

Does scarcity matter in children's behavior? A developmental perspective of the basic scarcity bias

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Abstract

The bias generated by the subjective perception of scarcity on economic behavior was investigated on two groups of children aged 9-10 and 12-14 years old and on a sample of adults. Children had to choose a toy among a set of identical objects varying only in color: one color was scarce the other abundant. Color was counterbalanced across conditions. Younger children showed a basic scarcity bias: they preferred systematically the toy that was scarce in color. In older children however this tendency disappeared and was reversed in adults. The results are coherent with a developmental explanation of the basic scarcity bias which tends to be present at early stages of cognitive development but gets weaker and is substituted by other strategies and social schema as the individual develops and accumulates experience.

Keywords: Scarcity, Decision-making, Children, Economic behavior

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1. Introduction

This paper is on scarcity. More precisely we investigated the bias generated by the subjective perception of scarcity on economic behavior. The concept of scarcity is not widely treated by the economic literature in spite of its crucial importance in determining the value of commodities.

From a traditional economic approach, a consumer is attracted by a given good because of the attributes embodied in the good itself (Lancaster, 1966). All the attributes of a good in the traditional approach are intrinsic, which means that they are embodied in

the given good independently from the context where the good is purchased and consumed. The attribute of scarcity, however, is not intrinsic but it is context dependent. To know if a good is scarce or abundant a consumer needs to know its “local” availability, whereas to evaluate the degree of a generic intrinsic attribute a consumer simply needs a reference scale usually built on the basis of previous consumption experiences. Moreover, to know if a good is scarce or abundant the consumer needs to know the degree of competition on the demand side. To know the total availability of a good in a given moment in time in a given place is not enough, in order to perceive it as a scarce good the consumer needs also to know if other consumers (and roughly how many of them) are interested to that specific good.

The definition of scarcity as a special attribute of commodities that puts together competition on the demand side with the degree of availability of that good in nature, recalls the concept of pricing. Within a specific market prices can be considered as a proxy of both scarcity and of the degree of desirability. There are situations, however, where prices are not related at all with the availability of a given commodity. Even not considering the many non-market contexts – state supply of welfare services – which are typical of the mixed economies one can quote some specific marketing strategies which are centered on scarcity but not on prices, like the one by Swatch and that we could call the “jellyfish” case.

A very famous example of a marketing strategy which betted on the scarcity effect – without using price signaling – is the tactic adopted by Swatch in the early eighties. As well known, Swatch entered in the wristwatches market with an innovative plastic analogical watch sold everywhere in Europe at the same price. The first models were all perfectly identical in the technologic attributes (same plastic case, same electrically powered mechanism, same size, etc.) but different in the case color, in the graphics of the quadrant and the strap. The marketing strategy used by Swatch was to produce a fixed number of each model and to sell the shops only the complete series and never a single model. The so called “Jellyfish”, which was the only completely transparent Swatch, met the taste of the majority of consumers and became very quickly almost impossible to find. It is worth noticing that the decision to produce a limited amount of each model was not advertised at all and apparently neither the shopkeepers nor the buyers were aware of this marketing choice until they realized that the Jellyfishes had become a “rare” model. It is

worth underlining that the majority of the shopkeepers accepted the Swatch advice to keep the Jellyfish price equal to the price of all the other models.

The Jellyfish examples seemed therefore to demonstrate that scarcity sometimes is not related to prices and that it cannot be considered homogeneous to the intrinsic attributes of a given commodity.

In the economic literature, the analysis of the mechanisms that define the value of commodities has been originally introduced by Adam Smith who distinguished between “value in use” and “value in exchange”. To explain the difference between these two concepts he presented the famous paradox of diamonds and water. As well known the diamonds and water paradox tells that even if water is very useful it is also generally very cheap while diamonds have little if none utility – they are mainly used as adornments – but they are very expensive. From this paradox Smith arrived to conclude that the willingness to pay does not depend from utility, i.e. he argues that the value of commodities is not influenced by utility but by some other mechanism, in his words: “the merit of an object, which is in any degree either useful or beautiful, is greatly enhanced by its scarcity” (Smith 1776, p.172).

About one century after the *Wealth of Nations* (1776) the Adam Smith’s solution of his paradox has been overcome by the Neoclassical economists. The concept of marginal utility, which is the core of the Neoclassical analysis, allows to re-link the value of commodities to utility and to explain why a consumer will pay one carat of diamonds millions times the price of a gallon of water. The idea embodied in marginal utility is that the value attributed to a given commodity by a consumer is determined by the ratio between the total utility that s/he obtains from the amount of the commodity already owned and the amount of utility that s/he can extract from an additional unit of the commodity itself. Through an apparently simple mechanism of comparison among the marginal utilities divided by the price of each good the consumer should then arrive to determine her/his willingness to pay for each amount of every existing commodity. The relative scarcity/abundance of a given commodity is “controlled” through the market price and becomes a non relevant characteristic for the consumer when s/he builds up her/his preferences map.

A point of weakness of the Neoclassical solution of the Smith’s paradox relies on the implicit assumption that the preferences structure of the consumer is not influenced by the relative disposable amount of each commodity. Telling it in a different manner this means

that the level of utility that the consumer can obtain from a given good is independent from the amount of the good existing in nature. Vice versa when this is not the case the marginal utility loses its property of “stable” measure of the willingness to pay because utility becomes dependent from the amount of the commodity existing in nature. It emerges a double system of interaction between preferences and quantity of the good in nature. Furthermore the marginal utility increases as the amount of the good consumed raises and this phenomenon modifies some of the mathematical properties of the indifference curves. When the marginal utility is increasing in quantity the utility curve takes the form of curve X_2 shown in figure 1. The curve X_1 instead is a traditional utility curve with decreasing marginal utility. When good X is a scarce commodity and the psychological attitude towards X is described by X_2 then there is a problem with the standard economic treatment of consumer choice because X_2 is not a continuous function and therefore is not differentiable out of the domain which goes from 0 to the maximum amount of the good disposable in the market.

