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Gönül Doğan, Kenan Kalayci and Priscilla Man

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PYRAMID SCHEMES

GÖNÜL DOĞAN[†], KENAN KALAYCI[‡], AND PRISCILLA MAN[§]

ABSTRACT. We invite experiment participants to invest their endowment in a pyramid scheme with a negative expected return. More than half of the participants invest regardless of their age, gender, education, income, and trust and fairness beliefs. Four interventions probe instruction tools that may deter pyramid investments. Exposure to possible payoff distributions or making payoff calculations diminishes investment rates, whereas seeing example pyramid outcomes or being exposed to a smaller pyramid scheme has no effect. Higher risk tolerance, preference for positively-skewed risk, and lower cognitive skills positively correlate with investment but explain a relatively small portion of investments.

Keywords: pyramid schemes, instruction methods, risk preferences, experiments

JEL classification codes: C90, D14, D81, D91

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[†]Faculty of Management, Economics and Social Sciences, Chair of Corporate Development and Business Ethics, University of Cologne. Email: dogan@wiso.uni-koeln.de.

[‡]School of Economics, University of Queensland. Email: k.kalayci@uq.edu.au.

[§]School of Economics, University of Queensland. Email: t.man@uq.edu.au.

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1. INTRODUCTION

Pyramid schemes are alluring, offering riches to a select few people who find themselves at the top of the pyramid. They are usually marketed as investments: a participant exchanges a joining fee for a solidified position in the pyramid. The joining fee then becomes a dividend and is awarded disproportionately to those who joined the scheme earlier than later. Many people fall for such schemes. The Federal Trade Commission (FTC) estimates that 400,000 people in the United States fell victim to some pyramid scheme in 2017 ([Anderson, 2019](#)), and in 2019, an estimated USD \$3.25 billion were invested in 60 different Ponzi schemes ([Iacurci, 2020](#)).¹ These victims' financial, personal and social well-being are often devastated when the schemes inevitably collapse. An extreme example is the Albanian Civil War of 1997, in which more than 2,000 people were killed and the government fell. The civil war was precipitated by the collapse of hugely popular pyramid schemes, which in 1996 had liabilities worth half the Albanian GDP and two-thirds of the Albanian population as investors ([Jarvis, 2000](#)).

In a pre-registered experiment, we created a simple pyramid scheme without deception. We provided participants with a chance to invest in the scheme and be placed randomly into the pyramid. Whilst it offered the *potential* of significant returns to players, the expected value of investment was negative. Hence fully rational individuals should decline the offer unless they are sufficiently risk seeking. For risk neutral or averse individuals, an investment in our setup indicates an inference failure.

Despite its simplicity, our novel setup reproduces defining properties of pyramid schemes: complexity of outcome and payoff inference, possibility of high earnings where the maximum possible earning increases with the number of investors, and a skewed payoff distribution in which most people lose money. Our pyramid scheme further eliminates confounding factors of real-life pyramid participation, such as beliefs or knowledge about

¹FTC considers a person to be a victim “if they purchased a membership in a pyramid scheme, were told that they would realize a promised level of earnings, and then earned less than half of that promised amount”.

one’s position in the pyramid, and the ability to convince others to join. As such, over-confidence, sophisticated inference or gullibility play no role in earnings, thereby allowing us to focus on the behavioural response to a “bare-bones” pyramid schemes.²

In our baseline setup, 58% of the participants chose to invest in the pyramid scheme. This is striking as these participants were informed of the structure of the scheme and were tested on their knowledge before being allowed to invest. This suggests that the allure of the scheme lies for the most part not in the cajolery of a pyramid scheme salesman, or a misunderstanding of how it works.

It is one thing to understand the mechanics of a pyramid scheme, and another to make the relevant inferences to overcome the tempting allure. We next tested several instruction tools that may be used to enhance deeper learning as opposed to a shallow understanding of pyramid schemes. These tools are based on inference helpers that are conceptually different from one another, and thus vary in multiple dimensions. Our aim here is thus not to incrementally manipulate an instruction tool in order to pinpoint the exact mechanism through which it works, as we are ex-ante agnostic about the success of each particular tool.³ Understanding the success (or lack thereof) of our treatments is the first step in designing an effective mitigation policy.

Two of our treatments — *Payoff Distribution* and *Examples* — provided information on the payoff distribution, but via different methods. In the *Payoff Distribution* treatment, participants were presented with a graph of the payoff distribution in the scheme before making an investment decision. In the *Examples* treatment, participants were given an example pyramid tree and its associated payoff distribution before making their decision.

²Antler (2018) proposes a sophisticated theoretical model of multi-level marketing schemes. While we appreciate his modelling, we prefer testing a simplistic pyramid scheme model for starker results.

³Our treatments are chosen from a “policy” point of view. We do not intend to unpack the decision process behind pyramid schemes decision because there are multiple approaches to reach the correct decision. In the absence of clear predicates on the relevant decision process while designing our study, we remain agnostic about the decision-theoretic mechanism involved.

Loosely speaking, Payoff Distribution provided information through direct instruction, while Examples provided information by presenting examples.⁴

The other two treatments — *Backward Induction* and *Small Pyramid* — forced participants to take steps that can be used to infer the probability of incurring losses after investment. In *Backward Induction*, participants calculated the payoffs of some investors in the lowest three levels of a pyramid tree that emerges when everyone invests. In *Small Pyramid*, participants worked through the payoff in each and every position in a perfect information pyramid tree with a small number of decision-makers. They were then asked to make an investment decision in the pyramid game with 200 decision-makers. In other words, both treatments drew participants’ attention to the reasoning behind a pyramid scheme’s payoff distribution. Backward Induction forced participants through the initial steps of backward induction, which is a particularly useful tool to infer how likely it is to lose money in pyramid schemes. Meanwhile, Small Pyramid put participants through the same problem in a smaller scale, which is cognitively manageable.

Our main result is as follows. In terms of providing information, direct instruction (Payoff Distribution) is effective in reducing the pyramid investment rate, but providing examples (Examples) is not. In terms of nudging participants to reason through the game, prompting backward induction (Backward Induction) is effective, but going through the same problem in a smaller scale (Small Pyramid) is not.

These results are striking on two fronts. First, when decision-makers perceive how likely they are to lose money, pyramid participation falls significantly. This is consistent with the experimental literature on asset bubbles, in which a better understanding of the underlying asset value reduces bubbles. Also, as in the asset bubbles literature (Kirchler et al., 2012; Huber and Kirchler, 2012), there is no significant difference between approaches in which such understanding is achieved. In Huber and Kirchler (2012), providing subjects with a figure of the asset value process and asking subjects to give an estimate of the asset value are both effective in reducing bubbles. Likewise, our Payoff

⁴Formally, Payoff Distribution provided the payoff distribution induced by all possible outcomes of the scheme, while Examples provided the payoff distribution in a single realized game play. To the best of our knowledge, there are no studies that compare the learning effect of encountering the payoff distribution in these two manners. In real-life, decisions on significant investment necessarily rely on information generated by one game play, since for individual decision-makers constructing the set of all possible outcomes and their associated payoffs is generally not possible.

Distribution and Backward Induction treatments are both effective in reducing pyramid scheme participation, despite coming from two different approaches.

However, methods within the same approach do not bear similar impacts. When evaluated in its entirety, the results point to whether applying an instruction tool requires *extrapolation* as a determining factor in its success: If decision-makers need to take an additional cognitive step to utilize an instruction tool in the pyramid scheme they face, the tool is ineffective.⁵ When information is provided, decision-makers fail to draw inferences from examples (Examples). When decision-makers are asked to solve the same problem in a smaller scale, they fail to extrapolate the conclusions to a larger scale (Small Pyramid), even when they are able to make optimal decisions in the small-scale problem. This is remarkable because the probability that an investor obtains a positive return in the small pyramid is similar to that in a large scheme when at least half of the participants invest. Thus, participants would have reached the correct conclusion if they had calculated the probability of a positive return and applied it to the large scheme. All in all, effective interventions are *immediate* — even if the intervention seeks to promote thinking and analysis.⁶

One may wonder if some unintended differences in our teaching tools might have contributed to the results. For instance, is Backward Induction the most effective treatment because individuals make more calculations? This is unlikely. Of all our interventions, Small Pyramid requires the highest number of pyramid calculations, while producing the highest pyramid participation rate. Likewise, Is the Payoff Distribution treatment successful and Examples unsuccessful because participants see a higher number or more realistic payoff distributions in the former? This is not true either. Both the payoff distributions and the examples are provided based on participants' guessed number of pyramid scheme investors (see Section 3). At the point of intervention, the guesses across treatments are practically indistinguishable. Hence participants see similar payoff distributions in both treatments. The main difference, though, is that Payoff Distribution provides “hard evidence” whereas Examples requires information to be generalized.

⁵Since we did not ex-ante expect the ability to extrapolate to be a determinant of pyramid decisions, our treatments do not isolate this component. Rather, taken together, our results support the (in)ability to extrapolate as playing a significant role in pyramid decisions.

⁶This may be no surprise to those who have taught undergraduate classes.

Supporting our conjecture that pyramid scheme participation is rooted in the inability to comprehend the payoff implications of the scheme, higher cognitive skills are associated with a lower probability of pyramid investment. As mentioned earlier, all participants must pass a quiz with questions requiring payoff calculations in various small pyramid scenarios before making their decisions. Participants who are successful with fewer attempts are less likely to invest. In the two treatments with additional calculations — Backward Induction and Small Pyramid — participants who make correct payoff calculations are markedly less likely to invest in the pyramid game. Meanwhile, we also measure backward induction capabilities via the race game ([Dufwenberg et al., 2010](#); [Gneezy et al., 2010](#); [Cardella, 2012](#)). While those who win the race game in multiple rounds are less likely to invest, the overall predictive power of the race game performance is rather small. These findings indicate that the capability to derive payoff implications plays a crucial role in reducing participation, but the manner in which this capability originates is less important.

Granted, there may be other factors contributing to investments in pyramid schemes, the most obvious one being risk preferences. We look at participants’ choices in eleven lotteries that are equivalent to varying the number of investors in our pyramid scheme. We call these lotteries “pyramid lotteries” for short. Participants who choose the pyramid lottery based on their guessed number of investors are 25.5% more likely to invest in the pyramid scheme. However, this explains a relatively small fraction of pyramid scheme investing, as only 22.9% of participants choose this lottery option.⁷ Additionally, we calculate the theoretical strength of probability weighting required to rationalize pyramid lottery choices. Roughly, the higher the number of investors, the weaker the required probability weighting to make investment an attractive option. The pattern observed in the actual pyramid lottery decisions is not reconcilable with this prediction: Pyramid lotteries with higher number of investors — with at least half investing — are markedly less likely to be chosen by participants. Similarly, a pure skewness preference (e.g., [Kraus](#)

⁷Risk preferences are rather sensitive to the measurement method. However, the predictive power of risk seeking would be even lower with the probability equivalence method, which classifies at most 14.2% of the subjects as risk seekers.

and Litzenberger, 1976) or salience explanation (e.g., Bordalo et al., 2012; Dertwinkel-Kalt and Köster, 2019), which would predict an increase in pyramid lottery choices with more skewed or salient payoffs, are not congruent with the actual pyramid lottery choices. Therefore, insights into pyramid investment or our treatment effects cannot plausibly originate from such channels.

