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I Did it Your Way.

An Experimental Investigation of Peer Effects in Investment Choices

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Abstract

We experimentally investigate imitation in investment choices and focus on cognitive aspects of decision making. At this aim, we manipulate three main dimensions of choice: time pressure, normative content of social information, and uncertainty of the investment. We document the existence of imitation, with stronger social effects among those who discover to be less cautious than their peers. In line with our hypotheses, a piece of information which is more representative of average group behavior induces stronger imitation. Furthermore, higher time pressure fosters imitation. In contrast to our hypotheses, imitation is weaker for uncertain investments than for risky investments.

Keywords: Peer effects, Investment Decisions, Bounded Rationality, Experiments.

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1 Introduction

In everyday life people adapt their decision rules depending on the circumstances. Usually, they need to juggle the simultaneous demands of uncertainty, lack of information, and time pressure. Faced with new tasks and little time to ponder options, everyone has experienced the convenience of imitation: following others is a strategy which is easy to implement and effort-saving. Economic theory has traditionally neglected social interactions of this kind and has focused on market-mediated relations between agents (Kirman, 1989). Only after the seminal work of Schelling (1978) economists have started to pay attention to direct social interactions, both theoretically and empirically. Since then, a wealth of studies have uncovered the relevance of social effects in many spheres of human life.[1] Several explanations for social effects have been proposed, with the following receiving major attention in the economics literature: (rational) social learning (Banerjee, 1992), payoff complementarities (Granovetter, 1978), and tastes for conformity (Bernheim, 1994). Here we focus on social effects in decision making under risk, a topic that is still relatively unexplored in economics (for a review see Trautmann and Vieider, 2011). The perspective we adopt is that of boundedly-rational social learning (Gigerenzer et al., 2011). Like in rational social learning, others' behavior offers relevant stimuli that enter the decision maker process and may lead to abandon private information in favor of information gathered from others' actions. Unlike in rational social learning, a boundedly-rational process does not require individuals to perform an accurate Bayesian updating of their priors and to maximize a well-defined objective function. Social stimuli may serve as an anchoring in a heuristic process that helps dealing with complex environments, when available information is non-instrumental.

Participants in our experiments are asked to make investment decisions in a series of prospects (Charness and Gneezy, 2010), some with positive and other with negative expected value. Some subjects are also given additional information about the choices of other participants in the same task. Within the conceptual framework of boundedly-rational social learning, we study how individuals adapt their investment behavior to: i) different levels of uncertainty of the task at hand; ii) external cognitive constraints; iii) alternative degrees of informativeness of the social signal obtained. With reference to uncertainty, participants face both risky lotteries, in which consequences of choices and their

[1] Among the domains in which social effects operate, the following have attracted the attention of economists: consumption/saving decisions (Duflo and Saez, 2002), microfinance (Banerjee et al., 2012), education (Cipollone and Rosolia, 2007; Duflo et al., 2011), work performance (Mas and Moretti, 2009), drinking and smoking (Case and Katz, 1991) crime (Glaeser and Sacerdote, 1996), social networks' participation (Egebark and Ekström, 2011), and pro-social behavior (Zafar, 2011).

associated probabilities are known, and uncertain lotteries in which the probabilities associated to outcomes are not known. For what concerns cognitive constraints, participants are given either shorter or longer time to make their choice. Finally, in terms of informativeness of the social signal, participants are either made aware of the choice of a single individual in their reference group or of the average choice of all individuals in the same group. In all cases the anonymity of the subjects originating the signal is preserved, and therefore there is no direct interaction between our subjects, but simply the possibility to access an additional piece of information, that is other subjects' choices. Thus, the evidence we provide has to be considered a lower bound for the role of peers in risky choices; in real settings factors such as reciprocal observation, communication and even simple group membership have been proven effective in enhancing and spreading social effects (for a general discussion about that see Shiller, 1995). Recently, Bougheas et al. (2013) showed how simple consultation between the members of a group can lead to a positive correlation in their investments, even if decisions are privately taken and each subject's earnings are defined only by his or her own (risky) choices. When subjects have the chance to consult with peers, individual risk-taking is not affected by ex-post feedback about their peers' choices and outcomes. This result gives support to the fact that positive social effects may emerge through manifold channels (e.g. observational, oral), with one prevailing over the other depending on environmental - or experimental - conditions.

We are going to test a set of behavioral hypotheses that relate to cognitive aspects of social effects in risky choices. First, we test whether uncertainty, as opposed to genuine risk, generates more imitative behavior. Previous contributions have shown that when it is difficult to assess the immediate consequences of a course of actions, individuals are more likely to adopt a simple "do-what-the-majority-do" rule (Laland, 2002). This rule suggests to take the action that the majority of the peers already took. Thus, under uncertainty we expect to observe more imitation, in particular when information about average behavior of the group, rather than of a single individual, is accessible. Second, we test whether higher time pressure fosters imitation. Previous experimental works have shown that higher time pressure tends to hinder deliberation and to favor instinctive decision making (see the literature review in Cappelletti et al., 2011). The predominance of instinctive instances in the decision making process should favor reliance upon the imitation heuristic as an easy rule to cope with complexity. Third, we test whether a higher degree of representation of "general" preferences of a reference group induces more imitation. Among others, Bicchieri (2006) suggests that for a descriptive norm to emerge it is necessary that a sufficiently large share of the population follows it. Thus, it is likely that individuals are going to adjust less their choices when a single observation is available than when aggregate information about group behavior is available.

