Young children use commodities as an indirect medium of exchange *

Isabelle Brocas
University of Southern California and CEPR

Juan D. Carrillo
University of Southern California and CEPR

November 2020

Abstract

Barter and commodity markets have been ubiquitous throughout history, suggesting that humans are good at exploiting profitable exchange opportunities. This paper studies our ability to trade through a developmental approach. We present a market experiment involving children who have not yet fully developed trading habits and are relatively unfamiliar with the concept of money. Namely, we ask 117 children aged 5 to 8 to trade in situations in which efficient market outcomes can either be achieved through simple barter or else necessitate the endogenous emergence of commodity money (trade requires transitory bookkeeping losses). We find that equilibrium outcomes are frequent (74% to 82% of subgroups depending on the treatment). Pareto efficient equilibrium outcomes occur in 82% of barter economies and 53% of commodity markets. Finally, 47% of children always trade efficiently. The results indicate that many young children can engage in profitable market exchanges.

Keywords: field experiment, market experiment, developmental decision making, trade.

JEL Classification: C93.

*We are grateful to members of the Los Angeles Behavioral Economics Laboratory (LABEL) for their insights and comments in the various phases of the project. We are especially thankful to Gabriele Camera and John Duffy for comments and suggestions. We also thank Nordine Bouriche and the staff at the Lycée International de Los Angeles for their support. All remaining errors are ours. The study was conducted under the University of Southern California IRB UP-12-00528. We acknowledge the financial support of the National Science Foundation grant SES-1851915. Address for correspondence: Juan D. Carrillo, Department of Economics, University of Southern California, 3620 S. Vermont Ave., Los Angeles, CA 90089, USA, <brocas@usc.edu>.

1 Introduction

Commodity money – a medium of exchange using goods with an intrinsic value – has been present in societies since the neolithic (Davies, 2010). Markets based on commodity money have been long recognized as a significant improvement over barter economies (which require a double coincidence of needs) and gift-exchange economies (which require trust and repeated interactions) (Smith, 1887; Jevons, 1885). Modern anthropologists argue against the existence of any large scale economy that operated without some form of currency (Humphrey, 1985), and case studies report that commodity markets spontaneously develop in closed economies such as prisons and POW camps (Radford, 1945), or in periods of monetary instability (Friedman, 1994). The ubiquitous presence of commodity money suggests that humans have a natural ability to exploit profitable exchange opportunities (Einzig, 2014; Quiggin, 2017).

In the last decades, economists have made significant progress in understanding the role of money as a medium of exchange (see e.g., Kiyotaki and Wright (1989, 1993); Lagos and Wright (2005)). Theories have been tested in controlled laboratory environments with an adult population (see McCabe (1989); Lian and Plott (1998); Duffy and Ochs (1999); Camera et al. (2013); Duffy and Puzzello (2014); Camera and Casari (2014); Jiang and Zhang (2018) for some examples and Duffy (2016) for a comprehensive survey). However, the question of how natural is our ability to trade and, more specifically, to recognize the value of commodities as a medium of exchange has not been addressed. Such questions require a developmental perspective. Indeed, adults are presumably "experts" at exchanges. By asking children to trade at an age at which trading habits are not entirely developed and money is still a somewhat unfamiliar concept, we can assess their aptitude to engage in profitable exchanges in markets of varying complexity.

To address this question, we design a field market experiment (Harrison and List, 2004) with young children – 5 to 8 years of age – and determine whether they can identify and exploit market opportunities and gains from trade in different environments. We consider three situations. In the *barter* treatment, trading is 'easy': the Pareto optimal outcome can be achieved through a series of bilateral trades, where all parties benefit from every exchange. This environment is closest to barter economies, since all trades are based on the double coincidence of needs. In the *commodity* treatment, trading is 'hard': some participants need to accept a temporary bookkeeping loss in order to eventually reach the Pareto optimal outcome. This situation is closest to commodity money markets, since trading only occurs if individuals recognize the value of a commodity as an indirect medium of exchange. In the *inefficient trading* treatment, there are no direct or indirect profitable trades, and any exchange is necessarily detrimental for at least one party. This environment is used as a control, and helps measure trading for motives other than a payoff improvement (altruism, experimenter demand, etc.).

The paper characterizes the equilibria in those markets and addresses two sets of questions. First, we investigate the empirical properties of our experimental markets, testing both for equilibrium compliance (is an equilibrium reached?) and for equilibrium selection (which equilibrium is reached?). Given our markets differ in trade complexity, we compare compliance and selection across markets. This analysis focuses on the performance of children at the subgroup level (three subjects, each in a different role). We study the sequence of trades, final allocations and efficiency. Second, we examine individual trading decisions across markets and we assess differences related to age and individual characteristics elicited through a short questionnaire. This aims to reveal the developmental trajectory in our window of observation and to identify traits that promote market performance.

We show that 82% of subgroups in the barter treatment and 79% in the commodity treatment reach an equilibrium outcome, that is, a situation where no pair of subjects can improve their payoffs with a bilateral trade. While this is below what we would expect from educated adults in such a simple setting (100%), it reflects a good understanding for a considerable fraction of subjects, especially given their limited attention and developing cognitive skills. Also, 82% and 53% of subgroups in the barter and commodity treatments reach the unique Pareto efficient outcome where all subjects obtain their highest payoff. It suggests that at least half of our population of young children understand and exploit market opportunities. The data also confirms the nested difficulty of these treatments. We then show that deviations across treatments are qualitatively and quantitatively different. In the barter treatment, there is excessive trading that results in minor (8%) aggregate losses. In the commodity treatment, there is insufficient trading, mainly because some subjects choose to keep their initial endowment and remain in the Pareto inferior equilibrium. These deviations imply significant (24%) losses. In the inefficient trading treatment, there is a small but statistically significant number of trades (one every nine subjects). Since these trades typically benefit one subject more than it hurts the other, they translate into small but positive welfare gains. Third, the analysis at the individual level shows that subjects are more likely to get the Pareto optimal equilibrium payoffs in the barter and inefficient trading treatments than in the commodity treatment. Equilibrium payoffs are also more prevalent for subjects with a self-reported preference for STEM over Arts and Humanities. By contrast, we found a negligible effect of age within our window of observation.

Surprisingly, List (2004) and List and Millimet (2008) are, to our knowledge, the only existing markets experiments with children. In these articles, the authors study price evolution in a decentralized sportscard trading market with slightly older children (average age 9.5 and 13, respectively). The papers show convergence to neoclassical equilibrium both when all children are experienced and when children are inexperienced buyers but they face professional experienced adult sellers. Convergence fails only when the market is populated by inexperienced children on both sides.

2 The experiment

Conducting a field experiment with a population of children presents interesting methodological challenges.[1] These challenges are more pronounced in market settings because protocols are usually more involved, and also with younger children because they are more prone to distractions and less capable of abstract reasoning. As developed below, we employ a novel design to address these obstacles.