From a policy perspective, our results suggest that consumer education focusing on the likelihood of losing money in large pyramid schemes is likely to be more effective than efforts focusing on the inevitably unstable structure of the scheme, as individuals may still struggle to draw meaningful conclusions from the latter. Importantly, there is little learning via encountering examples or experiencing a smaller scheme. Extending this insight to multi-level marketing — and to at least some cryptocurrencies — regulations requiring multi-level marketing companies to make explicit their salespeople’s earning distributions are likely to be more effective than warning potential recruits about the business model. When extrapolated to real-life decisions where outcomes vary vastly and probabilities are hard to estimate, such as insurance, retirement savings or human capital investment in “superstar” industries (e.g., Rosen, 1981), our results imply that better information on the outcome distributions would improve decisions. For decisions with a natural end-point (e.g., investment for retirement), showing backward induction steps would also be effective for better decision making.

Close to our paper are three studies that explore pyramid-like schemes: Antler (2018), Sadiraj and Schram (2018) and Bosley et al. (2019). Antler (2018) proposes a theoretical model about multi-level marketing schemes, which is sustainable via agents’ coarse beliefs. The model offers interesting insights into distinguishing multi-level marketing (which is legal) and pyramid schemes. For our purposes, though, we prefer testing the fundamental primitives of pyramid-like schemes. Sadiraj and Schram (2018) investigated investment decisions in Ponzi schemes with sequential multi-period decision-making with both informed and uninformed decision-makers. Different from ours, their setup comprised small groups with either 12 or 16 participants, and an underlying asset that was distributed as interest payment should a participant withdraw from the scheme. They found Ponzi schemes collapse faster with higher interest rates. Our study expands this

line of work to pyramid-like schemes without an underlying asset but with a large number of potential investors.

Bosley et al. (2019) ran a lab-in-the-field experiment eliciting participants’ decisions upon being offered a pyramid scheme investment opportunity. Like us, they did not deceive subjects on the mechanics of the scheme and the population size. Unlike us, in their pyramid game, participant payoffs did not depend on other participants’ decisions. Their only treatment involves a prompt asking them to “think carefully about [their] odds of winning” (Bosley et al., 2019, p. 3), which was ineffective in reducing investment. By introducing a very simple yet nontrivial pyramid decision in which payoffs depend on individuals’ position in the pyramid tree and treatments that deploy different instruction tools, we are able to distinguish between the efficacy of different interventions that may enable subjects to better reason in a pyramid game with a dynamic payoff structure. In particular, we show that when interventions are explicit and immediate, pyramid scheme investments can be deterred.

Since the seminal work of Wilcox (1993), a large literature has focused on how complex tasks affect choices. In these, complexity is defined by the increasing difficulty posed by the attributes of the task.⁸ While we do not formally measure the complexity of our baseline and treatments — there are multiple approaches through which one can reach the correct decision, each with varying dimensions of varying complexity — one can regard the treatments requiring more extra steps of reasoning as more “complex”. In this sense, our results indicate that information given in a more “complex” manner is less effective in helping decision-maker to identify the optimal solution.

Generally, cognitive skills have a positive relationship with equilibrium play and a negative relationship with decision-making biases (see Brañas-Garza and Smith, 2016; Brañas-Garza et al., 2019). In addition, performance in the cognitive reflection test or

⁸In experimental studies, a variety of task attributes have been tested as contributors to complexity, such as the number of choices or outcomes (e.g., Johnson and Bruce, 1997; Huck and Weizsäcker, 1999; Sonsino and Mandelbaum, 2001; Sonsino et al., 2002), the number of calculation steps required for a rational or correct solution (Carvalho and Silverman, 2019; Kalaycı and Serra-Garcia, 2016), and the difficulty of calculations such as requiring the use of Bayes’ rule for a correct solution (Brown et al., 2019; Charness et al., 2007; Enke, 2020). Recently, Oprea (2020) identified the dimensions of complexity as characteristics of rules that increase in costs to subjects who need to apply these rules repeatedly.

Raven’s matrices, two common measures of cognitive skills, is highly correlated with behavior in backward induction games (Akiyama et al., 2017; Brañas-Garza et al., 2012; Carpenter et al., 2013; Fehr and Huck, 2016). Our result that cognitive skills are negatively correlated with pyramid investment is consistent with these previous findings.⁹ However, the size of the effect is markedly smaller than those previously reported, possibly due to the fact that we use a more diverse subject pool.

2. MODEL

An initiator initiates a pyramid scheme by sending n invitations uniformly randomly to the N agents in the economy. Upon receiving an invitation to join the scheme, each agent decides whether to accept or reject the invitation. If an agent rejects, he leaves the game. If he accepts, he becomes a member of the scheme and n additional invitations will be sent on his behalf uniformly randomly to the population that has not yet received an invitation.¹⁰ The agents receiving these invitations will decide whether to join in the same manner. The game ends either when all agents have received an invitation, or when all current outgoing invitations are rejected.

The population size is common knowledge. However, when receiving an invitation, an agent does not know where he stands in the pyramid tree: he does not know the size of the population that has not yet received an invitation, nor does he know how many other invitations are sent along with his.

If agent i accepts an invitation from agent j , i is known as j ’s *immediate descendant* and j is i ’s *parent*. Upon joining, each member of the scheme pays an amount x to his parent. When a member acquires descendants, he pays his parent a fraction δ of the proceeds from all of his immediate descendants. Agents who reject the invitation receive nothing and pay nothing. The structure of the game and the payoff functions are common knowledge.

⁹There is no strong indication of whether this correlation implies causation. However, the relationship between cognitive skills and risk preferences is not robust. For example, Frederick (2005) found that those who scored high in the cognitive reflection test were less risk averse than those who scored low, whereas Thomson and Opeheimer (2016) found no such relationship.

¹⁰To abstract away from agents’ effort of recruiting members to the scheme, invitation generation is completely exogenous.

Because each agent can receive an invitation at most once, and he does not know his position in the pyramid tree, each agent has only one information set in this game. Thus, an agent's (behavioral) strategy can be described by the probability of acceptance when he receives an invitation. We consider Nash equilibria in which each agent's acceptance probability is optimal given other agents' strategies.¹¹

It is obvious that an equilibrium exists: every agent rejecting the invitation is an equilibrium. In fact, this is the only equilibrium when no agent is risk seeking. To see why, notice that this is a zero-sum game (in terms of the monetary payoffs). Since the initiator never loses money, the expected monetary payoff to any agent receiving an invitation must be negative, and strictly so if at least one agent accepts with positive probability. It is therefore never optimal for a risk neutral or risk averse agent to accept.

Notice that this is a dominant strategy argument: a risk neutral or risk averse agent should always reject regardless of what other agents do.¹² The strategy remains unaffected if some other agents are risk seeking or make sub-optimal choices. Consequently, in our setup, a fully rational individual is distinguished from a victim of the scheme by the ability to realize that the scheme is an unfair lottery, rather than the ability to understand other individuals' actions at each possible information set of the game. Thus, investment decision cannot be solely explained by the agent's anticipation of others' mistakes (e.g., quantal response, [McKelvey and Palfrey, 1995](#)), his inability to draw inferences from other agents' actions (e.g., cursed equilibrium, [Eyster and Rabin, 2005](#)), or his inability to distinguish between different nodes of other agents (e.g., analogy-based expectation, [Jehiel, 2005](#)).¹³

3. EXPERIMENTAL DESIGN

The experiment was programmed and conducted with the software o-Tree ([Chen et al., 2016](#)) using participants recruited from Amazon MTurk. Across five treatments, 3060

¹¹Since each agent has only one information set and there is no proper subgame, Nash equilibrium coincides with subgame perfect equilibrium and perfect Bayesian equilibrium.

¹²Not invest, however, is not obviously dominant ([Li, 2017](#)). This does suggest that a cognitively limited agent may fail to recognise it as a weakly dominant strategy.

¹³Since each agent has only one information set, analogy-based expectation has no bite in this game.

participants accepted the HIT, and among them 1032 participants finished the experiment. This is because, in line with the best practices when using online samples, and in particular MTurk (see e.g., [Chmielewski and Kucker, 2020](#); [Keith et al., 2023](#)), we allowed only those participants who answered all quiz questions correctly within three attempts to proceed to the investment decision in order to ensure high quality data. Participants were informed that this is the case. Each participant could participate in one treatment only. The Baseline (205 participants), Examples (203 participants) and Payoff Distribution (204 participants) treatments were run simultaneously in June 2018. These were pre-registered in the AEA RCT Registry with the identifying number AEARCTR-0003057. The Baseline (20 participants), Small Pyramid (200 participants) and Backward Induction (200 participants) treatments were run simultaneously in February 2019. These were pre-registered in the AEA RCT Registry with the identifying number AEARCTR-0003880. The second Baseline served two purposes: It replicated our initial findings in a smaller sample, and the investors therein served as matched participants in the first stage of the Small Pyramid treatment as explained in this section. The experiments lasted about 40 minutes and were conducted in English. The instructions used neutral language. Instructions for all of the treatments are available in the online appendix. The average pay was \$6.50, including \$2 for passing the quiz; the corresponding hourly pay was higher than the hourly federal minimum wage at the time (\$7.25).

In the experiment, each participant was endowed with \$4. This endowment was larger than the MTurkers' average hourly earnings on the platform ([Hara et al., 2018](#)). Participants then decided whether to invest their endowment in a pyramid scheme. Using neutral language, participants were first given detailed information on how the pyramid scheme works and the resulting payoffs. We chose the multiplier of 0.5 for payoffs, that is, $\delta = 0.5$ in the model. This multiplier is commonly advertised in real world pyramid schemes. Passing the quiz questions earned them \$2. Participants made their investment decisions privately and without knowledge of others' decisions. At the end of the experiment, participants were paid according to the pyramid tree that realized. All task information in the experiment was common knowledge.

