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BRIEF REPORT

Children Coordinate in a Recurrent Social Dilemma by Taking Turns and Along Dominance Asymmetries

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Humans constantly have to coordinate their decisions with others even when their interests are conflicting (e.g., when 2 drivers have to decide who yields at an intersection). So far, however, little is known about the development of these abilities. Here, we present dyads of 5-year-olds ($N = 40$) with a repeated chicken game using a novel methodology: Two children each steered an automated toy train carrying a reward. The trains simultaneously moved toward each other so that in order to avoid a crash—which left both children empty-handed—1 train had to swerve. By swerving, however, the trains lost a portion of the rewards so that it was in each child's interest to go straight. Children coordinated their decisions successfully over multiple rounds, and they mostly did so by taking turns at swerving. In dyads in which turn-taking was rare, dominant children obtained significantly higher payoffs than their partners. Moreover, the coordination process was more efficient in turn-taking dyads as indicated by a significant reduction in conflicts and verbal protest. These findings indicate that already by the late preschool years children can independently coordinate decisions with peers in recurrent conflicts of interest.

Keywords: coordination, cooperation, conflict, compromise, turn-taking, dominance

Humans are highly successful at coordinating their decisions with others when pursuing shared interests (Bicchieri, 2006; Tomasello, 2014). However, a central challenge of human social functioning is that people often have to coordinate even in social dilemmas in which their interests are conflicting, for example, when one of two drivers has to yield at an intersection or when deciding who has to do an undesirable part of a joint work project. What these situations have in common is that each individual prefers someone else to incur the cost of behaving cooperatively but everyone is worse off if no one volunteers to cooperate (commonly modeled as "volunteer's dilemmas" or "chicken games" in game theory; see Archetti, 2009; Rapoport & Chammah, 1966). In large modern societies these situations are often resolved through collectively agreed upon coordination rules grounded in our culturally shared normative understanding (e.g., standing in line at supermarket checkouts) and sometimes formulated in formal laws (e.g., traffic rules).

In repeated dyadic interactions, however, such explicit rules often do not exist and people are frequently required to generate solutions independently, for example, when two spouses have to decide who picks up the kids from school. One solution to dyadic conflict-of-interest coordination problems is to take turns at behaving cooperatively as this ensures that the interaction is mutually profitable in the long run. Indeed, turn-taking is commonly used in natural settings, as shown, for example, by ethnographic analyses of fishermen taking turns at fishing in preferred spots (Berkes, 1986), or anecdotal evidence of soldiers taking turns at assuming the most exposed position in a combat military formation (e.g., Rominger & James, 2003). Adults have also been shown to establish turn-taking strategies in a number of economic games (Bornstein, Budescu, & Zamir, 1997; Helbing, Schönhof, Stark, & Holyst, 2005). Turn-taking can also emerge as a stable strategy between rational agents without communication or insight (Lau & Mui, 2012) and has also been observed in various forms in a number of animal species—for example, in conflicts over coordinated movement in sticklebacks (Harcourt, Sweetman, Manica, & Johnstone, 2010), grooming patterns in macaques (Muroyama, 1991), or breeding rotations in royal penguins (Weimerskirch, Stahl, & Jouventin, 1992) suggesting that it can be an effective solution to a number of adaptive problems.

However, turn-taking is not the only mechanism by which individuals can coordinate their actions in situations marked by conflicts of interest. For instance, in disputes over resources ani-

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mal species have been argued to often use dominance assessments to coordinate approach behavior. Here, credible signals of dominance are often enough to cause subordinate individuals to back down, whereby potentially catastrophic escalations are avoided (Maynard Smith & Price, 1973).

Dominance asymmetries are also likely to play a role in human conflict-of-interest problems. For instance, people may be less likely to insist that it is their turn to order at a bar when their competitor is their boss or a menacingly looking weightlifter. Empirically, people have been shown to use other's physique (Nguyen, Petersen, Nafziger, & Koch, 2014; Stulp, Buunk, Verhulst, & Pollet, 2015) and social status (de Kwaadsteniet & van Dijk, 2010) as a coordination device, with participants making less assertive choices when paired with physically or socially dominant opponents. Previous studies with children also indicate that dominant individuals tend to control access to cooperatively produced resources in peer groups by using both quasi-agonistic (e.g., commands, physical attempts to control others' behavior) as well as affiliative strategies (e.g., requests, invites; Hawley, 1999; LaFreniere & Charlesworth, 1983, 1987). However, the extent to which dominance asymmetries also affect children's strategic coordination choices is currently unclear.