2.1 Population

We recruited 117 children in three grades: 38 from kindergarten (K, ages 5-6), 37 from first grade (1, ages 6-7) and 42 from second grade (2, ages 7-8), at the Lycée International de Los Angeles (LILA), a french-english bilingual private school in Los Angeles. Families at LILA are predominantly of caucasian ethnicity and upper-middle socio-economic status. The population is homogeneous although not representative of the US.[2]

2.2 Game and treatments

We conduct a market experiment to study the ability of young children to engage in efficient trade, avoid inefficient trade, and understand the opportunity cost of exchanges. The experiment is an implementation of a much simplified version of the Kiyotaki and Wright (1989) model. We formed groups of six participants, mixing males and females from the same grade. Children could not choose the groups they were in, and groups remained fixed for the entire session. We use a within-subject design where each group played the three trading treatments $\mathbf{t} \in \{\mathbf{B}, \mathbf{C}, \mathbf{I}\}$ in a randomized order, which we call 'barter' (**B**), 'commodity market' (**C**) and 'inefficient trading' (**I**) for reasons that will become clear in the next section.

[1] See Fréchette (2016) for a discussion of the methodological challenges posed by different populations and Brocas and Carrillo (2020b) for guidelines on how to address those challenges in the specific case of children. List et al. (2018) and Sutter et al. (2019) provide surveys of experiments with children.

[2] Ideally, we would have wanted a larger sample size but it is difficult to get a vast population of homogenous children. On the positive side, there is little self-selection within the school, since 73% of all the children in these grades took part in the study. Also, given the negligible effect of age (see later), 117 subjects is a large enough sample size to obtain statistically meaningful results.

The rules of the three treatments are identical. For each treatment, there are three roles $r \in \{a, b, c\}$, and each group has exactly two subjects in each role. A subject in role r of treatment $\mathbf{t}$ is initially given a card with three values $(x_r^{\mathbf{t}}, y_r^{\mathbf{t}}, z_r^{\mathbf{t}})$, representing the points that roles a, b and c would get if they hold that card when the trading period ends. The two subjects in the same role always receive the same initial endowment. Each subject can trade cards with any of the five other members of the group. Trade requires mutual agreement as detailed in the procedures below and we imposed no limit on time or number of trades. Treatments differ exclusively in the value of the cards that subjects initially get. The initial endowments for each role in each treatment are summarized in Table 1.

	role a	role b	role c
B	$(1,2,3)$	$(3,1,2)$	$(2,3,1)$
C	$(2,3,1)$	$(1,2,3)$	$(3,1,2)$
I	$(3,3,3)$	$(2,1,1)$	$(2,3,2)$

Table 1: Initial endowments by role $r \in \{a, b, c\}$ and treatment $\mathbf{t} \in \{\mathbf{B}, \mathbf{C}, \mathbf{I}\}$.

In treatment **B**, participants are initially endowed with the card of lowest value to them (1). Treatment **C** has the same cards as **B**, but participants are endowed with the card of medium value to them (2). In treatment **I**, each role has a different card. Notice that in **B** and **C**, roles are symmetric and therefore labels a, b and c are interchangeable, whereas in **I** roles are asymmetric. Overall, we propose a market where all cards are intrinsically valuable. Differences in valuations facilitate trade but profitable trades are more immediately obvious in some treatments than in others.

2.3 Implementation with children

In economic experiments with young children, it is of paramount importance to provide a fun and concrete environment that subjects with limited attention and prone to distraction can easily grasp and find engaging (Brocas and Carrillo, 2020b). This ensures focus, comprehension and eager participation. Also, we cannot overemphasize the importance of using a simple and visual procedure, with as little analytical description as possible. To achieve this, we referred to **B**, **C** and **I** as the "dog game," the "cat game" and the "kangaroo game" respectively. Roles were identified by colors (green-blue-red in the dog game, purple-orange-grey in the cat game and brown-pink-yellow in the kangaroo game).[3]

[3]While there is a risk that children had preferences over animals and colors, we opted for this presentation to make it engaging. During debriefing, subjects reported that they liked some animals and colors better than others, but tried to maximize points in order to get their favorite rewards.

At the beginning of each treatment, we put a tag around the neck of each participant with the color corresponding to their role and the animal representing the treatment (e.g., a green dog represents role a in **B**). All subjects could then easily remember their role and easily identify that of their peers. We then placed a card attached to an elastic wristband on the wrist of each child. The children were instructed to not remove the wristband under any circumstance. The card visually described its value as a function of the subject's role. Figure 1 describes the cards initially endowed by the green, blue and red roles (a, b and c) in the dog game (treatment **B**). In the leftmost card, we can see that the card is worth one point for the green role, two points for the blue role and three points for the red role. The cat and kangaroo games (treatments **C** and **I**) followed similar procedures.

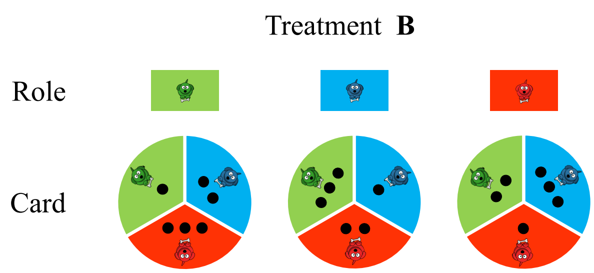


Figure 1: Initial endowments of green, blue and red role in the dog game.

The games were administered in a covered patio at the school. Before the trading game started, participants were encouraged to look at the roles (tags) and endowments (cards) of the five other subjects in their group. Once they were familiar, we implemented the following procedure in each group. Participants could discuss with each other in any way they wanted. However, we assigned strict property rights. Indeed, when a pair of subjects agreed to trade, they would come to the trading table. Participants were not allowed to touch their wristbands. Instead, the experimenter would request from both subjects verbal confirmation of the willingness to trade and, upon confirmation, the experimenter would proceed to exchange their corresponding wristbands (and record the trade in a piece of paper). Participants could not come in groups of more than two for an exchange either. However, a third subject could be invited by another participant (and sometimes was) to wait in line to subsequently perform a trade with one of the subjects involved in a current trade. If one subject did not verbally confirm a willingness to trade (which also occurred sometimes), we would not implement it. The process would continue with no time limit as long as there was a pair of subjects willing to trade. It took approximately 20 minutes to conduct the experiment. We deliberately stayed in a table at the corner of the patio, away from the conversations, to encourage the free exchange of information. We only intervened to enforce property rights, making sure that both parties agreed to a trade.[4]

2.4 Rewards

Games were highly incentivized. We set up a shop with 20 to 25 pre-screened, age appropriate toys (gel pens, friendship bracelets, erasers, figurines, die-cast cars, trading cards, squishies, bouncy balls, fidget spinners, etc.). Different toys had different point prices. Before the experiment, children were taken to the shop and showed the toys they were playing for. They were instructed about the price of each toy, and were explicitly told that more points would result in more toys. At the end of the experiment, subjects learned their point earnings. We accompanied the children to the shop to exchange points for toys and helped them determine the toys they could afford with their budget. We made sure that every child earned enough points to obtain at least three toys. Most children were familiar with this market transaction that consists of accumulating points or tickets that are subsequently exchanged for rewards, since it is commonly employed in fairs and arcade rooms.[5]

2.5 Other information

To control for age-related differences within grade, we collected information regarding the age in months of our participants at the time of the study (the study was conducted in May, that is, at the end of the school year). We also recorded the gender, number of older and younger siblings and preferred school topic, which we then coded into two broad categories (STEM vs. Arts & Humanities).[6] We report in Table 2 a descriptive summary of individual characteristics.