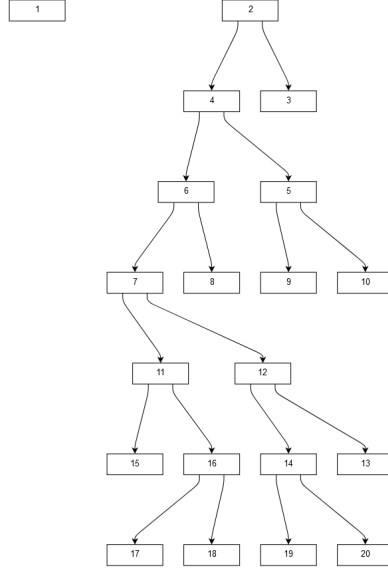


FIGURE 1. Realized pyramid tree with 20 participants

We constructed the pyramid scheme as follows. We invited participants to the experiment until about 200 participants had made an investment decision. In each treatment except the second Baseline, participants were informed that there were a total of 200 decision-makers in the experiment before they made their investment decision. After all participants had made their investment decision, we randomly drew two participants, and implemented their decisions. These first two participants constitute the starting points of a pyramid tree with two branches. If a participant chose to invest, we randomly drew two further participants as immediate successors of this investor. If a participant chose not to invest, no further participants were chosen as his successors. Therefore, a pyramid tree materialized only if at least one of the two initial decision-makers decided to invest, and the tree was constructed until either all participants were part of the tree, or all participants who were drawn as successors chose not to invest. As an example, Figure 1 depicts the tree that determined the payoffs of participants in the second Baseline with 20 participants. Participants' investment choices determined their final payoffs as follows. If a participant chose not to invest, she kept her \$4. If a participant chose to invest and but was not part of the pyramid tree, then she kept her \$4. If a participant chose to invest and was part of the pyramid tree, then she earned \$2 for each immediate—i.e.

first-degree—successor who also invested, \$1 for each second-degree successor who also invested, \$0.5 for each third-degree successor who also invested, so on and so forth.

Our design thus mimics a real-life pyramid investment that would materialize if we asked all potential recruits whether they would invest if given the chance and then randomly draw participants to the scheme. The probability of being drawn to the scheme (“invited”) is given by Appendix Figure B1. One may be worried that as the probability of being invited varies considerably over the relevant range of the number of investors,¹⁴ the extent to which subjects consider the possibility of not being invited is unclear. To account for this concern, we also consider subjects’ prospects conditional on being invited into the scheme in our analysis (see Section 5) and find no major differences in our conclusions.

After their investment decision, participants answered a series of questions. They had to guess the number of investors among the 200 participants¹⁵ and were paid \$1 minus the absolute difference between their guess and the actual number multiplied by \$0.1, if this amount was positive. They also made a dictator decision on how to distribute \$0.5 between themselves and another randomly-chosen participant in the treatment. At the end of each treatment, half of the participants were chosen as dictators and half were chosen as recipients and were paid accordingly.

We elicited risk attitudes using the probability equivalence method (Farquhar, 1984). In all treatments, participants chose between Option A and B, in which Option A gave a 50% chance each of winning \$1 or \$3 and Option B varied between a certain payment of \$1 and \$3 in increments of \$0.25. In the second Baseline, Small Pyramid and Backward Induction treatments, we added a second lottery task to also directly measure risk attitudes in lotteries equivalent to pyramid investment decisions, and paid one of the lottery tasks randomly. In this additional lottery, Option A depicted the average payoff distribution of 10,000 simulated pyramid outcomes of a certain number of investors, while Option B was a certain payment of \$4. We chose ten lotteries corresponding to 20, 40, 60, ...,

¹⁴This probability is akin to that in a typical contagion model. Think of the non-investors as the subpopulation immune to a disease. The probability of being invited—i.e., contracting the disease—remains low until the susceptible group reaches about 50% of the population, increases rapidly thereafter and then levels off.

¹⁵In the second Baseline, which was conducted with 20 participants, we asked the participants to guess the number of investors in the earlier and identical Baseline session with 200 participants.

200 investors out of 200 decision-makers.¹⁶ For simplicity, we call these pyramid lotteries. In addition, there is one lottery, which we call a pyramid guess lottery, in which Option A was based on the participants' guessed number of investors. Thus, participants made eleven choices. Participants were not informed that these probability-payoff pairings were based on the pyramid scheme.

Additionally, participants played the race game (Dufwenberg et al., 2010; Gneezy et al., 2010; Cardella, 2012). In the race game, the aim is to reach 15 on one's turn. The first player starts at 0 and chooses to add 1, 2 or 3 to 0. The second player chooses whether to add 1, 2 or 3 to it and so on, until the first player reaches 15. To remove the role of beliefs about what one's matched partner would do, we pitched participants against an optimally playing bot. The participant always starts, and since she plays against an optimally playing bot, wins only if playing optimally by aiming to reach 3, 7, 11, and 15 respectively. The game was repeated five times. Participants earned \$0.1 for each round that they won.

Finally, participants answered some background questions about their age, gender, annual income, highest educational degree earned, how often they buy lottery tickets, whether they buy warranties, whether they think that most people can be trusted or are fair, and whether they lend their belongings to friends. In the second Baseline, Small Pyramid and Backward Induction treatments, we also asked participants whether they currently hold an investment account, mortgage, bank loan, savings account, stocks and shares. We also asked two questions measuring their financial literacy, in which they could earn \$0.1 for each correct answer. Further, participants answered what they thought the experiment was about.¹⁷ The experiment concluded with a feedback page.

In all non-baseline treatments, we either provided participants with information or forced them to go through some calculations. Our first intervention, Payoff Distribution, provided the payoff distribution information, and tested whether pyramid investments

¹⁶Since the number of possible payoffs in the pyramid scheme rapidly increases with increasing number of investors, we adjusted the payoffs and their probabilities in such a way to only include \$0, \$2, \$4, ..., \$12, \$16, ..., \$28 as payoff outcomes while preserving the expected value of the lottery. Payoffs are in \$4 increments beyond \$12 as the probabilities of receiving payoffs above \$12 are fairly small. The exact numbers can be seen in the instructions in the Appendix.

¹⁷In the second Baseline, Small Pyramid and Backward Induction treatments, this question as well as their guesses on the number of investors were asked immediately after their investment decision.

indeed stem from an inability to estimate the payoff distribution. Relatedly, the Examples treatment provided at least one possible pyramid outcome and its payoffs, and tested the effectiveness of examples as a learning tool. Although both Payoff Distribution and Examples provided information, participants in the latter need an extra step of reasoning to infer that the example payoff distributions are likely to be representative of payoff distributions in general.

The other two interventions required participants to go through some calculations. In the Backward Induction treatment, participants calculated payoffs in the three lowest levels of the pyramid tree with 200 investors, as they would had they reasoned by backward induction. Such a representation makes it immediately clear that at least half of the investors lose money in a pyramid tree. In the Small Pyramid treatment, participants first decided whether to invest at each of the eight fixed positions in an eight-person all-invest tree. Unlike Backward Induction, which immersed participants in a large pyramid scheme directly, Small Pyramid requires participants to extrapolate their reasoning in a small scheme to a larger one.

Payoff Distribution Treatment

In the Payoff Distribution treatment, before making an investment decision, participants were asked to enter their guess regarding the number of investors out of 200 participants in that treatment. Based on their guess, they were presented with the payoff distribution of all investors averaged across 10,000 possible pyramid outcomes. Participants could afterwards try different numbers and generate pyramid outcomes up to 20 times.

Examples Treatment

In the Examples treatment, before making an investment decision, participants were asked to enter their guesses regarding the number of investors out of 200 participants in that treatment. Subsequently, they were presented with a randomly-generated pyramid tree and its associated payoff distribution based on the number of investors that they guessed. Participants could afterwards enter different (or the same) numbers of investors to generate example pyramid outcomes up to 20 times.

Backward Induction Treatment

In the Backward Induction treatment, before making an investment decision, participants were presented with the pyramid tree that arises when 200 out of 200 participants invest. The bottom three levels of this tree were highlighted with different colors, and participants had to calculate the payoff of a randomly-chosen player in each of the three levels starting from the last. They proceeded to their pyramid investment decision if they calculated all three payoffs correctly within five attempts. If their answers were not correct after five attempts, they were provided with the correct answers and a detailed explanation. Further, all subjects were informed that if all decision-makers invest, about half of the people would earn \$0 and a quarter would earn more than \$4.

Small Pyramid Treatment

In the Small Pyramid treatment, investment decisions involved two parts. First, participants were presented with a decision tree with eight participants. They then had to decide whether to invest in each of the eight possible tree positions knowing that all other participants had invested. Thus, they chose whether to invest eight times. The second part proceeded to the pyramid game with 200 participants. At the end of the experiment, one of the two parts was chosen for payment: if the first part was chosen for payment, one of the eight positions was randomly selected for payment. To facilitate payments, we ran the second Baseline parallel to the Small Pyramid treatment and informed the participants of the second Baseline that their decisions might be used in another session, and that they might earn additional money as a result. Participants in the second Baseline remained anonymous. We randomly drew the investors of this second Baseline to determine their additional payments, if any.

4. RESULTS

We start our analysis by describing our sample. As the last column of Table 1 shows, the average participant was 36.5 years old with an annual gross income of \$44,482. The median age in the U.S. population at the time was 38.2, and per capita annual gross

income was \$33,831 ([US Census Bureau, 2019](#)). Thus, our sample consisted of somewhat younger people with a higher self-declared income than the average at the time. In our sample, 44.7% were female, lower than the female share in the U.S. adult population, 51.3%. The completed years of schooling in our sample –15.41– was higher than the U.S. average –13.50– ([United Nations Human Development Programme, 2018](#)). Trust and fairness measures are based on the same questions as employed in PEW surveys, and our sample is not markedly different in these two questions compared to representative U.S. samples ([Rainie et al., 2019](#)).

In the probability equivalence risk elicitation task, 14.2% were risk seeking, and 50.2% were risk neutral. On average, they kept 33.9 out of 50 cents. The amount they kept are on a ballpark with many dictator experiments around the world. In other words, they gave 32.2% of their endowment in the dictator game, won 0.86 race games out of five, and needed 1.9 attempts out of a maximum of three to pass the quiz that measured their understanding of the pyramid game.

In the Backward Induction, Small Pyramid, and Baseline treatments with 20 subjects, we administered additional financial behavior, financial literacy, and pyramid lottery questions. Financial literacy was high, with participants answering on average 1.61 out of two financial literacy questions correctly. Most participants had investment and savings accounts, and held stocks. Finally, 22.9% of participants chose to invest in the pyramid lottery that was based on their guessed number of investors in the pyramid scheme.

Result 1. A majority of participants invest in a pyramid scheme.

