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The Color of Risk

- Risk aversion in children using red as framing

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Abstract. Traditional economic theory states that the economic agent is rational and that decisions under risk is governed by probabilities and the resulting payoffs. Modern studies have shown this to be far from how people behave. Recently the focus has turned to colors and their effect on economic choices. This study looks at 6 year old children in Sweden (N=123) and how their risk behavior is influenced by the color red. Using an easily communicable game and randomly assigning the children to playing it on red (green) background the risk preference is revealed. The red background is found to decrease the probability of the child acting as a risk seeker with 19.6 p.p. with a p-value of 0.054. The findings could potentially be used to, not only communicate danger to children, but also affect their behavior. The resulting policy implication could lead to large economic gains in terms of decreased societal costs of accidents. Further research is needed in order to test the results in a real world setting.

Keywords: Risk, colors, framing, children

JEL: C91, D03, D81

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1 Introduction

Red means run, son,
numbers add up to nothing

Neil Young

Every choice we make is associated with risk. Where to put our pension funds, what stocks to invest in or simply which school to enroll in. Choices can potentially have large economic consequences. Risk has been studied for a long time within the economic science, and for a long time it was considered to be an act of calculation of a rational agent. Recently a wide range of factors have been found to influence investment decision and our negotiations in addition to probabilities and payoffs. For instance, we are affected by the framing of these choices (Kahneman and Tversky, 1979).

Colors are ubiquitous; we can neither escape them nor avoid processing them (Elliot and Maier, 2007). Kliger and Gilad (2012) study how undergraduates make financial decisions under uncertainty when primed on red respectively green. They find that undergraduates primed on red are more risk averse then their counterparts and that students exposed to red thought that negative outcomes were more probable. In a similar study, Jiang et al. (2013) find that the effect of red is culture dependent. In China the effect is opposite where a decision framed by red has been found to increase the probability of positive outcomes. Both these studies are examples of the failings of traditional economic theory where colors should not affect a rational agent.

Financial markets, work environments or even our homes are all places where we are exposed to colors. These are also places where important decisions are made, decisions that may be influenced by colors. Understanding how and to what extent colors affect our economic decisions are thus of high importance. A better understanding of the effects could lead to policy implications facilitating avoidance of unnecessary risks.

Children's choices have potentially larger economic consequences than adults. Actions made early in life will affect a much longer time span. Educational choices affect for instance the subsequent life income (Boyer, 2006). As a result, children, have to pay for mistakes made early on in life. Ingesting medicine, crossing streets carelessly and playing close to dangerous machinery are all examples of risk where a choice can have severe economic consequences in terms of forfeited future income but also in immediate cost to society in terms of increased health care spending. The personal tragedies not mentioned. If colors such as red have an effect on children's behavior the color could be used in order to not only warn but to change children's risk behavior. Examples are medicine containers all in red or more red lights at street crossings outside kindergartens in order to decrease accidents. If red changes the risk behavior such policy suggestions could be of large economic consequence where both lives and money can be saved.

1.1 Purpose

Following Kliger and Gilad (2012) and Jiang et al. (2013) this study aims to scrutinize these results and to see if their results are valid in a Swedish setting and with a younger age group. Studying how children react to colors is also of interest since their perception of colors is less tainted by personal experience. Observed effects will to a larger degree reflect the intrinsic reaction to being framed on colors.

The author of this paper also argues that studying children's economic behavior is of high interest in its own right. The economic science has since its cradle mainly focused on adults. Following the Greek tradition it has considered children as agents of little or no importance (Bruni and Pelligra, 2010). This article fills an important position in a wider context as adding to the previous but limited literature interested in the economic actions of children.

To study children is also important considering the ongoing discussion of rationality in agents in the economic science. To the extent that humans are rational in their decision making it is of interest to research how rationality develops. In order to examine this issue economics should study the development of children as they often are considered less rational than adults. Studying children and the development of (ir)rational behavior could help create understanding of behavior in later years(Krause and Harbaugh, 1999). This paper however, makes no attempt to connect the dots nor depict the development of rationality.

1.2 Research Question

This leads the author to pose the question *Does the color red increase risk aversion among children?*

2 Background

2.1 Risk

Risk is defined by ISO 31000:2009 as the "effect of uncertainty on objectives" (*ISO 31000:2009 Risk management—Principles and guidelines* 2009) implying the possibility of both positive and negative outcomes. The focus of this study is however on loss aversion.

The economic science has traditionally viewed a decision under risk as a matter of probabilities and payoffs (Lopes, 1994; Boyer, 2006), making a decision under risk a matter of calculating and choosing the option with the highest expected value. Taking into account decreasing marginal utilities, Von Neumann and Morgenstern (2007) constructed a model with 4 rational axioms so that any agent fulfilling these axioms has an utility function. The formalized and prescriptive approach was criticized at its onset by claims that it

failed to describe decisions in real world situations (Allais and Hagen, 1979). Even the decisions by one of the contributors to the formalized approach deviated from the model when confronted with the Allais paradox (Lopes, 1994). One of the underlying implicit assumptions of the model is the invariance assumption, choices should be independent of their representation (Von Neumann and Morgenstern, 2007). However, Kahneman and Tversky (1979) found that choices under risk are not only dependent on probabilities and payoffs but also depend on the framing of the questions.

In an influential experiment two groups were asked to choose between two options. The options were identical in terms of outcomes but differed in the representation of the question. Both groups were told that "U.S is preparing for an outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed." Each group was given either the options 1 and 2 or option 3 and 4. The percentage of respondents preferring each alternative is in brackets.

1. If program A is adopted, 200 people will be saved. [72%]
2. If program B is adopted, there is a one-third probability that 600 people will be saved and a two-thirds probability that no people will be saved. [28%]
3. If program C is adopted, 400 people will die. [22%]
4. If program D is adopted, there is a one-third probability that nobody will die and a two-thirds probability that 600 people will die. [78%]

Using this results and additional experiments the authors were able to show that respondents are more risk averse in gains and risk seeking when options are framed as losses. The significant differences in response frequencies are due to what is labeled as framing effects. Framing is a heuristic or cognitive bias that has been observed when people are presented options in terms of gains or losses (Tversky and Kahneman, 1981). Heuristics could be regarded as a mental short cut or a rule of thumb for reasoning frequently used in cognition and was first introduced in the economic science by Simon (1957). According to heuristic theories the human mind can be thought of as having two systems, one fast system of thinking which is intuitive and less critical, and one slower system which is more rational and calculating. Using the terminology of Kahneman these modes of thought are referred to as system 1 and system 2 (Kahneman, 2011). Though expedient, the heuristic system repeatedly lead to biases in reasonings due to intuitive rather than logical thinking.

The observed deviations from the traditional and prescriptive theories formed the basis to the descriptive prospect theory on how people make decisions under risk (Kahneman and Tversky, 1979). The model can be roughly sketched out as:

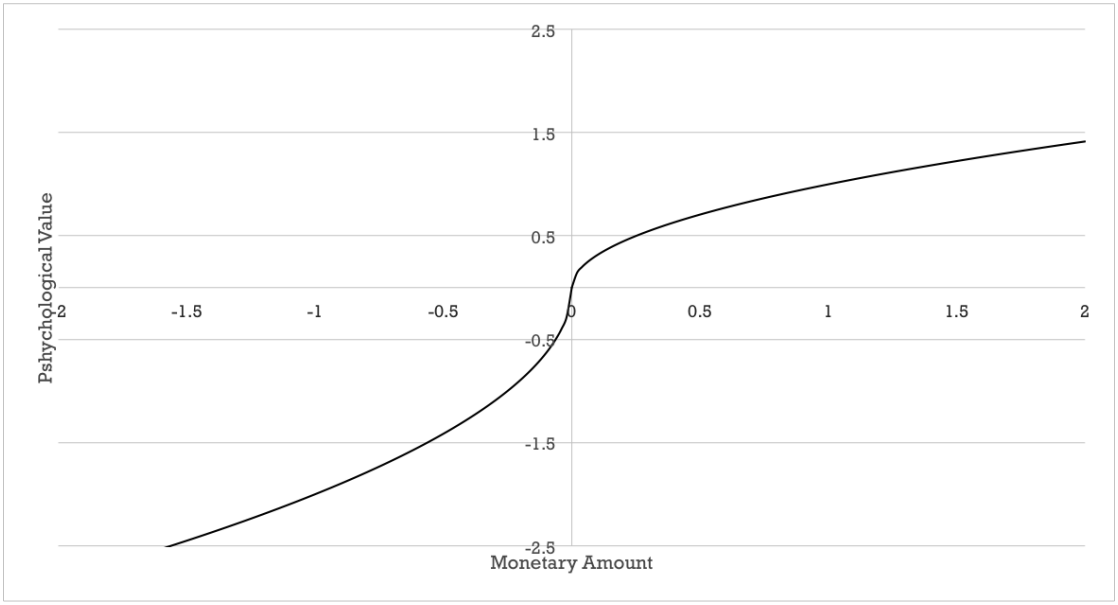

Figure 1: Graph depicting the outlines of the prospect theory. Redrawn from Kahneman (2011).

1. concave in gains
2. convex in losses
3. steeper in losses than in gains

The reasoning has since then been developed both through reformulations of the model as well as additional contributions to the list of heuristics. For instance, the model has been developed to the cumulative prospect theory (CPT) in order to better accommodate stochastic dominance (Tversky and Kahneman, 1992).