A copy of the read aloud instructions can be found in the Appendix. The statistical analysis uses a p-value of 0.05 as the benchmark threshold for statistical significance. Unless otherwise noted, when comparing aggregate choices we perform two-sided tests. Standard errors are clustered at the individual level whenever appropriate.

[4]The drawback is that we do not have recorded information of the trading processes or the mechanisms that lead to agreements (for example, who initiated the conversation). In our view, any intervention would have heavily polluted the natural flow of discussions and exchange of information between subjects.

[5]Overall, the procedure emphasized the importance of accumulating points while making the experience enjoyable for everyone (see Brocas and Carrillo (2020b) for a discussion of the importance of an adequate incentive system). We spent an average of $4 in toys per child.

[6]STEM refers to a self-reported preferences for Mathematics or Science. Consistent with the curriculum of the school, the other categories offered were Languages, History/Geography and Arts/Music, which we globally refer to as ‘Arts & Humanities’.

	K	1	2	All
Average age in months	72	85	97	86
% male	49	54	45	49
% with siblings	70	84	79	78
% preference for STEM	27	20	31	26

Table 2: Individual characteristics.

3 Theory and predictions

3.1 Fundamentals of the game

As briefly explained in sections 2.2 and 2.3, each market consists of six players, with two players in each of three roles. Each player has an initial endowment, which consists of a card that has different values depending on the role of the individual who possesses it. Individuals in the same role have the same initial endowment. Treatments differ exclusively in the values of the initial endowments, as described in Table 1. Roles and endowments are common knowledge.

For each treatment, we consider a free-form procedure, with the only restrictions that exchanges have to be bilateral and one-for-one: at any given time, any two players in the market can agree to exchange their endowments, which we call a "trade".[7] After a trade, both players stay in the market and can engage in further trades. We impose no time limit, no order of trades, and no limit in the number of trades. The trading game ends only when there exists no pair of individuals in the market who want to engage in an additional bilateral trade.

3.2 Definitions

Given this procedure, we cannot define an extensive-form game in the standard game-theoretic sense. Instead, we consider a simplified version of pairwise stability as the equilibrium concept, in the tradition of the network literature (see e.g., Jackson and Wolinsky (1996)). Formally, we call an "outcome" a situation where each player has one endowment. The starting outcome is determined by the initial endowments of players (set by the experimenter), and other outcomes can be reached through sequences of bilateral trades. Given 6 players, there are 720 outcomes, although some are redundant since not all roles and endowments are different in our experiment. The final outcome is the outcome when

[7] This means that, unlike typical experiments in the network literature, we do not impose some exogenous (random or deterministic) matching procedure.

the trading game has ended. In the spirit of pairwise stability, we call "equilibrium outcome" an outcome of the game where no pair of subjects can improve their payoff with a bilateral trade.[8]

Next, we define the two types of trades relevant in our market. We call "myopic improving" a bilateral trade that results in a strict improvement for both parties. An example is when a trades with c in treatment **B**. This type of trade corresponds to a barter exchange, where each subject strictly prefers the endowment of the other person, and trade is based on the double coincidence of needs. We call "forward-looking improving sequence" two consecutive bilateral trades that result in a strict improvement for all parties involved but require a transitory bookkeeping loss for one party. An example is when a trades first with b and then with c in treatment **C**. This type of trade corresponds to a commodity market, where a subject acquires another subject's commodity even though he values it less than his own one. He then uses it as a medium of exchange with a third person. These sequence of trades are substantially more sophisticated and require forward-looking reasoning from at least one player.

With these premises, we can now discuss basic properties of an equilibrium outcome. First, a game can have multiple equilibrium outcomes. Second, and by definition, an outcome cannot be an equilibrium of the game if a myopic improving trade exists. This, in turn, means that any Pareto optimal outcome is necessarily an equilibrium outcome of the game. Third, and more interestingly, some equilibrium outcomes may not be Pareto optimal. Indeed, if a Pareto superior outcome can only be reached with a forward-looking improving sequence (and not with one or several myopic improving trades), then players may remain in a Pareto inferior equilibrium outcome.

3.3 Analysis of outcomes by treatment

Recall that our groups have six players, two in each of three roles. For the empirical analysis, the unit of observation will be a "subgroup" of three players, one in each role. The outcome of the game consists of one outcome for each subgroup. It is possible that one subgroup reaches an equilibrium outcome while the other subgroup does not. However, it is important to note that subgroups are endogenously formed, with subjects deciding with whom to trade. This means that while groups are composed of the same six subjects in all three treatments, players may choose to trade with a different set of people in each treatment.

We classify outcomes of a three-player subgroup in four categories: PO_M, PO_F, EQ and NO. A PO is a Pareto optimal equilibrium outcome of the subgroup. However, we

[8]We also impose that no subject is worse-off than with her initial endowment only to rule out trading by a subject who can never benefit from any sequence of trades.

distinguish between two types, depending on whether the equilibrium is reached exclusively through myopic improving trades (PO_M) or with at least one forward-looking sequence of trades (PO_F). We call EQ a Pareto inferior equilibrium outcome of the subgroup. We call NO any other outcome, that is, an outcome which is not an equilibrium of the subgroup (and therefore does not exhaust all myopic improving trades). The treatments described in Table 1 vary in the type of trades that are required to improve payoffs, which in turn determines the complexity of the trading environment and the type of equilibria that can be reached.

In treatment **B**, both subgroups can reach a Pareto optimal equilibrium outcome with a payoff of 3 for every subject exclusively through *myopic* improving trades (PO_M). For example, a trades with c and then a trades with b. However, they can also reach EQ, in which case, they can either stay there or else reach the Pareto optimal equilibrium outcome through a forward-looking sequence of trades (PO_F). We call it the 'barter' treatment (**B**) because Pareto optimality can be achieved with simple, mutually advantageous trades only.

In treatment **C**, both subgroups can also reach the same Pareto optimal equilibrium outcome with a payoff of 3 for everyone, but it requires at least one *forward-looking* sequence of trades in each subgroup (PO_F). For example, a trades first with b and then with c. Naturally, players in a subgroup can also stay in the no-trading Pareto inferior equilibrium outcome (EQ), where all subjects keep their initial endowments and obtain a payoff of 2. We call it the 'commodity market' treatment (**C**) because Pareto optimality can only be achieved if at least one player in the subgroup recognizes the value of endowments as a medium of exchange, and accepts a transitory loss in the trading process.

Payoffs in the 'inefficient trading' treatment **I** are selected in a way that no myopic or forward-looking improving trade exists. Role a can only lose by trading with other subjects, and role c can only lose by trading with b. Therefore, there is trivially a unique PO_M equilibrium outcome with no trading. As discussed earlier, the rationale for this treatment is to determine if children trade for reasons other than a payoff maximization.

Table 3 summarizes the possible equilibria in each treatment.

