). Bars show SEMs.