Framing is thus an important factor affecting decisions under risk and one of the reasons to criticize the underpinnings of the economic agent as used in the traditional literature. There are various types of framing done by words such as the standard risky choice framing, attribute framing and goal framing (Levin, Schneider, and Gaeth, 1998). Studies have shown that framing effects are relatively stable over age in adults. In younger children it seems that the effects of framing increases with age while being observable in some studies at the age of 6 (Levin and Hart, 2003). Others studies observe it first around the age of 11 (Reyna and Ellis, 1994). The effects of framing have also been found to decrease when performing experiments in a foreign language. More specifically, loss aversion decreases using a foreign tongue (Keysar, Hayakawa, and An, 2012). In general, the list of cognitive biases has grown since its introduction.

2.2 Colors and Risk

There is a very limited number of articles focusing on the framing with color within the economic context. One of two exceptions is a paper by Kliger and Gilad (2012). In their article subjects are asked to make bets as well as evaluate probabilities of financial outcomes based on information with either known or unknown probabilities. The study was performed either with a red or a green background on a computer screen. The hypothesis of the authors is that red induces a fight-or-flight mechanism (see for instance Cannon (1929). This implies that the subjects will be risk seeking for gain framed questions when primed on red and risk averse when questions are framed as potential losses. Their results show that when the undergraduates (N=96) are asked to gamble in a situation with known probabilities red indeed makes subjects risk averse in losses. In their first set of 6 questions, the results from the 5 loss framed questions are in line with their hypothesis and significant on the 10 % level, 2 of the questions even with a p-value of less than 0.02. Only one question was framed in terms of gains and the result is contrary to their hypothesis, though not statistically significant. If the sign is an indication of the true effect, their hypothesis concerning fight-or-flight behavior may be wrong. A potential twist that would be more in line with the research they discuss would be that red within the economic context is a signifier of loss and when subjects are primed on red, loss schemes are activated making them in general reluctant to gamble.

In their second set of questions, subjects were asked to assign probabilities to different outcomes of a venture capital fund. More specifically they were asked what monetary reward subjects thought was equivalent to receive with certainty, compared to getting a pre-specified sum of money if the fund reached a particular condition. The authors conjecture that the group exposed to red will assign higher probabilities to negative returns of the fund and thus value the certain payoff lower than the green group. Similarly, the subjects are conjectured to assign lower probabilities to positive returns of the fund and value the certain payoff higher than the green group. Their findings corroborate their hypothesis, indicating that red indeed decreases risk aversion.

Another exception to the lack of literature on color and economic decisions is Jiang et al. (2013). They study if culture has an influence on how colors affect economic decisions of subjects. Hong Kong and mainland China are two cultures that are closely interlinked and share many features. Yet, in mainland China red is used when describing an upturn in the stock market, to accentuate increasing numbers in television shows and to signify an upwards direction in elevators. Green is used in the same settings but signifying the opposite. In Hong Kong, as in its former colonizing country Great Britain, the colors are used as in western cultures. Using this difference in culture they investigate how the priming of colors affect expectations on the macro economic development. Their hypothesis is that there is a cultural link in both countries between color and direction, namely up-red link in the case of mainland China and up-green in the case of Hong Kong.

Students (N=284) from mainland China and Hong Kong were given the same passage on

the national economic situation but where the names of the countries were exchanged in order to match the nationality of the participants. Within the two groups one subgroup was framed using red letters and the other using green letters. They found a significant difference in the predictions. Hong Kong natives predicted higher economic activity when framed on green than on red, whereas the students from mainland China predicted the opposite with significant differences. Jiang and colleagues argue that this speaks in favor of the effects of colors being culture dependent.

2.3 Colors and Behavior

Colors have long been suggested to have an effect on behavior, mood and cognition. One of the first discussants was Goethe who with his work *The Theory of Colours* discussed the perception of colors. The book has been influential and criticized. For instance, Wittgenstein argues that it is not a theory since it is impossible to make predictions based on the ideas presented (McGinn, 1991; Goethe and Eastlake, 1840). Another often cited paper is *Some Experimental Observations Concerning the Influence of Colors on the Function of the Organism* by Goldstein (1942). This paper proposes testable theories in contrast to Goethe's contribution. Goldstein discusses different reactions to colors among mentally ill patients. His results are often interpreted as colors with shorter wavelengths such as red and yellow have an arousing effect on subjects and colors with longer wavelength such as green and blue have a calming effect.

Colors can in addition be discussed from the perspective of chromatic and achromatic. Along this spectrum, colors have been found to have an effect on behavior. Frank and Gilovich (1988) studied the effect of black in the American football and hockey leagues found that teams wearing black rank the highest in the number of penalties against the team. Furthermore, a shift of colors from a non-black to a black uniform is paired with an immediate increase in the number of penalties against the team.

The link between colors and behavior, affect or cognition is debated in a large literature. There is literature supporting the idea of a link between cognition and colors (see for instance Stone, 2001; Elliot and Maier, 2007; Sinclair, Soldat, and Mark, 1998) and there is also literature that find no relationship (see for instance Stone and English, 1998; Kwallek et al., 1997; Hatta et al., 2002). Elliot and Maier (2012) argue that there are several reasons for the mixed result in previous color research. First of all, several studies have been unable to control the color treatment. Colors have been added to an existing milieu through a colored wall or colored lighting. Using colored walls in the background, the experimenter has little or no control over the treatment the subject receives. Colored lighting on the other hand could be viewed as too large encroachment since it creates an unusual work environment. Second, studies have not focused on experimental designs such as performing a double blind study. Third, the hues of the color are not controlled enough. However, some studies controlling for hues have found that red has an arousing effect in comparison to colors such as green and blue (see for instance Rajae-Joordens and Hanique, 2011)

Following their research, Elliot and Maier propose the color-in-context theory as a theoretical foundation that could be used in order to understand the effects of colors on behaviors and decisions. The theory is based on six premises:

1. Colors carry meaning. Colors have not simply an aesthetic value but are also carriers of information that go beyond the simple and subjective pleasant-unpleasant.

2. Viewing colors influences psychological functioning. Seeing colors causes an evaluative process of the stimuli. The evaluation of the color will in turn affect the perceiver's affection, cognition and behavior.

3. Color effects are automatic. The extraction of color information, the processing and evaluation of the same is not necessarily a conscious process.

4. Color meanings and associated responses have two sources: learning and biology. Throughout life some colors are repeatedly paired with certain concepts, e.g. pink is associated with femininity and blue with masculinity. Perceiving and thus evaluating colors is also proposed to have had a strong survival value when wanting to detect ripe fruit or a sexually available mate.

5. Relations between color perception and affect, cognition and behavior are reciprocal. The state of mind can affect in turn the way colors are perceived.

6. Color meanings and effects are context specific. The information conveyed with colors will depend on surrounding cues and the discourse within which the color is perceived.

Defined as such the color-in-context theory could explain increased risk aversion in an economic context.

There is a large body of literature, early and contemporary, focusing on red in achievement contexts. It has for instance been found that the color red can be a signal of superiority and dominance leading to contestants wearing red having an advantage in both individual sports (Hill and Barton, 2005) and team sports (Attrill et al., 2008). Though contrary to the mentioned articles' own propositions and following Elliot and colleagues, it is more likely that the effect of red is affecting the person seeing the color and not the person dressed in red. However more recent studies argue that the findings on team sports is not necessarily stable once controlling for team fixed effects though there is still much research needed in this area (Piatti, Savage, and Torgler, 2012). Furthermore, performance in intellectual tasks has been found to be impaired among subjects primed on the color red (Elliot and Maier, 2007). The latter finding is of importance since cognitive capability is important assessing choices and evaluating risk. Since red impairs cognitive performance it could be a confounding factor when faced with an economic decision.

2.4 Children and Risk

To study risk behavior among children is specially important for several reasons. The most obvious is that children not necessarily behave rationally in decisions involving risks. Children have less developed cognitive abilities which leads to miscalculation of consequences as well as the probabilities of the consequences occurring (Boyer, 2006). In addition, children are less developed emotionally. They have difficulties controlling their impulses and their own feelings (Developing Child, 2004). This inability to make beneficial decisions under risk can have severe economic consequences both in the short term as when crossing a street without care or in the long run as the choices made early on in life can cause economic losses for the rest of their life time. The latter holds true especially for adolescents where engagement in risky behavior might have large long term effects such as the decisions to start smoking, drinking alcohol or engaging in risky sexual behavior (Boyer, 2006).

One of the first large studies made on children's risk behavior was done by Slovic (1966). In his 1966 paper he studied how risk behavior differs depending on age and sex. He used a simple experiment where children were asked to pull switches from a sample of 10 where 9 would give a reward in the form of a spoon of M&Ms and 1 switch would result in the loss of all accumulated winnings. The children could thus increase their earnings by pulling more switches which at the same time increased the probability of losing the pot or could choose to stop voluntarily and collect it. The results of the study supported the notion of boys being more risk seeking than girls. However, differences between sexes appeared first at the age of 11. The paper was important in the literature of risk aversion among children for two reasons. It looked at children using a large sample size (N=1047) and using a setup specially designed to be easily understood and communicable to children. One of the fallbacks of the study was its selection bias, the experiment relied on children volunteering for the test in an amusement park. Most likely, this attracted children with a larger propensity to take risks. The experiment developed by Slovic (1966) has been found to have validity in predicting risk behavior in real world situations. Using the experiment Hoffrage et al. (2003) segment children depending on them behaving risk averse or risk seeking. Risk seekers were defined as children who once out of three rounds revealed to be risk seekers, i.e. having a risk preference $\Gamma < 0$ (see Figure 2. They found that the risk behavior in the game was closely correlated with the children's risk behavior in both simulated and real life traffic situations. Their findings suggest that the measure of risk behavior in the game is applicable to risk behavior in traffic situations, opening up for the possibility that the risk preference revealed in the game is correlated with behavior in real world experiments.