Figure 2 shows the average investment rates in the pyramid scheme per treatment. We use test of proportions and report two-sided p-values for treatment comparisons. Remarkably, in the Baseline, 58% of the participants invest in the pyramid scheme. Two interventions are effective. Providing payoff distributions in the pyramid scheme (Pay-off Distribution) leads to a 22.4% reduction in investment probability from the Baseline (p-value = 0.0074). Asking participants to calculate payoffs in the bottom three levels of a pyramid scheme in an all-invest scenario (Backward Induction) has an even larger effect: investment rate is 35.1% lower than in Baseline (p-value < 0.0001). The other

TABLE 1. Sample Characteristics per Treatment

	Baseline	Distribution	Examples	Backward Induction	Small Pyramid	Total
Age	35.55 (10.74)	36.96 (10.37)	36.23 (9.818)	37.59 (10.93)	36.32 (8.954)	36.51 (10.20)
Female	0.386 (0.488)	0.478 (0.501)	0.441 (0.498)	0.475 (0.501)	0.460 (0.500)	0.447 (0.497)
Annual Gross Income	38746 (28814)	44342 (32466)	44508 (31101)	46830 (35973)	48559 (32318)	44482 (32268)
Years of Schooling	15.12 (2.505)	15.66 (2.349)	15.46 (2.413)	15.54 (2.462)	15.28 (3.142)	15.41 (2.590)
Buys Lottery Monthly	0.182 (0.387)	0.209 (0.408)	0.228 (0.420)	0.250 (0.434)	0.205 (0.405)	0.214 (0.410)
Never Buys Warranty	0.511 (0.501)	0.463 (0.500)	0.490 (0.501)	0.445 (0.498)	0.425 (0.496)	0.468 (0.499)
Never Lends	0.596 (0.492)	0.635 (0.482)	0.603 (0.490)	0.670 (0.471)	0.630 (0.484)	0.626 (0.484)
Risk Seeking	0.121 (0.327)	0.155 (0.363)	0.154 (0.362)	0.139 (0.347)	0.144 (0.352)	0.142 (0.349)
Trusts Most People	0.532 (0.500)	0.572 (0.496)	0.554 (0.498)	0.525 (0.501)	0.555 (0.498)	0.547 (0.498)
People Are Fair	0.550 (0.499)	0.542 (0.499)	0.559 (0.498)	0.560 (0.498)	0.570 (0.496)	0.556 (0.497)
Amount Kept in DG	33.76 (13.35)	32.96 (12.40)	32.46 (13.26)	34.75 (11.76)	35.60 (11.98)	33.90 (12.62)
Race Games Won	0.987 (1.428)	0.911 (1.350)	0.848 (1.336)	0.780 (1.199)	0.725 (1.315)	0.854 (1.331)
Quiz Attempts	1.920 (0.622)	1.754 (0.636)	1.926 (0.665)	1.950 (0.671)	1.965 (0.668)	1.903 (0.655)
Financial Literacy	1.850 (0.366)			1.595 (0.550)	1.610 (0.538)	1.614 (0.539)
Investment Account	0.250 (0.444)			0.555 (0.498)	0.525 (0.501)	0.526 (0.500)
Mortgage	0.150 (0.366)			0.405 (0.492)	0.410 (0.493)	0.395 (0.489)
Loan	0.250 (0.444)			0.295 (0.457)	0.315 (0.466)	0.302 (0.460)
Savings Account	0.800 (0.410)			0.830 (0.377)	0.880 (0.326)	0.852 (0.355)
Stocks	0.250 (0.444)			0.475 (0.501)	0.555 (0.498)	0.502 (0.501)
Pyramid Lottery	0.200 (0.410)			0.244 (0.430)	0.217 (0.413)	0.229 (0.421)
Observations	225	203	204	200	200	1032

Notes: Means of variables collected in all treatments. Standard deviations are in parentheses. Buys Lottery Monthly is 1 if participants chose “More than once a week”, “About once a week” or “About once a month”, and 0 if “Once a year or less” in the corresponding question. Never Buys Warranty is 1 if they chose “Never” in the question “When buying appliances how often do you purchase extended warranties?” and 0 if they chose “Always”, “Most of the time”, or “Sometimes”. Never Lends is 1 if they chose “Never” in the question “How often do you lend possessions to friends?” and 0 if they chose “More than once a week”, “About once a week”, or “About once a month”. Trusts Most people is 1 if they chose “Most people can be trusted”, and 0 if they chose “You can’t be too careful”. People Are Fair is 1 if they chose “Would try to be fair” and 0 if they chose “Would try to take advantage of you” to the question regarding what most people would do. Amount Kept in DG depicts, out of 50 cents, what they kept for themselves in the dictator game. Race Games Won depicts the number of times that they won the race game out of five repetitions. Quiz attempts depict whether they tried to answer the quiz questions 1, 2, or 3 times. In the Baseline, the variables Financial Literacy, Investment Account, Mortgage, Loan, Savings Account, and Stocks are only collected in the second wave of the experiment, and they are therefore based on a sample size of 20. Financial Literacy is the total number of correct answers in two financial literacy questions. Investment Account, Mortgage, Loan, Savings Account, and Stocks take the values 0 or 1.

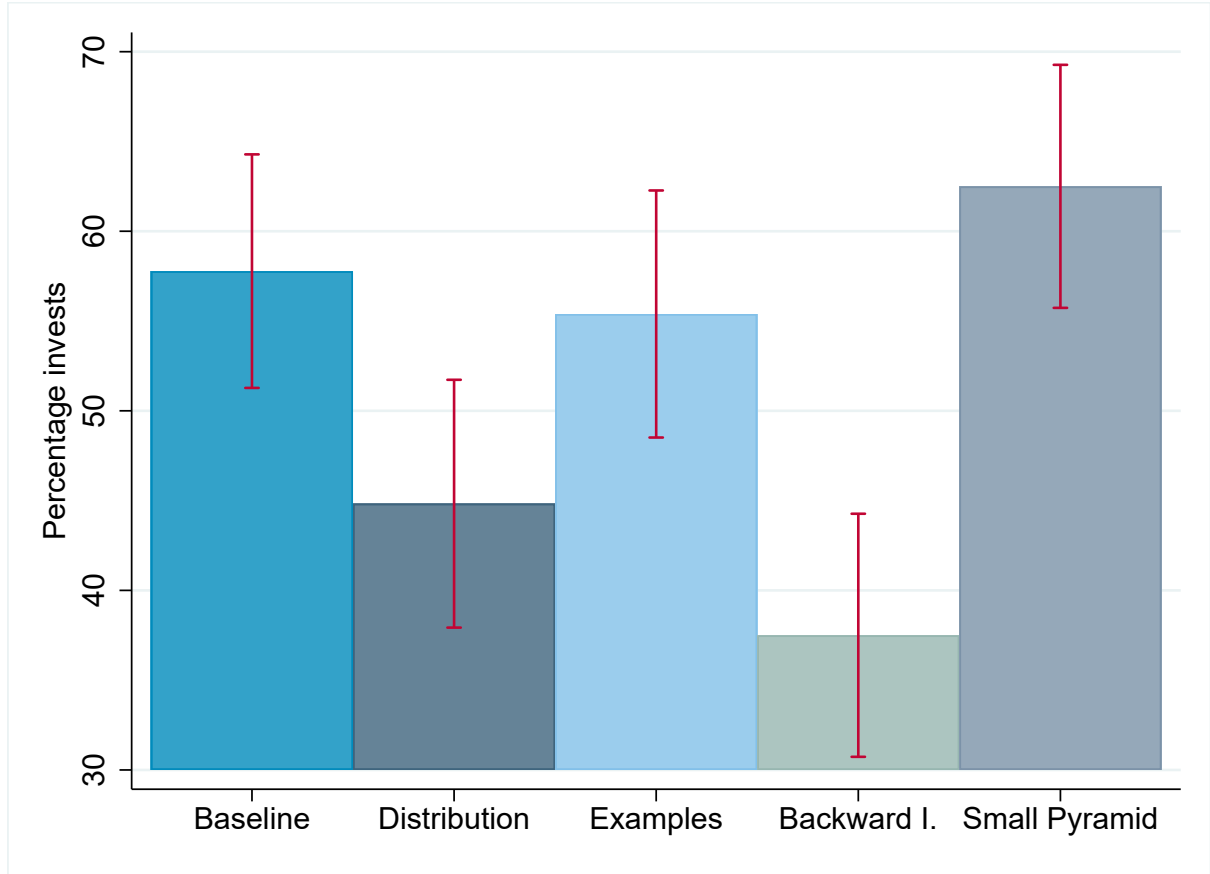


FIGURE 2. Investment rates in the pyramid scheme

interventions are ineffective: providing example outcomes (Examples) and making investment decisions in a full-information eight-person pyramid scheme (Small Pyramid) generate investment rates of 55.4% and 62.5%, respectively (p-values are 0.619 and 0.321, respectively, when compared with the Baseline).

Result 2. Information on average payoff distributions, and calculating payoffs of lowest level investors reduce the probability of investment. Examples of pyramid outcomes, and decision-making in smaller pyramid schemes do not affect investment behavior.

As all participants passed the quiz, they “understand” the mechanics of the pyramid scheme. Nonetheless, our results indicate that understanding the rules does not equate to being able to draw relevant inferences about the distribution of payoffs. The number of possible pyramid trees grows exponentially with the number of decision-makers, and it is impossible for a participant to directly calculate the payoff distribution within the time frame of an experiment. This suggests why, out of all four instructional interventions,

only the two that do not require further inference prove effective: Payoff Distribution simply provides the payoff distribution, while Backward Induction provides a visual and immersive exposition that if everyone invests, a high percentage—at least half—of investors lose money. The other treatments require extrapolation from either examples or a small pyramid scheme, which our participants did not seem to do.

Comparison between interventions along similar approaches indicates that the extra step of inferencing is the stumbling block. When participants are presented with information, participants in Payoff Distributions and Examples exhibited a similar pattern in generating examples. All participants see one distribution or one example tree based on their first guessed number of investors. Afterwards, participants in Payoff Distribution generated 0.77 new distributions on average; while participants in Examples generated 0.51 new examples. Most participants try at most one example after the first. Thus, the effect of Payoff Distribution is not due to better or more information than in Examples. Rather, we conclude that participants update their beliefs about pyramid outcomes when provided with averages but not single example outcomes.

Likewise, it is not that participants in Small Pyramid found small pyramid schemes confusing and “understand” less than their Backward Induction counterparts. First, Small Pyramid requires the highest number of calculations before making an investment decision. This means the success of Backward Induction is not due to payoff calculations merely. Second, the 8-person pyramid scheme presents an outcome in which 2 positions out of 8 make money. This is on par with the rate of participants with positive returns in the 200-person pyramid scheme with at least half investing. As an example, if there are 100 investors out of 200 decision-makers, the probability of having a positive return on a pyramid investment is roughly 19 percent (see Appendix Figure [A5i](#)). The corresponding rate with 200 investors is 28 percent.