	B	**C**	**I**
PO_M	YES	NO	YES
PO_F	YES	YES	NO
EQ	YES	YES	NO

Table 3: Existence of subgroup equilibrium outcomes by treatment

With this taxonomy in mind, we will study behavior across treatments. First, we test for *equilibrium compliance*: how many subgroups reach an outcome other than NO. Second, we test for *equilibrium selection*: how many subgroups reach Pareto optimal (PO_M or PO_F) vs. Pareto inferior (EQ) equilibrium outcomes.

3.4 Predictions

Remember that treatments **B** and **C** are identical except for the initial distribution of endowments. This means that the two treatments are comparable. Since subgroups start at equilibrium in **C** but not in **B**, we expect to observe a higher total proportion of subgroups reaching equilibrium outcomes ($EQ + PO$) in **C** than in **B**. Since myopic improving trades are sufficient to reach Pareto optimality in **B** but not in **C**, we expect to observe a higher proportion of subgroups reaching Pareto optimal equilibrium outcomes (PO) in **B** than in **C**. We also expect an overwhelming majority of subgroups staying in the no-trading Pareto optimal equilibrium outcome in **I**. Summing up, the treatments provide three market situations, that can be informally characterized as "easy" trading (**B**), "hard" trading (**C**) and "inefficient" trading (**I**). As for age trends, we expect older participants to reach more often the (most challenging) PO_F outcome and less often the (non-equilibrium) NO outcome.

While these theoretical predictions seem natural, we can also foresee several reasons conducive to deviations from theory. Despite the simplicity of the environment, a subject may feel satisfied after a trade that resulted in a partial improvement and not seek further exchanges. Concerns about the rationality of others may prevent reaching the PO_F outcome, whereas socially oriented subjects might engage in 'altruistic' trading whenever the benefit to another subject is sufficiently larger than their own loss.

4 Group behavior

The experiment consisted of nine sessions with two groups of six and one session with one group of six and one group of three. The group of three had K children who followed exactly the Pareto Optimal equilibrium predictions in all treatments. The analysis focuses on the remaining 114 subjects split in 19 groups of 6 players: 6 groups of grade K children, 6 groups of grade 1 children and 7 groups of grade 2 children (one grade K group had one subject from grade 1; we pooled it with the five other K groups). Since we found no treatment order effects, in the analysis we pool together all the data from each treatment. For most of the analysis, and as discussed in section 3.3, we use a subgroup of three participants, one in each role, as the unit of observation. Subgroups are endogenously formed and, therefore, are not independent within treatment.

4.1 Equilibrium outcomes

Figure 2 reports the empirical distribution of final outcomes by treatment and grade. The unit of observation is the "subgroup" of three participants, for a total of 38 subgroups in the sample. Since groups have six participants, each group is composed of two subgroups, of which it is possible that one reaches an equilibrium outcome while the other does not. Also, we notice that the number of trade combinations is limited. It is therefore important to provide a benchmark of comparison. To this purpose, we simulate a group of 6 subjects in **B** and **C** and assume that they engage in a fixed number of random trades. We then compute the proportion of subgroups that reach the different equilibrium outcomes given this random strategy. The results of this exercise are reported in Figure 2 (right).

	B	**C**	**I**
PO_M	22 [6,5,11]	—	28 [8,9,11]
PO_F	9 [2,4,3]	20 [5,7,8]	—
EQ	0 [0,0,0]	10 [2,4,4]	—
NO	7 [4,3,0]	8 [5,1,2]	10 [4,3,3]

# of subgroups from grades [K,1,2] in brackets

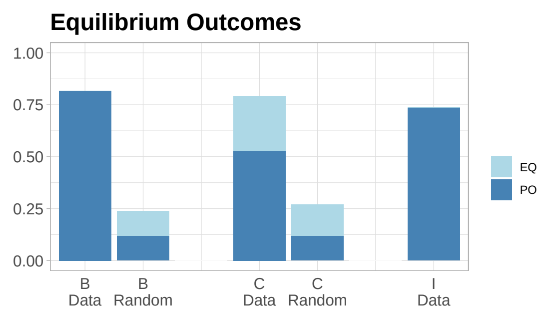


Figure 2: (Left) Subgroup outcomes by treatment. (Right) Pareto optimal and Pareto inferior equilibrium outcomes empirically observed and assuming random behavior.

An equilibrium outcome is reached by 82% of subgroups in **B**, 79% in **C** and 74% in **I**. These levels are statistically below full compliance (test of equality of proportions, p = 0.017, p = 0.009 and p = 0.002 respectively). Yet, equilibrium outcomes in both **B** and **C** are about three times higher than if participants engaged in four random consecutive trades (24% and 27%, respectively). Differences between empirical and random behavior are highly significant in both cases (test of equality of proportions, $p < 0.001$).[9,10]

Our first conclusion is that a significant fraction of young children seem to understand and exploit myopic and forward-looking market opportunities whenever they are present, and generally avoid trading when it is detrimental. Contrary to our prediction, differences

[9]For comparability, we considered four random trades which is similar to the empirical average in **B** (see next section). Behavior with three random trades (which is closer to the empirical average in **C**) is very similar than with four random trades: 10% of *PO* subgroups and 10% of *EQ* in **B**, 10% of *PO* subgroups and 18% of *EQ* in **C**. The exercise is of no interest in **I** since, by construction, any trade constitutes a deviation from theory.

[10]As a reference, we would obtain those empirical equilibrium levels if 76% and 71% of subgroups in **B** and **C** played according to theory and the rest played randomly.

in equilibrium compliance across treatments are not statistically significant (test of equality of proportions, p = 1.0). Behavior is similar across grades, with a possibly slightly lower rate of equilibrium compliance in K.

Although Pareto optimality is frequent in **B**, it is not always reached in the simplest possible way (PO_M). Indeed, initial trading patterns is such that optimality is achieved through a forward-looking sequence of trades (PO_F) in 24% of subgroups. Also, while several subgroups reach at some point the Pareto inferior equilibrium (EQ), none of them stay there.

The picture is different in **C**. Since subjects are initially at equilibrium and no myopic improving trades exist, 26% of subgroups do not trade, thereby staying at the inferior equilibrium (EQ). In 53% of subgroups, participants recognize the value of cards as a medium of exchange and accept a transitory loss in order to reach the Pareto optimal equilibrium outcome. Consistent with our prediction, PO rates are significantly lower in **C** than in **B** (test of equality of proportions, $p = 0.015$). The anticipatory forward-looking behavior of half the subgroups is present even among our youngest population of kindergartners.

There are at least three reasons for not reaching a PO equilibrium outcome: (i) satisfaction with current payoff, (ii) inability to perform a forward-looking sequence, and (iii) concern about the rationality in trading ability of others. Recall that **B** and **C** differ exclusively on the distribution of initial endowments. Also, notice that a forward-looking individual can achieve PO in **C** even if she trades exclusively with myopic peers, since we only need one subject in the subgroup to accept a transitory loss in the process. This means that only argument (ii) can explain the difference in the proportion of PO between **B** and **C**. Overall, we argue that subgroups that are unable to recognize gains of trading are responsible for the fraction of non-equilibrium outcomes in **B** and **C** (around 20%). Those able to recognize the value of barter but not of commodity money are responsible for the difference in PO outcomes between the two treatments (around 26%). The remaining subgroups recognize both simple (barter) and complex (commodity money) trading opportunities (around 53%).