Systematically studying children and their behavior in economic games, including behavior in risk taking games, was pioneered by Harbaugh and colleagues (see for instance Harbaugh, Krause, and Liday, 2003; Harbaugh, Krause, Liday, and Vesterlund, 2003; Harbaugh, Krause, and Berry, 2001; Krause and Harbaugh, 1999). Though in their paper investigating risk behavior in children they observe results contradicting the prospect

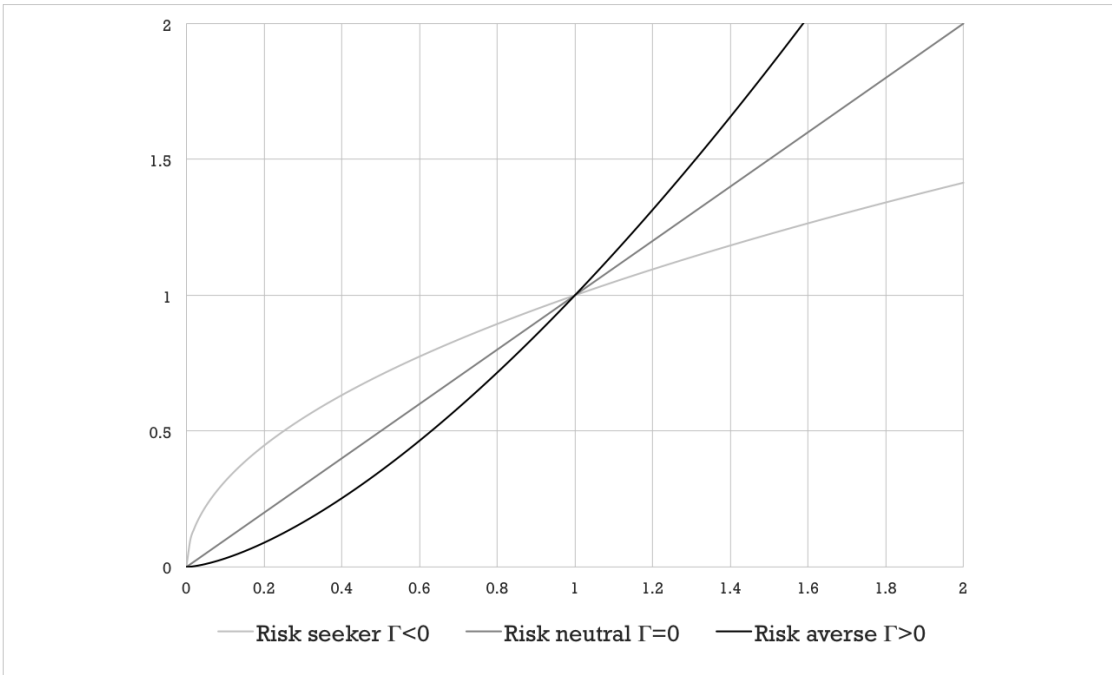

Figure 2: Graph depicting the utility curve $x^{1-\Gamma}$ with different risk preferences i.e. values on Γ.

theory raising doubts as to what extent the findings of the study are reliable. One criticism the authors themselves point out is their deviation from praxis in experimental design of the gamble which could explain the results (Harbaugh, Krause, and Vesterlund, 2002).

Table 1: Summary of hypothesized effects derived from previous literature

Theory	Effect of red	Comment	Literature
Color-in-context Theory	Increased risk aversion	Not tested on children or in the Swedish context	Kliger and Gilad (2012) and Jiang et al. (2013)
Expected Utility	No effect	Colors should not affect probabilities or subjective utilities	e.g. Von Neumann and Morgenstern (2007)
Prospect Theory	No effect	No projections about effects from colors	Kahneman and Tversky (1979)

2.5 Controls

To be able to calculate probabilities and payoffs in a game testing risk is fundamental. According to Schlottmann (2001) children are not capable of performing exact computations but there is evidence for 6-year-olds applying intuitive reasoning for understanding probabilities and payoffs, a method of estimating that they share with adults. Several other studies also show that children are able to use statistical information in order to judge a sample, though the skills develop with age (Jacobs and Narloch, 2001; Jacobs, Greenwald, and Osgood, 1995).

Systematic differences in risk preferences between sexes are widely discussed. In the literature survey by Eckel and Grossman (2008) contradicting results was found but the authors conclude that field studies on sex and difference in risk behavior support the general notion that females are less prone to take risks. The findings in laboratory environment are on the other hand not as conclusive. While there are many studies supporting the sex difference there is also a large heterogeneity within the examined studies. The heterogeneity in results may be due to the difference in designs of the studies which can cause large effect. As Eckel, Grossman, and Lutz (2002) pointed out, it is difficult to measure risk taking between separate tasks since gambles with similar payoffs can exhibit low correlation.

The socioeconomic background of a child has been found to be significantly correlated with performance in education and cognitive tests (Bradley and Corwyn, 2002). Most commonly socioeconomic status is described as a vector consisting of family income, parental education and the occupational status of the parents. In this study controls for

Table 2: Summary of the control variables derived from previous literature

Confounder	Included control	Hypothesized effect	Literature
Cognitive development	Parental education	?	e.g. (Bradley and Corwyn, 2002)
	Books at home	?	e.g. (Levitt and Dubner, 2006)
Educational performance	Parental education	?	e.g. (Bradley and Corwyn, 2002)
	Books at home	?	e.g. (Levitt and Dubner, 2006)
	Siblings	?	e.g. (Downey, 2001; Downey, 1995)
Gender	Sex	No effect	e.g. (Slovic, 1966)

the *parental education* are used but also the variable *books at home* as a proxy for socioeconomic status. *Books at home* has successfully been used in several studies as a proxy for socioeconomic status especially when examining academic performance of students (see for instance Wößmann, 2003; Wößmann, 2004; Levitt and Dubner, 2006).

The number of siblings has been found to have several effects on a child's development. Among others, the number of siblings has been shown to have a negative correlation with educational performance (Downey, 1995; Downey, 2001). Though the issue of causality have been questioned (Guo and VanWey, 1999) the correlation is observable.

3 Method

In order to answer the research question a experiment and a model was designed to test risk aversion among children. For a discussion on criteria for the experimental design and the pilot study performed, see 3.3 and 3.4.

3.1 Experimental Design

In the final version of the experiment one child at a time was seated in a secluded room with the experimenter. Facing the child was 20 red (green) cups turned upside down in two rows on a red (green) table cloth.

A cup hid 1 small plastic gorilla, referred to in Swedish as "Svarte-Petter" meaning black Petter, henceforth referred to as the old maid. The other 19 cups hid a 1 SEK coin. The children were allowed to turn as many of the cups as they preferred, one at

Figure 3: Picture of child playing the game. Printed with permission from child, parent and kindergarten. Not to be reprinted without the permission of the author.

Figure 4: Detail of the game showing the old maid and coin.

a time, and received every coin they found. The round stopped either by the child's choosing or if the child found the old maid. In the former case the money was put in a fictional safe. In the latter case, the child lost the money collected that round. The game was played 3 rounds. In the cases where a child found the old maid on turning the first cup of the round or when having played 3 times without saving any money, an additional round was offered to the child. After these rounds, the money in the safe could be used to purchase a variety of toys (glass pearls, small and large plastic animals) from a fictional store. Prizes in the game were decided upon in conjunction with child psychologist Kristina F. Rosenqvist and chosen to attract the interest of both boys and girls at the age of 6 years. The amount and type of toys they could purchase depended on their total winnings. The exact prices of the toys were not disclosed in advanced, only their ordinal values. The value of the money was rounded up so that all money was spent in the fictional store.

After each round, the child was asked to turn around and cover their eyes while new coins and the old maid was hidden under the cups. The position of the old maid was randomly assigned in advance using a computer program. Treatment was also predetermined using the same program. Introducing and playing the game took on average 15 minutes per child. To decrease the risk of the experimenter's own clothes being a confounding factor to the treatment similar clothes were worn when executing the ex-

periments namely a white shirt, dark chinos and a blue cardigan.

At each new kindergarten a similar procedure was performed presenting the case both for the teachers and for the children. The author met the teachers to explain the experiment and the purpose of the study some days in advance. On the day of the experiment the author introduced himself to the class of children, explained the reason for the visit and briefly the game (see appendix 9.1 Script of introduction for a script of the introduction).

The rules of the experiment was explained in a similar way every time for each child (see appendix 9.2 Oral presentation of the game for script of the presentation. Oral instructions were complemented by a graphic representation of the game (see appendix 9.3 Graphical representation of the game). Since the subjects were children the experimenter deviated from the script on some occasions in order to answer questions or to make sure the children were paying attention. This resulted in a variation in how the game was communicated but ethical arguments were given priority over exact reproductivity of the procedure. No round was however started before the child answered 4 control questions (see end of appendix 9.2 Oral presentation of the game). If the subject failed 2 of the questions the child was removed from the dataset.

The study was single-blind where the author performed all of the experiments and the children were unaware of the purpose of the experiment.

