ECONOMIC EXPERIMENTS THAT YOU CAN PERFORM AT HOME ON YOUR CHILDREN

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Abstract: Economic Experiments That You Can Perform At Home On Your Children
This paper describes some simple economic experiments that can be done using children as subjects. We argue that by conducting experiments on children economists can gain insight into the origins of preferences, the development of bargaining behavior and rationality, and into the origins of "irrational" behavior in adults. Most of the experiments are exploratory, and the objective is as much to learn how to conduct economic experiments on children and suggest avenues for further research as to describe specific results. Preliminary results suggest that while children are very different from adults in some ways, such as their rate of time preference, they are very similar in others, such as their bargaining and altruistic behavior. We also find that children can make choices that generally satisfy the usual transitivity test for rationality, and that in some ways they may even be more rational than adults. The paper includes protocols which can be used to replicate the experiments.

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I. INTRODUCTION

Economic theory is seldom used to analyze the behavior of children. We think it should be. Economic behavior starts in childhood, and children live in complex economic environments. They make choices about what to consume and they earn money. Children save, exchange goods, make decisions under uncertainty, and they share and bargain among themselves and with their parents and other adults.

This behavior is interesting for its own sake, and, if adolescents are included, it accounts for more than a trivial share of the total money economy. An understanding of the economic behavior of children is also important because of what it says about how families make economic decisions. Regardless of whether one believes that the family is the primitive unit of economic decision-making or whether family decisions are the outcomes of the self-interested actions of family members, the preferences and behavior of children are clearly important to this process.

While we believe that the study of the economic behavior of children can provide useful results for those studying these issues, a perhaps more important motivation is the simple fact that children grow up to be the adults that are the usual study of economists. In every science one of the first steps towards understanding something is understanding its development, and we believe economics is no different - we can learn a great deal about the economic behavior of adults by studying the development of that behavior in children.

Economists' tools are well suited for the analysis of many aspects of children's lives. The textbook description of economics is "the study of rational agents with insatiable wants and limited resources." The last two parts of that description, at least, are even more applicable to children than to adults, while the first is, at worst, only a matter of degree. The question then is whether we can learn interesting and important things by studying children. We have identified three research areas.

One concerns preferences. While it is possible that the preferences we see in adults are completely determined at fertilization, it seems unlikely. In this paper we discuss experiments that address preferences towards risk, consumption over time, and altruism at different ages. Another

question concerns bargaining behavior, or what Adam Smith called the "tendency to truck and barter." Is this behavior innate, as Smith claimed, or is it something that develops during childhood? The answer is clearly important for such issues as the design of market institutions and their success in different cultures. A third question concerns violations of rational behavior. If children are rational, the usual economic models should explain their behavior. The extent to which they do provides interesting information about the extent of that rationality. Perhaps more importantly, if adults are not rational an obvious place to start looking for the source of that failing is with the behavior of children. We develop experiments designed to test whether the violations of rational behavior that have been found in adult subjects can also be found in children.

In addition to these scholarly motives, there are other reasons to experiment on children. When we began, we simply wanted to give our children some idea about what sorts of questions economists were interested in and how they studied them. In doing so we found that children loved to participate in the experiments. They also enjoyed taking on the role of the experimenter, using their friends and classmates as subjects. Conducting experiments on children is also cheap: payoffs in dimes or candy represent significant changes in their budget constraints and are generally enough to make them think carefully about their decisions.

In this paper we describe modifications of economic experiments that others have used on adults, present some results in a simple fashion, to give rough ideas of how our subjects behave, and suggest directions for future research. With the exception of the last experiment, we did not conduct controlled experiments on random samples of subjects. Instead, we generally used our own children and their friends and classmates and concentrated on testing different protocols. Some experiments were not successful because the arithmetic was beyond the skills of our subjects. Some were too difficult to explain, or required so much simplification that the results were not interesting. However, some of our experiments worked very well in our trials. We report both the successes and some of the failures, with the objective of providing information about what works and what does not work.

Section II of the paper discusses the experiments. For each we include a brief introduction, a description of the experiment, some sample results, and a conclusion. Where appropriate, more detail

on the protocols is provided in the Appendix. Section III is an overall conclusion.

II.   EXPERIMENTS

EXPERIMENT 1: HOW MUCH WILL YOU BET?

This experiment measures risk aversion and also conducts a simple test for the existence of the "house money" effect, named after the often reported tendency of gamblers who win an initial bet to take bigger risks, since they are now playing with money won from the house. We use a very simple method for fitting the constant relative risk aversion (CRRA) utility function

$$U = \frac{x^{1-a}}{1-a},$$

where x represents disposable wealth and a is the coefficient of relative risk aversion. With this utility function the coefficient of relative risk aversion

$$\frac{-xu''(x)}{u'(x)}$$

is always equal to a, or more intuitively the aversion to gambles expressed as a proportion of wealth is constant as wealth changes.

