RUNNING HEAD: CHILDREN'S ATTENTION TO PROPORTIONAL INEQUALITY

Children's Attention to Proportional Inequality When Making Social Judgments

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Abstract

This current study explores how children use their ability to reason proportionally and attend to proportional inequality in social situations. Previous studies have found that adults tend to use their knowledge of proportion to evaluate resource allocations. This perception of fairness is used to judge social traits. In addition, non-human primates have been found to react negatively when an allocation received was less attractive than an allocation received by a conspecific. In this study, children were introduced to two cartoons, each of whom allocated a designated proportion of chips to the child and another amount to a perceived competitor to the child. The children were then asked to judge which cartoon they would prefer to be friends with. Sensitivity to the proportion of resources received compared to the rival would show that the propensity to measure a stranger's resource allocation by using proportion is a behavior enacted by both children and adults. It would also provide additional evidence that children are capable of attending to ratio and proportion before any formal education in the topic. The study found that children performed at chance when selecting which cartoon to be friends with, suggesting that children may not attend to the same social cues that adults attend to when judging friend-worthy traits among new peers.

Most adults would say they often use the perception of fairness to attribute social traits onto those that they have interacted with. To do this, they use proportion to decide if a set of resources has been distributed fairly. Previous studies have shown that children's judgments of resource allocations are distinctly different from that of adults. It has been found that young children's perception of fair resource distributions is very self-interested (Damon, 1975; Fehr, Bernhard, & Rockenbach, 2008; LoBue, Nishida, Chiong, DeLoache, & Haidt, 2011). Five-year-old children begin to understand equality and use proportion to determine how fairly a set of resources was distributed (McCrink, Bloom, & Santos, 2010). However, this understanding is limited to a strict adherence to equal allocation of resources to all members of the allocation, regardless of the effort put in by the members. As adults, we use proportion as the predominant decision factor to make judgments of allocations in social conditions when there is no effort involved in gaining resources (McCrink, et al., 2010; Newman, 1996). Additionally, older children and adults begin to think about other factors such as the proportion of resources received relative to the individual's contribution (LoBue, et al., 2011).

Previous research has suggested that children's inability to properly reason about the distribution of resources is due to their inability to understand ratio and proportion. For example, Piaget & Inhelder (1975) presented children with two jars that contained "target and non-target" marbles and asked each child which jar had the best chance of yielding a "target marble". The study showed that children under seven could not consistently focus on the denominator of a ratio – in other words, the children attended to the absolute value while disregarding the total amount of objects. Additionally, it has been found that children's social development is correlated with their mathematical reasoning (Damon, 1975). Damon (1975) suggests that children's ability to progress through Piagetian logical stages greatly parallels their progress

through certain levels of moral thinking. Young children tended to confuse their own desires with what was fair (Damon, 1975). Thus it was claimed that proper knowledge of certain mathematical and social concepts provided a crucial foundation for a child's proportional reasoning.

However, other studies have since shown that children possess a rudimentary capability to differentiate certain ratios and proportions. Studies have even established that an innate sense of ratio exists in infants. Six-month-old infants are able to successfully discriminate quantities that differed by a ratio of two (McCrink & Wynn, 2007). Additionally, others have claimed children's poor performance in Piaget & Inhelder's (1975) study occurred simply because they were not interested in the stimuli they were asked to attend to. In another study, children in two separate conditions were told they would receive a "prize" -- either a toy or a button – if they picked a chip of a certain color from one of two boxes (Yost, Siegel, & Andrews, 1962). Those children expecting to receive a toy were able to choose the box with a higher likelihood of yielding the target chip at a significantly higher rate than those who were to receive a button. In other words, high reinforcement children (those that were told they were to receive a toy), were able to maximize the probability of being rewarded by attending to proportion. Contrary to Piaget & Inhelder's (1975) claims, five-year-old children showed a significant sensitivity to both numerator and denominator when given an incentive to do so (Yost, et al., 1962). Following on the Yost et al.'s (1962) study, Denison & Xu (2010) revealed that twelve to 14-month-old infants were able to judge proportionality in the same way with large set sizes of lollipops.

If children are innately capable of attending to proportion, then they should, much like adults do, be able to use proportion as a way to reason about resource distribution and to measure fairness during social situations. In a recent study, McCrink, et al. (2010) explored how children

and adults use their understanding of proportion in a social context, specifically when they are making judgments of niceness. Children and adults were presented with two characters – a puppet with twelve chips and a puppet with four chips. The children were told that the chips they were given could be exchanged for a toy from the toy store. Thus, the children were given the proper incentive to attend to the amount of chips designated, but did have a specific amount in mind. The amount of chips each puppet gave to the child was manipulated on a proportional or absolute dimension – proportionally equal (2/4 versus 6/12), absolutely equal (3/4 versus 3/12), and conflict of both dimensions (3/4 versus 6/12). For example, in a proportionally equal condition, one puppet would give the participant two out of four chips while the second puppet would relinquish six of his twelve chips. After each interaction, the child or adult was asked which character was nicer. The study found that four-year-olds tended to focus on absolute amount when asked who was nicer. On the contrary, adults focused primarily on proportion when asked which puppet was nicer. It was found that five-year-olds began to show some sensitivity to proportion, as they favored the puppet that gave away a higher proportion of chips more often than four-year-olds did in the absolutely equal trials (3/4 versus 3/12). Thus, it was suggested that five-year-olds had the capabilities of focusing on proportion. Because adults primarily focused on proportion, they found the proportionally equal (2/4 versus 6/12) trial the hardest trial to judge who was nicer. This study challenges previous assumptions that both four and five-year-olds are self-interested or strict egalitarians when it comes to resource distributions. Additionally, it implies that young children are capable of using proportion in social situations. What does this finding say about children's ability to attend to ratio and proportion? Five-year-olds, much like four-year-olds, are typically not exposed to the topics of proportion or ratio in formal education – what is bringing this sudden change? Perhaps it is

linked to a child's increasing ability to engage in adult-like social behavior. On the other hand, perhaps four-year-olds *are* capable of attending to proportion, but need additional social incentives to do so.