Moreover the indifference curves built using two different utility functions of the kind of those described in figure 1 have the characteristic of having a marginal rate of substitution which increases in an explosive way over the region of smoothness. The smoothness region corresponds to the area in between the two curves of figure 1. Plotting an indifference curve starting from a Cobb Douglas utility function with parameters arbitrarily chosen gives the result shown in figure 2.

Finally it is worth noticing that the Neoclassical solution of the Smith’s paradox fails to appreciate scarcity as an important psychological as well as a strategic characteristic of commodities.

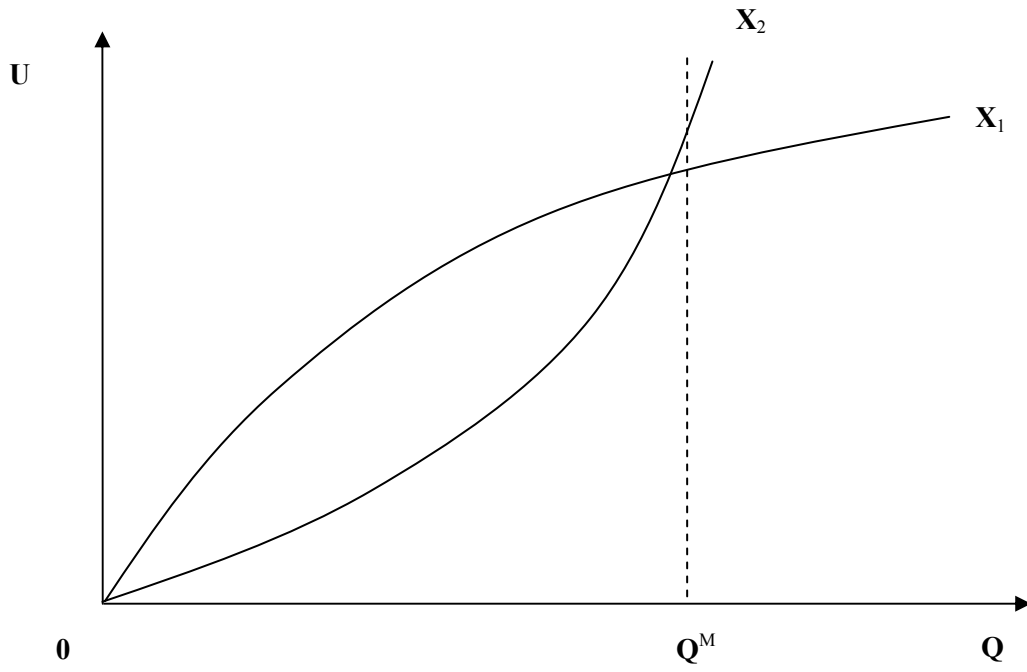


Figure 1. Two utility functions.

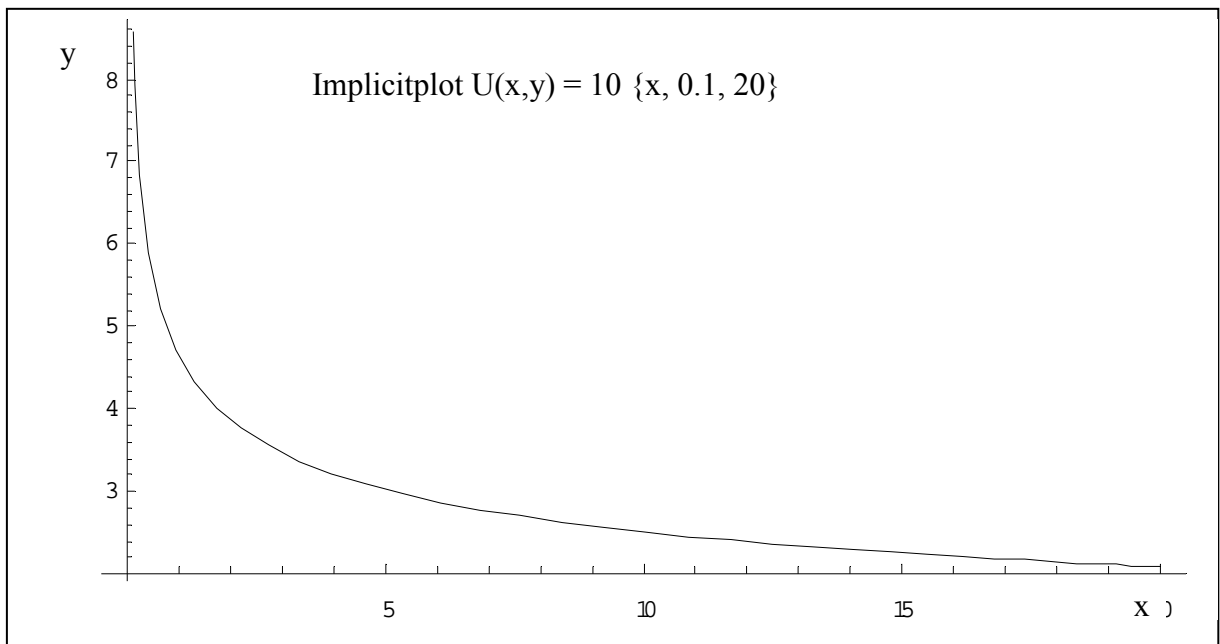


Figure 2. Indifference curve.