Children's emerging abilities to coordinate behaviors with others have been widely studied (e.g., Brownell, 2011; Eckerman & Didow, 1996; Meyer, Bekkering, Paulus, & Hunnius, 2010). Most of this research, however, has focused on how children learn to coordinate basic actions, for example, jointly pulling a handle (Brownell, Ramani, & Zerwas, 2006) or coordinating basic play activities (Eckerman, Davis, & Didow, 1989), or on how by engaging in coordinated activities children come to value joint commitments (Hamann, Warneken, & Tomasello, 2012). Only recently, studies started investigating children's abilities to coordinate their decisions in formal coordination problems (Goldvicht-Bacon & Diesendruck, 2016; Grueneisen, Wyman, & Tomasello, 2015a, 2015c; Wyman, Rakoczy, & Tomasello, 2012). This is particularly challenging because individuals facing coordination problems are fundamentally interdependent in the sense that each person's best choice critically hinges on others' choices, and vice versa, such that successful coordination often requires sophisticated strategic thinking (Schelling, 1960). Although these studies suggest that children become increasingly capable of solving a variety of coordination problems around the late preschool years, they all looked at situations in which children's interests were perfectly aligned.

In one of the few systematic studies on children's decision making in a conflict of interest (although not in a coordination problem involving interdependent decisions), two children were each able to access a marble by pulling a string, but the marble was lost if both children pulled (Madsen, 1971). Dyads of U.S/ American 8- and 11-year-olds performed dramatically worse than 5-year-olds, the latter of whom spontaneously managed to extract about half of all marbles (see also Kagan & Madsen, 1971). In another recent study 5-year-olds were further found to reciprocally help each other obtain a reward (Melis, Grocke, Kalbitz, & Tomasello, 2016).

However, these studies only examined zero-sum games in which only one player could profit at a time: We both help you or we both help me. No previous study, to our knowledge, has presented children with a conflict of interest requiring strategic coordination in the sense that on any trial each player's best decision depends on their partner's decision: Not cooperating pays off but only when one's partner cooperates, and vice versa. In the current study, we therefore examined if 5-year-old children can consistently coordinate their decisions in this type of situation. We hypothesized that children would primarily achieve this by taking turns at behaving cooperatively. A second hypothesis was that socially dominant children may achieve higher payoffs than their partners.

To test this, we repeatedly presented same-sex dyads of 5-year-olds with a conflict of interest (chicken game) using a novel methodology: Each child steered an automated toy train transporting a reward. The trains simultaneously moved toward each other so that in order to avoid a crash—which would leave both children empty-handed—one child necessarily had to swerve. By swerving, however, children lost a portion of their reward, such that it was in each child's interest to go straight, and for the other to swerve. We were interested in whether (a) children successfully coordinated their decisions over multiple rounds (where coordination was defined as one child going straight while the other swerved), (b) children took turns at swerving and turn-taking influenced children's game outcomes and negotiation patterns, and (c) dominance asymmetries affected children's success in the game.

Method

Participants

Forty 5-year-olds (M = 5.6 years, range = 5 years 3 months – 5 years 10 months, 50% girls) were tested in same-sex dyads. Children were recruited and tested at urban daycare centers and were familiar with each other. Allocation into dyads occurred randomly at each daycare center. Children were mostly Caucasian and mostly came from middle class backgrounds. An attempt to test 3-year-olds in the same paradigm was abandoned as pilot data (n = 10) suggested that children did not sufficiently understand the task.

Apparatus and Design

Children were presented with two battery-powered toy trains—one blue and one yellow—each carrying three marbles. The trains operated on wooden BRIO train tracks constructed 12 cm above ground level. In their starting positions the trains were facing each other about 2 m apart on a straight track (see Figure 1). Each train had two stations: one at the end of the straight track behind the opposing train's starting position and the other at the end of one of two tracks that swerved off the straight track. Players could exchange all marbles their train successfully transported to a station for stickers. The trains could be steered to either of the stations by means of a switch by the player assigned to that train. The switches were covered up so that players could not see their partner's switch from their starting position. A barrier separating the players prevented children from actively interfering with each other's choices. However, by leaning forward children could see one another while discussing their game choices.