We show that a large number of participants react to social information and revise their choices in the direction of those observed among their peers, particularly when they observe the average choice of the group of their peers rather the choice of a single individual. Furthermore, in line with our hypothesis, higher time pressure increases the propensity to imitate. In contrast to our hypothesis, uncertainty does not promote more imitation than risk. Our results provide support to the role of boundedly-rational social learning in risky investment decisions and encourage further research into the cognitive dimensions of social effects in decision making.

2 Related literature

Experimental settings present advantageous features in terms of identification of social effects and allow to overcome typical problems encountered in field happenstance data (e.g., Manski, 1993). The first experiments dealing with social effects in risky choices focused on informational cascades and on the ability of individuals to efficiently exploit social information. According to Anderson and Holt (1997), "Individuals generally used information efficiently and followed the decisions of others when it was rational" [p. 859]. However, Huck and Oechssler (2000) cast some doubts on rationality as the source of behavior observed in experimental cascades. Further skepticism about the rational foundation of herding behavior in informational cascades is prompted by the meta-study of Weizsäcker (2010).

Our experiment radically differs from informational cascades experiments as we neglect the possibility of rational social learning by making social information explicitly non-instrumental. Early experimental evidence collected in such environments is quite scattered. Goeree and Yariv (2007) and Corazzini and Greiner (2007) present largely conflicting results, despite the similar design employed. In both studies, subjects are sequentially presented with a binary choice between two risky prospects: they can observe choices of all previous movers, but they do not have private information on their peers' outcomes. Goeree and Yariv present evidence in support of conformity, with a large share of participants ready to forgo a private signal, which is informative from a Bayesian point of view, to conform to the uninformative history of choices. In contrast, Corazzini and Greiner do not find any consistent evidence of imitative behavior with non-instrumental information: the longer a sequence of identical choices shown to a decision maker, the lower the probability that she will follow the crowd. A non-negligible share of participants even displays "snob" behavior by preferring the option with the lower outcome to avoid choosing like the majority.

A bunch of recent experimental studies have investigated the interaction between risky choices and social comparison. The general assumption from which these works move is that individuals tend to compare their performance in risky choices with the performance of their peers (Linde and Sonnemans, 2012). However, different motivations underlying social comparisons are identified. Cooper and Rege (2011) ask participants to choose between lotteries characterized by various degrees of ambiguity. After each decision task, participants are reminded about their own choice for that task and informed about peer choices. Strong social feedback effects emerge in the experiment: across all treatments, observing a disagreement with the majority considerably increases the individual likelihood of changing the previous choices. The authors control for several sources of conformity and provide support to regret triggered by social comparisons as the main candidate to explain social effects in their experiment. Social interactions usually amplify regret from "wrong" choices and induce individuals to minimize this regret, so that they simply tend to follow what the majority does. A consequence of this imitative dynamic is that individuals tend to shift towards riskier positions, as riskier prospects naturally involve also higher potential regret.

Gantner and Kerschbamer (2011) investigate the impact of convex distributional preferences in terms of conformism in risky choices. The intuition underlying their theoretical and experimental work is that individuals keep record of their social status and evaluate their own potential results relatively to that of the others. Thus, individuals facing the same lotteries choose similarly, to align their outcomes once uncertainty is resolved. In a similar vein, Lahno and Serra-Garcia (2012) investigate about peer effects rooted in social feelings of envy and guilt (Fehr and Schmidt, 1999). When given feedback about peer choices, the rate of change in own choices is considerably higher than when no social feedback is available. This is interpreted as within-subject evidence of ex-post outcome comparisons. An interesting additional finding of Lahno and Serra-Garcia (2012), that has implications also for our work but slightly conflicts with the consequentialist logic of the paper, is that peer effects are stronger when the observed choice is the product of a deliberate choice of a peer and not an exogenously-imposed choice. Thus, to trigger imitation, social information must be a reliable signal of peers' preferences.

As our review of the relevant literature highlights, experiments in economics have so far devoted very scarce attention to cognitive aspects of social effects in risky decision making. Our contribution seeks to partly fill this gap, with particular attention to two main dimensions of social cognition: the trade-off between deliberative and intuitive reasoning and the degree to which social information is representative of the behavior of a reference group. For both these experimental manipulations, we asses our results against well-established strands of literature.

In many circumstances, the behavior of others may generate norms that affect individual decision making. However, just observing what others do can have very different consequences according to the nature of the norm that is established. Following the classification of Cialdini et al. (1990), it is possible to distinguish between *descriptive* norms, that specify what is done, and *injunctive* norms, that specify what ought to be done. Here we focus on descriptive norms as a source of evidence about what is the normal behavior in a reference group. Bicchieri (2006) further elaborates the classification put forward by Cialdini et al. (1990) and provides an analytic framework to distinguish between descriptive and social norms. In order to exist, both norms require that individuals have a conditional preference for conforming and maintain empirical expectations about the fact that a sufficiently large share of the population follows the norm. However, descriptive norms, differently from social norms, do not involve any feeling of obligation or any belief that others expect us to conform to the norm. In our experiment we contrast the low normative power of individual observation with the high normative power of majority choice. In a recent experimental work, Viscusi et al. (2011) report that observing choices in a reference group has a strong impact on individual choices. The interpretation given to this finding is that others' behavior helps "learn" own preferences when these are noisy. Thus, unlike in works reviewed above, the descriptive power of others' behavior does not refer to an existing norm, but to one's own risk preferences.