To estimate the coefficient of relative risk aversion we ask children to choose the amount of money g that they wished to stake in a better-than-fair gamble. We then find the value of a that maximizes expected utility for that observed choice of g. Since the gamble has a positive expected pay-

off, the children are willing to gamble at least something. If g is a continuous variable, then the degree of risk aversion can be calculated from the size of the bet, using the formula

$$a = \frac{\ln\left(\frac{p}{2(1-p)}\right)}{\ln\left(\frac{e-g}{e+2g}\right)},$$

where p is the probability of winning the bet and e is the starting endowment, consisting of the initial wealth plus the amount given for the experiment. Since our subjects were only able to make integer choices for g, we are only able to calculate bounds on a.

We then use those bounds to find the second round bet that will maximize utility, by calculating the integer gambles that maximize expected utility for each of the bounds of a. For a given level of a, the formula for the optimal g is

$$g^* = \frac{e(k-1)}{w+k},$$

where $k = \left(\frac{pw}{(1-p)}\right)^{\frac{1}{a}}$.

For the gamble used in this paper, we can use the simpler formula

$$g^* = \frac{1 - \frac{1}{2^{1/a}}}{1 + \frac{2}{2^{1/a}}}e.$$

Note that the optimal bet is decreasing in the endowment e, because of diminishing marginal utility, and that it is a constant proportion of this endowment, because of the CRRA functional form. We find g^* for each of the bounds of a, and say that a subject exhibits the house money effect if they won the first round gamble and their second round gamble exceeds the highest of these gambles. Note that we are assuming our subjects do not make errors.

Protocol

Each subject was given 5 dimes and told that she could keep as many as she would like or that she could gamble with them in a "heads-or-tails" game. If the subject won the coin toss she received double the amount gambled. If she lost the coin toss she lost only the dimes gambled. After the outcome of the first round, we allowed the children to place another bet on the same terms. They did not receive any additional endowment before the second round, and could bet as much or as little as they liked. To avoid the possibility that subjects would treat the entire experiment as a compound gamble, we did not let them know initially that this would be a two-round game.

Results and discussion

We report results from eight second graders, with an average age of 7. We assumed that each had an initial wealth of $1, plus the $0.50 from the experimenter. The results are obviously sensitive to initial wealth, and it would be useful to obtain better measures. The amounts gambled and the calculated a's are shown in the second through fourth columns of Table 1. This subject pool displayed a great deal of heterogeneity in risk aversion. We talked with the subjects about why they chose to gamble the amounts they did. Even second graders readily understood the concept of diminishing marginal utility, if explained in terms of their typical consumption goods. In fact, some children spontaneously proposed that explanation for their behavior.

Table 1: Gambling Experiment Results

subject	round 1 gamble	Calculated a: low bound	high bound	outcome	wealth + endowment + winnings	predicted 2nd round gamble: low bound a	high bound a	actual 2nd round gamble
1	1	1.6	4.6	win	10 + 5 + 2 = 17	1	2	2
2	2	1.0	1.6	win	10 + 5 + 4 = 19	2	4	3
3	1	1.6	4.6	lose	10 + 5 - 1 = 14	0	1	1
4	2	1.0	1.6	win	10 + 5 + 4 = 19	2	4	2
5	5	0.45	0.56	win	10 + 5 + 10 = 25	9	11	5
6	4	0.56	0.72	lose	10 + 5 - 4 = 11	2	3	1
7	3	0.72	1.0	lose	10 + 5 - 3 = 12	2	2	2
8	1	1.6	4.6	win	10 + 5 + 2 = 17	1	2	1

The second part of the experiment, as noted above, tests for the existence of the house money effect. This effect is often reported for adults, and we wanted to see if it could be found for second graders. Note that the assumption of constant relative risk aversion implies that those with larger wealth should make larger gambles. This could be a significant effect with children, given their small initial wealth, so we incorporate this in the calculation of the predicted second round gambles shown in the table. Considering the casual way by which it is estimated, and the supposedly unpredictable nature of children's behavior, the close relationship between the estimated optimal gambles and the actual gambles is rather surprising. Only two of the subjects, numbers 5 and 6, diverged from the estimated optimal bet. Of these, only subject 5 was a winner, and she actually gambled less than predicted.

While they obviously constitute a low power test, these results are not consistent with the prediction that children will tend to be less risk averse when gambling with house money. It may be that the sums of money involved in this experiment are so large to the children involved (it's easily possible for them to double their weekly incomes) that they are more careful in optimizing than adults. Another possible explanation may derive from the "mental accounts" explanation for the house money effect. The argument is that people budget by dividing their money into accounts for their various expenditures. Gambling loses are subtracted from the mental gambling account, and winnings are added back in, rather than thought of as a general increase in wealth. This explanation is often motivated by people's

need to budget so as to make sure they can pay their bills. It seems inappropriate for young children, who suffer small costs from failing to budget their money.

If the above results hold with more rigorous testing, this is an example of an apparent divergence between adult behavior and the behavior of children. We find it rather interesting that it may well be the case that the expected utility model may actually predict children's behavior better than it does adult's.

EXPERIMENT 2: HOW BIG A CHANCE?