Once switched on, the trains simultaneously moved toward each other. In order for them not to crash—in which case all marbles were lost—at least one train had to swerve. By swerving, however, two marbles fell off the train into opaque boxes from where they

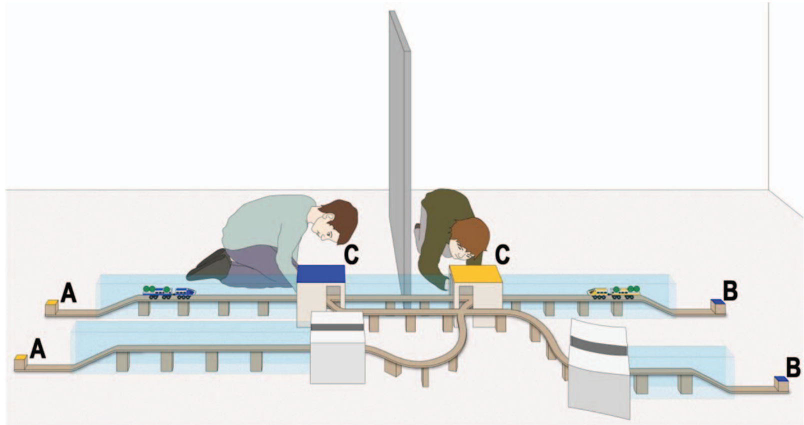

Figure 1. Experimental setup. A = Yellow train stations; B = Blue train stations; C = Switches. See the online article for the color version of this figure.

could not be retrieved any more. The train going straight retained all of its marbles so that it was in each player's interest to go straight and for one's partner to swerve, resulting in the payoff matrix depicted in Figure 2.

Procedure

Introduction. Both children were simultaneously introduced to the task by a first experimenter (E1). E1 first explained how the switches worked and asked each child to put it once into its straight and once into its swerving position. Using a single train, E1 then demonstrated how the marbles could be won. A second experimenter (E2) started the train via remote control and the train first went to its straight station retaining all its three marbles. E1 collected the marbles and exchanged them for three stickers from E2. This was repeated only that now the train went to its swerving station whereby it lost two marbles on the way. E1 thus only received one sticker from E2. Throughout this demonstration E1 recounted how many stickers he received through which action. The process was subsequently repeated with the second train so that children saw each train going once to each of its stations. Children were then asked to restate the payoffs associated with going straight and with swerving, and E1 provided corrective feedback in the very rare case of a mistake. E1 also explained that the trains would crash if both trains went straight, in which case all marbles would be lost. While E1 prepared the first test trial, each child received a drawing task and a sticker book into which they could put their stickers between trials.

Test trials. Before each trial, E2 left the test room. Each child was assigned one train and asked to sit down at the corresponding starting position. The default position of the switches was always identical for both trains but was counterbalanced across trials. On the first three trials E1 reiterated the payoff structure by saying:

> Now you have the chance to win stickers. Remember, by going straight one gets three and by swerving one gets one. If both trains go straight no one gets any. But you sort it out yourselves. Shortly, I will come back and start the trains.

On all subsequent trials E1 used the same instructions without restating the payoff structure. E1 then went behind a barrier, allegedly to do some work. After 15 seconds he returned, started the trains via remote control, and went back behind the barrier. This was done so that children felt they could interact freely and to reduce potential self-presentation motives. For the same purpose E1 replied to all complaints, tattling, or questions about how to play by saying "You guys sort it out yourselves." Once the trains started moving it took them another 15 seconds to reach the switch so that children had a total of roughly 30 seconds on each trial to negotiate their choices (however, children could communicate freely with each other at all times during the test). When the trains had reached their stations children retrieved the marbles and exchanged them for stickers from E2, who reentered after each trial. While children put their stickers into their sticker books, E1 prepared the following trial. After trials in which the trains had crashed E1 took all marbles off the trains and put them into a disposal box for children to see that they would not be used again.