For what concerns the access to cognitive resources, we refer to the general cognitive framework provided by the dual-system approach to decision making (e.g., Kahneman, 2003; Bernheim and Rangel, 2004; Fudenberg and Levine, 2006). Within this framework, choices are the result of the interplay of two systems, usually labeled System 1 and System 2. The former embodies affective thinking driven by instincts and emotions; it is fast and it requires a minimal amount of cognitive resources, so it is strictly connected with heuristic decision making. Differently, System 2 represents affect-free deliberative thought; calculative and goal-oriented, it thus requires a great amount of cognitive effort. Notwithstanding the simplification introduced by such a dichotomy, this approach can give important insights about our decision tasks. Previous works have already documented how the affective system may have a prominent role in decision making under risk (e.g., Starmer, 2000; Loewenstein and ODonoghue, 2007). When choices rely more on the intuitive system than on the deliberative one, heuristics are more likely to emerge. While the existence of decisional shortcuts in the form of simple heuristics is acknowledge by a rich interdisciplinary literature (among others, Heiner, 1983; Simon, 1990), considerations about their consequences in terms of optimal choice seem to differ. Heuristics are either portrayed as adaptive tools that support ecologically-rational choices (e.g., Gigerenzer et al., 2011), or as cognitive biases that lead to systematic deviations from optimal choice (Tversky and Kahneman, 1974). A normative assessment of heuristics extends beyond the scope of our work, however with the experimental setting described below we aim at providing sound evidence about the interaction between complexity of the environment and the resort to simple decisional rules (Bodenhausen and Lichtenstein, 1987; De Neys, 2006).

3 Method

3.1 Choice Task

Participants in our experiment choose how much risk they would like to bear in a series of risky investments. We adopt the task introduced by Gneezy and Potters (1997) and modified by Charness and Gneezy (2010). Experimental subjects participate in the following prospect. They are given an endowment of E tokens and choose how many tokens $x \in \{0, ...E\}$ they invest in a risky asset that delivers no returns with probability p_L and generates returns equal to 2.5 times the amount invested with probability $1 - p_L$.

$$P = \begin{cases} E - x & p_L \\ E - x + 2.5x & 1 - p_L \end{cases}$$

In prospect P, expected returns and risk borne are endogenously defined by the tokens x invested in the project. Specifically, when the minimum number of tokens is invested in P (i.e., $x = 0$), the prospect is fully safe and the positive amount E is earned with certainty. When $x > 0$, risk and expected returns change monotonically with x. In the experiment, the endowment E is set equal to 200 tokens.

We consider six alternative specifications for the probability of loss p_L. In five prospects out of the six considered, p_L is known and can assume five different values: 2/8 (25%), 3/8 (37.5%), 4/8 (50%), 5/8 (62.5%), 6/8 (75%). In one prospect, the participants are not informed about the actual value of p_L. When p_L is known, the prospect P represents a risky investment, while when p_L is not known P represents a genuinely uncertain investment.

Table 1 provides a summary of the five risky prospects implemented and of their expected values and standard deviations in correspondence to the minimum and maximum amount of tokens that could be invested in P. The column

EMP provides a description of the expected marginal profit of each token invested in the prospect.[2]

Table 1: Risky Prospects

			$x = 0$		$x = 200$	
P	p_L	EMP	EV	SD	EV	SD
#1	0.250	+0.875	200.000	0.000	375.000	216.506
#2	0.375	+0.562	200.000	0.000	312.500	242.061
#3	0.500	+0.250	200.000	0.000	250.000	250.000
#4	0.625	-0.062	200.000	0.000	187.500	242.061
#5	0.750	-0.375	200.000	0.000	125.000	216.506

As shown also by Table 1, prospects with $p_L < 0.6$ are characterized by positive expected marginal profits, while for prospects with $p_L > 0.6$ each token invested delivers a negative expected profit. In the following, we label prospects with positive EMP *positive-value* prospects, while we label prospects with negative EMP *negative-value* prospects. For the sixth prospect, no information is given to participants about the likelihood of losing p_L and thus participants could not assess its expected marginal profit. We label this prospect as *uncertain*.

3.2 Experimental Design

Participants in our experiment are randomly sorted into two groups: *Targets* and *Observers*. Those in the *Targets* group are taking part in the experiment at an earlier date than those in the *Observers* group.

Participants of the *Targets* group are asked to choose how many tokens x they want to invest in each of the six prospects described above. The prospects are presented in six distinct rounds in an individually randomized order. Only one of the six prospects is selected after the experiment and its outcome determines the actual earnings in the experiment. *Targets* participants are informed that their choices may be shown to other participants taking part in future experimental sessions but that their identity will never be disclosed.

Participants of the *Observers* group take part to two experimental phases, *phase* 1 and *phase 2*. In phase 1, they face the same tasks faced by those in the *Targets* group and, thus, choose how many tokens they want to allocate to the six distinct prospects. In phase 2, the participants face again the same tasks, but in a random order, and are given an additional piece of information about the choices operated in the same prospect by those in the *Targets* group.

[2] The expected value EV of the lottery is given by $EV(x) = (E-x)p_L + (E-x+2.5x)(1-p_L)$. Accordingly, the expected marginal profit EMP is obtained as $\frac{\partial EV(x)}{\partial x}$.

Finally, one of the prospects in phase 1 and one of the prospects in phase 2 are randomly chosen, with a different draw for each participant, and the outcomes of the two selected prospects determine the actual earnings in the experiment. In order to avoid the possibility of individual learning, subjects do not receive any feedback about their outcomes neither between rounds within each phase nor between phase 1 and phase 2. The entire procedure is communicated and explained in details to the subjects before the experiment begins.

For those in the *Observers* group, two main dimensions are experimentally manipulated in a between-subjects fashion: *Time Pressure* and *Information*. Concerning *Time Pressure*, participants are either exposed to a condition of *high* time pressure (*HIGH.tp*), in which choices in each round must be taken within 20 seconds, or to a condition of *low* time pressure (*LOW.tp*), in which choices must be taken within 40 seconds. Concerning *Information*, participants are either informed about the choice of a single individual randomly chosen among those in the *Targets* group (*IND.info*) or are informed about the average choice of all those in the *Targets* group (*AGG.info*). Thus, a total of four alternative treatments are obtained from the combination of the levels of the two conditions. Table 2 provides a summary of the labels that identify alternative treatments of our 2×2 design.