This is a quick experiment that to our knowledge has not been done on adults or on children. Give the subject a nickel, a dime, and a quarter on the condition that he agrees to choose one of the coins and gamble it. Heads you give him another of that coin, tails you take it back. In either case, the child keeps the coins that he didn't risk. Children generally decide to flip the dime. (Richer children, and presumably adults, may need to have the bets scaled up to get this effect.) This choice cannot be explained using the traditional version of expected utility theory, under which people are either risk averse, in which case they should gamble the nickel, or risk lovers, in which case they should gamble the quarter. The problem is the same as that of people with insurance policies buying lottery tickets. Interestingly, choosing to gamble the middle value is also at odds with the most common alternative to expected utility, Kahneman and Tversky's (1979) prospect theory. Prospect theory argues that people show risk aversion over gains, and so predicts that the child will gamble the nickel.

EXPERIMENT 3: THE SHOPPING GAME

This experiment tests the hypothesis that a child's behavior can be explained as resulting from the maximization of a continuous, monotonic, quasi-concave utility function. Afriat's (1972) theorem shows that satisfying the Generalized Axiom of Revealed Preference (GARP) is a necessary and sufficient condition for data resulting from such a process. Satisfying the GARP requires that if bundle x is revealed preferred to bundle x', it must not be possible to buy bundle x at the prices and incomes prevailing when x' was chosen.

In this experiment the subject is asked to allocate a budget between consumption of two

different goods. Wealth and the prices of the goods change for different "tries" of the experiment. After the child has made a decision for every try, the experimenter picks one try at random, and the subject gets the allocation that she chose for that try. Goods that are perfect substitutes or that are radically different in quality will produce many corner solutions and may not be the best test of rationality. We used pencils and small balls for the experiment reported here. In other experiments we have used various types of candy, with very similar results.

Our first efforts at revealed preference experiments made it clear that our subjects had trouble with the multiplication and addition necessary to calculate feasible allocations from prices and incomes. To work around this we presented them with a table showing all the allowable integer combinations of the two goods for each try. The child could then simply pick the most preferred quantities for each try from the lists. We then checked for violations of the GARP using an algorithm that accounts for the fact that a limited number of discrete bundles of goods are offered in each list.[1] In this situation, the criterion for satisfying the GARP can be restated as requiring that if bundle x is revealed preferred to bundle x', neither bundle x nor another bundle with all goods greater than or equal to those in x can be in the list where x' was chosen. In Figure 1, the combinations of goods we used are shown as dots, and the implicit budget constraints from which they are derived are shown as lines. The constraints were chosen so as to cross in many places, making it easy to violate the GARP.

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1 The algorithm is available from the authors as a Mathematica notebook. It is based on a version for the continuous case by Hal Varian (1995).
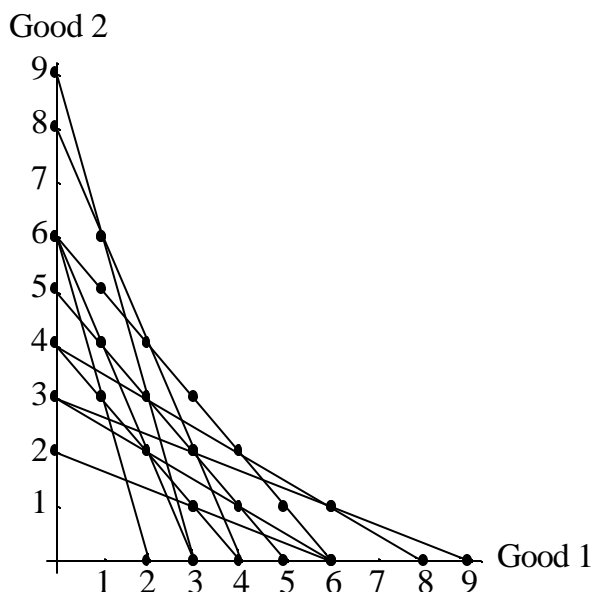
FIGURE 1: CHOICE SETS FOR THE REVEALED PREFERENCE EXPERIMENTS

Protocol

Subjects were told that they would get toys by participating in this experiment, but that unless they chose carefully the amounts and kinds of toys that they received might not be what they really wanted. The subjects were then shown a form with 11 lists of choice bundles, one list for each budget constraint in Figure 1. Each bundle was a combination of different amounts of the two goods, or a dot from the figure. Each child was told to choose his or her favorite bundle from each of the 11 lists, and that one of these bundles would then be picked for them at random. After the subject had made a choice from each list, the experimenter puled a number out of a hat to determine which choice would be paid out.

Results and discussion

Table 2 shows data from a sample of 5 children aged 7 to 11. Three of the subjects have no violations, the other 2 have 2 violations each. Choices that violate the GARP are in bold. The last column of the table shows Afriat's efficiency index, which can be seen as a measure of the severity of the violations. The index shows the smallest wastage of income which would make the observed choices

satisfy the GARP.[2] For subject 2, the violations are rather minor, using Afriat's measure, while for subject 4 at least one is very large. We ran computer simulations picking bundles at random, and found an average of 5.7 violations and a severity index of 0.65 with these choice sets. Our subjects' behavior does not seem random.