McCrink, et al.'s (2010) study raises a question: Why, if children are innately capable of understanding proportion and ratio, do they typically attend to absolute values when judging resource allocations? Perhaps it is simply because they do not recognize the amounts of chips remaining, and their attention must be brought to it. In a subsequent study, two new types of trials were included – "enhanced" and "non-enhanced" (McCrink & Lin, unpublished). In the enhanced trial, an attempt was made to bring the remaining amount of chips each character had left to the child's attention, so as to make each child more aware of the proportion of chips given. In the "non-enhanced" trial, no attempt was made to bring the child's attention to the remaining amount of chips. In addition, an archetypal theory-of-mind task was incorporated – a false belief task – to test any parallels that may exist between theory-of-mind capabilities and social judgment. However, no direct correlations were found between theory-of-mind passers and children who were sensitive to proportion during social judgments. Additionally, bringing attention to the amount of chips left over did not have an overall effect on how the child perceived the niceness of the puppet character. Thus, it remained unclear whether four-year-olds were interested in using proportion as a cue to a fair resource distribution.

One possibility is that it takes a competitive social context in order to prompt children to reason about proportion when making social judgments in the same way adults do. A new hypothesis was created in order to parallel individuals' tendencies to compare their own pay-offs to others after an allocation of resources (Brosnan & de Waal, 2003). Humans across cultures attend to fairness, and respond negatively when treated disadvantageously or undercompensated

relative to other individuals (Brosnan, 2006). Brosnan & de Waal's (2003) study found that this behavior was not uniquely human, as non-human primates were averse to disadvantageous inequality as well. The researchers found that capuchin monkeys respond negatively when they received a disadvantageous resource distribution compared to a conspecific. Capuchin monkeys were trained to trade a token with a human experimenter in exchange for a reward. Monkeys who witnessed a conspecific receive a more attractive reward (grapes compared to their cucumber) refused to participate. Brosnan & de Waal (2003) also noted that these monkeys accepted their reward of cucumbers when there was no more attractive reward available for comparison. Additionally, the capuchin monkeys accepted the cucumber even if the more desirable food was within sight, but not given to any other monkey. The same observations were found with chimpanzees as well (Brosnan, 2006).Since this behavior is regarded as evolutionary and instinctual in non-human primates such as chimpanzees, the current study aimed to explore whether or not children use their innate sense of proportion to engage in the same behavior. We hypothesized this competitive context will trigger children's ability to attend to proportion and willingness to use proportion to judge the friendliness.

The goal of study was to explore the presence of disadvantageous inequity aversion in children. Our study consisted of two cartoon characters, each with a designated amount of chips. Each cartoon character gave a certain proportion of chips to the child, and a proportion to a competitor, a toy monkey. The proportion of chips given to the child and the toy monkey varied between trials. In each trial, the child either received a higher proportion, a lower proportion, or an equal proportion relative to a competitor. If the child recognized that he or she received a disadvantageous share of chips compared to the monkey, then it presumably impacted how he or she views this stranger as a possible "friend". In order to compare the amount of chips the child

received in relation to the monkey, the child must use his or her perception of proportion. Thus, we anticipated that a child's motivation to measure how "friend-worthy" each cartoon character is will encourage him or her to use an innate ability to attend to proportion and ratio. We hypothesized that the higher the proportion given to the rival, the less likely both four and five-year-old children would be inclined to choose that character as a potential friend.

Methods

Participants

31 four and five-year-old children (18 females, 13 males) were recruited via invitations sent to parents from a database of birth records in the New York City area. 17 four-year-olds (*range* = 4 years 0 months to 4 years 11 months) and 15 five-year-olds (*range* = 5 years 0 months to 5 years 11 months) were run. In addition, participants were recruited from day cares, schools, and community groups in the metropolitan area. Adults were 14 undergraduate students (6 females, 8 males) recruited from a large, private university in New York City, and were reimbursed $5 upon completion of the study.

Child Procedure

Each participant was brought into a designated quiet room in the research center or in a pre-school, where the study was videotaped. The experimenter would introduce the child to a toy stuffed monkey named "Mr. Monkey" and placed the monkey next to the child. The children were then told that they were going to meet some new people – and each person had chips that they wanted to give to both the child and the monkey. The children were told that the chips could be used later to get toys, and that they would be competing with Mr. Monkey for the chips. It is

important to note that children were not told of an exact amount of chips needed to be obtained in order to get a toy. At the beginning of each trial (among a total of ten trials), the experimenter introduced the child to two pictures of cartoon characters. The experimenter presented the amount of chips each cartoon had by saying, "This is (character name), he/she has this many chips!" The experimenter would then say, "(Character name) wants you to have this many chips, and he/she wants Mr. Monkey to have this many chips," At the same time, the experimenter slid the designated amount of chips to the child and the toy monkey. This was repeated with the second cartoon character. At the end of each trial, all the chips both characters had were all distributed to the child and the toy monkey. No chips were left. The child was then asked, "Who do you want to be friends with?" The cartoon the child explicitly points at or the cartoon name the child explicitly said was our dependent measure. Once the child made his or her selection, the child was asked to collect the chips and keep it in a designated cup until the end of the study. The experimenter collected the monkey's chips and began the next trial (see Figure 1 for an example trial).