Third, in the Small Pyramid treatment, the vast majority correctly invest in the positions of the eight-investor tree that would earn them money, but not in positions that would lose them money. The average investment rate in money-earning positions is 84.8%, and in money-losing positions it is 27.3%. Those who invest in at least one of the money-losing positions are also 29.9% more likely to invest in the pyramid game with

200 participants (see Appendix Table B1). A similar picture emerges in the Backward Induction treatment: 71.5% of participants correctly calculate the payoffs in the bottom three levels of the 200-investor tree, and those who do are 21.8% less likely to invest in the pyramid scheme (see Appendix Table B2). The rates of correct decisions in Small Pyramid and Backward Induction are thus comparable. However, in the Small Pyramid treatment, participants would need to apply their observations in the small scheme to the larger scheme, which seems to be an excessive cognitive hurdle for most participants.

Result 3. Age, gender, education, income, trust and fairness beliefs are not associated with pyramid investments. Dictator giving is positively correlated with pyramid investments, with a very small effect size.

Next, we turn to the relationship between investment decisions and demographic variables, cognitive skills, and risk preferences. Table 2 reports linear regressions of the probability of investing in the pyramid scheme on treatment variables, demographic variables, and experimentally-elicited measures of risk, altruism and cognitive ability.¹⁸ Model 1 includes the treatment variables only, with Baseline being the reference treatment, and it confirms Result 2. Model 2 adds additional control variables. Models 3-5 look only at Backward Induction and Small Pyramid and include pyramid lottery decisions in the analysis. The results consistently show that a participant’s age, gender, income, years of education, trust and fairness beliefs have no effect on his investment in the pyramid scheme. Dictator giving is significantly positively correlated with pyramid investments, however, its effect is very small. A person who keeps everything has about 0.5% lower probability of pyramid investment compared with someone who keeps nothing.

Cognitive Skills.

Result 4. Cognitive skills are negatively correlated with pyramid investments.

Different measures of cognitive skills all point to a negative relationship between cognitive skills and pyramid investments. First, backward induction capability negatively

¹⁸The results are qualitatively similar when we use a logistic or probit regression. We report linear regressions as the coefficients are easier to interpret. For ease of exposition, we excluded the financial literacy and behavior controls from the regressions. Their inclusion does not affect the results, does not improve the F statistic, and none shows a significant effect.

TABLE 2. Probability of Investment in the Pyramid Scheme

	Model 1	Model 2	Model 3	Model 4	Model 5
Payoff Distribution	−0.130*** (0.05)	−0.133*** (0.05)			
Examples	−0.024 (0.05)	−0.041 (0.05)			
Backward Induction	−0.203*** (0.05)	−0.204*** (0.05)			
Small Pyramid	0.047 (0.05)	0.047 (0.05)	0.234*** (0.05)	0.229*** (0.05)	0.242*** (0.05)
Age		0.001 (0.00)		−0.002 (0.00)	−0.002 (0.00)
Female		−0.026 (0.03)		−0.025 (0.05)	−0.013 (0.05)
Annual Gross Income		0.000 (0.00)		0.000 (0.00)	0.000 (0.00)
Years of Schooling		0.004 (0.01)		−0.002 (0.01)	−0.000 (0.01)
Buys Lottery Monthly		0.069* (0.04)		0.005 (0.06)	0.013 (0.06)
Never Buys Warranty		−0.082*** (0.03)		−0.083* (0.05)	−0.061 (0.05)
Never Lends		−0.066** (0.03)		−0.037 (0.05)	−0.062 (0.05)
Trusts Most People		0.012 (0.04)		−0.019 (0.06)	−0.025 (0.06)
People Are Fair		0.019 (0.04)		0.025 (0.06)	0.022 (0.06)
Amount Kept in DG		−0.009*** (0.00)		−0.005** (0.00)	−0.005** (0.00)
Race Games Won		−0.029** (0.01)		−0.023 (0.02)	−0.027 (0.02)
Quiz Attempts		0.072*** (0.02)		0.080** (0.04)	0.107*** (0.04)
Risk		0.052*** (0.01)	0.039** (0.02)	0.037** (0.02)	0.050*** (0.02)
Pyramid Lottery C1			0.061*** (0.01)	0.058*** (0.01)	
Pyramid Lottery C2			0.030** (0.01)	0.030** (0.01)	
Pyramid Lottery Guess					0.255*** (0.06)
Constant	0.578*** (0.03)	0.493*** (0.15)	0.213** (0.08)	0.366 (0.23)	0.197 (0.23)
R ²	0.0327	0.1510	0.1565	0.2042	0.1888
Observations	1032	1004	384	384	384

Notes: OLS estimates. The dependent variable is 1 if the subject chose to invest, and zero otherwise. Standard errors are in parentheses. ***, ** and * indicates statistical significance at the 1%, 5% and 10% levels, respectively. Financial literacy, investment account, mortgage, loan, savings account, and stocks are excluded as controls.

correlates with investment. Each race game won reduces investment probability by 2.9%. However, as 60.6% do not win in any round of the race game, the effect of the race game is driven by those who win in multiple rounds.¹⁹ Second, the number of quiz attempts matters: each additional attempt increases the probability of investment by 7.2%. Third, as previously mentioned, in both the Backward Induction and Small Pyramid treatments in which participants have to calculate payoffs in pyramid trees, those who make correct calculations or decisions are less likely to invest in the pyramid game. In sum, backward induction capability and correct calculations of pyramid structures explain some of the pyramid investment decisions.

Risk preferences and financial behavior.

Result 5. Real-life risk-taking behavior as well as elicited preferences for risk positively correlate with pyramid investments.

We look at both self-reported real-life risk-taking behavior and lottery decisions. Participants who buy lottery tickets at least once a month are 6.9% more likely to invest. Similarly, those who purchase extended warranties and lend their possessions are 8.2% and 6.6% more likely to invest in the pyramid game, respectively.²⁰ Based on the probability equivalence method, each unit increase in the switching point in risk measurement—with 5 indicating risk neutrality—increases the probability of pyramid investment by 5.2%. As a result, those who are risk seeking are 23.5% more likely to invest compared with the rest. Notice that since only 14.2% of our participants are risk seekers, risk seeking explains a very small percentage of pyramid investments.²¹ Appendix Table B4 depicts the frequencies of switching points in the probability equivalence method. Neither financial

¹⁹Categorizing participants into “never winners” and the rest does not explain pyramid investments, whereas categorizing them into “at-most-once winners” and the rest shows that the latter group is 10.7% less likely to invest. Of course, such a cutoff is arbitrary, and caution should be taken with interpretation. In fact, the effect of the race game performance disappears in Models 4 and 5, possibly because its small effect requires a large sample to detect.

²⁰Note that insuring against modest losses (e.g., by purchasing extended warranties) cannot plausibly be explained by risk aversion (Sydnor, 2010). Relatedly, in a costly voting experiment, Faravelli et al. (2019) found that those who buy lottery tickets as well as those who purchase extended warranties are more likely to vote, despite low odds of being pivotal.

²¹For example, in Baseline, the investment rate among risk neutral or risk averse participants is 55.1% (108/196), and among the risk seekers it is 74.1% (20/27). Assuming that all other variables are distributed similarly across risk preferences, risk seeking explains approximately 5.1 investment decisions out of 128 in Baseline.

literacy nor any of the financial behavior measures (stocks, mortgage, loan, investment or savings account) explain pyramid investments.

Next, we turn to the predictive power of skewness preferences. For this purpose, we focus on participants' choices in pyramid lotteries in the Backward Induction and Small Pyramid treatments. As explained in the design section, we asked participants eleven questions to measure their preferences for skewed risk. Each question elicited their choice when faced with the lottery equivalent of pyramid decisions based on the average payoff distribution with 20, 40, ..., 200 investors out of 200. The mean, variance, and skewness of these distributions are depicted in the top panel of Table 4 in Section 5. The eleventh question asked whether the participant would keep \$4 or invest in the lottery induced by their guessed number of investors. A majority of participants (54.3%) do not choose the lottery in any of the questions, and among the rest, 29.7% switch only once. Applying a principal components analysis shows two major components.²² The first component is positively correlated with all eleven decisions, whereas the second component is negatively correlated with the first five decisions, and positively correlated with the rest. Models 3 and 4 show that both of these components are significantly associated with participants' decision to invest in the pyramid scheme. Thus, choosing lotteries that are more skewed is associated with a higher probability of pyramid investment. Model 5 drops the two components and uses participants' choice in the last pyramid lottery: those who chose the lottery based on their guessed number of investors are 25.5% more likely to invest in the pyramid scheme. Note that—similar to the probability equivalence method results—this explains a relatively small fraction of pyramid scheme investing since only 22.9% choose to invest in this pyramid lottery.²³ We further discuss skewness preferences in the next section.

²²Interestingly, a principal component analysis with all lottery risk measurements does not show a meaningful pattern between decisions in a probability equivalence method and pyramid lotteries. This signifies that these two measures capture different attributes or preferences. Therefore, we keep both measures in our analysis.

²³Pooling the Backward Induction and Small Pyramid treatments, the average investment rate among those who did not invest in the pyramid lottery equivalent was 45.0% (144/320), and among those who invested in the pyramid lottery equivalent it was 69.5% (66/95). Thus, assuming that all variables are distributed similarly across the two treatments and with no interaction effects, skewed risk preferences explain approximately 23.3 investment decisions out of 210.

Beliefs. Next, we look at the relationship between beliefs about pyramid investment rates and behavior. In all treatments, after the pyramid investment decision, we asked participants to guess, out of 200, the number of participants who choose to invest in their session. This is monetarily incentivized. In the Payoff Distribution and Examples treatments, we also elicited beliefs before they made a pyramid decision by asking them what they thought was the number of investors in their session, so that we could show them the associated payoff distribution or example tree.²⁴ We first discuss the results based on their incentivized guesses.

Table 3 depicts the regressions reported in the format of Table 2, with the addition of the variable Guess, reporting only the variables that show a significant effect in Models 1-5 of Table 2. A first observation is that in all model specifications, participants' guesses correlate highly significantly with their investment behavior, and including guesses in the regressions substantially increases the explained variance. Concordant with this, when pooling all data, the average guess among non-investors is 65.7, and among investors it is 121.9 (two sample t-test p-value < 0.0001). Second, the effect of the Payoff Distribution treatment vanishes with the introduction of guesses, whereas the Backward Induction treatment effect persists, albeit becoming smaller. Third, real-life risk-taking behavior shows up as significant only in the full sample, whereas elicited risk measures remain predictive of investment decisions.

