Much or More? Experiments of Rationality and Spite with School Children

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In a competitive environment the maximization of self-interest and the minimization of the other's interest can be seen as the two faces of the same coin. However, these motivations can lead to very different behaviors. In order to understand how these are expressed, we designed an experiment to measure the ability of children and teenagers to react to stimuli that induce behavior to act as a rational player (maximization of self interest) or as a spiteful player (minimization of other's interest). Each player faced the following dilemma: maximizing pay-off and incurring the risk of having a lower pay-off; or alternatively guaranteeing one's own pay-off was not smaller than the opponent's pay-off. A prize was attributed proportionally to the pay-off (Treatment 1) or to the player with highest pay-off (Treatment 2), which meant that the optimal behavior was different for each treatment. We performed experiments with 398 Portuguese children and teenagers and found evidence that younger children tended to be maximizers (in both variants) and that teenagers tended towards rational behavior when it was best for them and towards spiteful behavior when the latter was more advantageous.

There are many ways to be competitive (as there are many ways to be cooperative, too). The most studied one, both theoretically and empirically, is called "rationality" (maximization of self-interest). The term rationality traditionally refers to individuals acting towards the maximization of their own selfish interests, measured by the "pay-off" concept originally introduced in game theory (Neumann, & Morgenstern, 2004; Tversky, Kahneman, 1986). In a sense, one compares his/her fate in all possible scenarios and chooses the best possible outcome. However, in most real situations of experimental interest, people compete against each other. Taking as an example an experimental game, where each of two individuals has two strategic possibilities and pay-off functions associated with all possible combinations, a simple maximization of one's pay-off says nothing about the effect of this decision to the direct competitor's pay-off. If a strategic decision maximizes one's pay-off but results in an even higher pay-off for the

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opponent, then this may be a wrong decision in an environment of direct competition. In fact, mathematical models along these lines are considered the starting point of the studies of cooperation, as the benefit of one is also a benefit for the other (Chalub, Santos, Pacheco, 2006; Falk, Fehr, & Fischbacher, 2005; Hamilton, 1970; Leimar, & Hammerstein, 2001; Santos, & Pacheco, 2005; Santos, Pacheco, & Lenaerts, 2006; Trivers, 1971). Evolutionary psychology has further explored this by studying the impact that neurological and emotional processes related to altruism and cooperation have on the survival and spread of individuals (Van Lange, 1999; Van Lange, Agnew, Harinck, & Steemers, 1997; de Wall, 1996).

Defined as an act that causes loss of payoff (or any other type of cost) to the opponent, spite may be advantageous in a competitive scenario given certain precise conditions. We will not specify here the full set of conditions that make spite advantageous; we stress however, that rationality (maximization of own's payoff) and spite (minimization of other's payoff) are not mutually exclusive.

Humans display many behaviors that could be classified as spiteful and spite is often linked with negative emotional responses to inequity such as envy and jealousy (Berke, 1988; Dufwenberg, & Güth 2000; Salovey, & Rothman 1991; Smith, 1991). Although apparently maladaptive, these behaviors are suited to certain competitive contexts. By comparing payoffs directly with another individual, one could be empowered with the means of assessing the best strategy for obtaining a payoff. Some authors have suggested that this would elicit an "out-compete your neighbor" decision process that would allow exerting just the right amount of effort to succeed in outcompeting rivals (Hill & Buss, 2008). In economics, the process of dumping (where a firm decreases the price of its product, possibly below cost price, intending to drive competitors out of the market) is such an example (Winters, 1991). Humans also commonly display what is known as "last-place aversion." In this case individuals prefer to minimize the probability of being last (for example, in a ranking of income distribution), rather than maximizing their own pay-off (Kuziemko, Buell, Reich, & Norton, 2011). Spiteful behavior has also been identified in a study where higher-ranking individuals are more likely to spite lower ranking individuals than their similars (Fehr, Hoff & Kshetramade 2008).