Children were run in two different conditions - designated as (3,x) and (4,x). Some children were run in only one condition (N = 4, N = 9), while some children were run in both conditions (N = 25, 14 females). Each condition contained 5 trials. The order of the conditions was counterbalanced across participants by gender and age. The two conditions contained the following trials.

(1) (3,x) Condition, in which both cartoons within each of the five trials gave 3 chips to the child. One cartoon, Cartoon A (the constant giver), within each trial gave the child 3 chips, and the competitor 1 chip (this will be represented as (3,1)). The other cartoon,

Cartoon B (the variable giver), gave the child 3 chips as well, but a varying amount of chips to the toy monkey (the rival) within each trial. The amount of chips given to the rival varied between each trial in the amounts of 2, 3, 5, 7 and 9. These trials were represented by (3,2), (3,3), (3,5), (3,7), and (3,9). In this trial, the absolute amount of chips given to the child was kept the same, but the proportion given varied by the amount given to the competitor. For example, Cartoon A gave the usual steady proportion of 25% (1 of 4 chips) to the competitor, while Cartoon B could give either 40% (3 of 5 chips), 50% (3 of 6 chips), 63% (5 of 8 chips), 70% (7 of 10), or 75% (9 of 12).

(2) (4,x) Condition, in which one cartoon in each trial, Cartoon A (the constant giver), always gave the child 3 chips and the rival 1 chip (3,1). A second cartoon, Cartoon B (the variable giver) always gave the child 4 chips while varying the amount given to the monkey. The amounts were 1,2,4,6 and 8, represented in the form of (4,1), (4,2), (4,4), (4,6), and (4,8). In this condition, both the absolute amount and proportion of chips given to the child varied. Cartoon A gave the constant proportion of chips to the competitor (25%), while Cartoon B varied the proportion by giving either 20% of the chips (1 of 5 chips), 33% (2 of 6 chips), 50% (4 of 8 chips), 60% (6 of 10 chips), or 67% (8 of 12 chips) to the competitor.

The (3,x) condition was implemented to see if children could attend to proportion when absolute amount was equal (thus, the children could not use absolute amount as a basis for a judgment of friend-worthiness). Likewise, the (4,x) condition was used to explore whether children could attend to proportion despite the fact that one character gave the child more chips in terms of absolute amount. The varying proportion of chips given to the rival between trials was to explore whether or not there was a linear progression towards preferring the (3,1) cartoon

as the proportion of chips given to the rival increased. We also hypothesized a large shift in preferring the (3,1) constant character as a friend as soon as the other character begins to give a rival a higher proportion of chips (more than 25%). This expectation is shown in Figure 2.

The pair of cartoons in each individual trial looked identical with the exception of clothes color, eye color, and hair color. In addition, each of the trials began with a distinct pair of cartoons, as if the child was meeting two "strangers" upon every trial. The use of these characters was counterbalanced, in addition to the order of the conditions run, gender of the cartoons, the side each cartoon was presented on, and the trial order. Within each trial, one cartoon had white chips and one cartoon had black chips. This was to prevent any confusion during the allocation of chips. These neutral colored chips were chosen to mitigate the effects of color preference.

Adult Procedure

In addition to this procedure, a parallel study was run with adults (N = 14, 6 female). The adult parallel was a pen a paper task. All chip amounts and proportion given to the participant and the rival were kept the same.

Results

Overall Data

A chi-square goodness-of-fit test, corrected for multiple comparisons, was used to determine if children's distribution of friend selection differed from chance. For the (3,x) condition, children consistently chose the (3,1) cartoon as friend-worthy over the (3,5) cartoon ($\chi^2(2, N = 26) = 7.54$, $p = .006$). For all other trials, 4 and 5-year olds chose the (3,1) cartoon at

chance as more friend-worthy over the other cartoons ($p > .01$). For the (4,x) condition, children chose their friends at chance for every trial. Because there were no significant patterns or trends found in both conditions, the data were collapsed across the (3,x) and (4,x) conditions. These data are summarized in Figure 3. Additionally, the trials were represented as the percentage of chips given to the rival. The trial percentages are as follows: (4,1) = 20% of chips given to the rival, (4,2) = 33%, (3,2) = 40%, (3,3) and (4,4) = 50%, (4,6) = 60%, (3,5) = 63%, (4,8) = 66%, (3,7) = 70%, and (3,9) = 75%. The (3,1) constant in all conditions involves giving 25% of the chips to the rival, and 75% of the chips to the rival.

Gender

There were few obvious trends or differences in performance found between boys and girls. Girls chose the (3,1) cartoon at a significantly higher rate than boys in the (3,1) versus (4,2) trial, in which the rival received 33% of the chip allocations ($p = .002$). No other significant findings were present. The data are summarized in Figure 4.

Age

Again, there were few obvious trends and differences in friend choice found between four-year-olds and five-year-olds. Four-year-olds chose the (3,1) cartoon over the (3,5) to be friends at a significant rate ($p = .007$), while five-year-olds did not. Five-year-olds chose the (3,1) character over the (3,2) character, in which the rival received 40% of the resources, at a significantly higher rate ($p < .001$). In addition, the same finding was found in the (3,1) versus (3,7) trial, in which 5-year-olds did not choose the cartoon character who gave 70% of their chips to the rival ($p < .001$). The data are summarized in Figure 5.