Table 2: Treatment Labels

		Time Pressure	
		High	*Low*
Information	*Individual*	IND.info:HIGH.tp	IND.info:LOW.tp
	Aggregate	AGG.info:HIGH.tp	AGG.info:LOW.tp

3.3 Research Hypotheses

The preliminary hypothesis we are going to test is whether individuals have stable preferences when dealing with risky prospects or, alternatively, whether they are going to adopt others' choices as a cognitive anchor for their own choices. In particular, we are going to check if participants in the experiment modify their own choices from phase 1 to phase 2, so as to reduce the distance between own and others' choices.

In our experimental setting we also introduce controlled variations aimed at improving our understanding of the cognitive factors that may affect the tendency to imitate others' behavior in risky choices. Specifically, we experimentally manipulate three main dimensions of the choice task: the nature of the social signal received, the time constraint within which the decision must be taken, and the degree of uncertainty of the prospect to which the social signal refers.

With reference to the nature of the social signal, condition *AGG.info* has a stronger descriptive content and provides a more reliable assessment of what the majority of the population does (Bicchieri, 2006). Thus, given the stronger normative content of *AGG.info*, we hypothesize that individuals are more likely to imitate others' behavior when they receive a piece of information about average choices in the group (*AGG.info*) than when they are made aware of a single choice of a peer (*IND.info*).

The manipulation of the cognitive resources available when choosing is inspired by the so-called dual system approach to decision making (see, among others Epstein, 1994). In our experimental manipulation we modify the time pressure put on choices, which can be either high (*HIGH.tp*) or low (*LOW.tp*). Previous works successfully adopted this kind of manipulation to affect the relative importance of the deliberative process in decision making, with higher time pressure impairing deliberation and fostering instinctive decision making (e.g., Sutter et al., 2003). In the light of previous evidence, we hypothesize that under high time pressure individuals are more likely to rely on an instinctive "do-what-the-others-do" heuristic (Laland, 2002) and, as a consequence, that choices of the others have a stronger impact in the high time pressure condition (*HIGH.tp*) than in the low time pressure condition (*LOW.tp*).

Participants in our experiment choose how much of their resources they want to invest in a series of prospects that can be grouped into two distinct classes: *risky* and *uncertain* prospects. Risky prospects deliver a positive outcome with a certain probability and this probability of success affects the expected returns of the investment. In uncertain prospects the probability of success is never disclosed to participants and thus the expected returns of investing in prospects of this kind are not known. In uncertain prospects the connection between actions and consequences cannot be fully reconstructed. Previous works argued that in environments of this kind individuals are more likely to rely on decisional shortcuts (Gigerenzer et al., 1999). Thus, we expect to observe more reliance on the imitation heuristic in uncertain prospects than in risky prospects.

3.4 Participants and Procedures

The computerized experiments were conducted at the Cognitive and Experimental Economics Laboratory (CEEL) of the University of Trento, Italy. The experiment was programmed and conducted using the Z-tree software (Fischbacher, 2007). A total of 133 undergraduate students of the University of Trento took part to only one of nine distinct sessions, 15 belonging to the *Targets* group and 118 belonging to the *Observers* group. A show-up fee of €3.00 was paid to each participants and average earnings were equal to €7.65.

In each session participants received the same written instructions. Participants were given a few minutes to read instructions privately and then instructions were read aloud by one of the experimenters in the room.

Participants were sitting in cubicles inhibiting visual and verbal interaction with other participants. Questions were answered privately in the cubicle and the experiment started only after all participants had answered a set of control questions checking their understanding of the instructions. After the experiment, participants were asked to leave the room one by one and, to preserve the privacy of each participant, payments were dispensed in cash in a separate room.

4 Results

The analysis of the results is organized as follows: in Section 4.1 we provide a few descriptive statistics of the choices made by our subjects; in Section 4.2 we illustrate imitative patterns in observed choices; in Section 4.3 we present the results of a regression estimate about the impact of others' choices on revision of own choices and we highlight the main results of our analysis.

4.1 Description of Choices

Table 3 provides a description of the median number of tokens allocated to distinct prospects by investors in the Targets session and in the Observers sessions.

Table 3: Median Tokens Allocated to each Prospect

		P(WIN)					
		2/8	3/8	4/8	5/8	6/8	?
Targets		30.0	55.0	100.0	150.0	200.0	100.0
Observers (pooled)		37.5	50.0	100.0	140.0	175.0	100.0
Observers (by Treatment)							
HIGH.tp:AGG.info	Phase 1	30.0	50.0	100.0	130.0	175.0	100.0
	Phase 2	30.0	50.0	100.0	130.0	172.5	100.0
LOW.tp:INFO.agg	Phase 1	30.0	50.0	100.0	125.0	150.0	100.0
	Phase 2	35.0	50.0	100.0	134.0	175.0	100.0
HIGH.tp:INFO.ind	Phase 1	50.0	50.0	100.0	150.0	170.0	100.0
	Phase 2	50.0	60.0	125.0	150.0	185.0	105.0
LOW.tp:INFO.ind	Phase 1	50.0	50.0	100.0	122.5	190.0	100.0
	Phase 2	30.0	50.0	100.0	150.0	200.0	100.0

Table 3 clearly shows that in all experimental conditions participants assign more tokens to lotteries with higher expected values and thus seem to grasp the underlying features of the investment. Concerning the uncertain prospect, it can be noticed that the median value of the support seems to represent a salient investment level when the situation is ambiguous.