There are two possible explanations for why guesses explain a large part of the variance in our regressions. First, it could be the case that beliefs *cause* behavior. Consequently, the higher the number of investors that one expects in the resulting pyramid scheme, the higher the probability that a participant invests. Indeed, the results of twice-elicited guesses in the Payoff Distribution and Examples treatments make such an explanation plausible: although the average first guess is not different across the two treatments, the

²⁴We used the following wording for the Payoff Distribution treatment: "There are 200 participants in this experiment. Please enter the number of participants you believe would decide to invest \$4. After you click Next, you will see a graph that depicts the earnings distribution of participants who invested. This earnings distribution is based on the earnings of 10000 randomly drawn outcomes based on the number of participants you entered." The wording in the Examples treatment was similar.

TABLE 3. Probability of Investment in the Pyramid Scheme

	Model 1	Model 2	Model 3	Model 4	Model 5
Distribution	-0.043 (0.04)	-0.033 (0.04)			
Examples	0.011 (0.04)	0.009 (0.04)			
Backward Induction	-0.147*** (0.04)	-0.136*** (0.04)			
Small Pyramid	0.006 (0.04)	0.009 (0.04)	0.141*** (0.04)	0.139*** (0.04)	0.148*** (0.04)
Guess	0.006*** (0.00)	0.006*** (0.00)	0.005*** (0.00)	0.005*** (0.00)	0.005*** (0.00)
Buys Lottery Monthly		0.061** (0.03)		-0.015 (0.05)	-0.008 (0.05)
Never Buys Warranty		-0.051** (0.03)		-0.083* (0.04)	-0.067 (0.04)
Never Lends		-0.045* (0.03)		-0.039 (0.04)	-0.059 (0.04)
Amount Kept in DG		-0.005*** (0.00)		-0.001 (0.00)	-0.001 (0.00)
Race Games Won		-0.013 (0.01)		-0.009 (0.02)	-0.011 (0.02)
Quiz Attempts		0.047** (0.02)		0.047 (0.03)	0.068** (0.03)
Risk		0.047*** (0.01)	0.036** (0.01)	0.037** (0.02)	0.046*** (0.02)
Pyramid Lottery C1			0.043*** (0.01)	0.043*** (0.01)	
Pyramid Lottery C2			0.031** (0.01)	0.029** (0.01)	
Pyramid Lottery Guess					0.206*** (0.05)
Constant	0.011 (0.04)	-0.156 (0.12)	-0.232*** (0.08)	-0.271 (0.21)	-0.413** (0.21)
R ²	0.3399	0.4141	0.3720	0.3950	0.3877
Controls	Yes	Yes	Yes	Yes	Yes
Observations	1032	1004	384	384	384

Notes: OLS estimates. The dependent variable is 1 if the subject chose to invest, and zero otherwise. Numbers in parentheses are standard errors. ***, ** and * indicates statistical significance at the 1%, 5% and 10% levels respectively. In Models 3-5, Backward Induction serves as benchmark. Controls include age, gender, income, years of schooling, trust and fairness beliefs.

guess elicited at the end of the experiment is different in the direction of the treatment effect. In both treatments, participants who do not invest update their guesses downwards, while those who invest update their guesses upwards.²⁵

²⁵In the Payoff Distribution and Examples treatments, the average first guesses are 97.8, and 92.1, respectively (two-sided t-test $p = 0.140$), and the average second guesses are 84.3, and 93.4, respectively

Potentially, skewness preferences and the salience effect of large payoffs could be mechanisms through which beliefs cause behavior in the pyramid scheme.²⁶ Even though participants were neither presented with the largest possible earnings nor the payoff distribution (except in the Payoff Distribution treatment) the structure of the scheme made it clear that the larger the number of investors, the larger the maximum payoff in the scheme. As such, skewness also increases with the number of investors. Both mechanisms would then predict that in the pyramid lottery, i) the lottery choice rate with 200 investors is similar to the pyramid investment rate, and ii) the lottery choice rate increases with the number of investors. Neither is the case in our sample: overall, only 10.7% choose the lottery in the pyramid lottery with 200 investors and the correlation with pyramid investment decisions is quite low (0.237). Further, the rate of lottery choices generally decreases with the number of investors (see Table B3). Therefore, if beliefs cause behavior, it cannot be largely driven by (implicit) skewness seeking preferences or payoff salience.

A second explanation rests on what guesses actually measure. If participants invest for reasons unrelated to their beliefs, and they also believe that most other participants are like themselves, guesses and investment decisions would correlate without a causal relationship. Of course, our design cannot rule out this explanation. However, although the investment rate in the Backward Induction treatment is significantly lower than in the Baseline, the average guesses of investors and non-investors are not significantly different from the other treatments (t-test p-values 0.655 and 0.255, respectively). Further, the explanatory power of guesses in this treatment is significantly lower than in the Small Pyramid treatment.²⁷ All in all, the evidence supports the explanation that showing backward induction steps reduces the impact of beliefs on behaviour.

(two-sided t-test $p = 0.0619$). In both treatments, guesses change in the direction of behavior. Since the investment rate in Payoff Distribution is lower than in Examples, the average guess is also lower. Among non-investors, guesses decrease on average by 21.9 units, with 95% CI being $(-28.2, -15.7)$, and among investors increase by 12.4 units, with 95% CI $(6.5, 18.4)$.

²⁶Bordalo et al. (2012) proposed salience theory to organize various economic phenomena. Subsequently, other studies supported the notion that large numbers or large differences are salient and therefore affect lottery decisions, see, e.g., Booth and Nolen (2012); Frydman and Mormann (2016); Dertwinkel-Kalt and Köster (2019) and Königsheim et al. (2019).

²⁷Based on a regression that repeats Model 5 in Table 3 with the addition of an interacted variable of treatment and guesses.

5. DISCUSSION

Abstracting away from the interactive nature of the scheme, the decision to participate is similar to the decision to buy a lottery ticket, whereby one pays for a small probability of hitting the jackpot. As such, one possible explanation is that subjects might have overweighted the small probability of being able to profit from the scheme, while underweighting the more substantial probability of making a loss. For this purpose, we further investigate the possibility and strength of probability weighting in this section.²⁸

We make use of the eleven pyramid lotteries in the second Baseline, Backward Induction and Small Pyramid treatments (see Section 3). The observed choices on these lotteries are reported in Table B3. We consider an individual with risk neutral preferences over monetary outcomes, but who might have weighted probabilities. For our purpose, we adopt the one-parameter probability weighting function in Prelec (1998):

$$w(\pi; \alpha) = \exp[-(-\ln \pi)^\alpha],$$

where π is the objective probability.²⁹ The parameter α lies between 0 and 1, with $\alpha = 1$ meaning no weighting (i.e., $w(\pi) = \pi$) and $\alpha = 0$ meaning that all probabilities are weighted to be $1/e$. The lower the α , the stronger the probability weighting. For all of the lotteries that we have considered, the weighted expected payoff is decreasing in α , i.e., the stronger the probability weighting, the more attractive the lottery.

We solve for α in

$$\sum_{v \in V} w(\pi(v); \alpha) v = 4$$

where each v is a possible payoff (and V is the set of all possible payoffs) and $\pi(v)$ is the objective probability of obtaining payoff v . The dependence of π on the number of investors or the investment rate is suppressed for simplicity. The solved α then indicates the “strength” of probability weighting required to make an otherwise rational individual indifferent between receiving the lottery and receiving \$4 for certain. Any individual with

²⁸Since our experiment is not designed to detect different forms of probability weighting, we would not distinguish between different potential underlying sources of probability weighting. Rather, we would like to probe theoretically the strength of probability weighting required to deliver the observed choices.

²⁹One may argue that Prelec’s one-parameter weighting function is only a primitive form of probability weighting, and we have ignored a number of potential factors (e.g., gain vs. loss prospects). Nonetheless, we believe that it is a good benchmark to consider.

TABLE 4. Pyramid Lotteries: Imputed Probability Weighting Parameters

	Payoff Statistics			Prelec's α
	Mean	Variance	Skewness	
PANEL A: Pyramid Lotteries with fixed number of investors				
<i>Number of Investors</i>				
20	3.9542	0.1732	−9.1602	0.5824
40	3.9501	0.1851	−8.5486	0.7038
60	3.9425	0.2261	−7.0002	0.7899
80	3.9336	0.3812	−3.2186	0.8864
100	3.9209	1.6076	0.5314	0.9586
120	3.9028	7.5687	0.9472	0.9831
140	3.8730	13.1387	1.0836	0.9849
160	3.8323	17.8551	1.2361	0.9836
180	3.7866	21.6489	1.4057	0.9814
200	3.7364	24.3687	1.5567	0.9782
PANEL B: Pyramid Lotteries given observed investment rate				
<i>Investment Rate</i>				
0.375 (Backward Induction)	3.9364	0.3145	−4.3701	0.8603
0.448 (Payoff Dist.)	3.9280	0.7329	−0.5828	0.9275
0.554 (Examples)	3.9118	4.4746	0.8671	0.9762
0.578 (Baseline)	3.9070	5.8691	0.8899	0.9793
0.625 (Small Pyramid)	3.8960	8.6458	0.9318	0.9822
PANEL C: Pyramid Lotteries conditional on being invited				
<i>Investment Rate</i>				
0.375 (Backward Induction)	2.2831	5.3393	0.8071	0.6954
0.448 (Payoff Dist.)	2.9967	7.3500	0.6640	0.8295
0.554 (Examples)	3.7440	10.8016	0.6496	0.9632
0.578 (Baseline)	3.7962	11.6286	0.6907	0.9721
0.625 (Small Pyramid)	3.8374	13.1792	0.7852	0.9795

Notes: A pyramid lottery gives the same probability distribution over the same set of outcomes as in the pyramid scheme, given the number of investors or the investment rate. Panel A depicts the pyramid lotteries with fixed numbers of investors. Panel B depicts the pyramid lotteries with the number of investors fixed at the investment rate of each treatment. The payoff distributions used in the lotteries in Panels A and B are based on the pyramid game, thus individuals who are uninvited to the scheme are included with their \$4 earnings. Panel C depicts pyramid lotteries as in Panel B, but the probabilities on the outcomes are calculated conditional on the individual being invited into the scheme. Mean, variance and skewness refer to the corresponding summary statistics of the pyramid lotteries. Prelec's α gives the threshold probability weighting parameter at which a risk-neutral individual is indifferent between the lottery and the certain option of obtaining \$4. The lower the threshold α , the heavier the probability weighting.

α below this critical value would strictly prefer the lottery to a certain \$4, while those with α above this critical value would strictly prefer the safe option to the lottery.