3.2 Ethical considerations

Experimenting on children increases the urgency of attending to the ethical perspective. In order to secure that the experiment met ethical standards several professionals were consulted. Among them were Kristina F. Rosenqvist, licensed child and youth psychologist and psychotherapist working at Barnahus Östergötland, Carl-Göran Svedin professor at the department of Child and Adolescent Psychiatry at Linköping University and Polly Björk-Willén associate professor in pedagogical work and Ph.D. in Child studies at Linköping University. The pilot study also filled the purpose of testing the experiment, its effect on the children and the whole kindergarten before scaling up the study.

In order to receive an informed consent, the custodians of all the children were asked in advance regarding permission to allow their children to participate in the study (see 9.4 Letter to parents). In addition, the children were asked before the experiment whether or not they wished to participate.

Figure 5: The game as presented to the children.

3.3 Pilot Study

In the process of developing the experiment a pilot study was performed with 7 children in the ages 5-6 at the kindergarten Filosofiska in Skarpnäck, Stockholm. The study used raisins instead of coins, white cups on a colored tablecloth and was explained only orally. Following the pilot study 3 major changes were made to the game. First, the rewards were not motivating enough. This had two consequences, it was difficult to convince all the children to play the game and some of the children showed little interest in the rewards which the author attributed to the children's low utility of raisins. To counteract this behavior, raisins were replaced with 1 SEK coins which could be used to buy toys in a fictional store. Second, the presentation of the rules of the game used in the pilot was not pedagogical enough to ensure understanding among all children. This observation led to a simplified version of the verbal instruction which was further complemented by a visual presentation of the game. In addition control question were formulated in order to systematically control the understanding among the children. Third, to enhance treatment in the experiment the cups used were colored.

3.4 Criteria for choice of experimental design

Several criteria for the choice of method were formulated based on discussion with the mentioned professionals and based on previous literature. Listed is the criteria from the professionals.

1. Children are easily influenced by and attentive to others emotions. Any experimenter that engages with children must minimize his or her feelings towards the colors tested as well as limit the emotions conveyed to children except from creating a secure and calm environment for them.

2. Children have generally a short span of attention causing restriction on the length of the experiment.

3. Children have difficulties being focused on one task making it important that the environment of the experiment has as few distractions as possible.

4. The limits of the children's cognitive development implies that the rules of the game must be easy to understand as well as the payoffs and their probabilities.

5. Children have difficulties learning solely from audial instructions. To improve comprehension it is advantageous to convey the information not only orally but also in graphic form and to activate the children's motor skills.

Additional criteria for the best practice method was found in previous literature. Some authors have used the BART (Balloon Analogue Risk Task) in order to assess risk behavior, e.g. Lejuez et al. (2003). The method was found inadequate since it does not openly

reveal the probabilities of the potential choices but instead relies on lengthy experiments where the subjects are supposed to learn the probabilities of the choices throughout the game. However, the study stresses the importance of allowing for large variation in the potential outcome from the test.

The subjects in the experiment by Slovic (1966) had possibility to pull 10 switches which is relatively low variation in the outcome variable in relation to the BART experiment with a maximum of 128 "pulls". Other fallbacks of the experimental design in Slovic (1966) was the risk of saturation due to the decreasing marginal returns of M&Ms to the child and that it was performed in an amusement park. On the positive side the design has been proven to be quick and easily communicable. Payoffs and probabilities are graphical and understandable even for young children.

The experimental design of this paper was an attempt to counter the mentioned downsides of these experiments and others, e.g. Harbaugh, Krause, and Vesterlund (2002). The final design was a variation of Slovic (1966). The choice of method was based on its benefits as being a quick game, easily communicated, with known payoffs and probabilities and graphically understandable. The game is played one on one so the risk of distractions is low. The games uses 20 cups instead of 10 switches increasing the variation of the dependent variable. Using cups instead of switches was due to convenience and should according to this author have no impact on results. It was played 3 times instead of one, increasing the possibility of the children at least once stopping by choice and thus being able to reveal their true risk preference but also increasing the risk of children changing their behavior due to for instance learning behavior. The setback in terms of adaptive behavior is tested for in an additional analysis.

By using 1 SEK coins which can be traded into different rewards of the child's own choosing the problem of saturation is decreased. The price of the prizes remained undisclosed in order to avoid any threshold behavior where a child would stop when his or her earnings amounted to the value of their preferred prize.

3.5 Theoretical Framework of the Experimental Design

Assuming that player i has the utility function:

$$U(n) = \frac{n^{1-\Gamma_{ik}}}{(1-\Gamma_{ik})} \tag{1}$$

Where n is an integer $n \in \{0, 1, 2, ..., 19\}$ denoting the number of coins received by turning cups. The value of each coin is standardized to 1. Γ is a measure of the risk preference of the player. The subscript k denotes the color and takes one of the two values $k \in \{red, green\}$.

The game can be described as an iteration of the decision tree depicted in Figure 6.

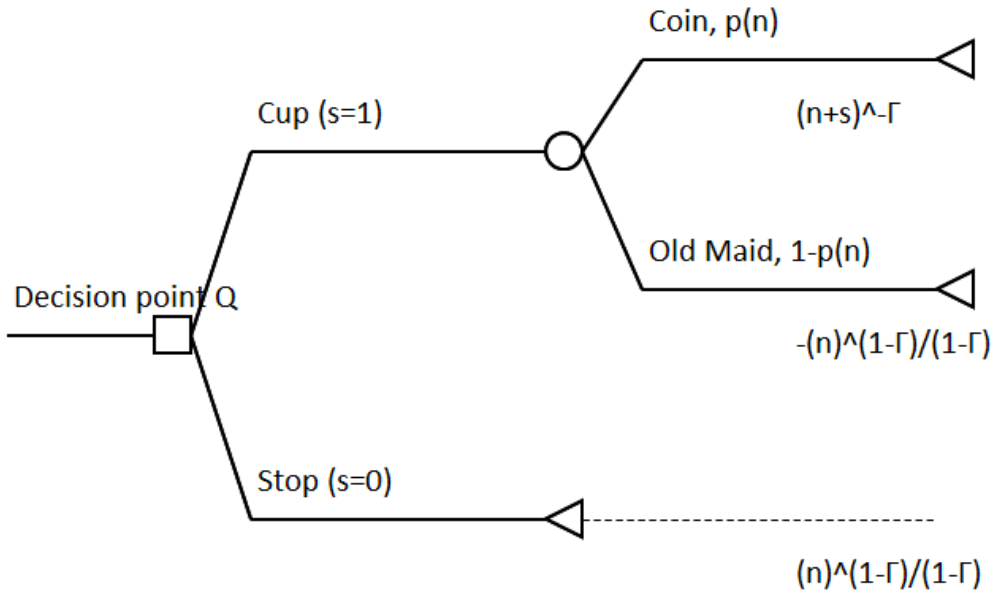

Figure 6: Decision tree of the game.

The player i chooses the decision variable s at point Q where $s \in \{0, 1\}$ and $s = 1$ is turning an additional cup and $s = 0$ is stopping the game. Choosing $s = 1$ leads to a gamble with two outcomes. Probabilities will depend on n and can be described as:

$$p(n) = \frac{19 - n}{20 - n} \tag{2}$$

With probability $p(n)$ utility of player i increases with $(n + s)^{-\Gamma_{ik}}$ and the player starts over at decision point Q. With probability $1 - p(n)$ player i loses $\frac{n^{1-\Gamma_{ik}}}{(1-\Gamma_{ik})}$ and the round is over. At the decision point 1 player i will set $s = 1$ as long as the bet is perceived to have a positive outcome given the value of Γ_{ik}, i.e. as long as the marginal utility of gaining an additional coin times the probability $p(n)$ is larger than the cost in utility of losing all coins times the probability $1 - p(n)$. Player i will thus play as long as:

$$(n + s)^{-\Gamma_{ik}} p(n) - \frac{n^{1-\Gamma_{ik}}}{1 - \Gamma_{ik}}(1 - p(n)) > 0 \tag{3}$$

$$(n + s)^{-\Gamma_{ik}} \frac{19 - n}{20 - n} - \frac{n^{1-\Gamma_{ik}}}{1 - \Gamma_{ik}} \frac{1}{20 - n} > 0 \tag{4}$$

A value of $\Gamma_i = 0$ reflects a risk neutral individual, if it is between $0 < \Gamma_i < 1$ the player is risk averse and if $\Gamma_i < 0$ the player is risk seeker. The expected value of the additional coin no. n for a risk neutral individual is presented in table 3 together with a list of the upper bound of the a player's revealed risk preference Γ when stopping after receiving n coins:

Table 3: Marginal utility of finding coin n given having found $n-1$ for risk neutral player and upper bound of Γ given stopping after n coins

n	Utility of finding coin n for a risk neutral individual ($\Gamma = 0$)	Upper bound on risk preference (Γ) stopping at n
0	.	.
1	0.95	0.8964
2	0.89	0.8351
3	0.83	0.7663
4	0.76	0.6888
5	0.69	0.6014
6	0.60	0.5014
7	0.50	0.3846
8	0.38	0.2517
9	0.25	0.0913
10	0.09	-0.1005
11	-0.10	-0.3355
12	-0.33	-0.6299
13	-0.63	-1.0104
14	-1.00	-1.5211
15	-1.50	-2.2443
16	-2.20	-3.3524
17	-3.25	-5.2842
18	-5.00	-9.6707
19	-8.50	-
20	-19.00	-

There is no solution for $n = 19$ or $n = 20$. In the former case the expression asymptotically approaches zero and for the latter it results in division by zero. Due to the integer nature of n, no player will be able to reveal exact risk neutrality though a risk neutral player will stop after turning 10 cups, a risk seeker will turn 11 or more and a risk averse player will turn 10 or less.