Siblings

We divided the participant pool into two groups: participants with siblings and participants without. We thought that this factor could potentially affect the way children perceive not getting some resources and sharing. Children with siblings chose the (3,1) character as more friend-worthy over the (4,8) character ($p = .01$). Despite this finding, there were no visible patterns found between siblings and only children. The data are summarized in Figure 6.

Adults

Adult performance in the parallel study differed greatly from that of children's. Adults chose the constant giver at an almost significant rate for all trials where the variable giver gave the competitor a higher percentage than the constant giver (over 25%) ($p < .03$). For the trials where the percentage of chips given to the competitor was high (from 63% to 75%), the adults chose the constant giver at a very significant rate ($p < .008$). In the trial where the constant giver gave a higher percentage of chips to the rival compared to the variable giver (20% compared to 25%), adults chose the constant giver at a very significant rate ($p = .001$). This data were very similar to the hypothesized data for the four and five-year-old children. The data are summarized in Figure 7.

Discussion

In order to explore how children and adults used proportion to reason about social traits, we had four to five-year-old children and adult participants choose with whom they wanted to be friends with after they were allocated resources from two strangers. Our first finding is that four and five-year-old children inconsistently chose their friends when we varied the proportion of resources given to the children and their rival. Secondly, we found that adults consistently used proportion when judging social traits such as friendliness. Adults chose the character who

allocated a higher proportion of chips to them as the character they wanted to be friends with. This solidifies previous evidence that adults largely use proportion to judge social traits (McCrink, et al., 2010). In addition, the finding provides evidence to our hypothesis that humans attend to proportion in competitive situations, and compare their pay-offs relative to other individuals. However, the data do not provide concrete evidence of young children's inability to reason proportionally in an adult-like fashion. Instead, methodological limitations and future directions will be discussed.

One limitation was that the study did not fully parallel the methodology used with non-human primates (Brosnan & de Waal, 2003; Brosnan, 2006). For example, the capuchin monkeys and chimpanzees were trained to trade tokens in exchange for a reward. The effort made to receive the reward may have encouraged the capuchin monkeys and chimpanzees to attend more to the reward received by conspecifics. In fact, it was found that capuchin monkeys attended to the effort made by other monkeys to deserve the received reward (Brosnan, 2006). Thus, future studies should have a participant perform a fairly difficult task that they believe is worthy of resource allocation. A rival that receives the same resource allocation for no effort could possibly make the participant more averse to inequality. The concept of effort may play a large role in whether or not the child feels entitled to the resource allocation in the first place. The child may be accepting of all resource allocations, as he or she has done little to deserve the allocation in the first place. In fact, one child proclaimed during the study, "But I did nothing to get these chips!"

In addition, the rewards allocated to the capuchin monkeys and chimpanzees varied on a *qualitative* level. The presence of inequality aversion in non-human primates has only been found when the subject received one cucumber and a conspecific received one grape. Thus the

absolute amount of reward given to both subjects was the same, but the quality was different. Another future study that could be implemented is to give a rival a more attractive reward (such as candy or a toy) and the participant an unattractive reward (such as a rock). This method would test if inequality aversion is present in children in the same way it is present in non-human primates. If so, further studies could test participants' sensitivity to proportion by manipulating the quantity *and* quality of the reward given to the participant and the rival.

Another question to ask ourselves is, "What is the meaning of friendship to children?" Research has shown that children tie the fairness of resource allocations to friendship often (Olson & Spelke, 2008). For example, it was found that children favored towards an equal distribution when there were enough resources – but greatly favored family, friends, or strangers that they perceived as "giving" when resources were limited (Olson & Spelke, 2008). In our study, each resource-allocating character had more than enough resources for both the participant and the rival. Because there were enough resources, the participants may favor equal distributions in addition to attending to inequality. Perhaps in their eyes, choosing a friend meant someone that gave equally in this situation of excess resources. However, they may not want their rival to receive a more attractive reward. This tension between these two concepts may have led to the inconsistent data found with four and five-year-old children. A future methodological change could involve limiting the number of resources available to the child and the rival.

Olson & Spelke (2008) also found that children, despite limited social experience, have a preference for those who share resources with them and *others* as well. Perhaps a child's preference for those that have provided resources to others in the past is directly linked with how they perceive this character as friend-worthy. When choosing who to be friends with, one may think about how these particular characters would act in the future. Choosing a character who

has shared with both the child and the rival may mean a higher chance of receiving resources at a later time. Thus, it is suggested that future studies do not ask children with whom they want to be friends with, but instead enact a less subjective dependent measure. Linked with this notion of friendship and the future, children may also have had a preference for the "richer" characters. McCrink, et al.'s (2010) study found that children had a baseline preference for rich individuals. Children may feel inclined to choose characters that, as a whole, have more resources than the other. Despite the fact that this particular character may choose to give a higher proportion of their resources to a rival, the child may choose to be friends with the richer character in hopes that they will receive more resources at some time in the future. Instead it is suggested that both characters within each trial have the same amount of chips, but given a different proportion of each amount to the child and the rival.

There is the possibility that children are attuned to proportion and averse to inequality, but cannot fully verbalize their unhappiness yet. A recent study has shown that even three-year-old children are unhappy with disadvantageous resource allocations, but do not explicitly say so (LoBue, et al., 2011). LoBue and colleagues discuss how asking for explicit verbal responses and judgments after resource allocations underestimates children's knowledge. Instead, behavioral and emotional signals in children during moments of unequal resource distribution were looked at. A child and a classmate were allocated stickers from the researcher. Each child was asked if the allocation was acceptable. While three-year-old and four-year-old children verbally rarely objected to the inequality, their emotional behavior coded by neutral coders showed that they were upset by the inequality. This finding implied that young children are well aware of inequality and fairness, but may be confused or unknowing when it comes to

responding to such inequality. Thus, there is a possibility that the children who participated in this study were not able to explicitly verbalize their preferences for what character.