It is also instructive to compare the behavior of each group across treatments. Such analysis cannot be made at the subgroup level, since subgroups are endogenously formed, so they contain different subsets of subjects across treatments. We call Pareto Optimal Equilibrium of the Group, POEG, a situation where both subgroups (i.e., all six members) reach the Pareto optimal equilibrium outcome. When we compare the behavior in **B** and **C**, we find that 5 groups reach the POEG in both treatments, 10 groups reach POEG only in **B**, and 4 groups do not reach POEG in either treatment. No group reaches POEG only in **C**. The result reinforces the nested difficulty of the barter and commodity markets.

Finally, subjects in the control treatment **I** stay mostly at the no-trading Pareto optimal equilibrium, although we also observe a number of deviations. These deviations are analyzed in the next section.

4.2 Trades and payoffs

To provide a descriptive idea of group trade behavior, we report in Figure 3 a representative (though non-exhaustive) list of examples of trading dynamics in the different treatments.[11] In these graphs, each node represents one participant. The group is composed of two participants (1 and 2) in each of the three roles (a, b and c). The number in the red box reflects the order of trades in the group.[12] The exchanges and corresponding final outcomes are summarized in the right side.[13]

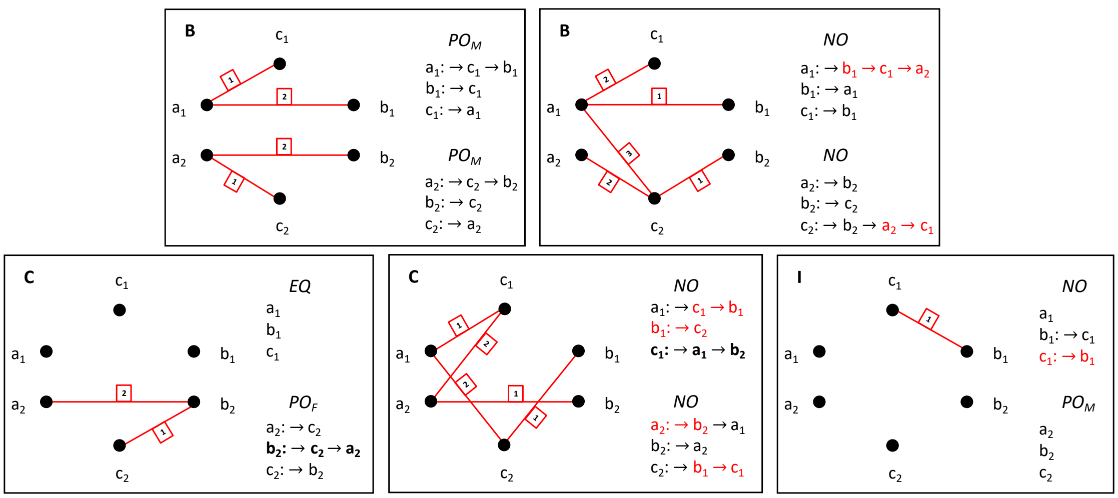


Figure 3: Representative examples of group trade dynamics by treatment.

These examples of trade dynamics provide informal, suggestive evidence that equilibrium outcomes in a given subgroup are typically reached through a short sequence of trades that closely follow the theoretical predictions: two myopic improving trades to reach PO_M in **B** (upper left), one sequence of forward-looking improving trades to reach PO_F in **C** (bottom left) and no trade to reach EQ in **C** (bottom left) or PO_M in **I** (bottom right).

[11] Labels are interchangeable in **B** and **C**, so a group where a_1 trades with b_1 and then b_1 trades with c_1 is indistinguishable from a group where b_1 trades with c_1 and then c_1 trades with a_1.

[12] Although all trades are sequential, for expositional simplicity we employ the same number when two trades involve different pairs of individuals.

[13] The fonts employed are: regular for myopic improving trades, bold for forward-looking improving sequence of trades, and red for inefficient trades).

By contrast, non-equilibrium outcomes (NO) are mostly characterized by longer than optimal strings that mix improving and non-improving trades both in **B** (upper right) and **C** (bottom center).

To formally investigate trade and payoffs across treatments, we report in Figure 4 the average number of trades per subgroup (dark histogram, left). The grey line represents the minimum number of trades to reach the PO equilibrium outcome, namely 2 in **B** and **C** and 0 in **I**). We also report in Figure 4 the average payoff loss of the subgroup relative to the payoff obtained in the PO equilibrium outcome (light histogram, right).

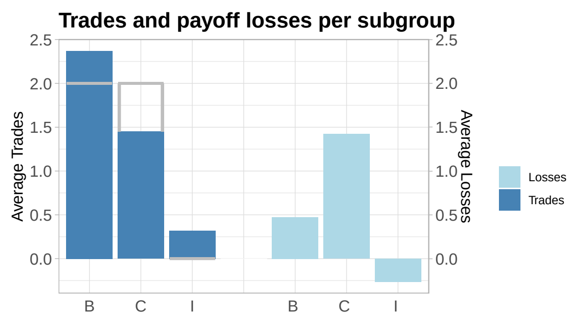
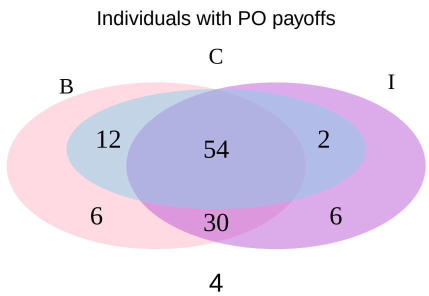


Figure 4: Trades and payoffs by treatment.

Despite similar aggregate proportions of equilibrium outcomes (Figure 2 - right), Figure 4 shows that behavior is substantially different across treatments. Participants trade excessively in **B** (two sided t-test, $p = 0.049$) and insufficiently in **C** (two sided t-test, $p = 0.016$). The former reflects a (small) number of suboptimal exchanges and translates into minor losses (0.16 points or 8% loss on average per participant). The latter is due to a fraction of subgroups that remains at the no-trading inferior equilibrium. These participants sacrifice significant payments to maintain their initial position, which results in substantially larger losses (0.47 points or 24% loss on average per participant). Finally, deviations in **I** are statistically significant (two sided t-test, $p = 0.004$) but small in absolute terms (1 trade for every 9 participants). These non-equilibrium trades are typically welfare improving, as reflected by the small but positive net gains of the subgroup (0.08 points or 4% gain on average per participant). It is plausible that a few "altruistic traders", willing to sacrifice one point to increase in two points the payoff of another player, are responsible for some of these sporadic deviations.

5 Individual analysis

We next study behavior at the individual level. Figure 5 (left) presents a Venn diagram with the number of individuals with *PO* payoffs in the different treatments (payoff of 3 in **B** and **C** and initial payoff in **I**). Figure 5 (right) reports a comparison of the proportion of individuals with *PO* payoffs by grade empirically observed and assuming three or four random trades in the group (random 3 and random 4).