The imputed Prelec's α 's are given in Panel A of Table 4, along with the means, variances and skewnesses of the payoffs from the pyramid lotteries. First note that when

the lotteries are positively skewed,³⁰ the critical α 's are close to 1, meaning that the required weighting function is close to linear. These imputed α 's are substantially higher (i.e., the weighting functions are closer to linear) than the empirical estimates in the literature.³¹ The high imputed α 's are due to the relatively small expected loss in the pyramid scheme. Even at its lowest expected value (when all 200 subjects invest),³² the expected payoff from the pyramid lottery still stands at \$3.74, which is 93.5% of the \$4 outside option. Heavy overweighting on the “favorable events” is not needed to bring the expected payoff of the lotteries to \$4.

The high imputed α 's may seem a good explanation of pyramid scheme participation. However, such a conclusion is inconsistent with the pyramid lottery choices. The critical α is non-monotonic in the number of investors. It peaks at 0.9849 with 140 investors, then falls slightly to 0.9782 with 200 investors. Nonetheless, since the critical α with 200 investors is higher than that with 80 investors, we should expect a higher uptake of Pyramid Lottery 200 than Pyramid Lottery 80. However, the reverse is observed (see Table B3), which suggests that probability weighting — at least in Prelec's form — is not the main factor behind the pyramid lottery choices.

To compare the pyramid lottery choices with the actual investment choices in the scheme, we construct lotteries based on the investment rates observed in the treatments,³³ then calculate the critical α 's as before. The results are given in the Panel B of Table 4. To ease inference, we order the treatments according to their investment rates.

Again, the first notable feature is that the critical α 's are relatively high, consistent with the pyramid lotteries with 100 or more investors. If we consider these lotteries as the

³⁰Pyramid lotteries with low number of investors are negatively skewed due to the large probability of not being invited and hence receiving \$4, which is higher than most payoffs from the scheme with few investors.

³¹Prelec (1998) informally stated that $\alpha = 0.65$ fits well with previous observations. Wu and Gonzalez (1996) estimate Prelec's α to be 0.74 using gain prospects. Bleichrodt and Pinto (2000) obtain estimates in the range of 0.533–0.589 in a medically-framed experiment. However, it should be cautioned that none of these previous experiments have considered probabilities as small as those involved in our experiment.

³²The expected payoff is decreasing in the number of investors because the higher the number of investors, the higher the chance of being invited into the scheme, which gives an expected payoff below \$4.

³³The events for these lotteries are obtaining \$0–\$2, \$2–\$4, ..., \$10–\$12, \$12–\$16, \$16–\$20, ..., \$24–\$28, with the payoff in each event corresponding to the expected payoff conditional on the payoff falling into the bracket. Probabilities with a fixed number of investors are weighted by the binomial probability of having the number of investors given the investment rate and then summed. Since a binomial distribution with 200 draws is fairly concentrated around its mean, using the investment rate produces results similar to fixing the number of investors at the expectation.

prospects that potential investors consider when they make their investment decisions, the light weighting required for investment to be attractive might seem a good explanation for the significant investment rates. However, such an interpretation is inconsistent with the observed pyramid lottery choices, as pyramid lotteries with similar summary statistics and critical α 's are chosen at a lower rate.

One may be concerned that the above lotteries are constructed taking into account the fact that an individual may receive \$4 due to not being invited into the scheme, despite having chosen to invest. For this purpose, we reconstruct the five lotteries at the observed investment rates, using probabilities *conditional on being invited into the scheme* instead. The results are given in Panel C of Table 4. The overall pattern remains similar. More considerable adjustments of probabilities are needed for investment in the Payoff Distribution and Backward Induction treatments, mainly due to the lower expected value of the pyramid scheme with a lower number of investors.

All these results point to two implications. First, a slight mis-estimation of probabilities is sufficient to lead to an investment decision. This may explain why, when the interventions do not provide immediate, overwhelming “hard evidence”, they are ineffective. On the other hand, though, the inconsistency of pyramid lottery choices under a formal probability weighting framework suggests that probability weighting is unlikely to be the main source of pyramid investments.

Because the maximum possible payoff in pyramid lotteries is increasing in the number of investors, one may also argue that the gain prospect of the lottery becomes more salient as the number of investors increases. If this is the case, the observed pyramid lottery choices are not consistent with salience theory (e.g., [Bordalo et al., 2012](#); [Dertwinkel-Kalt and Köster, 2019](#)), which suggests that individuals would prefer pyramid lotteries with more investors.

Along similar lines, one may also suspect that pyramid scheme investments could have been driven by skewness preference (c.f., [Kraus and Litzenberger, 1976](#)) as participants seek the positively skewed payoff distributions generated by the pyramid scheme. Table 4 indicates this is not the case — the more positively skewed pyramid lotteries were chosen least often (see Table B3). If one considers the treatment-induced pyramid lotteries

conditional on being invited, Backward Induction induces the most positively skewed pyramid lottery. Yet it is the treatment with the lowest investment rate.

In essence, while the pyramid scheme investment decisions are likely to be driven by probability misperception, evidence from the pyramid lottery choices shows little indication that the probabilities are mis-specified in a way prescribed by systematic probability weighting or salience. Likewise, the pyramid lottery choice patterns are at odds with a skewness preference explanation.

6. CONCLUSION

In a novel experiment, we invited participants to invest their endowments in a pyramid scheme. More than half of the participants invested. While risk seeking, preference for positive skewness and cognitive skills correlate with investment decisions, their effects are relatively small. Our interventions point to subjects' inability to draw relevant inferences at the crux of pyramid scheme investment. Interventions explicitly informing participants of the high likelihood of losing money discourage investments, while interventions requiring extrapolations are ineffective in dissuasion.

Our experiments provide insights into how individual decisions may be improved in situations with a large number of outcomes and payoffs, and tail events. In all of our treatments, the investment decision is the same, yet behaviors differ when different instruction methods are employed. In particular, providing initial steps for better reasoning without completion does not lead to a change in behavior relative to the baseline. This observation may point to what constitutes effective persuasion in a larger context.

Our study only scratches the surface in understanding pyramid investments. Future research could investigate the sensitivity of investments to monetary stakes as well as the number of investors to the scheme — which affects the skewness of the pyramid outcomes, and specify the exact constituents of their allure.

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APPENDIX A. EXPERIMENTAL INSTRUCTIONS

This appendix contains screenshots from the experiment. We will first show the (new) Baseline treatment. Then we will show the screenshots from other treatments when they differ from the (new) Baseline treatment. For all treatments, the screenshots are divided into seven parts: the introduction and quiz (Figure A1), five main parts (Figures A2–A6) and the questionnaire and payoff at the end (Figure A7).

A.1. New Baseline Treatment. The introduction part starts with the welcome screen and the consent page, followed by the instructions about the pyramid scheme (Figures A1c and A1d). Participants are then required to complete the quiz (Figures A1e to A1g). If they answer all questions correctly, they will see the “Quiz finished” screen (Figure A1h). If there is at least one incorrect answer, they will see the “Quiz second try” screen (Figure A1i). Participants are given three attempts at the quiz. If they fail all three attempts, they will be shown Figure A1j and will not be able to continue.

Main part 1 asks for the participant’s investment decision in the pyramid scheme (Figure A2).

Main part 2 (Figure A3) asks for the participant’s guess on the number of participants who invest, as well as what they think the experiment was about. The screen shown here (Figure A3a) refers to the number of participants in a previous experiment, since the new Baseline experiment was not run with 200 participants.

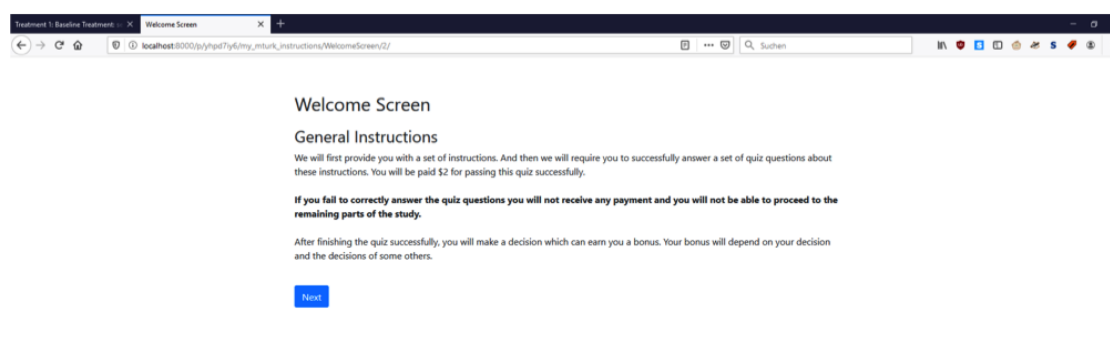
Main part 3 (Figure A4) is the dictator game.

Main part 4 (Figure A5) is the lottery choices. The first component (Figures A5b–A5c) elicits risk preferences using the probability equivalence method (Farquhar, 1984). This is common to all treatments. The second component (Figures A5d–A5o) asks participants to choose between the lottery equivalences of the pyramid scheme given a fixed number of investors and the safe outside option. The last pyramid lottery (Figure A5o) has the number of investors equal to the participant’s guess in Part 2 (Figure A3a). This screen was not shown if their guess was zero.

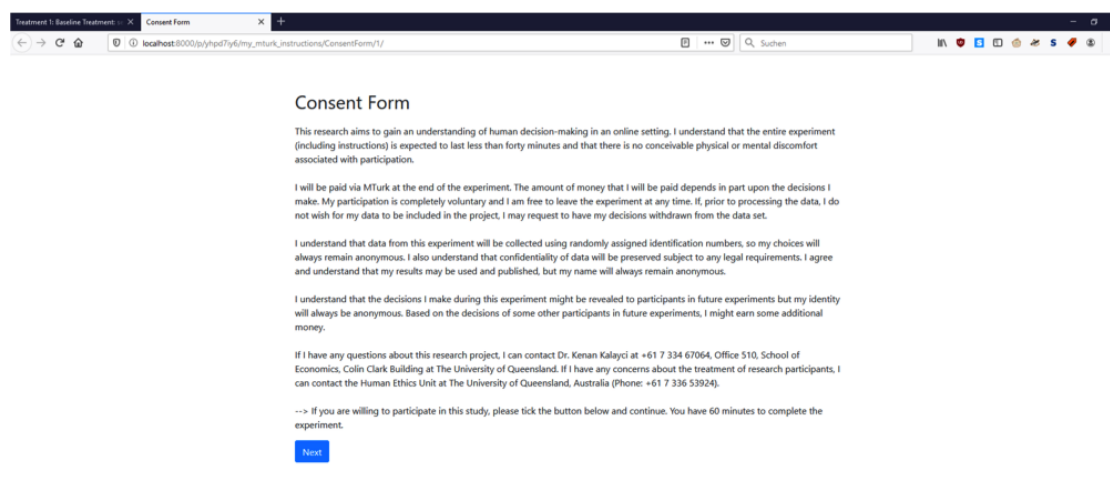
Main part 5 (Figure A6) is the race game. The choice screen (Figure A6b) updates according to the participant’s and the bot’s choices. There are five rounds of the game.