Lastly, there is the methodological limitation of whether the child participants were in a situation where their inequality aversion would arise. Although the children were told that the cartoon characters could all be potential friends, their attention and investment in the situation may vary from that of a real-life situation. The child participant's competitor for resources, Mr. Monkey, may not be a worthy competitor for some children. Previous studies have discussed the possibility of a child not revealing his or her true aversion to inequality or attention to fairness unless competing with an equal, such as a classmate (LoBue, et al., 2011). Future studies should have children compete with another child of the same age and gender for resources.

In conclusion, our findings on children's proportional reasoning during social situations are inconclusive. However, these data do not provide concrete proof that four and five-year-old children cannot use proportion in the same way adults do when judging fairness and friend-worthiness. Steps should be taken to acknowledge and adjust the many methodological limitations with this study in order to properly explore what children are actually thinking during and after resource allocations.

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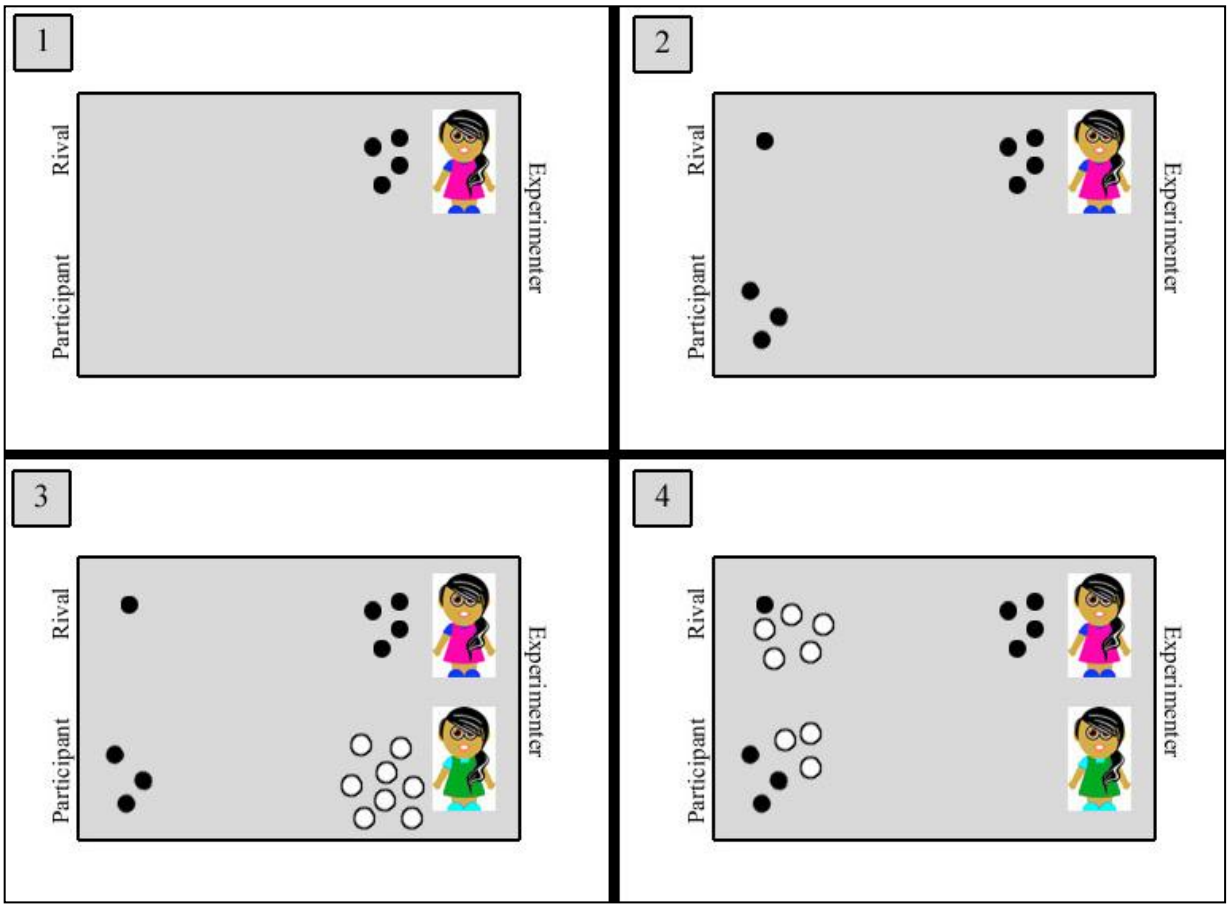

Figure 1. An example of a trial in the study. Firstly, the child is introduced to one cartoon character and the amount of chips he or she has. Secondly, a certain proportion of chips are allocated to the child and the rival. Next, the second character was introduced and his or her chips were allocated to the child and the rival.