Scarcity and attractiveness

It is a common experience for everyone who ever had the chance of buying an expensive bottle of wine that of feeling especially attracted to a rare bottle compared to a wide available one, regardless of the price. However, why scarcity enhances attractiveness is still an unresolved issue. We support the idea that scarcity acts on consumer's economic behavior at different psychological levels. To begin, let's define a scarce good as one that meets at least these two minimum requirements: (i) the good has to be perceived as scarce (unavailable); (ii) there has to be some degree of competitive pressure to obtain the good (the same good meets the preferences of at least two individuals but there is not enough to satisfy both). When these two features are present, scarcity influences the consumer economic behavior in three ways:

1. Scarcity as a status symbol. People are attracted by scarce goods because they make them feel "unique" and member of distinguished social groups (Veblen, 1899/1965). An example are the limited editions of luxury goods.
2. Scarcity as an investment. People are attracted by scarce goods because they think they can earn some economic profit from them. The typical example is the stamp collector who offers disproportionate amount of money to buy the last piece that finally completes the collection.
3. Scarcity as a basic bias. People are attracted by scarce goods due to a primary motivational mechanism that acts unconsciously and instinctively and is present in non human animals, in children and in adults.

At level one and two of this classification, scarcity operates as an element from which the consumer infers other good's favorable attributes such as, high price, status symbol, personal uniqueness and commercial strength. This inferential process is fairly conscious, socialized, and intentionally used such as in the case of the trading of rare goods (eg. diamonds, stamps etc.).

At the third level, instead scarcity operates as a basic and primary bias leading consumer to operate choices in favor of scarce goods in an automatic and not necessarily conscious manner.

While the first level has been studied and frequently used in marketing strategies, the most intriguing in our view and, up to now, never studied is the second level. At this level scarcity acts as a basic bias, guiding preferences and choice in an implicit way. This is the point towards which this paper is addressed.

Several examples of how scarcity acts on consumer's perception of the good through the mechanisms of status symbol and investment (first two levels) can be found in previous research work. Psychological and marketing research has repeatedly found that scarcity affects consumer's perception of goods by enhancing attractiveness (Szybillo, 1975), desirability (Lynn, 1989), and perceived price (Lynn & Bogert, 1996) (see Lynn, 1991, for a review).

One psychological theory describing scarcity effects on good perception is "commodity theory" (Brock, 1968). According to this theory, scarcity enhances the value (or desirability) of anything that can be possessed, is useful to its possessor, and is transferable from one person to another. As Brock (1968) writes: "any commodity will be valued to the extent that it is unavailable" (p.246). In his quotation, "value" can be equated with utility in the sense that it refers to a commodity's "potency for affecting attitudes and behavior" (Brock, 1968, p.246); while "unavailability" or scarcity is defined as (a) limits on the supply or the number of suppliers of a commodity, (b) the costs of acquiring, keeping or providing a commodity, (c) restrictions limiting possession of a commodity, and (d) delays in providing a commodity. Commodity theory, though formalizing scarcity effects, however, does not explain what psychological process, or processes, underlie these effects.

One explanation for scarcity effects on the perceived utility of a good that fits level one of our classification, is "uniqueness theory" (Snyder & Fromkin, 1980). According to this theory consumers may desire scarce goods as a way to differentiate themselves from others. Consistent with this explanation, studies have found that subjects high in need-for-uniqueness show a stronger preference for scarce commodities than those low in need-for-uniqueness (Fromkin, 1970; Powell, 1974; Lynn & Harris, 1997a; 1997b).

A second explanation that fits level two of our classification refers to price appreciation (Lynn, 1989). People presumably associate good's scarcity with higher prices (Lynn & Bogert, 1996) and since high priced goods are status symbol (Veblen, 1899/1965), and price is often used as a cue to good quality (Monroe & Petroschius, 1981) then people perceive scarce goods as more desirable.

We don't reject nor support these explanations; instead we designed a study to identify the existence of a third explanation, the basic scarcity effect, described as level three in our classification. Our study, nevertheless, differentiates from the researches cited

previously in several methodological aspects that are relevant for the generalizability of the results:

1. In previous studies individuals are presented with a representation of the object to be evaluated (eg. a picture representing a bottle of wine or a famous painting). Differently, in our study individuals are presented with real goods.
2. In previous studies the utility of owning the good is inferred from a judgment not from a choice. Individuals are told to evaluate the object on a series of attributes (eg. good's attractiveness, the future price of, the change in demand, the good's desirability, or some other type of utility measure). Differently, in our study individuals are told to choose among two goods, we therefore measure directly a behavior not a behavioral intention nor a simple judgment of value.
3. In previous studies the consequences of the judgment do not affect in any way the individual that makes the judgment, in our study the participant really keeps the item chosen (automatically taking the cost of renouncing to the other).
4. In previous studies scarcity is induced artificially through explicit communication (eg. individuals are told that one object is widely available while the other is not). In our study scarcity is directly experienced through visual perception of the goods (one item is less numerous than the other).

To summarize, differently from previous research, we use real objects, true choices, and participants in our experiment perceive scarcity through a direct and sensory manner. Therefore, scarce and abundant goods had their original and true utility value.

The basic scarcity bias

The basic scarcity bias is assumed to act implicitly and motivate behavior through an instinctive way. We hypothesize that the perception of a good as a scarce one stimulates those neural systems, such as the limbic system, that Damasio (1995) describes as those responsible of activating the archetypical stable patterns of behaviors that are genetically inherited. More precisely, we suggest that the higher mental processes of choice – which are built through the personal history of each person – are influenced by the scarcity bias which is an inherited stable behavioral prototype.

Therefore, what we assume is an evolutionary implication of the scarcity bias.

Imagine a situation where there are only two types of foods, food A and food B, food A is abundant and food B is scarce. Now assuming:

H1 - identical attractiveness for both the foods for all the consumers

H2 - fixed cost to obtain a unity of each food

H3 - preference for a balanced diet

Within this setting the rational consumption strategy is to take first the scarce good and then the abundant because in this way the probability of obtaining at least one unit of both the goods increases. Moreover this strategy should be transmitted through a selective process.

In animal behavior competition is a major force that determines species survival. Competitive ability depends on the capacity of the predator to reach the prey first and the most competitive predator acquires its daily energy requirement in the shortest time, leaving time for other activities.