A comparison of tokens allocation by the same individual in phase 1 and phase 2 shows that there is a statistically significant difference only in treatment HIGH.tp:INFO.ind (Wilcoxon Signed Rank Test: p-value=0.026, all other p-values ≥ 0.243).[3] Furthermore, no statistically significant difference is observed when comparing choices in phase 1 and in phase 2 of each treatment with choices in the Targets session (Wilcoxon Rank Sum Test: all p-values ≥ 0.181).[4] Thus, subjects in our experiment do not seem to systematically revise their strategies after the first experimental phase, either because they do not follow multi-period strategies that condition choices in one phase on choices in the other, or because there is no widespread learning after the first six rounds. Both cases are also ruled out by the fact that, at the aggregate level, risk propensity does not change between the two phases, while at the individual level risk preferences do not interfere with the subjects' imitative attitude (see Subsection 4.3); this would not hold if subjects adopted intertemporal decision rules.

Choices in positive-value risky prospects provide us with a measure of the degree of risk aversion of participants. In particular, the number of tokens allocated to prospect P(Win)=4/8 provides us with a fine-grained measure of the degree of risk aversion. In a first step, we classify individuals that allocate less than the maximum amount to the prospect as risk averse, those who allocate the maximum amount but invest nothing in the negative-value prospects as risk neutral, and the remaining individuals as risk seekers. From this classification we obtain that 83.1% of participants are risk averse, 4.2% are risk neutral and 11.9% are risk seeker.[5] In a second step, we estimate the coefficient of risk aversion (r) for risk averse subjects, obtained from a Constant Relative Risk Aversion utility function $U(x) = \frac{x^{(1-r)}}{(1-r)}$.[6] The median coefficient of risk aversion thus obtained is equal to 0.328 revealing that our representative participant is slightly risk-averse (Holt and Laury, 2002).

[3]To perform our tests, we compute the average allocation across prospects for each individual and then compare the distribution thus obtained across experimental conditions via a Wilcoxon signed rank test.

[4]The absence of significant differences between Phase 1 and Target sessions suggests that being aware that own choices will be displayed to others does not systematically affect behavior.

[5]Those who did not express a choice within the time limit (0.8%) could not be classified.

[6]For risk-seeking subjects, the prospects at hand do not allow to obtain a useful measure of the coefficient of risk aversion.

4.2 Reaction to Peer Choices

Table 4 shows the frequency of choices (Freq) and the average difference (Mean $\triangle$) between tokens allocated to prospects in phase 1 (x_1) and phase 2 (x_2). Choices are distinguished according to the standing of choices in phase 1 relative to choices in phase 2 (columns) and to the Targets (T) (rows). In bold we highlight frequencies that provide support to a positive impact of the target on choices.

Table 4: Reaction to the Target

		$x_2 > x_1$	$x_2 = x_1$	$x_2 < x_1$
		AGG.info:HIGH.tp		
$x_1 < T$	Freq (%)	**48 (29.4%)**	48 (29.4%)	5 (3.1%)
	Mean $\triangle$	**33.381**	0.000	-25.625
$x_1 = T$	Freq (%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Mean $\triangle$	-	-	-
$x_1 > T$	Freq (%)	5 (3.1%)	31 (19.0%)	**26 (16.0%)**
	Mean $\triangle$	28.750	0.000	**-41.889**
		AGG.info:LOW.tp		
$x_1 < T$	Freq (%)	**62 (35.6%)**	45 (25.9%)	10 (5.7%)
	Mean $\triangle$	**30.811**	0.000	-18.208
$x_1 = T$	Freq (%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Mean $\triangle$	-	-	-
$x_1 > T$	Freq (%)	3 (1.7%)	29 (16.7%)	**25 (14.4%)**
	Mean $\triangle$	52.333	0.000	**-38.517**
		IND.info:HIGH.tp		
$x_1 < T$	Freq (%)	**47 (27.5%)**	28 (16.4%)	2 (1.2%)
	Mean $\triangle$	**40.977**	0.000	-22.500
$x_1 = T$	Freq (%)	5 (2.9%)	26 (15.2%)	3 (1.8%)
	Mean $\triangle$	36.250	0.000	-41.667
$x_1 > T$	Freq (%)	2 (1.2%)	40 (23.4%)	**18 (10.5%)**
	Mean $\triangle$	100.000	0.000	**-40.633**
		IND.info:LOW.tp		
$x_1 < T$	Freq (%)	**34 (20.4%)**	29 (17.4%)	8 (4.8%)
	Mean $\triangle$	**31.981**	0.000	-11.933
$x_1 = T$	Freq (%)	3 (1.8%)	26 (15.6%)	3 (1.8%)
	Mean $\triangle$	43.750	0.000	-31.667
$x_1 > T$	Freq (%)	2 (1.2%)	40 (24.0%)	**22 (13.2%)**
	Mean $\triangle$	55.000	0.000	**-40.371**

The number of choices providing support to a positive impact of the target on choices are equal to 45.4% and 50% for the aggregate information condition, in the high and low time pressure respectively. The remaining choices mainly display constancy of preferences. In the individual information condition, choices positively affected by the target amount to 38.0% and 33.6%, in the high and low time pressure conditions respectively. Also in case of individual information the remaining observations are mainly choices that do not vary from phase 1 to phase 2. The average differences in correspondence to the choices providing support to a positive impact of the target show a considerable reaction both for those above and below the target, with the former showing a slighter stronger adjustment in absolute terms.