	B	**C**	**I**
K	0.80	0.57	0.80
1	0.87	0.59	0.76
2	1.00	0.62	0.86
total	0.89	0.60	0.81
random 3	0.26	0.26	—
random 4	0.29	0.29	—

Figure 5: Number (left) and proportion (right) of equilibrium players

By construction, the proportion of subjects at equilibrium (57% to 100% depending on the treatment and age group) is higher than the proportion of *PO* subgroups. Indeed, all subjects in a *PO* subgroup play at equilibrium while some subjects in the other subgroups may still play at equilibrium. According to Figure 5, 58% of participants reach *PO* under both barter and commodity markets **B** and **C** while only 7%-8% would reach it with 3 or 4 random trades. This difference is statistically significant (test of comparison of proportions, $p < 0.001$). Furthermore, 47% of the population reaches the *PO* equilibrium payoff in all three treatments. Only 11% of participants play at equilibrium in **B** and **C** but not in **I**. This constitutes the absolute upper bound on the proportion of rational but altruistic players: they reach the *PO* equilibrium when everyone can benefit but are willing to sacrifice some payoffs otherwise. This small number is not surprising since we know from previous research that costly sharing is not prevalent at this age.[14] The diagram further illustrates the previously discussed nested difficulty of barter and commodity markets. Indeed, 97% of individuals who play at equilibrium in **C** also play at equilibrium in **B**. At the same time, 83% of individuals who do not play at equilibrium in **B** do not play at equilibrium in **C**. Finally, for treatment **B** there is a significant difference across grades in the proportion of equilibrium choices (3-sample test for equality of proportions, $p = 0.013$).

[14]For example, in Fehr et al. (2008), strongly generous and strongly egalitarian children (children who prefer allocation (1,1) over (2,0)) account for 20% and 35% of the sample at 5-6 and 7-8 years of age, respectively.

This difference is largely due to the higher performance of participants in grade 2 compared to grade K (test for equality of proportions, $p = 0.025$) and to some extent compared to grade 1 (test for equality of proportions, $p = 0.091$). There is no significant difference in performance across grades in treatments **C** and **I**.

To investigate the determinants of individual choice, we run Probit regressions where the dependent binary variable is whether the subject obtained the *PO* equilibrium outcome. Our independent variable is the Age in months of the participant at the date of the experiment. We perform regressions for each treatment separately (**B**, **C**, **I**), as well as a measure of equilibrium choice in all three treatments (**All**). We then control for the demographic variables described in section 2.5: gender, a dummy variable indicating whether participants have siblings, and their self-reported favorite school topic (STEM vs. Arts and Humanities). The results are presented in Table 4.

	B	**C**	**I**	**All**	**B**	**C**	**I**	**All**
Age	0.038*	0.002	0.001	-0.003	0.032^{o}	-0.001	-0.007	-0.008
	(0.016)	(0.011)	(0.012)	(0.011)	(0.018)	(0.012)	(0.013)	(0.011)
STEM	—	—	—	—	0.442	0.593^{o}	0.263	0.723*
					(0.537)	(0.321)	(0.361)	(0.314)
Male	—	—	—	—	-0.142	-0.333	-0.253	-0.280
					(0.406)	(0.272)	(0.309)	(0.272)
Siblings	—	—	—	—	-0.493	-0.304	-0.139	-0.382^{o}
					(0.321)	(0.203)	(0.229)	(0.203)
Constant	-1.878	0.058	0.755	0.156	-0.761	0.673	1.710	1.039
	(1.269)	(0.930)	(1.056)	(0.922)	(1.421)	(1.005)	(1.180)	(0.999)
# obs.	114	114	114	114	102	102	102	102
AIC	74.759	157.72	115.83	161.66	60.051	139.13	103.57	141.57

(standard errors in parenthesis); ^{o} $p < 0.1$; * $p < 0.05$; ** $p < 0.01$

Table 4: Probit regressions of equilibrium choice by treatment and overall

Equilibrium behavior is associated with age only in **B** but its significance decreases in the presence of controls. This confirms our previous findings that age is not a major determinant of optimal play in our window of observation. Participants with a preference for STEM are also significantly more likely to play at equilibrium in **C** and in all treatments together compared to participants with a preference for Arts or Humanities. This is an intriguing finding, especially since it relies on non-incentivized, self-reported preferences. By contrast, gender and siblings have no significant effect on equilibrium behavior.

We next perform a Logistic regression of individual equilibrium behavior. We include dummies for each treatment (**C** is the omitted treatment) and the same variables as before (age, topic preference, gender, and siblings). We report the findings in Table 5.

	(1)	(2)
B	1.757***	1.938***
	(0.305)	(0.346)
I	1.046***	1.064**
	(0.299)	(0.331)
Age	0.015	0.004
	(0.013)	(0.013)
STEM	—	0.824°
	—	(0.433)
Male	—	-0.365
	—	(0.315)
Siblings	—	-0.558
	—	(0.384)
Constant	-0.870	0.554
	(1.127)	(1.110)
# obs.	342	342
AIC	348.843	303.548

(clustered standard errors in parenthesis)
° $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 5: Overall logistic regressions of equilibrium choice

The differences across treatments in Pareto optimal behavior described in Figure 2 (right) are reflected in the regressions. Indeed, equilibrium behavior is significantly more likely in **B** and in **I** than in **C**. As in the previous regression, participants with a preference for STEM perform better. Again, neither age nor the other individual characteristics (gender, siblings) are predictors of performance.

6 Power analysis

The main hypothesis tested in the paper is the distance between empirical and random behavior. The number of students enrolled in the study was constrained beforehand by the school enrollment and could not be changed, resulting in 38 subgroup observations per treatment. The frequency of equilibrium play if the 38 groups act randomly (our null hypothesis) is 0.24 in **B** and 0.27 in **C**. With significance level $\alpha = 0.05$ and power $1 - \beta = 0.80$, observed frequencies over 0.54 in **B** and 0.58 in **C** are considered significant.

Given the empirically observed frequencies (0.82 in **B** and 0.79 in **C**), ex-post power is 0.99 in both scenarios. A Bayes Factor analysis returns a very large Bayes factor indicating that we have extreme evidence that choice proportions are different from those generated by random play. Also, and in the context of replication, we follow the post-study probability (PSP) methodology proposed by Maniadis et al. (2014). Assuming an initial prior p_0 that participants would play randomly, the posterior probability that the alternative hypothesis is correct given our discovery is:

$$\mathrm{PSP} = \frac{(1-\beta)(1-p_0)}{(1-\beta)(1-p_0) + \alpha\, p_0}$$

The PSP as a function of the prior p_0 is represented in Figure 6 for significance level $\alpha = 0.05$ and power $1-\beta = 0.8$.