An interesting example of how competitive responses may adapt to food partitioning is that of salmon. In salmon farming usually many fish are kept in the same tank and they are fed by introducing a large number of food pellets of similar size and color all at once. Interestingly, in one experiment, a group of salmon were fed with a mixture of brown and yellow pellets (70%-30%), while other two groups were fed with either yellow or brown pellets. Results showed that salmon ate more pellets and grew faster when they were given the mixed diet (Jakobsen, Johnsen and Holm, 1987). The increased size of the salmon in the mixed diet condition was due especially to the smaller fishes growing more than the smaller fishes fed with only one-color diet. The explanation of the authors was that feeding mixed diet reduced the “confusion cost” since the density of uniform food particles was lowered to the benefit of smaller-less competitive fishes. To our purpose, however, this is an example of how the perceived relative proportion of the two types of pellets (two-colour diet) changes the feeding behavior.

A similar mechanism was found with pigeons. Eight individually housed pigeons (*Columba livia*) were tested against each other in pairs in foraging trials. Food consisted of equal number (100) of two seed types that are easily distinguished visually (peas and vetch). Though, even if two pigeons had a preference for the same food type of the mixture, when they were set in the presence of each other foraging simultaneously on the same patch, they altered their initial seed preferences in ways that lead to resource partitioning (Inman, Lefebvre & Giraldeau (1987). In other words, one of the two pigeons adapted to the preferences of the other by choosing the complementary seed. The authors explain this result assuming that by adopting this behavior, a gregarious forager can

reduce competition through diet choice modification when a food patch contains different food types, a form of intraspecific resource partitioning. To our purpose, what is important here is that (i) competition can alter preferences and (ii) pigeons are sensible to the perceived proportion of the two types of food.

According to our hypothesis, the basic scarcity bias is an automatic and primary response mechanism that should operate at a very beginning stage of cognitive development. Children have been found to possess some simple rules of logic that are not yet diluted by the acquisition of social schemas and often they outperform adult humans in several tasks. For example, Jacobs and Potenza (1991) examined the use of the representativeness heuristic (Kahneman & Tversky, 1972). According to this heuristic, people make probability judgments based on the similarity or representativeness of one example to the reference category. Using an example from Jacobs and Potenza (1991), imagine that Sarah knows that she is one of twelve children trying out for a part in the school play, she might calculate her chance of being selected as one in twelve. Such thinking would exemplify use of the base rate. On the other hand, if the part in the last year's play was awarded to a child who goes to the same church as Sarah, she might decide that due to the fact that she is similar to that child in one respect, her chance of being selected is actually much higher. The latter strategy would exemplify representativeness-based thinking because Sarah used similarity as a basis for judging probability.

Jacobs and Potenza (1991) tested children attending the first, third, and sixth grade but also college students and found that the proportion of answers based on the representativeness heuristic increased with age. Their conclusion was (Jacobs and Potenza, 1991, p. 175): "...the use of the representativeness heuristic ... is based on the development of social schemas that can be used to make judgments in social situations where base rate data are difficult to collect and integrate. ... the judgment biases reported in adults could be considered 'smart errors'."

Children are more primitive than adults in the sense that they, like non-human animals, have lower cognitive abilities and are less likely to respond using social schema or rules, in part because they might not possess them at all, but also because they are more spontaneous and instinctive.

Another example is provided by Webley and Plaisier (1997) who tested if children aged 5-6, 8-9, and 11-12 show the same mental accounting pattern of responses using a

slightly modified version of the classical “lost ticket scenario” (Tversky & Kahneman, 1981) that they adapted from a previous study by Krouse (1986). The scenario was the following:

“Imagine you are at a fairground with your parents. Your mother gives you a 50 pence coin, and your father gives you a one pound coin. After walking around for a while you decide to use the 50 pence coin to buy a ticket for the merry-go-round. But then you discover that you have lost your ticket (or: But then you discover that you’ve lost the 50 pence coin so you can’t use it to buy a ticket for the merry-go round). Would you use the one pound coin to buy a new ticket?”

They found that older children (11-12) show a mental account pattern of results (when the money is lost, most children buy the ticket, but they do not when the ticket is lost) but this difference was not found in younger children aged 8-9 and 5-6. Younger children systematically decide to buy the ticket independently from the ticket lost/money lost manipulation. They show a pattern coherent with the maximization of subjective utility: they search for positive reinforcement. The same results were found earlier by Krouse (1986) who tested 90 elementary school children and found that only six-grader’s responses followed a mental account pattern, while first and third graders did not.

Similarly, Arkes and Ayton (1999) found that there are no instances of the sunk cost effect) in lower animals. Sunk cost effect describes the tendency of pursuing a failing course of action because of the amount of money or time or effort already invested in it. This behavior is not rational in the sense that one should decide based on incremental costs and benefits. Arkes and Ayton (1999) conclude that rules or social schema can be highly advantageous, but they can be a detriment when they are overgeneralized to situations in which they are no longer appropriate. They suggest that animals, as well as children, do not manifest the sunk cost effect because they are less likely to use abstract rules (Arkes and Ayton, 1999).

Following this line of research we hypothesize that the basic scarcity bias is an automatic and primary response mechanism that operates at a very beginning stage of cognitive development and decreases with age as cognitive processes develop and become structured. More precisely, as the child grows older the scarcity bias’ effect is diluted (substituted or overcome) due to the intervention of other social schema or rules learned through experience (e.g. Market strategies or self-control over the impulsive tendency to

follow scarcity effects). To test if the basic scarcity bias affects equally younger and older children we studied two age groups.

4. Experiment 1

4.1. Sample, design and procedure

A total of 88 children participated in the study divided in two age groups of 44 children each. The first age group included children aged 9 and 10 (mean age 9.47) and 45.5% were males and 54.5% were females. The second age group included children aged 12 and 14 (mean age 12.1) and 45.5% were males and 54.5% were females.

Half of the children in each age-group was assigned to the condition “A” and half to the condition “B”. In each condition the child had to choose among a set of identical objects of which 15 were of one color and 3 were of the other color. Color was counterbalanced in the two conditions: in condition A color1 was scarce and color0 abundant (3 vs. 15); in condition B color0 was scarce and color1 abundant (3 vs. 15).