For this study, the starting point was to understand if the propensity for spiteful behavior was present in children along with the propensity for rationality, or if children displayed these propensities at different stages of their development, ultimately comparing the motivations and the ability of children and teenagers to react to stimuli that induced behavior in one or the other direction. Namely, we wanted to quantify, according to age, the propensity for acting rationally or spitefully.

The literature on studies of spite with children is very limited. Spiteful choices (as described above) were reported to appear spontaneously in about 22% of subjects between 3 to 6 years old in an anonymous ultimatum game (Fehr, Bernhard, & Rockenbach, 2008) and appeared more often than chance at ages 5 to 8 in a face-to-face experiment designed to replicate studies of altruism in chimpanzees (House, Henrich, Brosnan, & Silk, 2012). Using the dictator game, other studies reported that younger children tended to be more selfish and that pro-social choices increased as children became older (Fehr, *et al* 2008; Harbaugh, Krause, & Liday, 2003; Hook, & Cook 1979). In the dictator game, the proponents were assumed to be interested in maximizing their own pay-off; however, their observed behavior frequently contradicted this assumption. One possible explanation was that participants took into account other's pay-offs (Camerer, 2003). This was confirmed by the studies of Benenson, Pascoe, and Radmore (2007) and Knight and Kagan (1977), where competitive behavior among children arose substantially by 9 years of age. It was suggested that children with better fluid cognitive skills were more likely to be spiteful (Bugelmayer & Spiess, 2011). These findings were argued as likely related to the improvement in children's ability of calculating proportionality (Kagan, & Madsden, 1972; Streater, & Chertkoff 1976; Toda, Shinotsuka, Mcclintock, & Stech, 1978), a reasoning that is echoed in Piaget's work on child developmental stages (Piaget, 1965).

In this sense, the present study aimed at comparing strategic choices in children within a competitive scenario. Unlike most studies that focused on spite (Foster, Wenseleers, & Ratnieks, 2001) and compare this behavior with that of altruism, we intended to compare it in a competitive environment where the other choice was to be rational, in the sense of pay-off maximization. For that effect, we presented a face-to-face game to assess how children behaved competitively when presented with the following dilemma: (i) maximizing pay-off and incurring in the risk of having a pay-off lower than the opponent, or (ii) deciding not to maximize pay-off while, on the other hand, guaranteeing that it is not smaller than the opponent's pay-off. The game was presented in two treatments. In the first one (A), a prize was given to both players, proportional to their accumulated pay-off; in the second one (B), a prize was given to the player with the highest pay-off. Therefore, the optimal strategy was different in each treatment; in the first case the rational strategy maximized the expected value of the prize, while, in the second, this was obtained by the spiteful strategy.

Psychological research on motivation tends to be made via eliciting responses from subjects to questions raised by researchers. Despite this, economics research tells us that individuals might not be properly motivated to provide accurate responses without material incentives (Fan, 2000). In this sense, the stimuli for the children's behavior, spiteful or rational, in our experiment, was assumed to be a consequence of the material incentive (although its monetary value was largely symbolic).

The game was designed such that rational players would choose the maximizing strategy; nonetheless, they risked having a pay-off lower than that of the opponent. Alternatively, spiteful players would choose the spiteful strategy, reducing their own payoff but still managing to reduce opponent's payoff even more. We expected that players would learn the best strategy and converge to the Nash equilibrium (Nash, 1950) in Treatment A (both players playing rationally) and to the non-Nash (spiteful) equilibrium (both players playing spitefully) in Treatment B, ultimately playing different strategies in Treatments A and B. We also predicted that older children would be better at devising the optimum strategy than younger children.

METHOD

Participants

Participants were 398 children from 5th to 11th grades from 6 different schools on the island of São Miguel in the Azores Archipelago, Portugal. Grades 6, 9 and 11 were discarded from analysis because sample sizes were too small and grade 6 did not play one of the variants (we required a minimum of 15 sessions in each game in a given grade to consider it). After removing these participants from the sample, our study comprised 350 children in 175 sessions, as each person participated only once (See Table 1 for descriptive frequencies). Each session was composed of a 5-round game. Columns represented player two's strategy and the entry (*a*,*b*) indicated the result of the game: pay-off *a* for the first player and *b* to the second player.