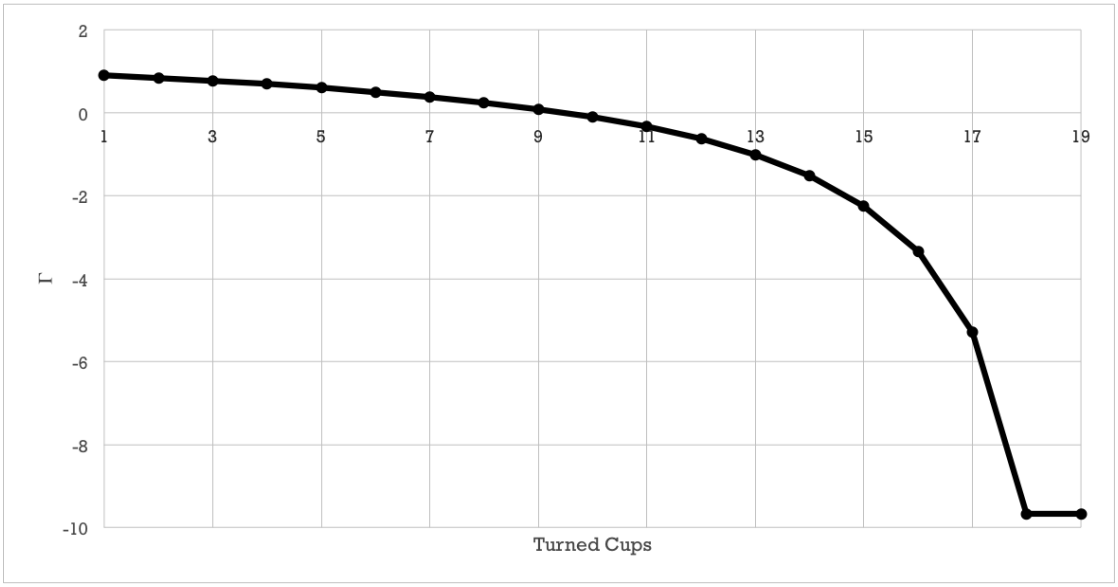

Figure 7: Graph depicting the relationship between turned cups and the corresponding upper bound of Γ.

4 Hypothesis

Based on the model and previous literature two hypotheses will be tested.

Hypothesis 1 - Effect of red on likelihood of acting as risk seeker
Following Hoffrage et al. (2003), the first hypothesis is that exposure to red will decrease the likelihood of acting as a risk seeker in at least one round:

$$P(\Gamma_{ik} < 0 \mid k = red) < P(\Gamma_{ik} < 0 \mid k = green) \tag{5}$$

The hypothesis will be tested using the regression:

$$riskseeker = \beta_0 + \beta_{riskseeker} k + \beta_x X + \epsilon \tag{6}$$

Where $riskseeker$ is a binary variable with the value 0 if $\Gamma_{ik} > 0$ in all rounds and 1 if $\Gamma_{ik} < 0$ in one or more rounds. Furthermore, k is the treatment variable with the value 1 if $k = red$ and 0 if $k = green$ and X is the set of control variables. The null-hypothesis following the regression is:

$$H_0 : \beta_{riskseeker} = 0$$
$$H_1 : \beta_{riskseeker} \neq 0$$

Hypothesis 2 - Effect of red on Γ
The second hypothesis is that players exposed to red have a lower risk preference i.e. a higher Γ:

$$\Gamma_{red} > \Gamma_{green} \tag{7}$$

which will be tested using the regression:

$$\Gamma = \beta_0 + \beta_\Gamma k + \beta_x X + \epsilon \tag{8}$$

Where k is the treatment variable with the value 1 if $k = red$ and 0 if $k = green$ and X is the set of control variables. The null-hypothesis following the regression is:

$$H_0 : \beta_\Gamma = 0$$
$$H_1 : \beta_\Gamma \neq 0$$

5 Data and Sample

The total sample of the study was 123 children at the age of 6 years from 5 different schools. The children were from kindergartens in both Linköping and Norrköping. The kindergartens were situated in areas with different socioeconomic background, from homogenous upper-middle class areas to more heterogenous areas with lower socioeconomic background. The schools were reached through personal contacts or through contacts to personal contacts of the author.

Descriptive statistics of the sample are presented in table 4 Descriptive statistics and correlation between the controls are presented in the appendix table 8 Correlation of controls. *Sex* is a dummy variable with the value 0 if subject is a female. *Color blind* is a dummy variable with the value 1 if subject is color blind. *Siblings* is the number of siblings living with the child. *Fathereduc* and *Mothereduc* are a measure of the education of the father and mother respectively. The variable have the value 1 if the parent has finished primary school, 2 if finished high school, 3 if finished vocational school, 4 if ≤ 3 years of university and 5 if $\geq$3 years of university. *Books* is the number of books at home where 1 is ≤ 25 books at home, 2 is $26 - 50$, 3 is $51 - 100$, 4 is $101 - 500$ and 5 is ≥ 500 books at home. The variable k is a treatment variables with value 1 if subject was exposed to red and 0 if subject exposed to green. The variables *n Round1-4* is the number of successfully turned cups in respective round. A missing value implies the child found the old maid. *Mean no. turned cups* is the mean of turned cups. Γ is higher bound of the numerically calculated risk preference. *ddate1-6* are dummy variables for the dates of the experiments.

Seven observations were deleted from the sample due to failure to correctly answering 3 of the 4 control questions.

Table 4: Descriptive statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
ID	63.25	36.976	1	125	116
Sex	0.517	0.502	0	1	116
Colorblind	0	0	0	0	112
Siblings	1.393	0.863	0	5	112
Fathereduc	3.583	1.375	1	5	108
Mothereduc	3.839	1.366	1	5	112
Books	3.795	1.041	1	5	112
k (Treatment)	0.534	0.501	0	1	116
n Round1	5	4.613	1	19	59
n Round2	5.414	4.608	1	19	58
n Round3	6.48	4.803	1	19	50
n Round4	8.071	5.269	1	19	14
Mean no. turned cups	6.373	4.728	1	19	92
Γ	0.391	0.558	-1.521	0.896	87
Risk seeker	0.293	0.458	0	1	92
ddate1	0.13	0.338	0	1	115
ddate2	0.165	0.373	0	1	115
ddate3	0.087	0.283	0	1	115
ddate4	0.113	0.318	0	1	115
ddate5	0.096	0.295	0	1	115
ddate6	0.087	0.283	0	1	115
ddate7	0.174	0.381	0	1	115
ddate8	0.148	0.356	0	1	115

6 Result

Testing whether the randomization was successful, all control variables were regressed on treatment and the result is presented in appendix, table 10 Testing randomization. None of the tested variables can on a statistically significant level explain variation in the treatment pointing towards randomization being successful. The distribution of n both in total and by treatment is presented in Figure 8.

Females were treated to a higher degree than males, though the difference was not statistically significant. The difference depend on treatment not being assigned randomly stratified on sex, see appendix table 9 Treatment by sex.

Result hypothesis 1 - Effect of red on likelihood of acting as risk seeker
The total distribution of the binary variable *riskseeker* is presented in table 9, in total and divided by treatment.

Regressing the variable *riskseeker* on the full specification the treatment is found to decrease the likelihood of a subject acting as a risk seeker in one of the rounds with 19.6 p.p., the result is significantly different from zero with a p-value of 0.054, the full results are presented in table 5 Result hypothesis 1, regressions on risk seeker. The results are stable using a parsimonious or logit model. In the parsimonious treatment decreases the probability of acting as a risk seeker with 17.8 p.p. with a p-value of 0.064. Using a logit model treatment is significant on the 2.5% level and is estimated to decrease the likelihood of acting as a risk seeker with 22.6 p.p.. In the fourth regression, ddate5 becomes significant as the constant is dropped. Sex is found to be insignificant and the education of the mother highly significant increasing the likelihood of the child acting as a risk seeker with 13.7 p.p.. Excluding *mothereduc* leads to *fathereduc* becoming significant with a positive coefficient.

An additional analysis was performed intended to test for signs of learning behavior. Children who failed in their first round might adapt a new strategy and approach the game differently in the second or third round. One dichotomous variable was constructed for each round, $Fail1 - Fail3$ with the value 1 if the player found the old maid in respective round and 0 otherwise. The result from regressing failure in later round on failure in earlier rounds is presented in table 6. Finding the old maid in the previous round is correlated with the likelihood of finding the old maid in the following round with a high statistical significance. Contrary to the hypothesis, finding the old maid in Round 1 or Round 2 increases the likelihood of finding the old maid in Round 2 or Round 3. The high statistical significance disappears however using both $Fail1$ and $Fail2$ as explanatory variables.