The children arrived at the laboratory in groups of about 22. They were informed about the general aim and procedure of the study as a group (see appendix for detailed instructions). The toys used in the experiment were four: a teddy bear, a small soft plastic ball, a pen and a pencil-sharpener. Each toy was in two colors. Teddy bears could either be dark brown or light brown, the balls could be green or dark pink, the pens were either orange or green and the pencil-sharpener was either red or green. The scarce color toys were placed always in the same position as shown in figure 3. Each child had to choose one toy and the toy chosen was to be kept by the child as a reward for participating in the experiment.

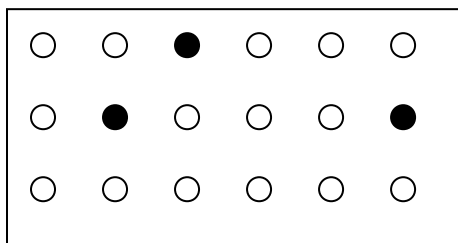


Figure 3. Distribution of scarce objects in the experimental set

4.2. Data analysis and results

Since we used four different toys, choices were distributed among these according to child's initial choice. To reach a significant number of observations, choices were aggregated across the different toys. Color was the only distinctive characteristic among the toys of the same type (eg. teddy bears were either light brown or dark brown) therefore we chose arbitrarily one of the two colors for each toy and we aggregated data using this criteria. The following table (Table 1) shows the aggregation pattern.

Table 1. Aggregation patterns.

	Color 0	Color 1
Teddy bear	Dark brown	Light brown
Soft plastic ball	Yellow	Fuchsia
Pen	Orange	Green
Pencil-sharpener	Red	Green

Children's choices relative to the first age group are shown in Table 2. The majority of the children chose color0 when this was scarce (69.9%) while the minority chose it when it was abundant (39.1%); seemingly, the majority of the children chose color1 when this was scarce (61.9%) while the minority chose it when it was abundant (38.1%). Summarizing, the results show that children in the first age group preferred systematically the scarce toy over the abundant toy.

Table 2. Contingency table Color x Condition (first age group).

	Condition A	Condition B	Total
Color 0	9 (39.1%)	14 (69.9%)	23 (100%)
Color 1	13 (61.9%)	8 (38.1%)	21 (100%)
N	22	22	44

Condition A: color1 scarce, color0 abundant; condition B: color0 scarce, color1 abundant.

To compare raw frequencies across conditions gives only a partial representation of the phenomenon we analyzed. To go more deeply into the analysis of the data we need to test first if the choice was not purely random, second, we need a statistical test to verify if the differences observed are or not significant. To eliminate the hypothesis of a random

choice we carried out a modified t-test for the two conditions (samples). The t-tests have been computed comparing the observed samples proportions with the theoretical distribution of a random variable. More precisely, defining $\hat{\mu}_i$ (with $i = A$ or B) as the probability of choosing a given toy under condition A or condition B computed from the observed distribution of the choices and μ the probability derived from the distribution of a theoretical random variable, we have that $\hat{\mu}_i - \mu = 0$ is the null hypothesis. Rejecting the null hypothesis means that the choices are not random. The probability of choosing a scarce toy under condition A was $\hat{\mu}_A = 0.636$, while the probability of choosing randomly was $\mu = 0.167$, the null hypothesis was rejected for alpha = 0.05 (alpha is the level of significance of the t-test). Concluding, the choice behavior of the first age group under condition A was not random.

Repeating the same analysis for the second sample (condition B) gave similar results. The value of $\hat{\mu}_B = 0.409$, while the probability of choosing randomly was $\mu = 0.833$, also in this case the null hypothesis was rejected for alpha = 0.05. Concluding, the choice behavior of the first age group under condition B was not random. Furthermore, comparing the $\hat{\mu}$ values of the two samples we notice that $\hat{\mu}_A > \hat{\mu}_B$, and therefore we can state that the probability of choosing a given color under condition of scarcity is higher than the probability of choosing the same color under condition of abundance.

What now we need is to test if the difference between the $\hat{\mu}$ values is statistically significant. A way to assess this is to compute a binomial distribution of the probability of the observed choices (see figure 4). Observing the distributions in figure 4 we see that for a number of observed choices less than 12, the probability of choosing a toy (of a given color – the benchmark color) is greater under conditions of abundance, while when the observed choices are more than 12, the probability of choosing the benchmark color toy is greater under conditions of scarcity. As a result, the majority of choices were made under condition of scarcity. The difference is statistically significant at 85%¹.

¹ The test we used to check the significance level is computed by starting from the maximum likelihood estimator of a Bernoullian distribution which is $\hat{\theta} = \frac{\sum_{i=1}^n x_i}{n}$. The maximum likelihood estimator for a

Bernoullian random variable of parameter θ has a distribution which can be approximated by a Gaussian. Therefore the difference between two parameters of different groups has the following distribution:

$$\hat{\theta}_1 - \hat{\theta}_2 \xrightarrow{n \rightarrow +\infty} N\left(\theta_1 - \theta_2, \frac{\theta_1(1-\theta_1)}{n_1} + \frac{\theta_2(1-\theta_2)}{n_2}\right)$$