A series of non-parametric tests corroborate the evidence highlighted by Table 4.[7] In particular, when the first choice is below the target a stronger propensity to increase rather than to decrease the number of invested tokens is observed, for all experimental conditions (all p-values< 0.003). In contrast, when the first choice is above target a stronger propensity to decrease rather than to increase the tokens allocated is observed, for all experimental conditions (all p-values< 0.009). Thus, deviations from the target positively affect the distance between the first and the second choice: when the first choice is above the target the second choice tends to be below the first choice, and viceversa.

Result 1 *Positive social effects are identified in the investment task under investigation: investors who discover to be more cautious than their peers tend to increase their risk exposure, while investors who discover to be less cautious than their peers tend to decrease their risk exposure.*

4.3 Regression Analysis

In Table 5 the outcome of an OLS regression analysis is reported. The aim of this estimation is to improve our understanding of the determinants of the change in tokens allocation as a reaction to others' choices and experimental conditions.[8]

The dependent variable in the estimated model ($DIFF.own$) is given by the difference between own choices in phase 2 and in phase 1. Thus, when the number of tokens allocated to a given prospect is bigger (smaller) in phase 2 than in phase 1, the dependent variable has a positive (negative) value.[9] The main explanatory variable is given by the difference between the choice of the others (i.e., the target) and own choice in phase 1 ($DIFF.target$). When the number of tokens allocated to a given prospect by the observed other is bigger (smaller) than the number of tokens allocated to that prospect in phase 1, the variable has a positive (negative) value. The variable provides us with a measure

[7]Non-parametric test are conducted following this procedure: for each individual we compute the number of choices for all nine combinations of deviation from the target and deviation from own previous choice (see Table 4); then, we compare the frequency of individual choices in pairs of conditions via a paired Wilcoxon signed rank test.

[8]Individuals in our experiment perform repeated choices. Accordingly, we adopt a difference in differences approach to control for potential biases in the estimation due to unobserved idiosyncratic factors.

[9]Only choices of those whose change in their tokens allocation is compatible with imitative behavior are considered in the regression.

of the marginal impact of peer choices on own choices. In the analysis, we focus on the coefficient of this variable to asses the extent of peer effects.

The variable $ABOVE.target$ is equal to 1 when the choice in phase 1 is above the target and equal to 0 otherwise. Variables $AGG.info$ and $HIGH.tp$ are dummy variables capturing the information and the time pressure experimental treatments, respectively. The variable $TOT.tokens$ captures the total number of tokens invested in the risky prospects, and we use it as a control for the risk propensity of participants in the experiments, with a higher number of tokens revealing lower risk aversion. To gain in the understanding of the determinants of social effects a few interactions with variable ($DIFF.target$) are considered. Specifically, interactions involving total tokens invested, treatment factors and positioning relative to the target are considered and are identified in Table 5 by a $DIFF\times$ followed by the short label of the considered variable. Finally, a bunch of control variables are also taken into account: *Round*, which provides a control for the round in which the choice is taken, *Age*, which measures the age of the participants, and $Female$, which controls for their gender.

Table 5 reports the outcome of four distinct regression estimates. In column (1) choices for all prospects are considered. In columns (2) to (4) only choices for positive-value ($P(win) \geq 50\%$), negative-value ($P(win) \leq 37.5\%$) and uncertain prospects are considered, respectively.

Table 5: Regression Analysis (OLS)

DIFF.own	(1) Pooled	(2) Positive-Value	(3) Negative-Value	(4) Uncertain
(Intercept)	1.916 (15.926)	−9.446 (24.910)	10.687 (21.465)	61.032 (53.865)
DIFF.target	0.290 (0.073)***	0.339 (0.115)**	0.368 (0.168)*	−0.059 (0.204)
ABOVE.target	−34.287 (5.322)***	−35.265 (9.029)***	−22.475 (7.783)**	−34.346 (21.804)
AGG.info	−4.005 (3.397)	−15.536 (6.135)*	0.589 (4.345)	29.573 (13.668)*
HIGH.tp	−0.141 (3.260)	−2.798 (5.234)	−0.842 (4.205)	15.299 (11.978)
TOT.tokens	0.026 (0.011)*	0.048 (0.020)*	0.011 (0.015)	−0.020 (0.041)
DIFF×ABOVE	0.275 (0.113)*	0.272 (0.182)	0.413 (0.193)*	0.474 (0.266)$^{\circ}$
DIFF×AGG	0.088 (0.051)$^{\circ}$	0.245 (0.087)**	−0.031 (0.080)	−0.226 (0.149)
DIFF×HIGH	0.103 (0.048)*	0.131 (0.073)$^{\circ}$	−0.032 (0.080)	0.021 (0.149)
DIFF×TOT	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.001)
Round	0.737 (0.875)	0.226 (1.371)	−0.258 (1.184)	0.375 (2.703)
Age	0.306 (0.585)	0.713 (0.877)	0.000 (0.790)	−1.485 (2.178)
Female	−6.124 (3.054)*	−2.688 (4.518)	−5.601 (4.279)	−27.543 (8.951)**
Adj. R^2	0.721	0.720	0.745	0.684
Num. obs.	282	147	97	38

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\circ}p < 0.1$

The regression output of column (1) shows that peer choices positively affect own choices, both for subjects who are more risk averse than their target and less risk averse than their target. This emerges from the positive sign of $DIFF.target$ and of the interaction between $DIFF.target$ and $ABOVE.target$ ($DIFF \times ABOVE$). The coefficient of the interaction term also shows that those displaying a lower risk aversion than the target tend to conform more to their peers' behavior than those displaying a higher risk aversion than the target. This asymmetry in reaction is confirmed by the negative coefficient of $ABOVE.target$.