Result hypothesis 2 - Effect of red on Γ

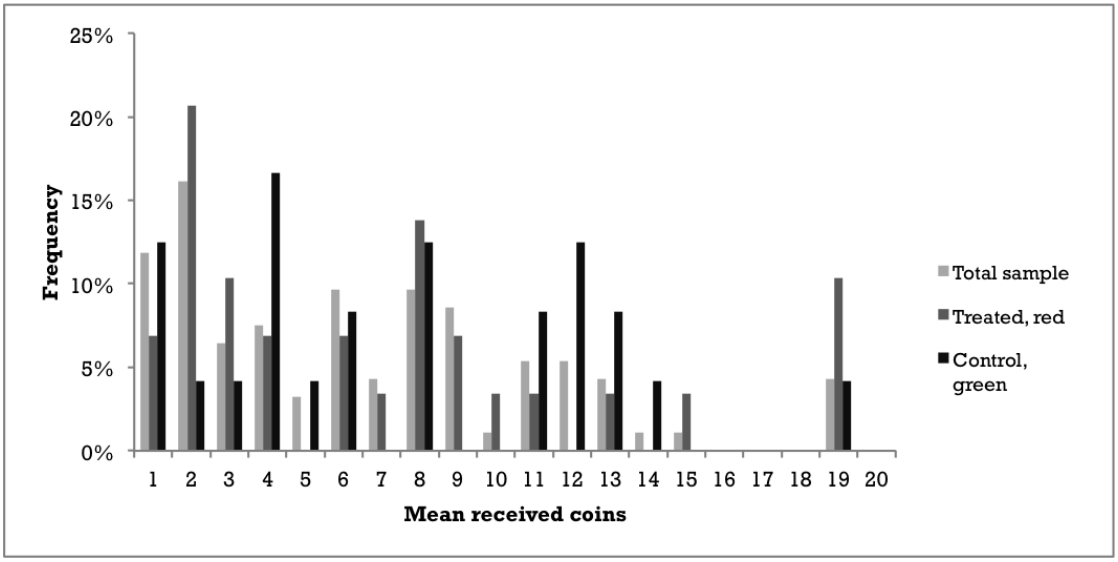

Figure 8: Histogram depicting mean number of received coins in total and by treatment.

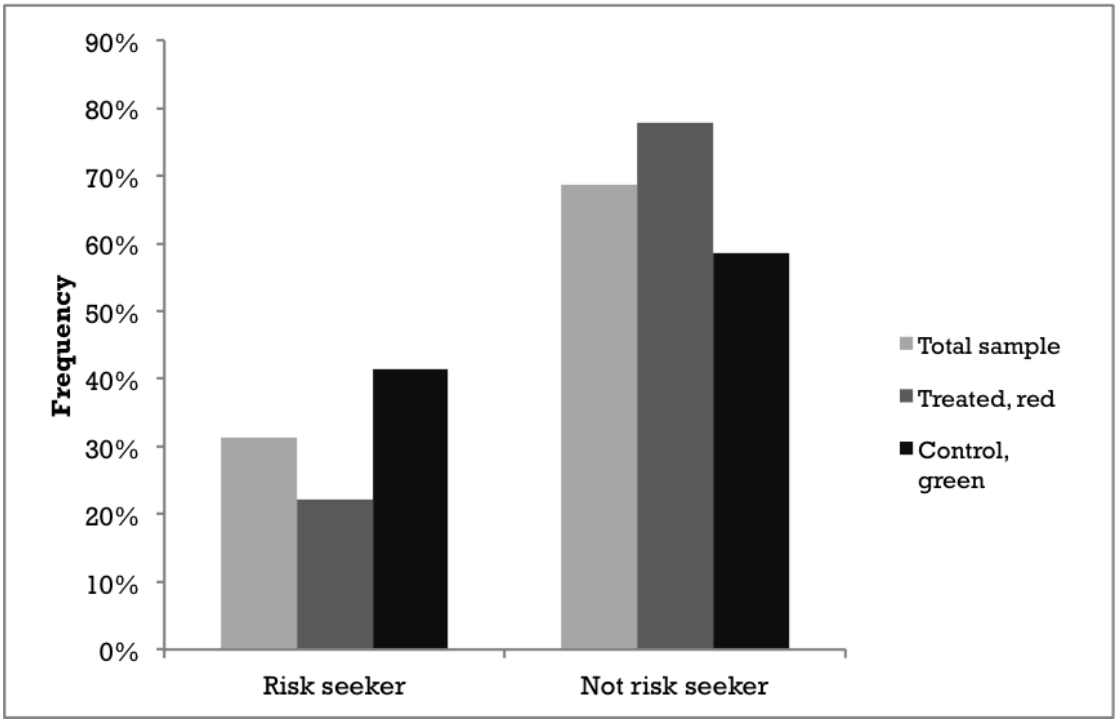

Figure 9: Histogram depicting risk seekers in total and by treatment.

Table 5: Result hypothesis 1, regressions on risk seeker

	(1) Full Spec.	(2) Pars.	(3) Logit	(4) Margins calculated from Logit
treatment	-0.196*	-0.178*	-1.292**	-0.226**
	(0.054)	(0.064)	(0.035)	(0.025)
sex	0.0537		0.0823	0.0144
	(0.591)		(0.878)	(0.878)
siblings	-0.00982		-0.101	-0.0176
	(0.872)		(0.798)	(0.798)
fathereduc	-0.0358		-0.307	-0.0539
	(0.503)		(0.321)	(0.335)
mothereduc	0.137***		1.053***	0.184***
	(0.002)		(0.001)	(0.001)
books	-0.0358		-0.244	-0.0428
	(0.493)		(0.459)	(0.466)
ddate1	-0.0736		-0.825	-0.123
	(0.778)		(0.398)	(0.291)
ddate2	0.133		0.132	0.0237
	(0.548)		(0.887)	(0.890)
ddate3	0.175		0.607	0.120
	(0.444)		(0.544)	(0.579)
ddate4	0.180		0.292	0.0543
	(0.522)		(0.790)	(0.803)
ddate5	-0.189		-2.251	-0.237***
	(0.400)		(0.116)	(0.003)
ddate6	0		-1.099	-0.145
	(.)		(0.510)	(0.343)
ddate7	-0.107		-1.227	-0.167
	(0.595)		(0.279)	(0.154)
ddate8	0.0606		0	
	(0.784)		(.)	
_cons	0.0891	0.386***	-2.069	
	(0.713)	(0.000)	(0.231)	
N	87	92	87	87

Marginal effects; *p*-values in parentheses

(d) for discrete change of dummy variable from 0 to 1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Post hoc analysis of learning behavior

	(1) Ind. fail2	(2) Ind. fail3	(3) Ind. fail3
dep. fail1	0.328***		0.139
	(0.000)		(0.153)
dep. fail2		0.207**	0.161*
		(0.024)	(0.098)
_cons	0.339***	0.466***	0.420***
	(0.000)	(0.000)	(0.000)
N	116	116	116

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Given that a mean of n was observed for each player, Γ was solved for numerically by setting equation 4 equal to zero and $s = 1$. The resulting value of the risk preference reflects thus the upper bound of the individual, for players successfully turning 19 cups the lower bound of the risk preference was used instead since there is no solution for the upper bound using $n = 19$.

The result from regressing Γ on treatment and control variables is presented in table 7. The coefficient on the treatment is -0.18 but not statistically significant. A similar result for the coefficient and significance of treatment is found for the parsimonious specification. Since it was observed that a relatively large number of treated chose to turn 19 cups, see Figure 8, an additional analysis was performed to assess whether there could be a heterogenous effect of red on risk behavior, i.e. some decreasing their risk preference while others increasing it. Excluding the players turning 19 cups the coefficient becomes positive and has a p-value of 0.176, we can thus not reject the null at any conventional level of hypothesis testing. Following the hypothesis of heterogenous effects a Fisher's exact test was performed to test whether red induced excessive risk seeking since 4 out of 5 outliers were in the treatment group. Using Fisher's exact test in order to test the null hypothesis of red and green equally induce excessive risk a p-value of 0.229 is observed. It is thus not possible to reject the null of equal effect on excessive risk seeking, here defined as turning 19 cups. The variable *sex* is insignificant in all regressions with a coefficient between -0.58 and -0.07. Noteworthy, the coefficient on *mothereduc* is as in previous regressions highly significant with a coefficient between -0.63 and -0.17. An increase in the mother's education is correlated with a decrease in Γ and thus an increase in risk preference.

Table 7: Result hypothesis 2, regressions on Γ

	(1) Full Spec.	(2) Pars.	(3) Excl. $meanturnedcups = 19$
treatment	-0.180	-0.222	0.182
	(0.684)	(0.616)	(0.176)
sex	-0.579		-0.0730
	(0.320)		(0.569)
siblings	0.464*		0.0313
	(0.095)		(0.684)
fathereduc	0.0159		0.00863
	(0.948)		(0.883)
mothereduc	-0.630**		-0.172***
	(0.016)		(0.002)
books	0.237		0.0260
	(0.196)		(0.709)
ddate1	2.253		-0.00850
	(0.167)		(0.978)
ddate2	1.573		-0.395
	(0.316)		(0.217)
ddate3	1.469		-0.238
	(0.331)		(0.435)
ddate4	1.273		0
	(0.498)		(.)
ddate5	1.246		0.306
	(0.496)		(0.218)
ddate6	0		0.0595
	(.)		(0.854)
ddate7	2.271		0.193
	(0.155)		(0.434)
ddate8	1.224		0.177
	(0.464)		(0.488)
_cons	-0.355	0.0407	0.793*
	(0.824)	(0.869)	(0.058)
N	87	92	83

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

7 Discussion

Discussion hypothesis 1 - Effect of red on likelihood of acting as risk seeker
The results corroborate the first hypothesis. The color red decreases the likelihood of acting as a risk seeker in at least one out of the three rounds. The effect is large and the probability of acting as a risk seeker decreases with 19.6 p.p. with a p-value of 0.054, when primed on red. This is in line with the results from Kliger and Gilad (2012) and Jiang et al. (2013).