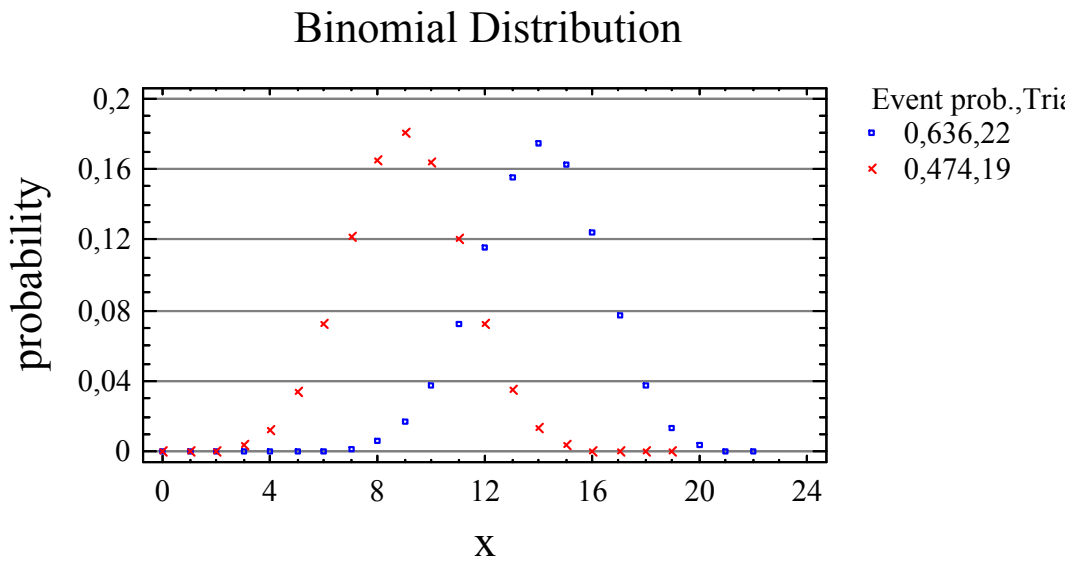


Figure 4. Binomial distribution of the probability of observed choices (first age group).

Children’s choices relative to the second age group are shown in Table 3. Almost the same percentage of children chose color0 when this was scarce (53.6%) and when this was abundant (46.4%). Furthermore, color1 was chosen more frequently when it was scarce (62.5%) than when it was abundant (37.5%). Summarizing, the data show that there is a slight tendency for children in the second age group to prefer the scarce toy over the abundant toy.

Table 3. Contingency table Color x Condition (second age group).

	Condition A	Condition B	Totals
Color 0	13 (46.4%)	15 (53.6%)	28 (100%)
Color 1	10 (62.5%)	6 (37.5%)	16 (100%)
N	23	21	44

Condition A: color1 scarce, color0 abundant; condition B: color0 scarce, color1 abundant.

As for the first age group, we tested first if the choice was not purely random, second, we carried out a statistical test to verify if the differences observed were significant. A

Starting from the given distribution we can compute the confidence interval in the following way:

$$\lambda_{1,2} = (\hat{\theta}_1 - \hat{\theta}_2) \pm 1.96 * \sqrt{Var(\hat{\theta}_1 - \hat{\theta}_2)}$$

modified t-test for the two conditions (samples) showed that the probability of choosing a scarce toy under condition A was $\hat{\mu}_A = 0.565$, while the probability of choosing randomly was $\mu = 0.167$, therefore the null hypothesis was rejected for alpha = 0.05 (alpha is the level of significance of the t-test). Repeating the same analysis for the second sample (condition B) the value of $\hat{\mu}_B = 0.714$, while the probability of choosing randomly was $\mu = 0.833$, but in this case the null hypothesis was not rejected for alpha = 0.05.

Concluding, the choice behavior of the second age group was not random under condition A but we cannot exclude that it was random under condition B. Given these results, the comparisons between the $\hat{\mu}$ values of the two samples is not meaningful.

The analysis of the binomial distribution of the probability of the observed choices confirms this pattern of results. As shown in figure 5, the two distribution curves of the binomial are almost overlapped which means that there is no a clear distinction between the two observed pattern of choices. In other words, this can be read as a confirmation of the low or null effect of scarcity on the choice of older children. As a result, we cannot state that the majority of choices in the second age group were made under condition of scarcity. The difference was not statistically significant ($p = 0.42$).

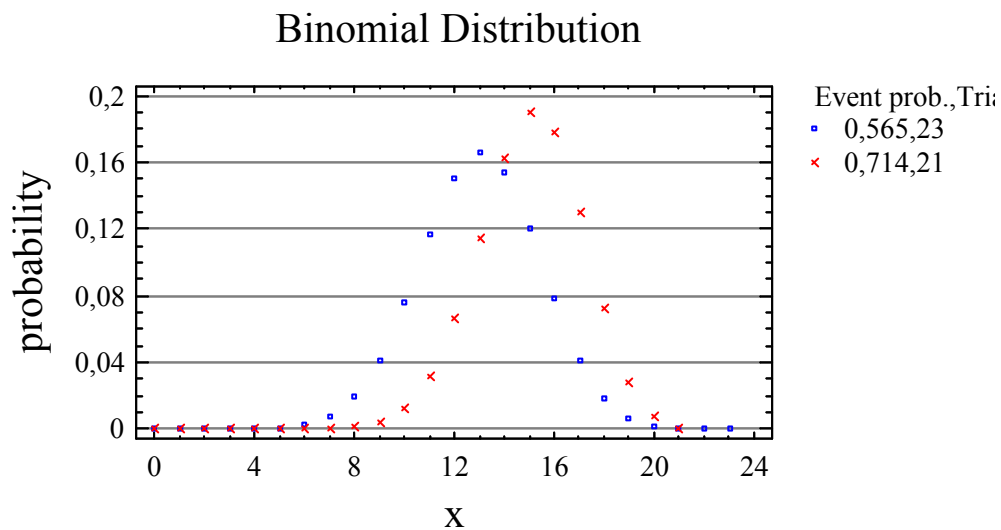


Figure 5. Binomial distribution of the probability of observed choices.

The results of experiment 1 support the basic scarcity bias hypothesis only for the younger children. The older ones seemed less influenced by scarcity, their choice behaviors followed the classical preference patterns (eg. they choose the pen of the color they liked the best).