Result 2 *The imitative adjustment towards peer choices is stronger for those who discover to be less cautious than their peers than for those who discover to be more cautious.*

As shown by column (1) of Table 5, higher time pressure fosters the positive impact of peer choice on own choices ($DIFF \times HIGH$). With reference to the information treatment, a stronger imitative adjustment is observed, although statistically weakly significant, when aggregate information is provided than when individual information is provided ($DIFF \times AGG$).

Result 3 *When less time is given to deliberate on investment choices, stronger imitative adjustments in choices are observed.*

Result 4 *When information provides a more accurate description of average behavior in the reference group, stronger imitative adjustments in choices are observed.*

Regression outputs in columns (2)–(4) of Table 5 allow us to assess whether behavior differs across alternative classes of prospects. Column (2) refers only to positive-value prospects and shows that for this subset of prospects social effects are observed but, differently from the pooled regression, no asymmetry in reaction is observed between those above and below the target. In contrast, the asymmetry in reaction is observed in the negative-value prospects (column (3)). In the uncertain prospect (column (4)), those below the target do not react to social information, while those above show a weak tendency to imitate behavior observed among their peers.

Result 5 *In positive-value and negative-value prospects, subjects adjust their behavior to that of their peers, both when they discover to be more cautious and less cautious than their peers. In negative-value prospects, however, the adjustment is stronger for those less cautious than their peers. In uncertain prospects, only those less cautious than their peers weakly adjust their behavior.*

When taking into account different types of prospects in isolation (columns 2–4 in Table 5), it can be noticed that the type of prospect heavily affects how time pressure and the nature of social information impact on imitation. Specifically, higher time pressure and aggregate information foster social effects only in positive-value prospects.

Result 6 *The positive impact of higher time pressure and aggregate information on imitation in investment choices is limited to positive-value prospects and does not extend to negative-value and uncertain prospects.*

5 Discussion and Conclusion

In Section 4 we have highlighted six main results that relate to our research hypotheses. We have shown that a large number of participants positively reacts to social information and revise their initial choices to align their behavior to that of their peers. Furthermore, we have shown how the impact of others' choices is stronger among those who observe more cautious behavior among their peers, in particular in negative-value and uncertain prospects. To gain in the understanding of the nature of imitative behavior, we experimentally manipulate features of the signal and of the cognitive resources available to elaborate the signal. For what concerns the nature of the social signal, when social information is informative of the average behavior in the reference group, subjects adjust more to what they observed. Similarly, when less cognitive resources are available when choosing, the impact of peers' choices is stronger. We also show that effects of this kind tend to be stronger in positive-value prospects than in uncertain and negative-value prospects.

Evidence gathered in our experiment confirms that social effects play a fundamental role in the investment choices here considered. Moreover, imitative behavior in investments is largely affected by environmental factors working at the cognitive level. In line with our research hypotheses, both the normative content of social information and the time constraint foster imitative behavior. In contrast to our hypotheses, the difficulty faced in reconstructing the link between actions and consequences, as proxied by genuine uncertainty versus risk, does not foster imitation. What we observe is that in uncertain prospects only those that discover to be less cautious than their peers tend, weakly, to adjust their choices. A stronger adjustment for those less cautious than their peers is observed also in negative-value prospects. This asymmetry in reaction may be explained by some form of social comparison that becomes more relevant in investments that are more likely to produce losses (Cooper and Rege, 2011). Adopting the perspective of Prospect Theory (Kahneman and Tversky, 1979), it may be that for the same expected distance between own outcome and others' outcome, social differences loom larger in the domain of losses than in that of gains, because of loss aversion. This may, at least partly, explain the asymmetry in adjustment documented here for negative-value prospects. However, further research is needed to address this point and to understand how prospect theory operates in social domains (on this, see Linde and Sonnemans, 2012).

As highlighted in Section 1, several mechanisms that can generate correlation patterns in choices have been identified in the literature, i.e. social learning, payoff complementarities and taste for conformity. We interpret our results as the outcome of a boundedly-rational social learning process. Individuals adapt to the environmental conditions and adopt decisional shortcuts conditional upon the nature of the signal received and upon the cognitive resources available (e.g., Laland, 2002). Among potential explanations, this seems the most convincing given the nature of the allocation task and the conditions faced in the experiment. To elaborate, rational social learning is an unlikely explanation for the imitative pattern observed because choices of others do not convey any relevant information about the attractiveness of a task. Furthermore, the treatment effects highlighted above suggest that the imitative adjustment is not the result of mere taste for conformity. If this were the case, we should have observed a similar correlation in behavior across alternative treatments, in particular across distinct levels of uncertainty and of time pressure.

A few recent works, investigate the role of payoff complementarities in risky choices for individuals endowed with social preferences (e.g., Lahno and Serra-Garcia, 2012). The intuition underlying these works is that social preferences, mainly in the form of inequity aversion, should produce a correlation in behavior in risky choices because of ex-post payoff considerations. While this may potentially represent an important source of peer effects, behavior in our experiment does not seem to be heavily affected by such considerations. First, payoff considerations seem to involve deliberation and, in our case, more deliberative resources were associated with less imitation. Second, the asymmetry of imitation registered only in negative-value and uncertain prospects cannot be easily accommodated within this class of models. Finally, we do not find any correlation between risk preferences and imitation, in contrast to what predicted by social preference models (on this, see Gantner and Kerschbamer, 2011).

The evidence presented here highlights the relevance of social effects for decisions involving a non-deterministic outcome. Decisions of this kind are frequently met in environments in which information about choices made by others is available. We highlight the relevance of cognitive factors that promote mechanisms of boundedly-rational social learning. However, we also show how other motivations may interact with such mechanisms. Our work adds some evidence on the importance of social effects in investment choices and calls for further research to advance our understanding of the complex interplay between environment and cognition in shaping social learning.