a

		Player 2	
		Go straight	Swerve
Player 1	Go straight	0 | 0	3 | 1
	Swerve	1 | 3	1 | 1

b

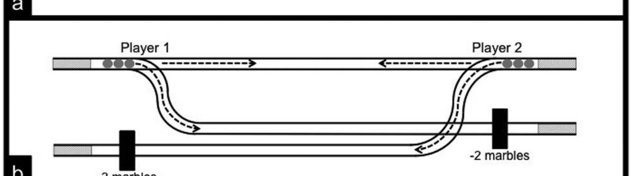

Figure 2. (a) Payoff matrix of the game. The left number in each cell corresponds to Player 1's payoff, the right number to Player 2's. (b) Schematic illustration of the train routes. Both players start with three marbles. They can keep all marbles successfully transported to a station (marked in gray at the end of the train tracks). If they go straight players either retain all rewards or crash with the other player's train (whereby both lose all marbles). By swerving players avoid the crash but inevitably loose two marbles.

Children played 12 rounds in total (they knew they would play multiple rounds but not the exact number), then put their remaining stickers into their sticker books and were thanked for their participation.

Coding. All sessions were videotaped and coded from tape. For each trial we coded individual and dyad payoffs. For each dyad we counted the number of turns, where a turn was defined as coordinating successfully (i.e., one child going straight and the other swerving) after having coordinated in reverse order on the previous trial (i.e., the child swerving on the current trial previously went straight). The probability of a turn occurring by chance (i.e., random choices) after coordination was therefore 0.25. Other ways of taking turns or dividing rewards fairly would have been possible in principle (e.g., alternating every two trials or switching halfway through the experiment). However, because we did not observe any of these strategies in a pilot study, we did not include them in our coding scheme (children also did not appear to use these strategies in the experiment).

We transcribed all of children's on-task communication and coded for their use of normative language, protest, and normative protest (see Table 1 for definitions and examples). We also coded for each trial whether or not children had a conflict and if they had reached an agreement before their trains passed the switches. Normative language—commonly interpreted as a way of expressing existing rules and of generating pressure to conform (Rakoczy, Warneken, & Tomasello, 2008)—was assessed to test whether children understood turn-taking as a normative rule. Protest, conflicts, and verbal agreements can be thought of as indicators of the efficiency of the negotiation process. A second coder blind to the predictions of the study recoded 20% of the transcripts. Intercoder reliability was generally high (see Table 1).

To assess children's dominance relation, dyads were left alone with a box containing a toy before the first test trial. The child who—over the course of one minute—handled the toy longer received a score of 1 and the other child a score of 0 (if the difference was shorter than eight seconds both received a score of 0). This measure thus corresponds to theoretical accounts defining dominance in terms of resource control (Hawley, 1999). In addition, we asked kindergarten teachers to rate which child they perceived as more dominant in everyday peer interactions. Children rated as more dominant received a score of 1 and their partner a score of 0. If rated equally dominant both children received 0s. We combined scores from both measures and considered the child receiving a higher score overall as the dominant child of the dyad. Having two measures had the advantage that children's dominance relation could still be assessed if one measure proved uninformative (e.g., twice children did not unpack the toy). Dyads in which children had equal dominance scores in both measures ($n = 3$) or in which there was disagreement between the two measures ($n = 2$) were excluded from the dominance analysis.

Because previous studies have found differences in cooperation patterns among friends as compared to nonfriends (LaFreniere & Charlesworth, 1987; Matsumoto, Haan, Yabrove, Theodorou, & Carney, 1986), we assessed friendship status between children by asking teachers to rate whether children in a dyad were friends or not.

Analysis. To test if children coordinated successfully and if they took turns we compared their decisions to chance (i.e., randomly choosing between going straight and swerving). We then ran several models to test if turn-taking affected dyad payoffs (Model 1) or payoff divisions within dyads (Model 2) as well as whether dominance asymmetries were related to children's payoffs and turn-taking frequencies (Models 3–4). Finally, we investigated dyads' negotiation patterns in relation to turn-taking frequencies (Models 5–9) and payoffs (Model 10).