Hoffrage et al. (2003) found a link between acting as a risk seeker in the game and taking larger risks in real traffic situations. A reduction in the probability of acting as a risk seeker has thus large consequences in a wider context. Risk seekers in their study decided to cross the street in 12.5% of the instances when the distance to an oncoming car was so short that they would have to run or hurry their steps at a pedestrian crossing. In comparison, a similar decision was made only in 2.8% of the times by the risk averse, a significant difference. Accidents happen only seldom but reducing a risky behavior can have large economic consequences in terms of direct costs of health care and indirect costs due to for instance forfeit income etc.. If these experimental results have validity in real world settings, the color red has a potential to decrease the number of risk seekers with 19.6 p.p.. Elliot and Maier (2012) argues that the meaning and effect of a color is context specific. In order to draw any conclusion as to what extent the results are generalizable to other situations it is important to first understand what context actually has been tested in the laboratory setting. Some children might have perceived the setting as a game and others as a risky situation. It is possible that players playing until the 19^{th} cup did not perceive the situation as one where they could potentially experience large losses, but rather that they focused on "winning" the game, i.e. finding all the coins. This is a problem with the study since it could be argued that it lacks some ecological validity, i.e. the experiment lacks in mimicking real world situations. The calm and controlled context of the game is relatively dissimilar to chaotic real world situations.

Still, according to the author of this paper the results could have external validity within some contextual boundaries. Previous research has found a link between this measure and behavior in real world situations making it plausible that the results in this study follow the same logic even though this in particular was not tested in this study. Age and culture are most likely the most important relevant boundaries. First, the children in this study were 6 years old. Children develop rapidly implying that though the results hold for 6-year-olds the same might not be true for children of age 9 or 4. Second, the results of color have been found to be cultural dependent implying that these findings have validity in the Swedish cultural context but might have no validity in a Chinese setting. To test whether these results hold within these two contextual boundaries are an important issue for future research. Furthermore, the link between the result of the game and risk behavior in real world is another area of future research.

If the results from this experiment hold in more real world contexts and in the whole of Sweden it is possible to discuss policy implications that could have substantial economic consequences. Examples where red could be used to decrease risk behavior could be, but are not limited to, medicine containers, dangerous tools and street crossings. Further studies are needed to test the effect of such policy implications. Together with earlier research on colors and economic decisions (Kliger and Gilad, 2012; Jiang et al., 2013) the findings from this study supports the notion of additional infringements to the invariance axiom (Von Neumann and Morgenstern, 2007). The traditional view of the economic agent as simply governed by rationality is again found to be lacking. The framing in terms of colors could have an effect on economic decisions in addition to other cognitive biases. It is however of interest to research the field more in order to test these findings, test other colors in various cultures, other ways of framing using colors and the effect of these framings on economic agents of different ages.

Result hypothesis 2 - Effect of red on Γ
In regards to the second hypothesis, whether red reduces the risk preference as measured by Γ, no effect of red was observed on the risk preference of children. Looking at the distribution of the results, 4 out of the 5 cases of excessive risk seekers (players turning 19 cups) were treated with red (see Figure 8). This led the author to investigate the existence of a heterogenous effect, i.e. that red affects the children differently. Such effects could potentially fit within the color-in-context theory. Excluding the 5 cases of excessive risk taking there are some indications that red could have an effect on risk behavior in the remaining subgroup. This raises two questions, should the sample be divided and are the results from this division large enough to be of interest for future research. However, using Fisher's exact test for evaluating the statistical significance in small samples, the p-value is 0.229, making discussions of heterogenous effects difficult though they could be accommodated by existing theories. Using a larger sample in future research it would be possible to assess whether these weak indications actually reflect a solid relationship.

The reason for no observed effect along this variable could be that the sample is still to small in order to draw any conclusion especially since the effect along this measure has a much larger variance than the dichotomous measure. With the increased variance there is also a probability of increased noise in the variable increasing the chance of a type 2 error. Furthermore, as red have been shown to have an impairing effect on cognitive skills it is also possible that red affects the subjects by making them less capable of intellectually assessing the risks at hand which could be a confounding factor, though it should have the same effect on both hypotheses.

In regards to the control variables, sex is a statistically insignificant predictor for risk behavior. This is in line with Slovic (1966) who found no relationship between sex and risk behavior before the age of 11. Surprisingly, *mothereduc* was found to be highly significant and positively correlated with risk behavior. Here the author of this paper can only speculate, could it be that well educated mothers are ensuring that no negative

consequences happen to their children even when they engage in risky behavior? This mindset could lead the children to underestimate the probabilities of negative outcomes and their costs, and thus engage in more risky behavior. Another potential explanation could be that children of mothers with higher education valued the potential earnings less due to them already having an abundance of toys at home. Studies looking at cultural variation in how agents act in economic games have shown that subjects tend to act in analog with what is perceived to be beneficial in the local context (Henrich et al., 2001). Such reasoning fit well into what is observed in the sample where the children could arguably act in accordance with what is beneficial in their home environment.

7.1 Limitations

A main concern when doing a single blind study is that the experimenter could influence the behavior of the subject through unconscious cues and thus affect the subjects in a way that is in line with the suggested hypothesis. In that aspect the study would have benefitted from being double-blind. This would however have required at least two additional individuals performing the experiment, one for each color. It would further have required that the two experimenters on site were unaware of what the other person is doing if they were to perform the test in the same kindergarten. In all, a double-blind study was deemed superior but not viable given the economic resources of the study. The experimenter has in this study aimed towards approaching the children without imposing any emotions or cues upon them. It has been shown that children are especially susceptible to such influence. It is however possible that the setup of the study as single-blind can have influenced the result.

Color blindness is mentioned as a confounding factor in color research. In this study being color blind would have made the treatment invalid since the subject would no be able to experience the red color. The consequence on the observed treatment effect would be an attenuation bias. Roughly 8 % of the male population and 0.5% of the female population suffer from some sort of color deficiency (Gegenfurtner and Sharpe, 2001). Out of the sample with 60 males and 56 females, on average 5 males and no females should be color blind. Still none of the children were reported being color blind. This could either reflect that none in the sample was color blind or, which is more likely, that parents are still unaware of the child's eventual deficiency. It is thus likely that some of the observations were color blind leading to a decreased observed effect. Color blindness should however not only be viewed as a confounding factor in this type of research since color blind individuals could be used as the perfect control group when assessing the effects of colors such as red in future research.

Elliot and Maier (2007) also discuss the importance of controlling for hues in color research. This study lacks in that respect since the wavelength of the treatment was not controlled. Another aspect discussed by Elliot and colleagues is the doze of the treatment in color research. Given the method used in this study there is no doubt as to whether or not treatment was given since it was impossible to play the game without seeing the

table cloth, i.e. being exposed to treatment as long as the subject perceive colors. It is of interest to investigate how to and the consequences of raising the intensity of the treatment. How could one increase the dose of the color without revealing the purpose of the study and how would subjects react to, for instance, a redder environment? This is an area for future research.

Some of the children expressed disappointment with the potential prizes making such subjects less likely to be utility maximizing. The author has however no reason to believe that such discontent was not on average random among the population.

Some post hoc analysis were done to investigate the possible existence of learning behavior in the game. Following these results the children tended not to adjust their actions in the following round towards a more safe strategy i.e. by stopping at an early stage to ensure some payoff. What was observed was instead that an initial failed round increased the likelihood of the subsequent round being a failure with high statistical significance. The children did not stray away from their risk preference. Those who have a propensity to take larger risks and who will thus find the old maid with larger probability stick to this behavior irrespective of the outcome in the previous round. A more efficient way of dealing with the possibility of learning behavior could have been view the rounds as a nested game where the outcome in round 1 could have an influence on the actions in round 3. Using such a structure could potentially give more answers to the children's behavior and could be a basis for future research.

In regard to the sample the author argues that the sample was mainly coming from lower to upper-middle class families in mid-sized Swedish cities. In the sample there are no representatives from the the large cities and from the smaller and northern municipalities. Future research is needed in order to study whether these results can be generalized to these groups.

8 Conclusion

This study has examined how risk behavior among 6 year old children is affected by colors. Using a simple game where the children were asked to turn cups in accordance with their preferences, their risk profile was estimated. Using randomization, half of the group was treated by playing the game on a red (green) background. Playing on a red background, the probability of a child acting as a risk seeker decreases with 19.6 p.p. with a p-value of 0.054. This contradicts the idea of rational economic agents and more specifically the invariance theorem stating that decisions should be irrespective of presentation. The results are in line with the color-in-context theory suggesting that colors have different meanings in different context. The context in the experiment is discussed as being associated with loss. Some vague indications for a heterogenous effect are found.

The education of the mother is found to have a high statistical significant correlation

with increased risk behavior. Sex is on the other hand not found to have any predictive power which is in line with earlier literature finding no significant correlation among children of this age.

The policy implications of the findings could include using red in situations and with object where children should display extra care such as street crossings and medicine packages. Further research is needed in order to examine children's response to treatment in real world settings and to make sure that there are no heterogenous effects of red.