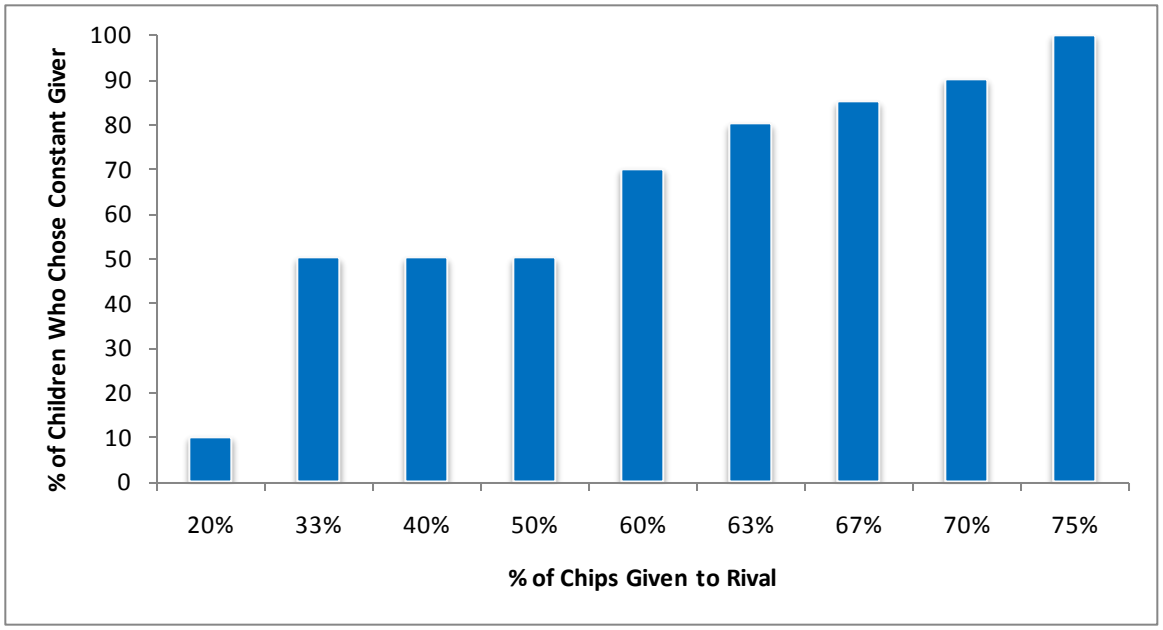

Figure 2. Predicted outcome of the percentage of children who choose the constant giver compared to the percentage given to the rival, shown with the (3,x) and (4,x) condition collapsed.

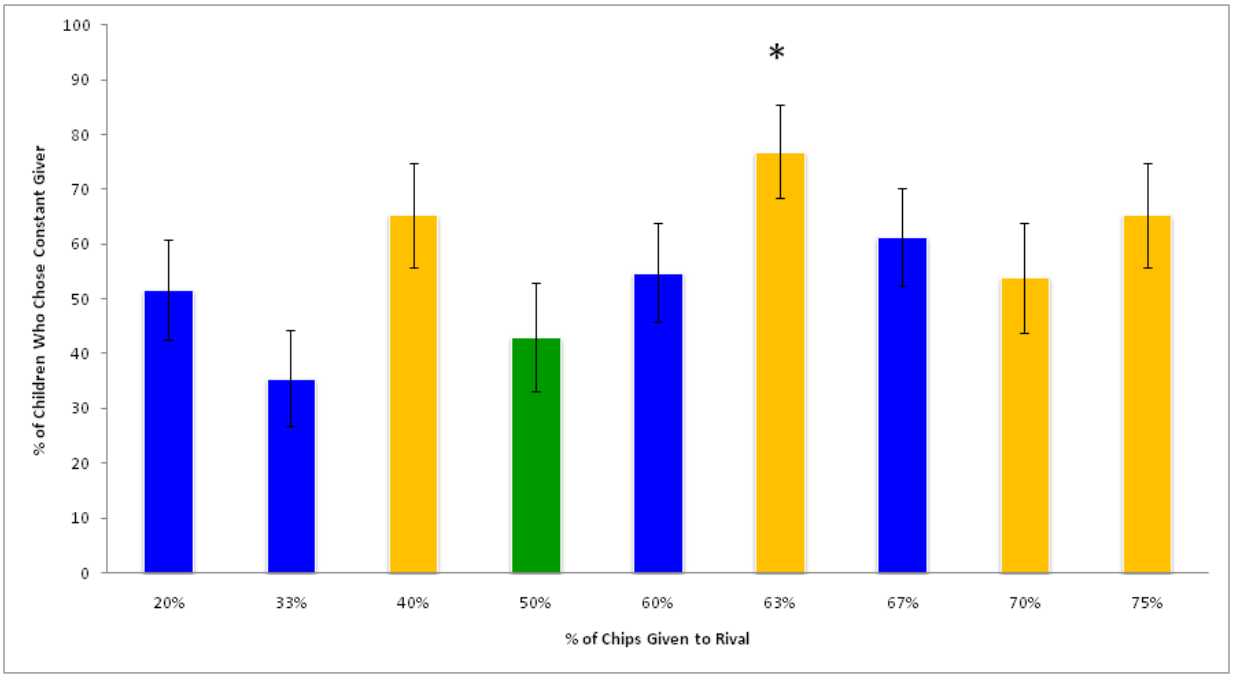

Figure 3. Percentage of children who chose the constant giver compared to the percentage given to the rival, shown with the (3,x) and (4,x) condition collapsed.