TABLE 2: RESULTS FROM THE SHOPPING GAME.

Subject	Age	Good x, good y choices for each of the 11 tries											number of GARP violations	Afriat's severity index
1	7	0,6	2,3	0,9	2,2	2,4	2,3	0,2	0,2	5,1	8,0	6,1	0	1
2	9	0,6	3,0	**1,6**	0,4	**3,2**	3,2	6,0	4,1	3,3	4,2	9,0	2	0.89
3	10	0,6	3,0	3,0	4,0	1,6	1,4	6,0	6,0	0,6	8,0	9,0	0	1
4	10	**0,6**	1,4	0,9	1,3	0,8	1,4	**6,0**	2,2	0,6	8,0	9,0	2	0.33
5	11	2,0	3,0	0,9	4,0	3,2	2,3	3,1	6,0	5,1	2,3	9,0	0	1

We were interested in seeing whether the frequency and severity of violations increased with age and other factors, so we replicated this experiment, first on undergraduates and finally on Ph.D. economists. Violations were still distressingly common. One possible explanation for this was suggested in exit interviews with the economists, who professed to be very uncomfortable having to make choices based on lists of alternatives, instead of information on the incomes and prices used to compute the lists. The consensus was that with this information they could have easily found choices that would not have violated the GARP. Indeed its not hard to think of a few simple rules of thumb that, when applied to information about prices and incomes, would guarantee choices consistent with GARP.

This raises the question of what adults are actually doing when they choose, in the real life situation of income constraints and prices. Are people making choices that maximize a continuous, monotonic, quasi-concave utility function or are they simply applying rules of thumb along the order of

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2 The index is computed using relative prices and incomes which will generate each discrete list of choices.

"well, the price of tomatoes went up, so I'd better buy less this week." If consumer choice is driven by simplifying rules of thumb it may be possible to determine whether these rules vary with age and at what age children begin to employ adult-like rules.

We argue that this experiment shows that even rather young children are very deliberate in their economic decision-making and not necessarily less rational than adults. They seem to ponder seriously the choices presented in our experimental settings, and they are notorious for lengthy deliberation at real stores.

EXPERIMENT 4: MAKING YOUR BEST BARGAIN

Psychologists have looked at bargaining behavior in children. Toda, Shinotsuka, McClintock and Stech (1978) found that competitive behavior in non-economic settings increases with age. Murnighan and Saxon (1998) examined children's behavior in an ultimatum game with hypothetical payoffs. They found that their youngest subjects, kindergartners, seemed quite unstrategic, sometimes offering everything. They were also most likely to not reject very small offers. Third graders demonstrated a strong sense of fairness when they were dealing with M&M's, but were strategic with money. In general, subjects seemed much more interested in M&M's than money, and behavior was often different across the two treatments. Older subjects offered less to their partners than did younger subjects, and were also more likely to reject small offers.

We used an alternating offers experiment to study bargaining behavior. This requires two subjects, though one can be the experimenter. The goal is to reach an agreement over the division of an endowment. One subject proposes a division of the endowment. The other subject can either accept or reject. If she accepts, the experimenter implements the division. If she rejects she then makes a counter-offer, and the other subject then accepts or rejects. The pay-offs for this experiment were structured so that delay in reaching an agreement reduced the size of the prize. We accomplished this by using a pile of candy as the prize, with the experimenter taking away one piece each time an offer was rejected.

Our first attempt to investigate the bargaining behavior of children used a model with no costs. Kagel and Roth (1995) discuss the fact that equal division is common in these kinds of experiments.

Children do the same. In every case the first mover would offer as close to a 50/50 split as possible, and this offer would be accepted. In a sense this is encouraging: the Pareto optimal result is first round agreement. When asked, the offeror generally explained that this offer was "fair." Further questioning however, revealed that offerors also expected that an offer of less than half would be rejected. We then conducted the experiment described below, which was slightly more successful at inducing competitive behavior.

Protocol

We used an experiment following Hogatt et al. (1978) where "costs" known only to the individual are subtracted after the division is agreed upon. Costs were either high (6) or low (0) and were determined by draws from a fair deck. We did not try to maintain anonymity. Subjects were not allowed to accept an offer that did not cover their costs. With each iteration, the total to be divided was reduced by one piece of candy. The total initial endowment was ten pieces of candy.

Results and Discussion

We did seven runs on pairs of seventh graders, using small candies as the prizes. The behavior we observed was extraordinarily cooperative. In five runs the subjects managed the result that maximizes group payoff: agreement on the first offer. This occurred even when the costs were unequal, indicating a strong preference for quick agreement. (While we prohibited side payments after the experiment, we have found that children are experts at evading such restrictions.) Of the remaining two runs, one involved a proposed 5/5 split where the second mover had costs of six. By the rules, he was not allowed to accept. In the next round, the second mover proposed a 7/2 split, and that was accepted. In the other run that did not end with the first offer, the initial offer was 9/1. The second mover had costs of six, so this was rejected. The second mover counter-offered with 7/2 which was rejected. The first mover then offered a split of 2/6, which was accepted. While it is not surprising that the second mover accepted a 2/6 offer, the making of that offer seems inconsistent with the first mover's rejection of the 7/2 proposal. One explanation might be that the first mover realized that the second

mover had costs of six only after rejecting the 7/2 offer.