All models were fitted in R (R Core Team, 2014) using the function "glmer" (for Generalized Linear Mixed Models, Baayen, 2008) of the R-package lme4 (Bates, Maechler, Bolker, & Walker, 2014), "glm.nb" (for Generalized Linear Models with negative binomial error structure) of the R-package MASS (Venables & Ripley, 2002), or the functions "lm" and "glm" (for Linear Models or Generalized Linear Models, respectively). We ran several model diagnostics for each model (see Table 2). These were unproblematic unless otherwise stated. We always first compared a full model with a null model not including the test predictors but retaining all control predictors, random intercepts, and random slopes. We only tested for effects of individual test predictors if this was granted by the full-null model comparison. For details on individual models, see Table 2. All reported confidence intervals (CI) are 95% confidence regions.

Table 1
Coded Communicative Categories

Communicative category	Definition	Example	κ coefficient
Normative language	Use of normative vocabulary, particularly deontic modal verbs (must, have to, ought to) normative adjectives (right, wrong), or explicitly referring to a joint agreement	"You must swerve." "Don't do it wrong!" "Remember, we have agreed on this."	.925
Protest	Expressing objection to another's choice or proposed strategy.	"Hey! That's mean!" "No! We don't do it like that!"	.838
Normative protest	Expressing objection to another's choice or proposed strategy using normative language.	"Hey! You mustn't do that!" "No, you are breaking the rule!"	.841
Agreements	Children explicitly reach a joint decision of how they will choose by both stating complementary strategies or one child explicitly approving of the other's proposal.	Child 1: "I will go straight" Child 2: "Ok, I will swerve." or Child 1: "Let's both swerve." Child 2: "Ok."	.882
Conflicts	Children state opposing strategies at least three times or nothing is said after both children state opposing strategies.	Child 1: "I want to go straight." Child 2: "No me!" Child 1: "No me!"	.727

Table 2
Model Descriptions

	Question	Dependent measure	Test predictors	Control predictors	Random intercepts	Random slopes	R-function	Error structure	Offset terms	Model diagnostics
1	Did turn-taking affect payoffs?	Overall dyad payoff	Number of turns, Friendship	Sex	—	—	lm	Gaussian	—	• Distribution of residuals • Residuals plotted against fitted values • Absence of collinarity
2	Did turn-taking affect fairness?	Payoff difference between children in a dyad/2	Number of turns, Friendship	Sex	—	—	glm	Poisson	Dyadpayoff^{log}	• Overdispersion • Checks for influential cases • Absence of collinarity
3	Did dominance affect payoffs?	Overall individual payoff	Dominance^{z} *Number of turns	Number of turns, Sex, Friendship	Dyad	—	glmer	Poisson	Dyadpayoff^{log}	• Overdispersion • Checks for influential cases • Absence of collinarity
4	Was the dominance asymmetry related to the turn-taking frequency?	Number of turns taken by the dyad	Dominance asymmetry	Sex, Friendship			glm	Negative binomial^{o}		• Overdispersion • Checks for influential cases • Absence of collinarity
5	Was communication affected by turn-taking?	Agreements	Number of turns	Sex	—	—	glm	Poisson	—	• Overdispersion
6		Conflicts	Number of turns	Sex	—	—	glm.nb	Negative binomial^{o}	—	• Checks for
7		Normative language	Number of turns	Sex	—	—	glm.nb	Negative binomial^{o}	—	influential cases
8		Protest	Number of turns	Sex	—	—	glm	Poisson	—	• Absence of
9		Normative Protest	Number of turns	Sex	—	—	glm.nb	Negative binomial^{o}	—	collinarity
10	Did communication affect payoffs?	Dyad payoff (by trial)	Agreements, Conflicts	Sex, Trial number	Dyad	Agreement, Conflict, & Trial number within Dyad	glmer	Poisson	—	• Overdispersion • Checks for influential cases • Absence of collinarity

^{log} denotes log-transformation. ^{z} denotes z-transformation. ^{o} denotes overdispersion; in these cases we assumed a negative binomial error distribution.
* denotes the interaction between two predictors.

Results

Dyads achieved higher payoffs than chance, meaning that they successfully coordinated their decisions (mean dyad payoff = 41.30, *SD* = 5.77, chance = 30, $t(19) = 8.747$, $p < .001$; Figure 3).