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9 Appendix

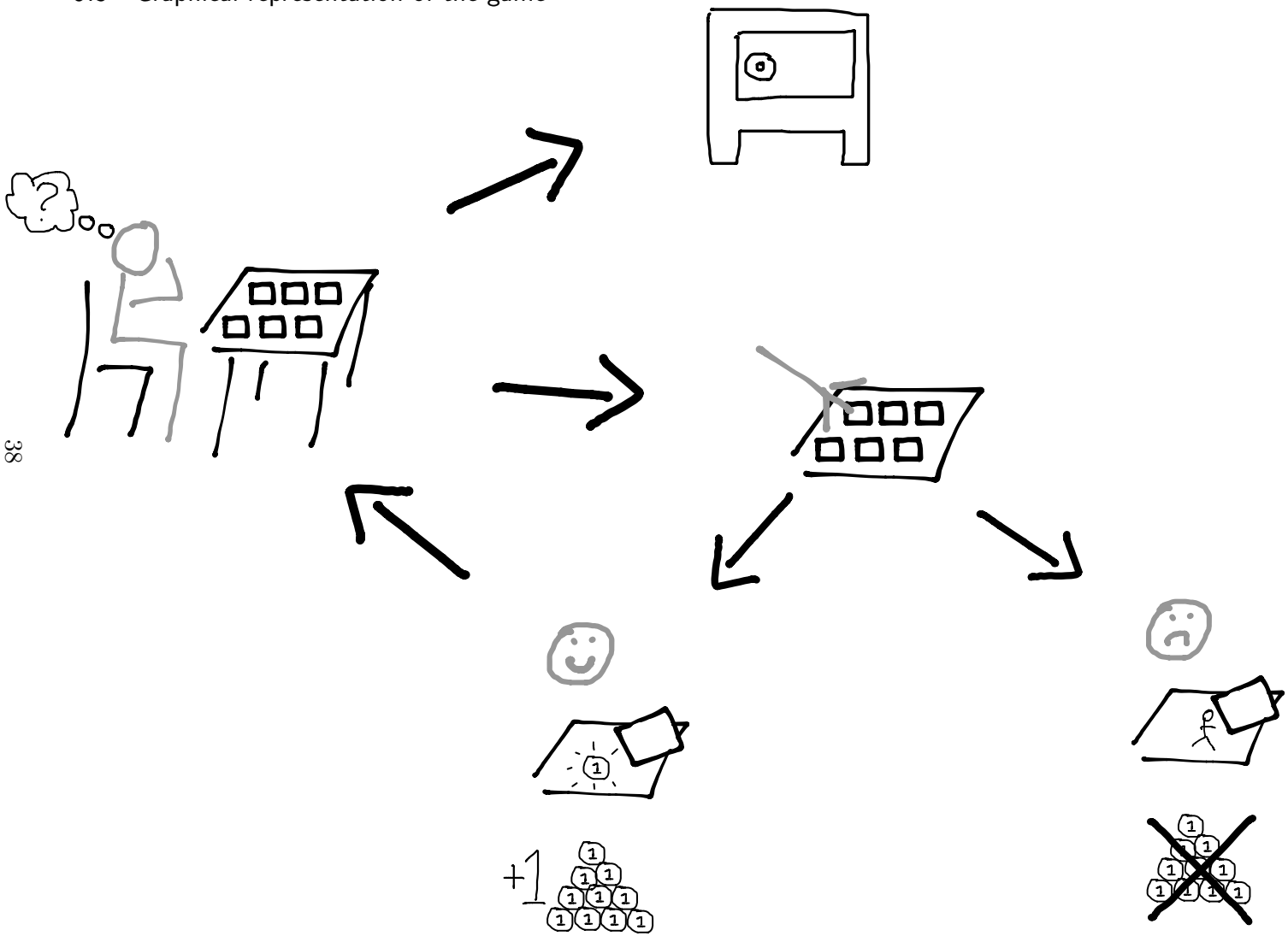
9.1 Script of introduction

Hi! My name is Ádin Hjertberg. I go to school just as you do. But in my school we do research. Research is fun since you can get answers to new questions. But it is important that you think thoroughly of your decisions when doing research. Today we are going to do research together, and I want you to think thoroughly of your decisions. Those of you who like will be able to play a game with me called "Cup or Stop" (Kopp eller Stopp in Swedish) where, if you are lucky, you can win some toys. Everyone who participate will at lest get some reward. I look forward to playing with you soon!

9.2 Oral presentation of the game

Hi (name of subject here)! You can sit here. This is your wallet (pointing towards empty container) and this is the secure safe (pointing towards the paper depicting safe) and these are cups. Beneath all of these cups except one, where there are coins. Under one of them there is the old maid (holding up the black gorilla). So today we are going to do research and it is important that both you and I think before we do our decisions. The way we are going to do research is by playing "Cup or Stop". We are going to play the game 3 times during which you can win coins (holding up a 1 SEK). All the coins you have in your secure safe (pointing towards the safe) after these 3 rounds can be used to buy toys (pointing towards shelf with toys). The more coins you have, the more and larger toys you will be able to buy. This is how we play the game (showing partly hidden graphical visualization of the game). This is you in front of the cups thinking. You always have a choice. Either you can chose to turn a cup or you can stop. If you chose cup, you can turn any cup you like and you get what is beneath (revealing more of the graphical visualization). If you find a coin (putting a coin on the table) you can put that in your wallet (pointing towards the wallet) and play again. Try putting the coin in the wallet (child puts coin in wallet). Good. Then you have to think again, do you want to turn another cup or do you want to stop. Because beneath one of these cups there is the old maid. If you find her (revealing more of the game), she will take all the money in your wallet and the round is over. The money in your safe is secure, she can't get to those, but she will take the money in your wallet. But you can also chose stop. If you chose stop (revealing the last part of the game), we put all the money you have collected in your wallet in the secure safe and the round is over. When the money is in the safe the old maid can't get to it. So you have to think before you do your decision, either you chose cup and then you may find a coin and can continue to play or you may find the old maid who takes your money and the round is over. Or you can chose stop and then we put all your money from your wallet in the secure safe and the round is over.

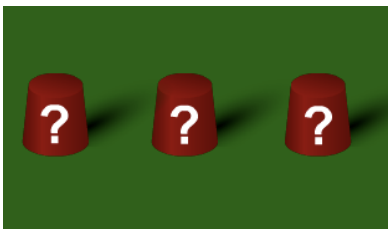
Control questions: So what happens if you find the old maid? What happens if you find a coin? What should you do if you want your money to be secure? How many old maids are there in the game?


1
+1
1

9.4 Letter to parents

Vilken färg har risk?

I min mastersuppsats på Handels i Stockholm är jag intresserad av hur färgen röd ändrar riskbeteende. Det finns vissa studier som visar på att vuxna blir mindre riskbenägna av färgen röd. Gäller detta även för barn eller är det något vi lärt oss i ekonomiska sammanhang?



För att testa det vill jag spela ett spel med barnen på Förskolan FA & FD på (...) där barnen får vända på koppar och har chans att vinna några leksaker. Spelet är utvecklat av mig i samarbete med två barnpsykologer och lärare på Handels samt bygger på tidigare forskning inom området. Jag har även spelat det med barn på såväl (...) som (...) i Linköping. Tillåter du att ditt barn är med i studien? Reslutaten anonymiseras och alla barn får såklart med sig en liten leksak som tack för att de deltar! Jag vore tacksam om Du/Ni inte diskuterade syftet med studien med Ert barn, det vill säga att testa effekten av färg. Men prata gärna om spelet i övrigt!

Tveka inte att kontakta mig om du har några frågor.

Ádin Hjertberg
0706-033289
adin.hjertberg@gmail.com

☐ Ja! Mitt barn får vara med i undersökningen. Glöm inte fylla i de 4 frågorna på nästa sida.

☐ Nej, jag vill inte att mitt barn deltar.

Namn på barn

Förälderns namn

Datum

Bakgrundsfrågor att fyllas i av föräldrarna:

Vet du om ditt barn färgblint?

☐ Ja ☐ Nej

Hur många syskon/halvsyskon bor tillsammans med ert barn i hemmet?

Vad har barnets föräldrar för utbildning? Ringa in kön samt sätt kryss i rutorna.

Kön	Förälder 1 Man / Kvinna	Förälder 2 Man / Kvinna
Grundskola	☐	☐
Gymnasium	☐	☐
Yrkeshögskola	☐	☐
<3 års Högskole- eller Universitetsutbildning	☐	☐
>3 års Högskole- eller universitetsutbildning	☐	☐

Hur många böcker har Ni hemma? Det går ca 40 böcker per meter bokhylla.

0-25	☐
26-50	☐
51-100	☐
101-500	☐
>500	☐

9.5 Additional tables

Table 8: Correlation of controls

Variables	Siblings	Fathereduc	Mothereduc	Books
Siblings	1.000			
Fathereduc	-0.011	1.000		
Mothereduc	-0.053	0.594	1.000	
Books	-0.070	0.531	0.502	1.000

Table 9: Treatment by sex

Sex	% & $No.Treatmentgroup$	% & $No.ControlGroup$
Male	50% / 31	50% / 31
Female	55% / 34	45% / 30

Table 10: Testing randomization

	(1) treatment
sex	-0.101
	(0.338)
siblings	0.0720
	(0.237)
fathereduc	0.0247
	(0.653)
mothereduc	0.00526
	(0.915)
books	-0.00988
	(0.872)
ddate1	0.00931
	(0.966)
ddate2	0.0237
	(0.908)
ddate3	0.0602
	(0.815)
o.ddate4	0
	(.)
ddate5	0.106
	(0.654)
ddate6	0.109
	(0.685)
ddate7	0.213
	(0.304)
ddate8	0.0445
	(0.835)
_cons	0.334
	(0.299)
N	107

p-values in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$