		Player 2	
		max	min
Player 1	max	(15,15)	(5,11)
	min	(11,5)	(2,2)

TABLE 1 Descriptive frequencies. Frequencies Described Are After Participants Removal

Treatment		Frequency	Percent
	A	178	50.9
	B	172	49.1
	Total	350	100
Age			
	10	13	3.7
	11	5	1.4
	12	88	25.1
	13	96	27.4
	14	44	12.6
	15	49	14
	16	51	14.6
	17	4	1.1
	Total	350	100
Grade			
	5th Grade	20	5.7
	7th Grade	150	42.9
	8th Grade	94	26.9
	10th Grade	86	24.6
	Total	350	100
School			
	Ribeira Grande	258	73.7
	Roberto Ivens	16	4.6
	Laranjeiras	42	12
	Lagoa	8	2.3
	Antero de Quental	26	7.4
	Total	350	100

The participation of each student was strictly voluntary, but was presented to the students as an opportunity to develop a taste in mathematical and economical issues. The study was performed outside normal lecture period. No personal information was requested either from the students or teachers other than the date of the experiment, age and class year of the participants. To ensure that the children did not feel any pressure towards a certain action due to the presence of university researchers, we presented the teachers with the tools to perform the experiments. For that purpose we gave the teachers of 6 schools a crash course in game theory history, economic experiments and the practical execution of our experimental protocol during March 2010. The schoolteachers then chose the appropriate date to run the experiments, which ranged from March to June, 2010.

The experiment required 4 playing cards from two distinct decks, one with a red back and one with a black back which we designated as “Red” and “Black.” Each player then received one “Red” and one “Black” card. These corresponded to *max* and *min* in our payoff matrix, respectively. It is important to note that the terminology “*max*” and “*min*” was never used during the training or during the experiments. In each class, the schoolteachers divided the children into two groups: A and B. Each of the pairs in these groups played the game corresponding to their group letter in the experiment for five rounds. After appointing each pair of children to their respective group, the teacher handed each of them a score sheet with the payoff matrix (which means students had access to it during the entire duration of the experiment). The following information was recorded on the score sheet:

1. Ages of each participant;
2. School year of each participant;
3. What card was played by which student in rounds 1 through 5;
4. Score of each student after each round and total score.

After all students sat down, the teachers read the following information aloud and explained the procedure of the experiment out loud:

• All players have the same rights and duties;
• Each player receives one red and one black card
– For group A: The prize will be proportional to the number of points obtained by each player at the end of the game.
– for Group B: The prize will be given to the player with the highest score.

1. Each player chooses either the Black or the Red strategy
2. The referee requests the strategies be shown
3. The referee records the participant’s strategies and resulting points in the provided experimentation score sheet.
4. Items 1 to 3 are repeated an additional four times.
5. After everyone in the class played, I will write the total scores for each Treatment in the blackboard and proceeded with awarding the prizes:

• Group A: the prize will be given proportional to the points obtained by each player with 15 points equaling 1 piece of candy.

• Group B: the prize will be given to the player with the highest score. The payoff will be a high valued chocolate, in case of a tie, the chocolate will be divided among the two.

After this information was provided and when there were no doubts regarding procedure of the experiment, the game began.

Statistics

We assumed the null hypothesis "players do not play differently in Treatments A and B" and calculated the probability *P* that this hypothesis was confirmed. We referred to the strategies of a given player in a given game by a number q in the interval [0,1], if, in that game, he/she played strategy *max* with probability q. Furthermore, we called N_A the number of times that a given player played strategy *max* in Treatment A and N_B the number of times the same player played strategy *max* in Treatment B. The total number of trials was given by N. (In this sense, he or she played strategies N_A/N and N_B/N, for games A and B, respectively.)