We then ran binomial tests to inspect for each dyad whether the number of turns taken significantly exceeded the 25% chance level (note that this chance level is computed under the conservative assumption that children chose randomly between going straight and swerving; if children generally favored one option the chance level would be lower). We then used Fisher's omnibus test to inspect whether these *p* values combined were significant. This was indeed the case, $\chi^2 = 195.24$, $df = 40$, $p < .001$, suggesting that, overall, children used turn-taking as a strategy. We then inspected individual binomial tests, which revealed that 12 out of 20 dyads took turns significantly above chance. Out of these 12 dyads 8 explicitly agreed to take turns.

Turn-taking only led to a slight increase in payoffs (Model 1, estimate ± *SE* = 0.597 ± 0.300, $F_{1,15} = 3{,}950$, $p = .065$, CI = [−0.043, 1.238]), and friends achieved slightly lower payoffs than nonfriends (estimate ± *SE* = −4.179 ± 2.058, $F_{1,15} = 4{,}124$, $p = .060$, CI = [−8.565, 0.207]).

Moreover, turn-taking significantly reduced how unfairly payoffs were divided between children in a dyad (Model 2), where unfairness was defined as the halved difference between children's individual payoffs divided by the overall dyad payoff (estimate ± *SE* = −0.230 ± 0.045, $\chi^2 = 28.894$, $df = 1$, $p < .001$, CI = [−0.321, −0.145]). Whether or not children were friends, on the other hand, did not affect how unfairly payoffs were divided (estimate ± *SE* = −0.231 ± 0.296, $\chi^2 = 0.617$, $df = 1$, $p < .435$, CI = [−0.824, 0.343]). Because the data in Model 2 were somewhat overdispersed (overdispersion parameter of 1.5), we reran this model after correcting for overdispersion (see Gelman & Hill, 2007), which yielded practically identical results.

Furthermore, dominance and the interaction between dominance and turn-taking combined had a significant effect on individual payoffs (Model 3, $\chi^2 = 12.97$, $df = 2$, $p = .002$). Further analyses showed that dominant children achieved significantly higher payoffs than less-dominant children, but only in dyads in which turn-taking was rare (as indicated by a significant interaction between dominance and turn-taking on individual payoffs, estimate ± *SE* = −0.168 ± 0.083, $\chi^2 = 4.17$, $df = 1$, $p = .041$, CI = [−0.341, −0.009]; Figure 4).

To follow up this result, we computed a continuous estimate of the dominance asymmetry in a dyad by dividing the amount of time the dominant child handled the toy in the dominance test by the overall time the dyad handled the toy. We then examined whether the degree of the dominance asymmetry in a dyad affected turn-taking frequencies (Model 4[1]). This revealed no significant effect ($\chi^2 = 0.12$, $df = 1$, $p = .728$).

In order to examine whether turn-taking was related to children's communication, we ran a general linear model for each communicative category with the number of turns taken as the only test predictor (Models 5–9). This revealed that turn-taking was significantly related to decreases in protest and conflicts and an increase in joint agreements. Normative language and normative protest were not significantly affected by turn-taking (see Table 3 for model summaries). Finally, dyad payoffs were not significantly affected by children's explicit joint agreements and conflicts before making a choice (Model 10, $\chi^2 = 3.48$, $df = 2$, $p = .176$).

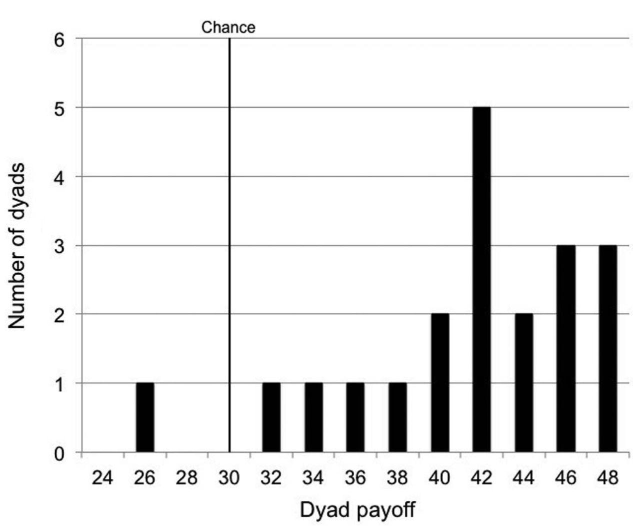

Figure 3. Dyad payoffs.