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Appendix

A Translated Instructions

Welcome, you have just received 3,00 Euros for showing up on time.

We gently ask you to read these instructions in silence and with attention. Any kind of communication with other participants is forbidden. If you have doubts or questions, please raise your hand. One of the laboratory assistants in the room will answer privately to your question. Should you show any behavior aimed at disturbing the regular running of the experiment, you will be asked to leave the room and you won't receive any payment.

The experiment is made of two phases and in each of them there will be 6 rounds of choices. The kind of decisions you will have to take is described in the following paragraphs.

Depending on your choices and a random drawing you will earn an amount of money; during the experiment your earnings will be calculated in tokens. At the end of the experiment each token you have earned will be converted into real money at the following rate:

$$1 \text{ token} = 0{,}01 \text{ Euro}$$

For example, if you earned 300 tokens, you would be given 300*0,01 Euros in cash (3 Euros).

Before starting the experiment, you have to answer some questions aimed at verifying your understanding of these instructions. The experiment won't start until every participant has answered to the questions.

Your choices

Phase 1

At the beginning of each round you will receive an endowment of 200 tokens and you will have to choose how many tokens you want to invest in a given lottery. The tokens invested will be deducted from your endowment.

The lottery could have a positive outcome with a certain probability; in this case your earning will be equal to 2.5 times the tokens invested in the lottery itself. Alternatively, the lottery could have a negative outcome with a certain probability and in this case you will lose the tokens invested, without earning anything.

The probability of a positive outcome and of a negative outcome vary between rounds and they will be communicated at the beginning of each round. For example, in one of the rounds you will have 4 out of 8 possibilities to obtain a positive outcome (50%) and 4 out of 8 chances to obtain a negative outcome (50%). In one of the rounds you will have to choose how many tokens to invest in the lottery, but you will not know the probability of a positive or negative outcome. In that round, instead of the probability of winning or losing you will see a question mark "?".

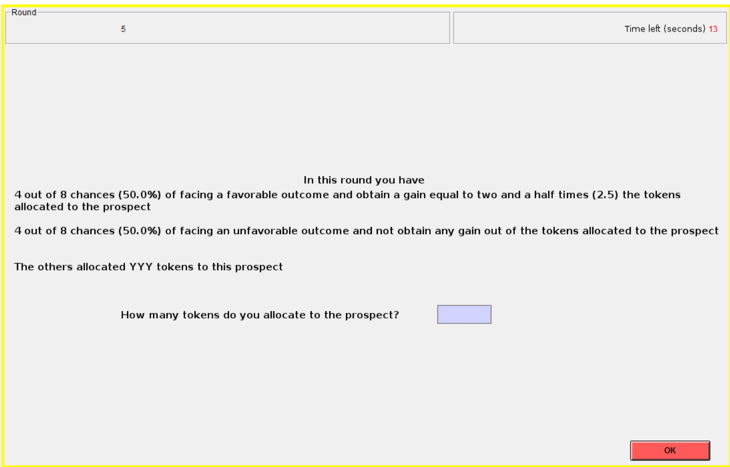
You will be able to invest in the lottery an (integer) number of tokens between 0 and 200. The earning for each round will be determined in the following way: in case of positive outcome, the tokens invested in the lottery will be deducted from the initial endowment and the tokens earned from the lottery will be added to the remaining balance; in case of negative outcome, the tokens invested in the lottery will be deducted from the initial endowment. It is not allowed to accumulate earnings (or losses) from one round to the other.

In each round you will have **20 seconds**[10] to make your decision.

Phase 2

In phase 2 you will be presented with the same lotteries as in phase 1, but not necessarily in the same order. Additionally to the lottery, you will receive a further piece of information: **the average number of tokens invested in the same lottery by a group of individuals who took part to an experiment run in this laboratory last week. The participants to that experiment had to decide how many of their 200 tokens to invest in the same lotteries that you will encounter. In each round, then, you will be able to see on the computer screen the average number of tokens invested by that group in the very same lottery. Members of that group will remain totally anonymous.**[11]

The following figure represents the structure of the snapshot that you will use to express your choice in Phase 2. Instead of the letters YYY, you will find the actual amount invested by the other participants in the given lottery. In the top-right corner of the screen the seconds left to express your choice will be counted. The snapshot for phase 1 is similar to the one below, with the only difference that in phase 1 you will not receive any information about other people's choices.



Aggregate Information Treatment

[10] In the Low Time Pressure Treatment this was replaced with **"40 seconds"**.

[11] In the Individual Information treatment the text in bold was replaced by the following: **"the number of tokens invested in the same lottery by an individual randomly selected between those who took part to an experiment run in this laboratory last week. The participants to that experiment had to decide how many of their 200 tokens to invest in the same lotteries that you will encounter. In each round, then, you will be able to see on the computer screen the number of tokens invested in the same lottery by another person. The identity of this participant will remain totally anonymous."**

Individual Information Treatment

Your payment

One out the 6 rounds in Phase 1 and one of the 6 rounds in Phase 2 will be randomly selected for the final payment. For each of the chosen rounds the outcome of the lottery will be determined through a random draw performed by the computer.

Your final earning will be defined by the number of tokens invested in the lottery and the outcome of the lottery in the round which has been randomly selected. A random draw will be performed for each participant and the outcome of the drawn lottery will not be dependent on the outcomes of the other participants.

To be more precise, the computer will randomly draw a number between 0 and 100. If the drawn number is less or equal to the winning probability (in percentage terms) of the round which have been selected, the lottery outcome will be positive. If the drawn number is greater than the winning probability of the lottery, the lottery outcome will be negative.

If you did not express any choice within the **20 seconds**[10] at your disposal in the round which has been selected, your earning will be zero for that round.