While these results obviously suggest something about children's attitudes towards fairness, they make it difficult to say anything about their ability to behave strategically in a bargaining situation. In order to induce more competitive behavior, we tried dividing the subjects into teams, telling them that they should try to get as much candy as possible for their team. By couching the game in terms of team payoffs, we hoped to take advantage of inter-group altruism and intra-group competition. However, initial results with this technique have not been encouraging, perhaps because of the rather complicated protocol we used.

EXPERIMENT 5: HOW LONG DO YOU WANT TO WAIT?

The ability to defer gratification is considered a hallmark of maturity (see for example, Krueger, Caspi, Moffitt, White and Stouthamer-Loeber, 1996) and has been shown to increase with age. (Mischel, Shoda and Rodriguez, 1989.) Therefore, we would expect a child's discount rate to fall with age. This experiment is designed to measure discount rates. It originated with an old family tradition, according to which the "tooth fairy" buys a child's baby teeth at a price that depends on the day of the month on which the tooth comes out. If the tooth comes out on the first of the month, the price paid is a dime, on the second day the price is two dimes, and so on. We made a slight modification to the tradition, allowing the child to delay putting a tooth under the pillow for as long as she wanted. Note that on the fifth day of the month the subject earns a return $r = \$0.10 / \$0.50 = 20\%$ by waiting one day. On the tenth of the month, the return to waiting has fallen to 10%. This aspect of the tooth fairy's payout makes it easy to approximate the discount rate, using revealed preference.[3] Our subjects have shown astonishingly high discount rates: 3% per day is not unusual.

Of course, neither a tooth nor a tooth fairy is necessary for this experiment. An alternative procedure would be to put a dime in a jar and explain that another dime will be added to the jar every day until the child decides to empty the jar. Bounds for the interest rate can then be found using the

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3 There is also an income effect. However, a dime is such a small portion of lifetime earnings that the bias owing to this should be negligible.

formula given above. The same experiment can be done with candy, but it is likely that the result will be downward biased by the fact that the marginal utility for that particular good will diminish at a faster rate than that for money. Children can of course perform the same experiment on their parents, using some good that the child knows the parent enjoys. Be aware that if the experiment is simultaneously performed on more than one subject, an element of competition will be added which may bias the results. An additional important possible bias can occur when a child is trying to accumulate a specific amount of money, to buy some particular good.

If our estimate of the rate at which children discount future consumption is remotely close to correct, it follows that, somewhere between the ages of 6 and, say, 26, discount rates change by about 2 orders of magnitude. A very small difference in the extent of this change would have a large effect on the discount rate of adults, a parameter of fundamental importance to the economy.

EXPERIMENT 6: **SHARING**

Last we discuss a more formal experiment, conducted on large numbers of subjects, using a protocol that we designed to be as similar as possible to those that others have used on adults. Complete results are in Harbaugh and Krause (1998). The basic experiment, as typically performed on adults, is very simple. Subjects are put into groups of size n and given some money. They can keep the money or contribute it to the group. Contributions to the group are multiplied by some parameter a that is greater than one but less than n, and then divided equally among all group members. The ratio a/n is the marginal private return (MPR) to a contribution.

Since a is greater than one, the pareto optimal decision is to give everything to the group. Since it is less than n, the individually rational contribution, for a selfish person, is to give nothing. Adults playing this game are initially far more generous than would be true if they were motivated by plain selfishness. With repetition, most gradually start to free-ride, but many continue to contribute substantial amounts, suggesting that a taste for altruism is, if not universal, at least widespread. The existence of such a preference is confirmed by a wide variety of behaviors in non-experimental settings. One of our objectives in this experiment is to compare the extent of altruistic behavior in children with that of adults.

Protocol

Our subjects were recruited at after school programs, and randomly assigned into groups of six. We used a's of 2 and 4, making for MPR's of one-third and two-thirds. Instead of money, we gave each an endowment of five white poker chips before each round. They were told that at the end of the experiment they would be able to use the tokens to purchase goods such as fancy pencils, small stuffed animals, super balls and toy airplanes from a store which we set up at the site. The exchange value of one token was about 10 cents. In what can only be described as a very successful effort to increase the salience of the rewards, subjects were shown the goods available at the store in advance. From surveys of their parents we learned that our subjects averaged about $3 in weekly allowance, so they typically doubled or tripled their disposable incomes for the week.