In Treatment A, where the best strategy was given by the strategy q=1, the probability that an equal or better result was obtained with the strategy q is given by:

$$F_A(q, N_A, N) = \sum_{i=N_A}^{N} \binom{N}{i} q^i (1-q)^{N \quad i}.$$

For Treatment B, where q=0 gives the best strategy, the probability of obtaining an equal or better result with strategy q is given by:

$$F_B(q, N_B, N) = \sum_{i=0}^{N_B} \binom{N}{i} q^i (1-q)^{N-i}.$$

The probability of having a better result in both Treatments is given by the product of F_A and F_B. Finally, we defined *P* as the maximum, over all possible values of q, of the product of F_A and F_B. Therefore, *P* was the maximum probability of attaining a result as good as or even better than the one observed using the same strategy for both Treatments.

Next, we analyzed which strategies were being played in each Treatment to assess if children were trying to maximize the absolute or the relative pay-off (i.e., if they were playing as rational or spiteful players) and combined rounds to analyze differences in total *min* and *max* plays between the two different Treatments. Afterwards, we ran Probit Regression analysis on each round as a dependent variable in order to understand whether children were making their decision based on their age, grade, school, previous rounds and payoffs. Finally, we ran the same analysis with relative payoffs to understand if children were considering their absolute or relative payoffs.

RESULTS

In our first analysis, the results showed seven significant cases, four of which with $p < .01$. 5th graders played different strategies in Treatments A and B in the first round; 8th graders played different strategies in rounds 1, 3 and 4 with a probability greater than chance and 10th Graders played different strategies in rounds 1, 3 and 4 with a probability greater than chance (see Table 2). In Table 2 consider that players adopt the same strategy in both Treatments (null hypothesis). Here, we show maximum probability that, under the null hypothesis, a better result is obtained in both (note that it is always possible, under the null hypothesis, to obtain a better result in at least one Treatment). Bold text denotes significant results. Despite these results not showing which strategy was used for each Treatment, they suggested that older children understood better that each one induced strategic differences.

TABLE 2 Binomial Cumulative Distribution for Both Treatments Simultaneously.

	Round 1	Round 2	Round 3	Round 4	Round 5
5th Gr.	**0.018**	0.58	0.34	0.18	0.45
7th Gr.	0.16	0.53	0.63	0.08	0.89
8th Gr.	**0.05**	0.25	**0.04**	**0.05**	0.28
10th Gr.	**0.006**	0.07	**0.004**	**0.004**	0.31

We considered as our following question whether or not children were playing the correct strategy for each Treatment. Therefore, we computed the probability p_A of playing optimum strategy *max* in Treatment A and probability p_B of playing optimum strategy *min* in Treatment B (see Table 3). Here, 5th and 8th graders correctly played the *max* strategy in round 1 of Treatment A, but only 8th graders played the correct strategy *min* in round 3 of Treatment B. Children in the 10th grade played the correct strategy *max* in rounds 1 and 3 of Treatment A and the correct strategy *min* in round 4 of Treatment B. Results were not conclusive, but indicated that rational behavior was more easily understood than spiteful behavior.

TABLE 3 Probabilities of Playing Correct Strategy (*max*) in Treatment A (p_A) & Correct Strategy (*min*) in Treatment B (p_B). Bold Text Denotes Significant Results for Binomial Test of Each Game

Grade	**Round**	**p_A**	**p_B**
5th	1	**0.92**	0.5
8th	1	**0.57**	0.56
	3	0.5	**0.64**
	4	0.57	0.56
10th	1	**0.77**	0.45
	3	**0.7**	0.55
	4	0.57	**0.76**

Our next set of results aimed at understanding which factors influenced the children's decisions. For that effect, we calculated Probit regressions where each round was the dependent variable, followed by a Type III intercept model with Age, Grade and School as constant independent factors and each round adding the previous round and payoffs as factors.