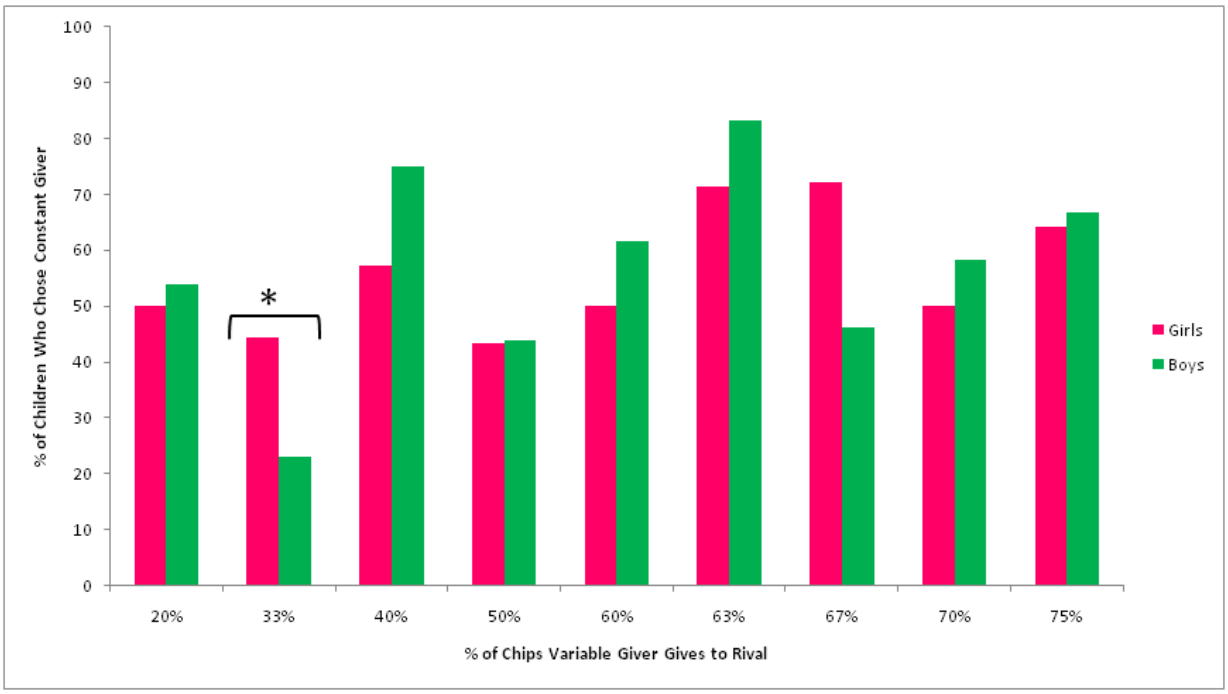

Figure 4. Percentage of girls and boys who chose the constant giver compared to the percentage given to the rival, shown with the (3,x) and (4,x) condition collapsed.

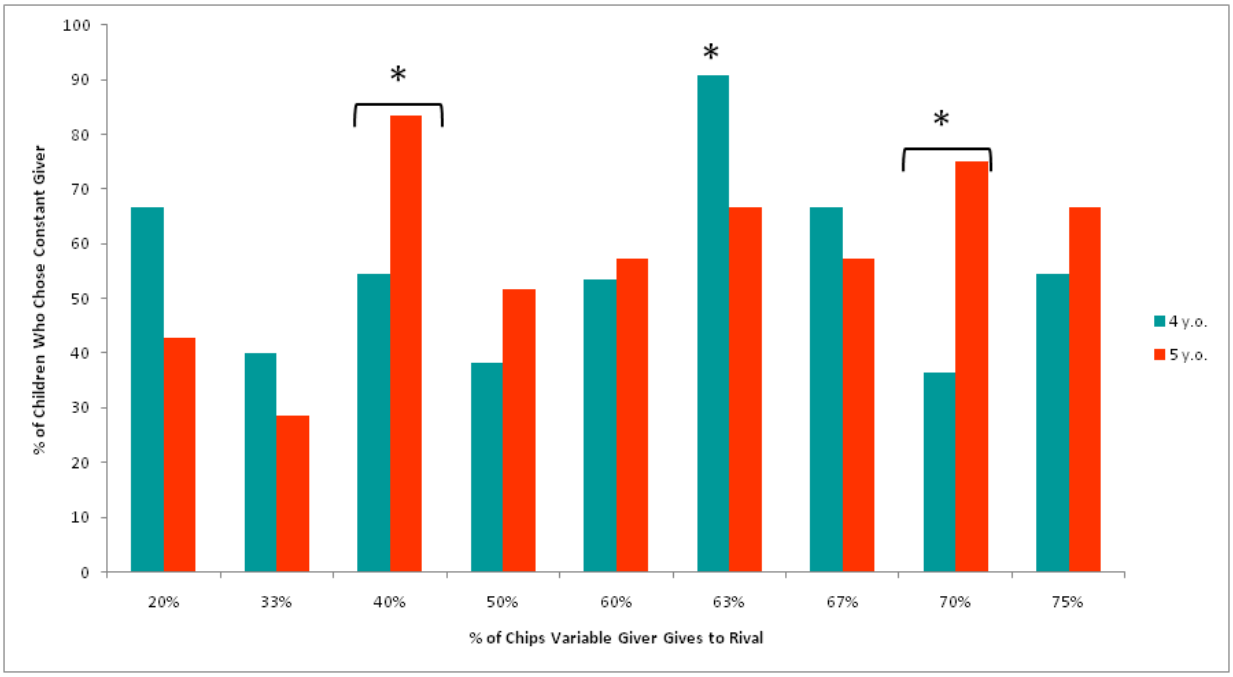

Figure 5. Percentage of four and five-year-old children who chose the constant giver compared to the percentage given to the rival, shown with the (3,x) and (4,x) condition collapsed.