The subjects were seated behind partitions, and were assured that all their actions would be confidential and that we would never disclose who was in what group. They were given a cup to keep their earnings in, and a padded manila envelope marked with their identification number to be used for contributions. At the beginning of each round their 5-token endowment was placed in front of them and they placed the tokens they wanted to keep in their cup and the tokens they wanted to contribute in the envelope. After each round the envelopes were collected, payoff computed, and the earnings returned to them in the same envelopes. They were then asked to count out the returned tokens and place them in their cup. When this was done, we distributed 5 new tokens to each participant and started the next round.

We emphasized that each token they contributed to the group would result in every person in the group getting one-third (two-thirds in the high MPR treatment) of a token, and that therefore contributing a token would mean less for them personally, but more for the group. We also acted out two different scenarios, showing that when everyone donated, the group got more, but that any one member could do even better by not donating.

Results and Discussion

The initial level of contributions was very comparable to the one-third to one-half of the endowment typically found in experiments on adults. As can be seen in Table 3, first round contributions for the subjects at sites with the higher MPR were higher than those at the low MPR sites. This difference, which Ledyard (1995) calls one of the "strong effects" to be found in public goods experiments, is significant at the 0.05 probability level using a t-test.

While children's' contributions in the first round are similar to those of adults in terms of the level of contributions and the effect of the MPR, the pattern over time is different. While contributions by adults generally decrease over time, as seen in Figure 2, contributions by children tend to increase over time. Since (for selfish preferences) the Nash equilibrium in these experiments is zero contributions, this increase is the wrong direction from the point of view of most learning models. If we look at the relationship between age and the change in contributions, we find the increases are coming from the younger children. Children aged 10 and above do seem to be learning to free-ride.

TABLE 3: FIRST ROUND CONTRIBUTIONS BY MPR.

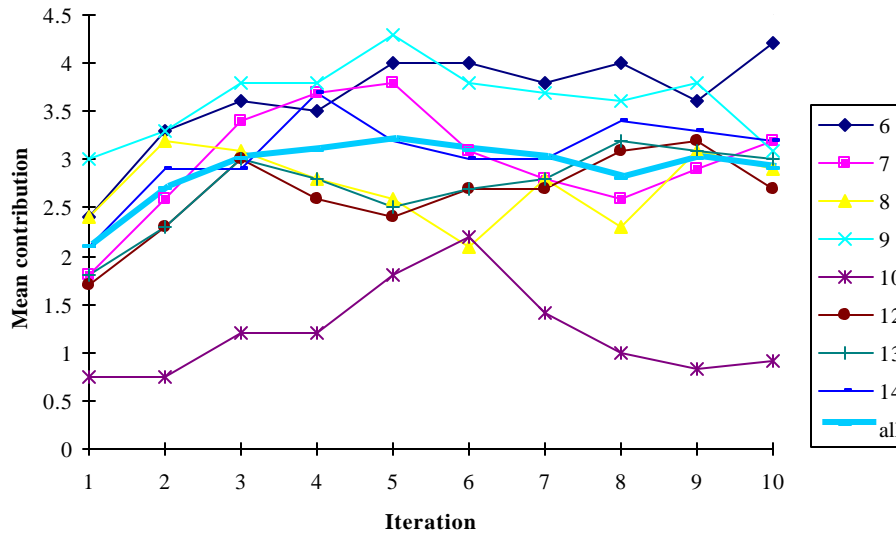| Site	Subjects	First round contributions: Mean	S. Dev.
Low MPR sites	137	1.9	1.5
High MPR sites	71	2.4	1.6

FIGURE 2: MEAN CONTRIBUTIONAS AT DIFFERENT SITES, BY ITERATION

We believe that the finding that young school children contribute in a way that is not drastically different than that of adults is robust and somewhat surprising. In the other experiments described above we show that some behaviors change drastically between childhood and adulthood - choice over time, for example. However, on further thought, it seems appropriate that children would have the same sort of altruistic behavior as adults: both live in very social environments with repeated interactions with others, and with many opportunities for others to observe their behavior and reward or punish them for it. Our subjects are already old enough to have received a large amount of encouragement to engage in sharing activities, and have experienced the advantages, and disadvantages, of altruism in many different settings.

III.   CONCLUSIONS

In this paper we have discussed the development of protocols for economic experiments that can be performed on children. We believe that we have shown that there are no inherent reasons why such experiments cannot be performed successfully, and in fact that in some ways, such as cost and salience, children may be better subjects than adults. With the exception of the last, these experiments

were done informally with children that we know, and not with a random sample under controlled conditions. Still, the results of even these casual experiments suggest that further work on the economic behavior of children will produce interesting results.

We have shown that when faced with economic choices, children generally behave as economic theory predicts rational agents should. This was true even among children who were too young to calculate probabilities, compute expected returns, or in some cases, multiply numbers reliably. This finding should not really be a surprise. Kagel (1987) discusses some similar results for rats and pigeons. When our subjects did not behave according to the theory, their deviations were generally predictable, and resembled the deviations that we find in adults, such as "excessive" altruism.