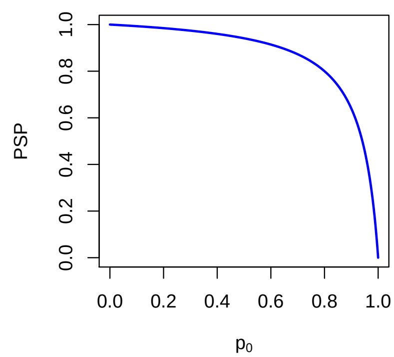


Figure 6: Post-study probability (PSP)

According to Figure 6, the posterior probability that the alternative hypothesis is correct is above 0.5 for any $p_0 < 0.94$. Assuming a diffuse prior ($p_0 = 0.5$), the posterior belief of a significant effect is PSP $= 0.94$.

Alternatively, we could also compare our empirical results with the behavior under perfect rationality. Using, once again, $\alpha = 0.05$ and $1-\beta = 0.8$, observed frequencies below 0.82 are declared as significantly different in both **B** and **C**. Given the observed frequencies (0.82 in **B** and 0.79 in **B**), ex-post power is marginal: 0.79 in **B** and 0.86 **C**. By contrast, the Bayes Factor analysis returns a very large Bayes factor indicating that choices are significantly different from perfect compliance to equilibrium.

7 Conclusion

This study examines the ability to recognize the role of commodities as a medium of exchange at an age where money is still a relatively abstract and unfamiliar object. We have reported that children reach Pareto optimal outcomes more often in barter economies compared to commodity markets. Yet, half of the subgroups accept transitory losses to reach the Pareto optimal equilibrium outcome, suggesting that many children as young as 5 years old can understand the value of commodities as a basic medium of exchange.

Overall, deviations in our experiment are unlikely to be driven by lack of understanding (only 4 subjects never reached the Pareto optimal outcome), altruism (it can explain non-equilibrium in **I** and only in **I**), or beliefs that others are myopic (a rational forward-looking individual can reach the equilibrium in both **B** and **C** even if everyone else only engages in myopic improving trades). Instead, we have argued that about one quarter of subjects does not realize the gains from barter and another quarter of subjects understands barter but is not forward-looking enough to accept transitory bookkeeping losses. The behavior of the remaining one-half of the participants is consistent with the predictions of rational homo-economicus agents.

Being able to evaluate options and to reason logically and strategically are qualities of great assistance for optimal trading. Those abilities are, however, developing during early elementary school and students in that age range are still transitioning towards rational behavior. In particular, they have been shown to have unstable preferences (Harbaugh et al., 2001; Brocas et al., 2019) as well as limited logical (Tecwyn et al., 2014) and strategic thinking (Sher et al., 2014; Brocas and Carrillo, 2019, 2020a) abilities. Yet, participants in our study are able to play at equilibrium, suggesting that market forces are helping the decision-making process. This finding echoes experimental results in adults, where it is common to observe higher compliance with equilibrium predictions in market situations than in two-person contexts.

This does not mean that logical abilities are irrelevant in that process. Recent research shows that math and cognitive abilities help strategic choices both in children (Czermak et al., 2016; Fe and Gill, 2018) and adults (Gill and Prowse, 2016; Proto et al., 2019). The positive correlation between a preference for STEM and a Pareto optimal equilibrium behavior suggests the possibility that players prone to logical thinking may have guided collective choices towards superior outcomes. While a preference for STEM is neither a guarantee that a participant thinks more logically than others nor evidence of causality, such correlation has already been established in other strategic contexts (Brocas and Carrillo, 2019). It is therefore plausible that children who like activities based on logical thinking are more attracted by STEM topics and vice-versa. However, unveiling a definite relationship would require further investigation.

The fact that age is associated with the ability to barter but not with the ability to use commodities as a medium of exchange is intriguing. It suggests that trading through myopic improvements relies on an ability that is developing through our window of observation whereas trading through forward-looking improvements requires an ability that for some children develops after the age considered here. A tentative explanation is that barter relies on number comparison and simple logic that is known to develop early and gradually, even before mathematics are introduced to children (Fisher et al., 2012). By contrast, forward-looking improvements rely on more abstract forms of reasoning such as mentalizing (anticipating the efficient outcome and backward inducting the optimal sequence of trades). Although a fraction of children might have already acquired that logic (Tecwyn et al., 2014), the development is heterogenous (Bishop et al., 2001), so it is possible that further improvements occur after our window of observation.

While our experiment suggests that the behavior of a significant fraction of participants follows the predictions of rational theory, it does not answer the more fundamental question of whether such ability is innate or acquired before the age of 5. If it is the latter, it cannot unveil the mechanism by which such ability is developed.[15] More generally, it is not uncommon in a novel study to raise more question than answers are provided. We know from previous research that the behavior of children is affected by friendship ties (Chen et al., 2016) and the socio-economic status of the family (Charness et al., 2019). One can only speculate if our results would hold under anonymous interactions and with disadvantaged children. Robustness to larger groups is also unknown. We hope that the paper will stimulate future research in the area.

[15] Addressing these fascinating questions seems challenging. In our experience, understanding the fundamentals of this game would be difficult for children younger than our current participants.

References

DVM Bishop, G Aamodt-Leeper, Cathy Creswell, R McGurk, and DH Skuse. Individual differences in cognitive planning on the tower of hanoi task: Neuropsychological maturity or measurement error? *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, 42(4):551–556, 2001.

Isabelle Brocas and Juan D Carrillo. Steps of reasoning in children and adolescents. Working paper, 2019.

Isabelle Brocas and Juan D Carrillo. The evolution of choice and learning in the two-person beauty contest game from kindergarten to adulthood. *Games and Economic Behavior*, 120:132–143, 2020a.

Isabelle Brocas and Juan D Carrillo. Introduction to special issue "understanding cognition and decision making by children." studying decision-making in children: Challenges and opportunities. *Journal of Economic Behavior & Organization*, 2020b.

Isabelle Brocas, Juan D. Carrillo, T Dalton Combs, and Niree Kodaverdian. The development of consistent decision-making across economic domains. *Games and Economic Behavior*, 116:217–240, 2019.

Gabriele Camera and Marco Casari. The coordination value of monetary exchange: Experimental evidence. *American Economic Journal: Microeconomics*, 6(1):290–314, 2014.

Gabriele Camera, Marco Casari, and Maria Bigoni. Money and trust among strangers. *Proceedings of the National Academy of Sciences*, 110(37):14889–14893, 2013.

Gary Charness, John A List, Aldo Rustichini, Anya Samek, and Jeroen Van De Ven. Theory of mind among disadvantaged children: Evidence from a field experiment. *Journal of Economic Behavior & Organization*, 166:174–194, 2019.

Jingnan Chen, Daniel Houser, Natalia Montinari, and Marco Piovesan. Beware of popular kids bearing gifts: A framed field experiment. *Journal of Economic Behavior & Organization*, 132:104–120, 2016.

Simon Czermak, Francesco Feri, Daniela Glätzle-Rützler, and Matthias Sutter. How strategic are children and adolescents? experimental evidence from normal-form games. *Journal of Economic Behavior & Organization*, 2016.

Glyn Davies. *History of money.* University of Wales Press, 2010.

John Duffy. Macroeconomics: a survey of laboratory research. *Handbook of experimental economics*, 2:1–90, 2016.

John Duffy and Jack Ochs. Emergence of money as a medium of exchange: An experimental study. *American Economic Review*, 89(4):847–877, 1999.