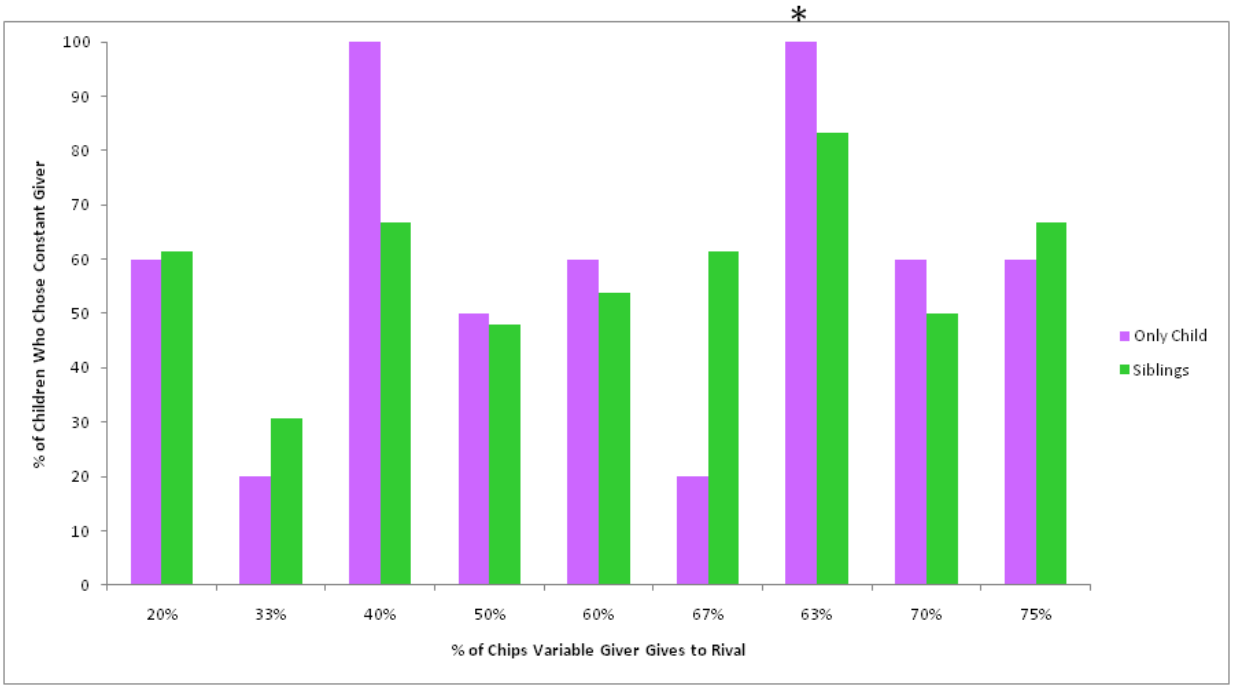

Figure 6. Percentage of children with siblings and only children who chose the constant giver compared to the percentage given to the rival, shown with the (3,x) and (4,x) condition collapsed.

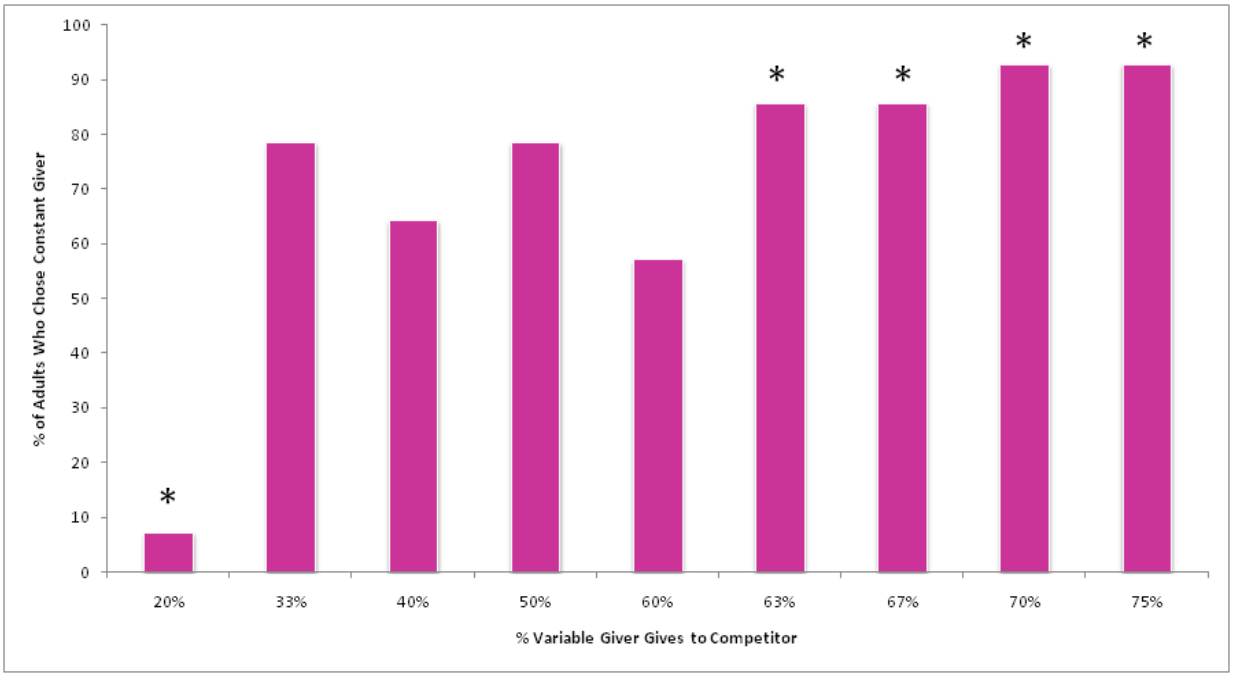

Figure 7. Percentage of adults who chose the constant giver compared to the percentage given to the rival, shown with the (3,x) and (4,x) condition collapsed.