We found that children's behavior in experiments can be very close to that of adults. They do not seem to be totally selfish, and their willingness to share is responsive to the cost of doing so. They seem to exhibit a similar taste for fairness in bargaining situations. In some ways, such as behavior under uncertainty, it may turn out that theories such as expected utility maximization predict children's behavior better than they do that of adults. It is also clear from this study that the preferences underlying children's behavior can be very different than those adults, such as their extremely high rate of time preference.

We believe that further experimental study of children's economic behavior will lead to a better understanding of the behavior of adults, by providing information about the formation of preferences and about the origins of the violations of rational behavior that are commonly detected in experiments.

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APPENDIX: PROTOCOLS FOR THE EXPERIMENTS

EXPERIMENT 1: HOW MUCH WILL YOU BET?

Instructions to the experimenter:

      You should have about $3 in change for each child who participates in this experiment, but you will probably not need it all. You may want to adjust the amounts to fit the age of the child, or use candy instead of money. Record the amount gambled, and the current disposable wealth of your subject before the experiment. For consistency between subjects, this wealth should include all funds available to the child for discretionary purchases over the following 7 days.

Instructions to the subject:

      "I am giving you these 5 dimes. You can keep them if you want, and spend them on whatever you want next time we go shopping. Or you can gamble some or all of the dimes with me. The gamble works this way. You put however many dimes you want to gamble into a pile, and the rest into your pocket. No matter what happens you will get to keep the dimes in your pocket. After you've decided how much to gamble, I will flip a penny. If it comes up heads, you get to keep the dimes in the pile, and I will also give you two extra ones for each one that you had put into the pile. But, if the coin comes up tails, I get to keep all the dimes in the pile. For example, suppose you bet 2 dimes. If the coin comes up heads, I'll give you another 4 dimes, and you'll have 9 dimes all together. If it comes up tails, you'll be left with 3 dimes. Do you understand the game?"
After the outcome of the first round, announce the following: "Ok, I've decided to repeat the game one more time. The rules are the same as before. How many dimes would you like to gamble this time?"

EXPERIMENT 3: THE SHOPPING GAME

Instructions to the experimenter:

      The budget constraints we used are given below. The Mathematica program for checking choices for GARP errors is available from us on request. While in our experience children 10 or older can do the experiment with paper, an alternative that works well with younger children is to display the physical bundles on tables or desks, one table for every try. We then give the children 11 slips of paper with their names on them, and tell them to slide one slip under the bundle they like the best at every table. Alternatively, the bundles for each of the budget constraints can be put on a different sheet of paper. This makes it easier to explain to the subjects that they can only pick one bundle from each try.

Instructions to the subject:

      This is an experiment about how you make choices. By playing, you will get some toys (or candy.) But unless you are careful about how you choose, you may not get exactly the amount or the kind of toys that you want. Look at the table. Underneath the part that is labeled "Try 1" there is a column for Tootsie Rolls and a column for Jolly Ranchers. (Or whatever two goods are being used.) You can decide on any combination of Tootsie Rolls and Jolly Ranchers that is in the list under Try 1.

After you chose a combination under Try 1, chose one for each of the other tries. When you are all done choosing, I will pick a letter from 1 to 11 from this hat. Since you don't know what number will come out of the hat, look carefully at the list under **each** try and chose the combination that will make you happiest.

ALLOWABLE CHOICES FOR THE SHOPPING GAME.

TRY 1	TRY 2	TRY 3	TRY 4	TRY 5	TRY 6	TRY 7	TRY 8	TRY 9	TRY 10	TRY 11
X,Y	X,Y	X,Y	X,Y	X,Y	X,Y	X,Y	X,Y	X,Y	X,Y	X,Y
2,0	3,0	3,0	4,0	4,0	5,0	6,0	6,0	6,0	8,0	9,0
1,3	2,2	2,3	3,1	3,2	4,1	3,1	4,1	5,1	6,1	6,1
0,6	1,4	1,6	2,2	2,4	3,2	0,2	2,2	4,2	4,2	3,2
	0,6	0,9	1,3	1,6	2,3		0,3	3,3	2,3	0,3
			0,4	0,8	1,4			2,4	0,4	
					0,5			1,5		
								0,6		

EXPERIMENT 4: MAKING YOUR BEST BARGAIN

Instructions to the experimenter:
     We used an experiment where "costs" are subtracted after the division. These costs were determined by draws from a fair deck. A black card meant costs were 0, a red card meant they were 6. Only the first mover drew a card, and subjects were not allowed to show their cards to each other. These instructions presuppose that subjects are seated across from each other. An alternative is to put groups in separate rooms, tell each person that they are paired with a randomly chosen person from the other group, and promise anonymity.

Instructions to the subject:
     This experiment examines how people make bargains. You and the other player must decide how to split this pile of candy. You will get to keep the amount of the pile you agree on, minus your cost. If you draw a red card, you have high cost, and 6 pieces of candy will be subtracted from your pile. If you draw a black card, you are low cost, and nothing will be deducted from your pile. You are not allowed to show your card! (Draw cards now.) **You can't agree to a pile that is smaller than your cost! Then you would owe me candy, and that's not allowed!**
     To decide how to split the candy you will take turns making offers as follows. Person A goes first. A splits the pile into a part for themselves and a part for the other person. Person B then decides whether to accept or reject this split. If B accepts, each person gets the candy in their pile, minus their cost. If B rejects, then B gets to propose a split of the candy, and A gets to accept or reject. However, every time an offer is rejected, one piece of candy gets subtracted from the pile.