5. Experiment 2

As discussed in the introduction, Adam Smith distinguished between “value in use” and “value in exchange”. In experiment one we found that value in use is a determining factor of younger children’s preferences when they choose an object that they will keep for themselves. Following Smith’s idea of value in exchange, choice of an object should be done according to some selling strategy. Hence, the characteristic of scarcity should increase its salience in a selling context since in a market context to own a scarce good puts the agent in a position of commercial strength. We tested this hypothesis in experiment 2 where children were asked to choose a toy not to keep for themselves but that they should then sell to another children.

The design of experiment 2 was thought to create a situation where choosing the scarce toy or choosing the abundant one was strategically equivalent. The absence of a dominant strategy is aimed at eliminating a spurious effect in the decision process. Once more we needed to be sure that the scarce toys were preferred exclusively because of a bias and not due to a rational computation of the best choice. With the experimental setting used here, if a child chooses the scarce toy this is not because it is the best choice but because s/he is attracted by scarcity.

To verify if there was not a Nash dominant strategy in the game embodied in the experimental design we carried out a numerical simulation reported in the appendix. The simulation was done using a simplified version of the game with only 5 players, perfect information and a known sequential dynamic. In the real experiment the number of players is much higher, there is not perfect information and the game sequence is not known. Obviously if in the simplified version of the game there is not a dominant solution this is also true in the real game. Starting from the extended solution tree of the game (see the appendix) and using a backward solution strategy it is quite easy to demonstrate that no dominant strategy can be followed by the players.

5.1. Design and procedure

A total of 30 children aged 10 to 12 (mean age 10,56) participated in the study. Fifty-seven per cent were males and 43% were females. A larger set of children (n = 46) actually participated in the study but the data collected on this sub-sample (n = 16) are not presented here because not relevant to the issue discussed here. More precisely their task was only to support the focal experiment (they had to buy a toy from their classmates) and make it credible.

The material used in the choice condition was the same of that in experiment 1. The instructions are reported in appendix. Each child had to choose a toy from the set and he/she was told that they will be asked to sell it to their class mates.

5.2. Data analysis and results

Choices were aggregated across toys as in experiment 1. Children's choices are shown in Table 4. No difference was found between choices of the two colors in the two conditions. Almost the same percentage of children chose color0 when this was in condition of scarcity (44.4%) than when this was in condition of abundance (55.6%) and the same was for color1. Summarizing, the data showed that children did not prefer systematically the scarce toy over the abundant toy.

Table 4. Contingency table Color x Condition (market).

	Condition A	Condition B	Totals
Color 0	10 (55.6%)	8 (44.4%)	18 (100%)
Color 1	7 (58.3%)	5 (41.7%)	12 (100%)
N	17	13	30

Condition A: color1 scarce, color0 abundant; condition B: color0 scarce, color1 abundant.

The reasons reported by children for their choice are shown in Table 5. Most of the children seemed to make a choice according to how much they liked the toy, disregarding whether it could be easily sold or not. More precisely, they believe that the one they like the best is also the one that can be more easily sold.

Table 5. Reasons given for the choice of the toy.

Reasons	Frequency	Percentage	Valid Percentage	Cumulative Percentage
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Nicer	18	60,0	66,7	74,1
Was liked by a friend	5	16,7	18,5	92,6
Scarcity	2	6,7	7,4	100,0
Other	2	6,7	7,4	7,4
Total	27	90,0	100,0	
Missing	3	10,0		
	30	100,0		

6. Experiment 3

This last experiment was carried out to test if scarcity bias is also present in adults. Forty students (mean age 22; 25 males and 15 females) were asked to participate in an experiment on decision making styles. They were told that their task was to complete a short questionnaire describing their decision making style and they would have been rewarded with a pen for participating. The students entered the laboratory and sat in front of a table. On the table we provided a container with 18 pens. The pens were all identical except for the color: fifteen were orange and three green in condition A, while fifteen were green and three orange in condition B. Students were told to choose a pen and use it to fill in the questionnaire. It was stressed that the pen they chose had to be the one they wished to keep as a reward for participating in the study.

The results of adult choices are shown in table 6. As can be seen, a symmetrically opposite effect to the scarcity bias was found. Adults systematically preferred the abundant pen. The orange pen was chosen more frequently when it was abundant (61.9%) and the same happened for the green pen (63.2%). This pattern of results tells us that there is no scarcity bias, more precisely, it tells that some other selection strategy was acting in the mind of the students choosing a pen. Their choices, indeed were not random.

Table 6. Contingency table Color x Condition (adults).

	Condition A	Condition B	Totals
Color 0 (Orange)	13 (61.9%)	8 (38.1%)	21 (100%)
Color 1 (Green)	7 (36.8%)	12 (63.2%)	19 (100%)
N	20	20	40

Condition A: green scarce, orange abundant; condition B: orange scarce, green abundant.

A modified t-test for the two conditions showed that the probability of choosing a scarce color under condition A was $\hat{\mu}_A = 0.4$, while the probability of choosing randomly was $\mu = 0.167$, therefore the null hypothesis was rejected for $\alpha = 0.05$ (α is the level of significance of the t-test). Repeating the same analysis for the second sample (condition B) the value of $\hat{\mu}_B = 0.65$, while the probability of choosing randomly was $\mu = 0.833$, but in this case the null hypothesis was only marginally significant for $\alpha = 0.07$.

Concluding, the choice behavior of the second age group was not random under condition A and it tended to be not random also under condition B. Comparing the $\hat{\mu}$ values of the two samples we notice that $\hat{\mu}_B > \hat{\mu}_A$, meaning that the probability of choosing a given color under condition of abundance is higher than the probability of choosing the same color under condition of scarcity.

The analysis of the binomial distribution of the probability of the observed choices confirms this pattern of results. As shown in figure 7.1, the two distribution curves of the binomial are not overlapped which means that there is a distinction between the two observed pattern of choices. For a number of observed choices less than 11, the probability of choosing a pen of a given color is greater under conditions of abundance, while when the observed choices are more than 11, the probability of choosing the benchmark color pen is greater under conditions of scarcity. As a result, the majority of choices were made under condition of abundance. The difference is statistically significant at 90%.