John Duffy and Daniela Puzzello. Gift exchange versus monetary exchange: Theory and evidence. *American Economic Review*, 104(6):1735–76, 2014.

Paul Einzig. *Primitive money: In its ethnological, historical and economic aspects.* Elsevier, 2014.

Eduardo Fe and David Gill. Cognitive skills and the development of strategic sophistication. *Available at SSRN 3285484*, 2018.

Ernst Fehr, Helen Bernhard, and Bettina Rockenbach. Egalitarianism in young children. *Nature*, 454(7208):1079–1083, 2008.

Paige H Fisher, Jennifer Dobbs-Oates, Greta L Doctoroff, and David H Arnold. Early math interest and the development of math skills. *Journal of Educational Psychology*, 104(3):673, 2012.

Guillaume R Fréchette. Experimental economics across subject populations. *The handbook of experimental economics*, 2:435–480, 2016.

Milton Friedman. *Money mischief: Episodes in monetary history.* Houghton Mifflin Harcourt, 1994.

David Gill and Victoria Prowse. Cognitive ability, character skills, and learning to play equilibrium: A level-k analysis. *Journal of Political Economy*, 124(6):1619–1676, 2016.

William T Harbaugh, Kate Krause, and Timothy R Berry. GARP for Kids : On the Development of Rational Choice Behavior. *American Economic Review*, 91(5):1539–1545, 2001.

Glenn W Harrison and John A List. Field experiments. *Journal of Economic literature*, 42(4):1009–1055, 2004.

Caroline Humphrey. Barter and economic disintegration. *Man*, 20(1):48–72, 1985.

Matthew O Jackson and Asher Wolinsky. A strategic model of social and economic networks. *Journal of economic theory*, 71(1):44–74, 1996.

William Stanley Jevons. *Money and the Mechanism of Exchange*, volume 17. Kegan Paul, Trench, 1885.

Janet Hua Jiang and Cathy Zhang. Competing currencies in the laboratory. *Journal of Economic Behavior & Organization*, 154:253–280, 2018.

Nobuhiro Kiyotaki and Randall Wright. On money as a medium of exchange. *Journal of Political Economy*, 97(4):927–954, 1989.

Nobuhiro Kiyotaki and Randall Wright. A search-theoretic approach to monetary economics. *The American Economic Review*, pages 63–77, 1993.

Ricardo Lagos and Randall Wright. A unified framework for monetary theory and policy analysis. *Journal of Political Economy*, 113(3):463–484, 2005.

Peng Lian and Charles R Plott. General equilibrium, markets, macroeconomics and money in a laboratory experimental environment. *Economic Theory*, 12(1):21–75, 1998.

JA List, R Petrie, and A Samek. How experiments with children can inform economics. Working paper, 2018.

John A List. Testing neoclassical competitive theory in multilateral decentralized markets. *Journal of Political Economy*, 112(5):1131–1156, 2004.

John A List and Daniel L Millimet. The market: Catalyst for rationality and filter of irrationality. *The BE Journal of Economic Analysis & Policy*, 8(1), 2008.

Zacharias Maniadis, Fabio Tufano, and John A List. One swallow doesn't make a summer: New evidence on anchoring effects. *American Economic Review*, 104(1):277–90, 2014.

Kevin A McCabe. Fiat money as a store of value in an experimental market. *Journal of Economic Behavior & Organization*, 12(2):215–231, 1989.

Eugenio Proto, Aldo Rustichini, and Andis Sofianos. Intelligence, personality, and gains from cooperation in repeated interactions. *Journal of Political Economy*, 127(3):1351–1390, 2019.

A Hingston Quiggin. *A survey of primitive money: The beginnings of currency*, volume 1. Routledge, 2017.

Robert A Radford. The economic organisation of a pow camp. *Economica*, 12(48):189–201, 1945.

Itai Sher, Melissa Koenig, and Aldo Rustichini. Children's strategic theory of mind. *Proceedings of the National Academy of Sciences*, 111(37):13307–13312, 2014.

Adam Smith. *An Inquiry Into the Nature and Causes of the Wealth of Nations.* T. Nelson and Sons, 1887.

Matthias Sutter, Claudia Zoller, and Daniela Glätzle-Rützler. Economic behavior of children and adolescents–a first survey of experimental economics results. *European Economic Review*, 111:98–121, 2019.

Emma C Tecwyn, Susannah KS Thorpe, and Jackie Chappell. Development of planning in 4-to 10-year-old children: Reducing inhibitory demands does not improve performance. *Journal of Experimental Child Psychology*, 125:85–101, 2014.

Appendix: sample of instructions

[these are instructions for the treatment order **B-C-I**; instructions are analogous for the other orders of play]

Hello,

We are going to play a few games. In all the games, you will earn points. At the end of the experiment you will go to the toy shop and buy toys with your tokens. Are you excited?

Let's start with the "dog game". First, we are going to distribute tags with different colors for different people.

[distribute two red dog tags, two blue dog tags and two green dog tags in each group]

You can look at the color of your friends' tags. Colors will be important to get points.

[give them some time to look at the tags of others]

Now, we are going to attach one card to your wrist. It is very important that you never remove the card from your wrist.

[attach the wristband of each card to each player; make sure that each color gets the card that has one point for themselves]

Look at your card. It has points on it. The points in the red area are the points that the card is worth for the person with the red tag. The points in the green area are the points that the card is worth for the person with the green tag. The points in the blue area are the points that the card is worth for the person with the blue tag. Different players have different cards, and some cards are worth more for some people than others

[give an example of a card, ask some questions about how much they are worth].

We are going to give you some time to look at your card and the cards of your friends. If you find someone who wants to exchange a card with you, you can both come to me and I will exchange the cards for you. I will be sitting over there. You can only exchange a card for a card. It is also very, very important that you do not exchange cards by yourself. Only I can exchange the cards for you. Is it clear?

You can exchange your card as many times as you want, as long as you find someone who is willing to exchange with you. If you do not want to exchange your card, it is also ok. You don't have to.

At the end of the game, I will look at the card you have and write the points you got given the color of your tag.

[give another example and ask a question to check understanding]

Is this clear to everyone? Do you want to play?

[start; make sure they don't trade by themselves; when a pair of children comes, ask for verbal confirmation from both children of their willingness to exchange; write down every exchange; at the end, write down the points of each player]

We are going to play now the "cat game". The rules are very similar. We are going to give one tag and one card to each of you.

[distribute two purple cat tags, two orange cat tags and two grey cat tags in each group; distribute the cards; make sure that each color gets the card that has two points for themselves]

Look at your card and the cards of your friends. Note that the colors and points are different than before. Just like before, if you find someone who wants to exchange a card with you, you can both come to me and I will exchange them. Are you ready to play?

[start]

Our last game is the "kangaroo game". It is the same rules as before but with new cards and new colors.

[distribute the tags and cards; make sure to give the correct cards to the correct colors]

If you want to exchange cards come to see me over there. Ready?

[start; at the end of the game]

Now we are going to tell you how many points you got in total. We will write the points in a piece of paper and you can exchange the points for toys in the toy shop. Thanks for playing with us.

[proceed to compute points and distribute notes with the points accumulated]