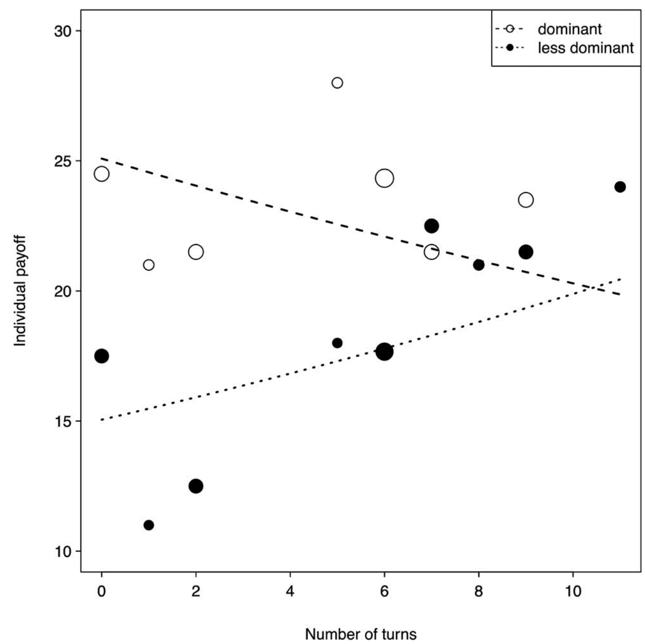

Figure 4. Effects of dominance and turn-taking frequency (*x*-axis) on individual payoffs (*y*-axis). Lines depict payoffs (as predicted by the model) of dominant and less dominant children at different turn-taking frequencies (the plot model also controlled for the effects of sex, friendship, dyad payoff, and the random effect of the dyad). Points represent observed mean payoffs per turn-taking frequency. The area of the points corresponds to the number of observations.

[1] We thank an anonymous reviewer for suggesting this additional analysis.

Table 3
Effects of Turn-Taking On Communication—Model Summaries

Response variable	Estimate	Error	X^2	p	CI
Normative language	−.054	.056	.86	.354	−.169, .060
Protest	−.366	.109	16.23	<.001	−.610, −.174
Normative protest	−.164	.146	.92	.337	−.506, .161
Agreements	.067	.026	6.55	.010	.016, .119
Conflicts	−.169	.074	5.13	.023	−.316, −.031

Discussion

Our results demonstrate that dyads of 5-year-olds successfully coordinated their decisions in a repeated chicken game and obtained payoffs significantly higher than would be expected by chance. The majority of dyads (60%) adopted a turn-taking strategy such that children alternated between swerving and going straight. Although turn-taking only led to a slight increase in dyad payoffs, it was associated with an increase in explicit joint agreements prior to choosing and a reduction in conflicts and verbal protest. Hence, turn-taking led to more efficient, less antagonistic interactions and reduced what could be conceived of as the transaction costs (Coase, 1960) associated with negotiating a solution. Turn-taking was not associated with an increase in children's use of normative vocabulary, suggesting that children did not view turn-taking as a normative rule that they ought to engage in. Moreover, in contrast to previous findings (e.g., LaFreniere & Charlesworth, 1987; Matsumoto et al., 1986) game outcomes were unaffected by whether children in a dyad were friends (if anything, friends achieved slightly lower payoffs).

In dyads in which turn-taking was common, payoffs were fairly equally divided between children. In dyads in which turn-taking was rare, however, payoff divisions were heavily skewed in favor of dominant children (see Figure 4). In one dyad, for instance, the dominant child went straight on all 12 trials while his partner always swerved. This was the case even though children were entirely unable to directly interfere with each other's choices. This corresponds to previous findings showing that socially dominant children are more successful at gaining access to resources in groups and that they increasingly use nonphysical strategies to do so (e.g., Hawley, 1999; LaFreniere & Charlesworth, 1983, 1987).