For Treatment A, we modeled *min* plays as the response category and *max* as the reference category. We found that for Round 1 of Treatment A, Age, Grade or School did not influence children's *min* responses. In Round 2, Round 1 and Payoffs of Round 1 influenced children's *min* responses (Round 1 Wald's $chi_{(1)} = 7.949$, $P < 0.05$; Payoff 1 Wald's $chi_{(1)} = 3.611$, $P < 0.05$). For Round 3 both Round 1 and Round 2 proved to influence children's *min* responses, (Round 1 Wald's $chi_{(1)} = 7.133$, $P < 0.05$; Round 2 Wald's $chi_{(1)} = 4.835$, $P < 0.05$). For Round 4, payoffs of Round 1 and 2 influenced children's *min* responses significantly (Payoff Round 2 Wald's $chi_{(1)} = 12.032$, $P < 0.01$; Payoff Round 2 Wald's $chi_{(1)} = 10.396$, $P < 0.01$). Finally for Round 5, only *min* plays in Round 1 influenced children's behavior (Wald's $chi_{(1)} = 4.466$, $P < 0.05$).

For Treatment B, we used the same procedure but instead modeled *max* responses and *min* as reference category. Here, very few significant influences were found. For Round 1, we found an influence of Grade in the *max* responses to *min* plays (Wald's $chi_{(3)} = 6.905$, $P < 0.05$). In Round 3, School influenced the *max* responses (Wald's $chi_{(3)} = 9.658$, $P < 0.05$), however, this result can be readily explained by the skewness of the sample with one school clearly dominating. Round 4 presented an influence of the Payoff of Round 1 in the *max* responses (Wald's $chi_{(3)} = 4.036$, $P < 0.05$).

After this analysis we considered only absolute and relative payoffs as our factors. Interestingly, the results were unexpected as Treatment A revealed that relative payoffs were a major influence in children's decisions, especially in rounds 2 and 3 (see Table 4).

TABLE 4 Treatment A Probit regression. Wald's Chi Square and *p* Values for Relative & Absolute Payoffs with Rounds as DVs

Dependent	Factors	Wald's Chi square	df	*p*
Round 2	Rel. payoff Round 1	7.473	2	0.024
Round 3	Rel. payoff Round 1	11.896	2	0.003
	Rel. payoff Round 2	11.108	2	0.004
Round 4	Abs. payoff Round 1	4.277	1	0.039
Round 5	Rel. payoff Round 4	9.777	2	0.008

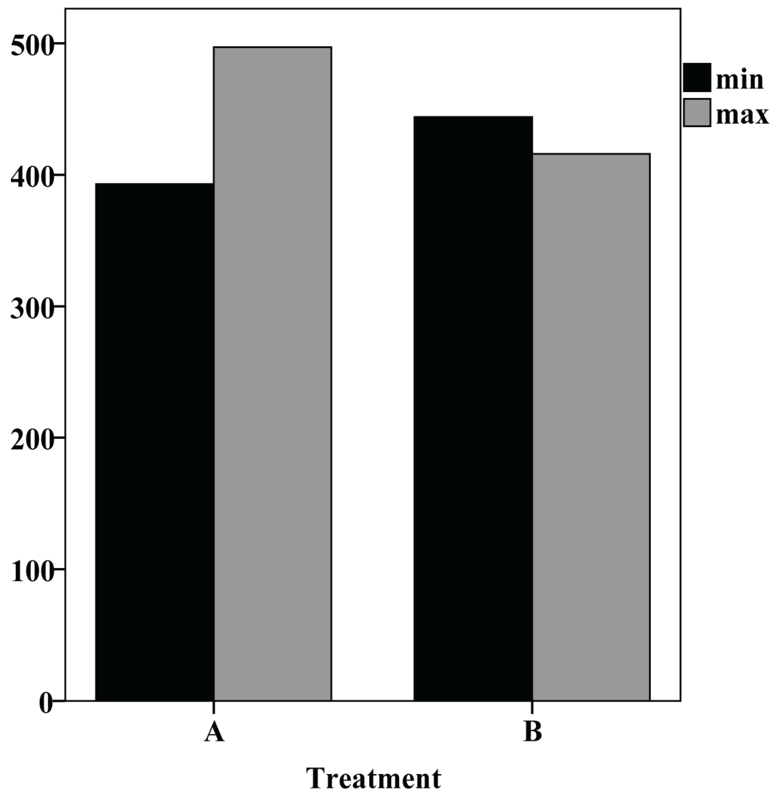
For Treatment B on the other hand, only two significant results were obtained (Round 4 as dependent and Payoff of Round 1 as factor: Wald's $chi_{(1)} = 7.171$, $p < 0.05$; and Round 5 as dependent and Payoff of Round 3 as factor Wald's $chi_{(1)} = 3.988$, $p < 0.05$).