EXPERIMENT 6: **SHARING**

LINEAR PUBLIC GOOD PROTOCOL:

We first had the subjects gather around a table and read the following instructions to them.

We are going to play a game. By playing the game, you will earn tokens that you can use to buy things at our store. (Show store.) Each white token that you get during the game is worth about 10 cents, and in addition you may get some red tokens that are worth about 3 cents. Pay very careful attention to these instructions, because the better you understand them the more tokens you can earn, and the more tokens you have the more things you will be able to buy. If you have questions raise your hand. Otherwise, please be quiet and listen carefully, just like you would to your teacher in school.

You will get 10 turns at the game. At the beginning of each turn we will give you 5 white tokens, and you may get more tokens at the end of each turn, depending on your decisions and the decisions of the people in your group. Remember, the more tokens you have at the end, the more stuff you can buy, so pay careful attention to these instructions! You are going to be in a group with 5 other kids. You will be in the same group during the whole experiment. We are not going to tell you who is in which group, and we aren't going to tell anyone else who is in your group. We are going to keep this a secret even after the experiment is over, so no one will ever know.

You get to decide whether you are going to keep your tokens or are going to share them with your group. We do not think it would be better for you to share the tokens or better to keep them. No one will know how many you shared or how many you kept or whether you shared or not. Keep your decision a secret: you are not allowed to ask other kids what they did, or tell them what you did. If you do, we may come and take a token away from you!

You will be sitting at these desks. Each desk will have a "keeping cup" and a brown envelope in front of it. The keeping cup is for your tokens, and the envelope is for the ones that you want to share. At the beginning of each round, we will give you 5 new tokens. You will put the ones that you want to share in your envelope, and the ones that you want to keep in your cup. You can share any number of tokens, from zero to 5. The partitions are there so that you can keep your choice a secret. When everybody has made their choice we will collect all the envelopes.

Now, I will tell you how the sharing works. I will add 3 more tokens for every 1 that kids share. So, what if I get these six envelopes back? (Experimenter then dumps out six envelopes that have one token each) See, each envelope had one token in it. Now there are six tokens in this group's pile. (Experimenter then counts out the ones that are added.) Now there are 24 in the pile. So now I need to split this up to the six kids: each one gets four tokens back. I will put 4 tokens in each envelope, and

deliver them back. These kids would then put the tokens in their keeping cups.

Let's try that again. So, what if I get these six envelopes back? (Experimenter dumps out six envelopes that have 0,1,1,0,3,0 tokens in them.) OK, now there are five tokens in this group's pile, so I add three more five times. Now there's 20 in the pile. Each kid gets 3 back, and I have 2 left over. See these red tokens? Three reds equal one white. So I am going to make some change, just like 5 pennies make one nickel. (Count out, 3 reds for each white) Now I have six reds, so each kid can get one. I will put 3 whites plus 1 red in each envelope.

Remember: If you get a red one back, it means just part of a white one. ALL the kids in each group get back exactly the same number of tokens, no matter how many they share or keep. Notice that the kids who shared nothing got just as many tokens back as the kid who shared 3.

We then had the subjects sit down at tables, with tri-fold partitions for privacy, and read them following.

There are five white tokens at your place. These tokens belong to you. You may keep all of them if you want, or you can share some or all of them with your group. We do not think it would be better to share or to keep, we are just interested in what you decide to do.

Decide how many tokens you want to keep and put them in your cup. Put the number of tokens you want to share in your envelope. When you are ready raise your hand so a helper can pick up your envelope. Don't let anyone else see how many you are sharing or keeping!

Remember: For every token that you and the other kids in your group share, I will add 3 more tokens. Then I will divide all the tokens up equally. If you get a red one back, it's as if I tried to divide up a white token in three parts.

Remember: You might get back more than you shared, but you might get back less. It all depends on what the other kids in your group do.

We then collected the envelopes, recorded the contributions, and passed back the earnings. The following was read after each subsequent round.

OK, now let's play another turn. A helper will give you back your envelope with the tokens you get from your group's pile, and another helper will give you five new tokens. You can't share any of the tokens that you get back in your envelope, so count them, quietly, and then put them in your cup right away. You can share as many of your new tokens as you want to. Raise your hand when you're ready to have your envelope picked up. The same five other kids are still in your group. They don't know

whether you are in their group, or how many you shared last time.

After the ninth round, we also read the following.

The game is almost over. You have only one more turn to play this game.

After the tenth round, we read this.

We hope you enjoyed the game. Now we want you to start counting out your tokens. We will hold up the things from the store one at a time. If you want to buy something, hold up your hand and we will bring it around to you. Thanks for helping us.