It is not obvious, however, by what exact mechanism dominance asymmetries affected children's choices. The possibility of physical coercion, for instance, was ruled out in the current paradigm and is thus unlikely to account for the observed effect. Another possibility is that dominant children were able to credibly communicate their intention to go straight so that less-dominant children perceived swerving as their best possible response. In this case, however, the question arises why it did not occur to less-dominant children to punish their partners by letting the trains crash. Although this would have caused immediate losses to both players, it could have forced dominant children to rethink their strategy in the long run. Perhaps, less-dominant children also perceived the cost of coordination breakdown as more severe or they may have been more risk-averse and preferred securing a small certain reward over a gamble for a large one.

Another interesting question is why some dyads successfully established turn-taking whereas others coordinated along dominance asymmetries. One explanation—that the degree of the dominance asymmetry is related to children's turn-taking—was not supported by the analysis. However, maybe a more fine-grained measure of dominance than the current one is necessary to detect such effects. Another possibility is that individual differences in inhibitory control may have played a role, as turn-taking requires children to forego immediate rewards in order to achieve profitable outcomes in the long run. Correspondingly, previous research has shown that inhibitory control is related to other strategically prosocial behaviors in preschoolers, for example, the tendency to share resources with others in anticipation of reciprocation (Sebastián-Enesco & Warneken, 2015). Another alternative is that differences in children's preference for fair outcomes affected their propensity to take turns.

The fact that most children spontaneously initiated and independently sustained a turn-taking scheme in the absence of an authority suggests that this is a salient solution when facing repeated conflicts. Previous work has already shown that children can reciprocally alternate favors in a zero-sum game in which only one of two children could win a reward per round while the other received nothing (Melis et al., 2016). The current study extends these findings by demonstrating that preschoolers can spontaneously initiate and sustain a joint turn-taking strategy in repeated coordination problems in which—despite conflicting motives—it is in everyone's interest to reach an agreement in any given round. Interestingly, from a very young age children coordinate behaviors with others in turn-taking sequences—for example, when smiling or vocalizing toward each other in face-to-face interactions with adult caregivers (Trevarthen, 1979) or when rolling a ball back and forth (Hay, 1979). It should be noted, however, that this is a completely different phenomenon than turn-taking as observed in the current study. Whereas children appear to engage in early playful turn-taking episodes out of intrinsic enjoyment and in order to share positive emotions, turn-taking in the current study served as a joint compromise to resolve a recurrent dispute. Indeed, many dyads established turn-taking through explicit joint agreements, often by highlighting the fairness of the resulting payoff division, suggesting that turn-taking was a deliberate solution based on an advanced understanding of its strategic advantages.

However, an interesting question is how children acquire the ability to resolve disputes by taking turns. Children in our study are likely to have had previous experiences with adults directly instructing them to take turns with peers. On the other hand, children may also reliably learn to take turns as they gain experience with recurrent peer conflict over limited resources. Future investigations—particularly with populations varying in parental and peer experiences—could further elucidate the role of socialization practices on the development of turn-taking strategies. A limitation of the current paradigm was that it appeared too complex for younger children. Three-year-olds in a pilot study had difficulties integrating the different aspects of the task into a meaningful decision (e.g., remembering how to steer the trains, keeping track of which payoffs were associated with which game decision, or that one's own outcome depended on the decision of the partner). Hence, methodologies suitable for testing younger children would help to address questions relating to developmental processes involved in the observed behaviors.

The fact that children in the current study knew each other and could openly communicate contrasts with most studies on strategic coordination in adults. Indeed, a striking aspect of coordination in humans is that people often manage to jointly agree on a solution even without communicating (Mehta, Starmer, & Sugden, 1994; Schelling, 1960). Recent studies have shown that some of these abilities are already present in late preschoolers (Goldvicht-Bacon & Diesendruck, 2016; Grueneisen et al., 2015a, 2015b, 2015c). However, whether children can also coordinate without communication when facing conflicts—for example, when having to tacitly agree on a division of resources—would be an interesting question for future research.

In conclusion, our results demonstrate that 5-year-olds are able to coordinate their decisions with peers, even when their interests conflict. Although some dyads coordinated along dominance asymmetries, they mostly did so by jointly establishing a turn-taking strategy. This suggests that, already by the late preschool years, children possess a basic requirement for negotiating mutually beneficial outcomes despite having opposing preferences.

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