This can be read as a confirmation of the low or null effect of scarcity on the choice of adults. An explanation, absolutely speculative, to this behavior is that adults acted according to an altruistic principle in that they decided to take the pen of the abundant color because they felt thankful to the experimenter and didn't want to reduce his storage of the scarce color pen.

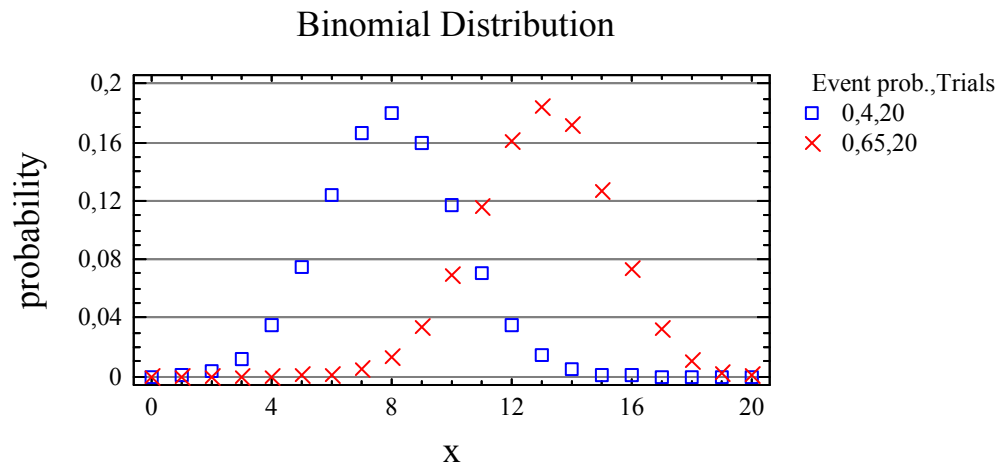


Figure 6. Binomial distribution of the probability of observed choices (adults sample).

7. Conclusions and Discussion

Younger children, aged 9-10, show a basic scarcity bias (they systematically prefer the toy scarce in color) while in older children, aged 11-12, the bias is less present and is reversed in adults. These results are coherent with a developmental explanation of the basic scarcity bias which tends to be present at early stages of development when cognitive abilities are low, but gets weaker and is substituted by other strategies as the individual grows older.

These data support the idea that scarcity operates at a basic level, as an automatic and primitive response. The data also support the idea that this bias follows a developmental pattern, decreasing as cognitive development increases. At higher stages of cognitive development, as in older children and adults, the bias is presumably diluted by other social schema or rules that enter into the construction of preferences and determine choice. These other rules might be an altruistic attitude or more simply, older children and adults have learned ways to resist the persuasive nature of scarcity. Marketing strategies in fact are built upon this basic bias and try to reactivate the effect induced by the perception of scarcity enhancing this characteristic.

Other biases were found to follow the same developmental pattern although in the opposite direction. The use of the representativeness heuristic, for example, increases with age (Jacobs & Potenza, 1991). This result is attributed to an increased use of social schema learned through experience and an application of these schema in a indistinct

manner. Jacobs and Potenza (1991) talk about “smart errors” made by adults when they apply uniformly these social schema in every situation, forgetting base rate information. On the other hand, children seem to follow some simple rule of logic. Mental accounting is absent in children up to 9 years, as well, while it is present in children of 11 and older and in adults. Younger children were found to give behavioural responses compatible with a pure positive reinforcement strategy. And similarly, Arkes and Ayton (1999) found that sunk costs are absent in non-human animals. These data all seem to tell that children and non-human animals follow some simple rules such as positive reinforcement, base rates, increased utility.

The results of our experiments go in the same direction showing that children possess a basic scarcity rule that naturally increases the good’s attractive power and this bias decreases with age, presumably due to cognitive development.

Although our data, as any new finding, need to be replicated and certainly would benefit from further research, we are convinced that perception of scarcity serves an adaptive function because it communicates to the individual the urgency of obtaining the good. The basic scarcity bias is a primary motivational system because with it the good becomes attractive and the individual is moved toward its achievement, without it the good has its normal attractive power due to the attributes that define it. Scarcity, in other words, boosts the attractive power of goods acting at a very primitive level.

Appendix 1

Instructions for experiment 1

The class is introduced in the laboratory and the experimenter describes the study as follows:

“Today we will play a game: we will pretend that it is your birthday and you will be given a toy as a present. One at a time you will go in the next room where you’ll find a catalogue of toys. You can choose the toy you like the best among those represented, but only one toy. After you make the choice you will be shown the “factory of toys”. The factory of toys is the place where they build the toys like the one you chose. You can choose one toy among those in the factory and keep it.”

Each child is brought in the adjacent room one at a time and shown the catalogue. The toys represented in the catalogue are four black and white pictures of the real . The order of presentation of the pictures is randomized. After deciding which toys he liked the best the child was shown the factory of toys relative to the chosen toy. The toys in the factory are all identical except for the color. Fifteen toys 15 were of one color and 3 of the other. The color changed according to the experimental condition. The instructions were as follows: produces toys with a continuous rhythm so that you will find the exact number and quality of toys that the children coming before you found. Choose the one you like and you will allowed to keep it.”

Appendix 2

Instructions for experiment 2

Choice condition

The instructions are as follows: “Today we will play a game at the end of which, if you are good enough, you will receive a toy . This is the game: one at a time you will visit the room next to this were you will be shown a catalogue of toys. You have to choose one toy that you will have to sell to your schoolmates. Your schoolmates will receive 10 tokens that they can use to buy your toy. With the tokens you earn you will be able to buy another toy – different from the one you choose in the first place. The more tokens you will earn, nicer will be the final toy you could buy.” Then the procedure and the instructions continue as in experiment 1.

Market condition

The instructions were as follows: “Today we will play a game. You will be given 10 tokens. With these tokens you can buy one or more toys from your classmates. The toy or toys you will buy is yours and you can keep it”.

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