Finally, we wanted to determine the overall trend in *min* and *max* plays. For that effect we combined all rounds into a single variable and plotted a chart (Figure 1) that shows total *min* and *max* plays separated by Treatment and calculated binomial proportions to understand if the differences between *max* and *min* are significant.

DISCUSSION AND CONCLUSION

At first glance, our results showed that younger children did not understand that there were strategic differences in both our Treatments as overall they seemed to adopt the exact same strategy in both, despite not being in their own interest to do so; older children understood that both Treatments had different strategies. The data also pointed towards younger children (5^{th} to 7^{th} grade) tending to play rationally more than spitefully and teenagers (10^{th} Graders) tending towards rationality when it was best for them and for spiteful strategies when the latter were more advantageous. We also found that more children played *max* in Round 1 of Treatment A then slowly reversed their strategy, and that fewer children started with *min* in Round 1 of Treatment B then slowly increased this strategy. However, Probit analysis revealed that spiteful strategies were more common when they were not advantageous. This could mean that the children perceived treatment A across all grades as

FIGURE 1 All rounds combined *max* & *min* plays for Treatments A & B.



Note: Binomial tests Treatment A: *max* proportion = 0.56, *min* proportion = 0.44, $P < 0.001$; Treatment B: *max* proportion = 0.48, *min* proportion = 0.52, *P* n.s.

a collaborative effort, and *min* responses triggered reciprocal behavior, maybe as punishment for a non-collaborative action or simply as a spiteful action, where a child preferred to win against the other at the cost of points that could result in fewer candies. In fact, we found similar patterns between what children played in our experiment and the strategy of win-stay lose-shift (Nowak & Sigmund 1993). Despite the *max* strategy being the rational one, probability of playing *min* in any Round was highly influenced by both *min* plays and payoffs of previous Rounds.

This effect could be explained by a feeling of envy towards the other player's pay-off or some other effect that drove children to reduce the effective *max* plays after they started playing correctly. This explanation relates to previous findings that claim that socialization practices that affect human altruistic and competitive behavior impact at similar ages and that the circumstances that drive each of these behaviors are learned with age (Benenson, *et al* 2007). In Treatment B, grade was influential in the decision of playing *max* in the first round, meaning that older, more rational children were better at a competitive game than younger children. In this Treatment, reciprocal behavior was not observed apart from Round 4 with a minor influence from the Payoff of Round 1.

In this context, children responded to other's pay-offs in different ways in each Treatment. Inequity aversion played a bigger role in Treatment A, with children that had negative relative payoffs retaliating in the following rounds with spiteful strategies. Our results point toward spiteful preferences being present when children directly played against each other. Psychologically, spite is often linked with negative emotional responses to inequity such as envy (Ben-Ze'ev, 1992; Salovey, 1991; Smith, 1991). Envy and spite are negatively charged concepts that have been considered maladaptive (Hamilton, 1970; Hill & Buss, 2008). However, these responses to inequity might play an important role in human development. In this sense, spiteful participants could be better equipped to cope with competitive environments, especially when pitched against efficiency-minded and inequality-averse participants as was shown by Loukas, Rudolf, and Matthias (2012). Nonetheless, we must acknowledge that other effects might have influenced the children's behavior. One possibility is that the participants' gender might have impacted on how teenagers played. Also, despite the original design comparing behavior in two competitive environments, children's desire to fight for status and reputation might have been different in both Treatments, against our assumptions.

Further work should consider the influence of anonymity and reputation when strategic decisions are both of a competitive nature, as in the present work. Despite the fact that our experimental setting did not consider these effects (particularly for logistic reasons when dealing with children) we cannot deny that reputation effects could have occurred during the game. We also plan to repeat the study in different locations; the design could be extended by a post-game interview, shedding some light on the children's thought processes during each game and ultimately the ontogeny of spiteful behavior in humans.

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