At the end of each round, the participant will be shown either a win (Figure A6c) or lose (Figure A6d) screen, depending on their outcome.

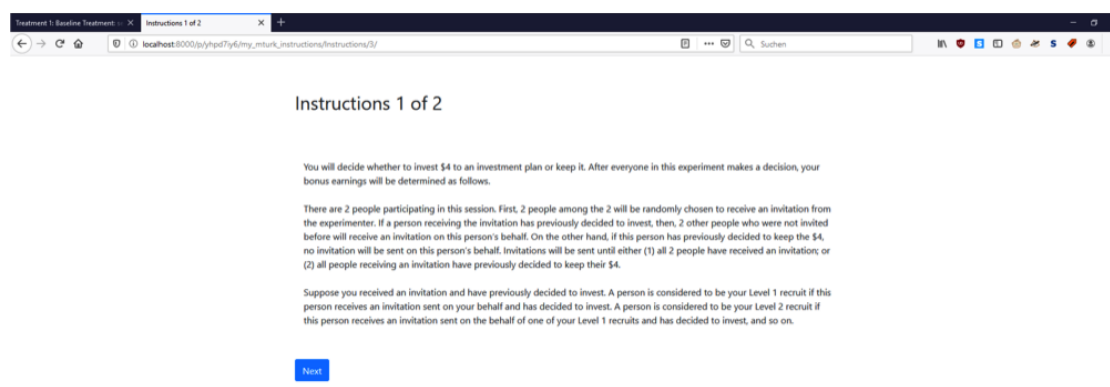
The final part (Figure A7) includes a demographic survey (Figures A7a and A7b). The initial payoff summary (Figure A7d) does not include all payoffs, as choices from other participants are needed to determine payoffs from certain parts of the experiment.



(a) Welcome page

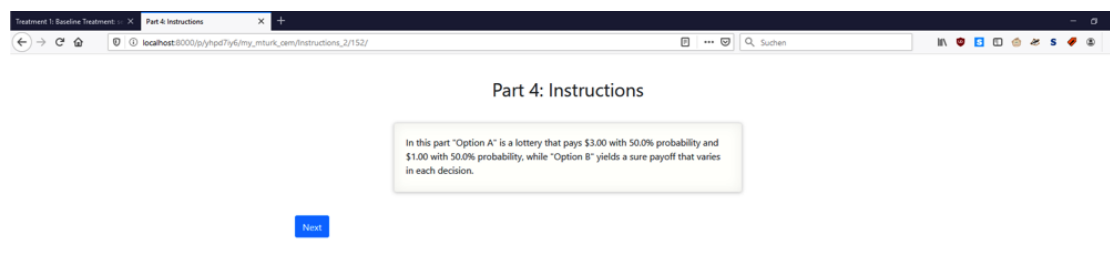


(b) Consent page

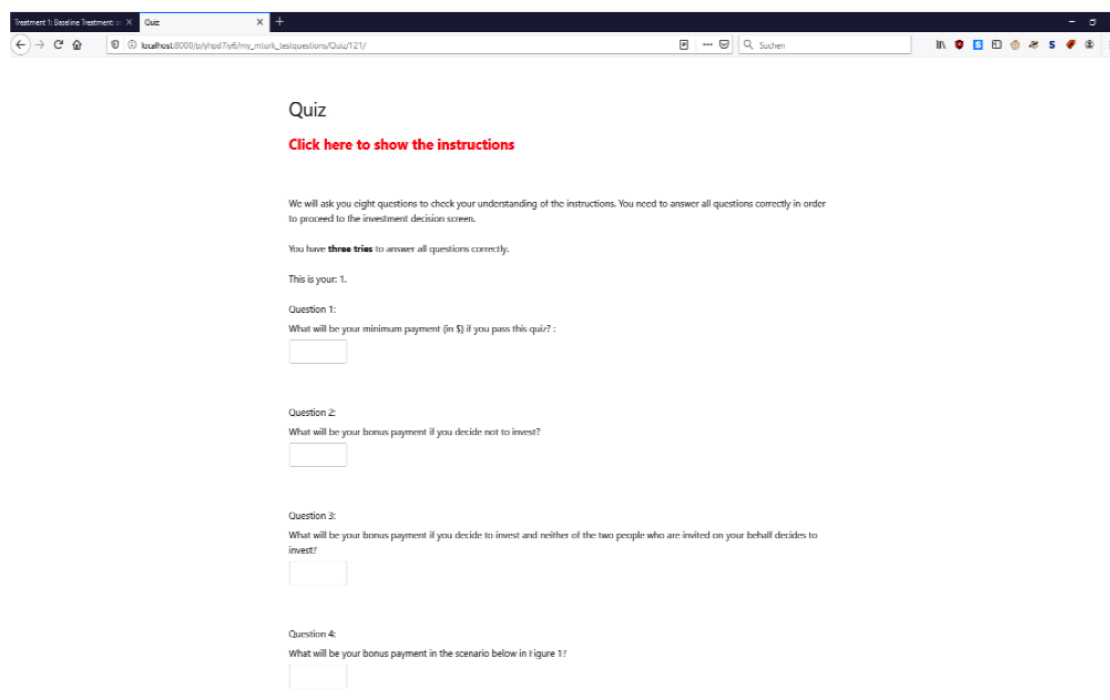


(c) Instructions, part 1

FIGURE A1. Screenshots: Instructions and quiz



(d) Instructions, part 2



(e) Quiz, part 1

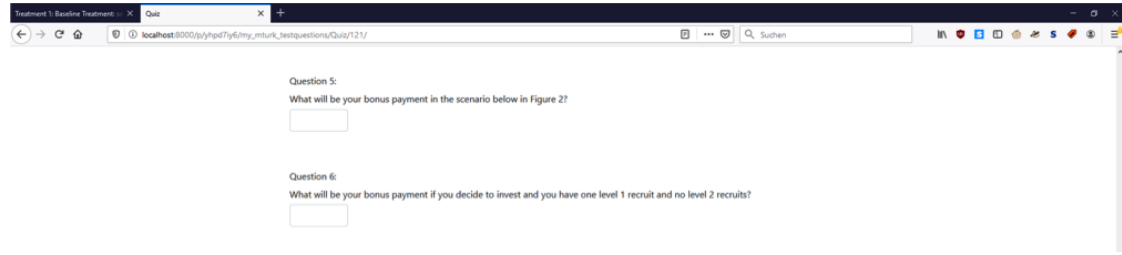
FIGURE A1. Screenshots: Instructions and quiz (continued)

Instead, each participant is given a code to check the results days after the experiment (Figure A7g), along with the diagram of the realized pyramid tree (Figure A7h).

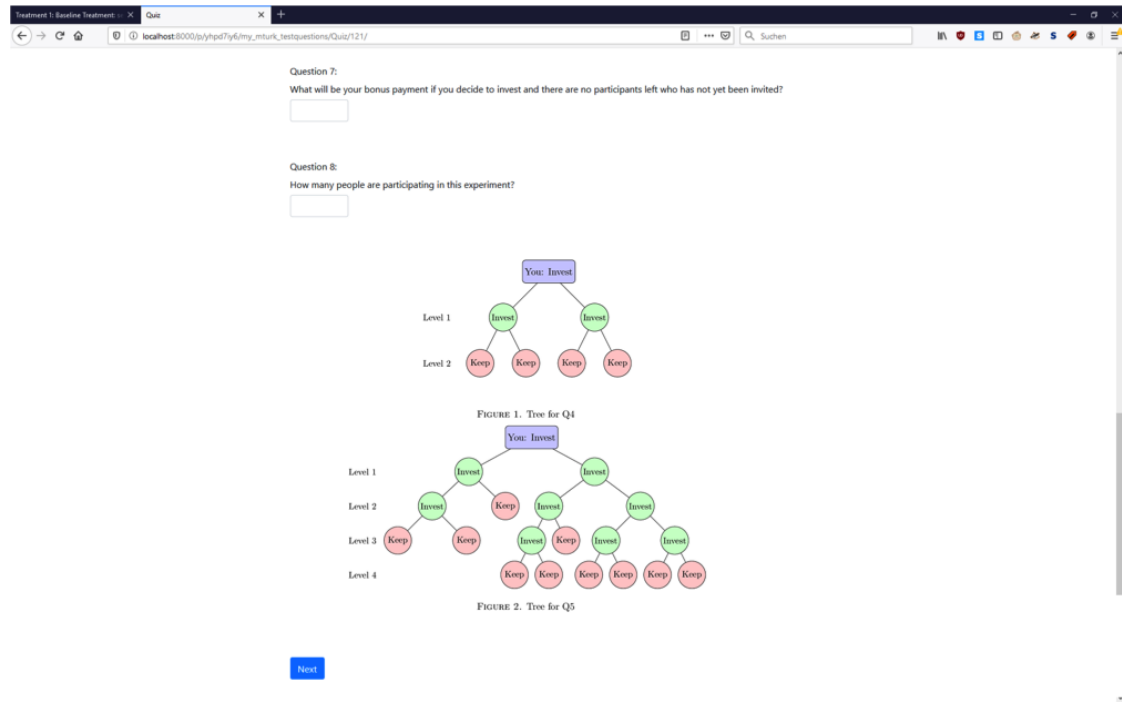
A.2. Old Baseline Treatment. The first difference comes at the consent page (Figure A8), where the fourth paragraph (in the New Baseline Treatment) is omitted, since the data from this treatment is not shown in any other experiment.

Main part 2 of the New Baseline Treatment is omitted. The guessed number is asked in the survey (Final Part) instead.

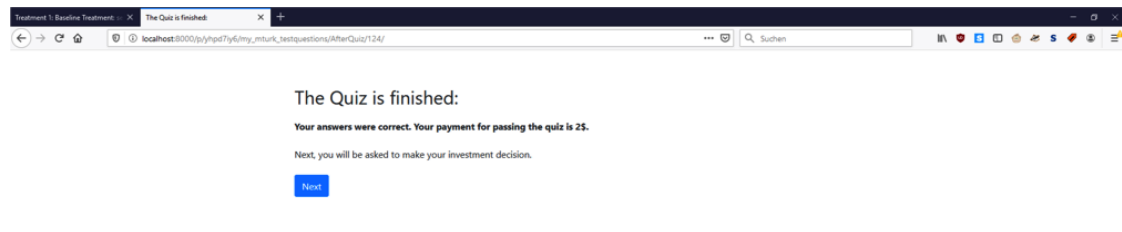
Main part 4 (lottery choices) is different from the New Baseline Treatment as only the probability equivalence method is used. The only screens in this part are shown in Figure A9.



(f) Quiz, part 2



(g) Quiz, part 3

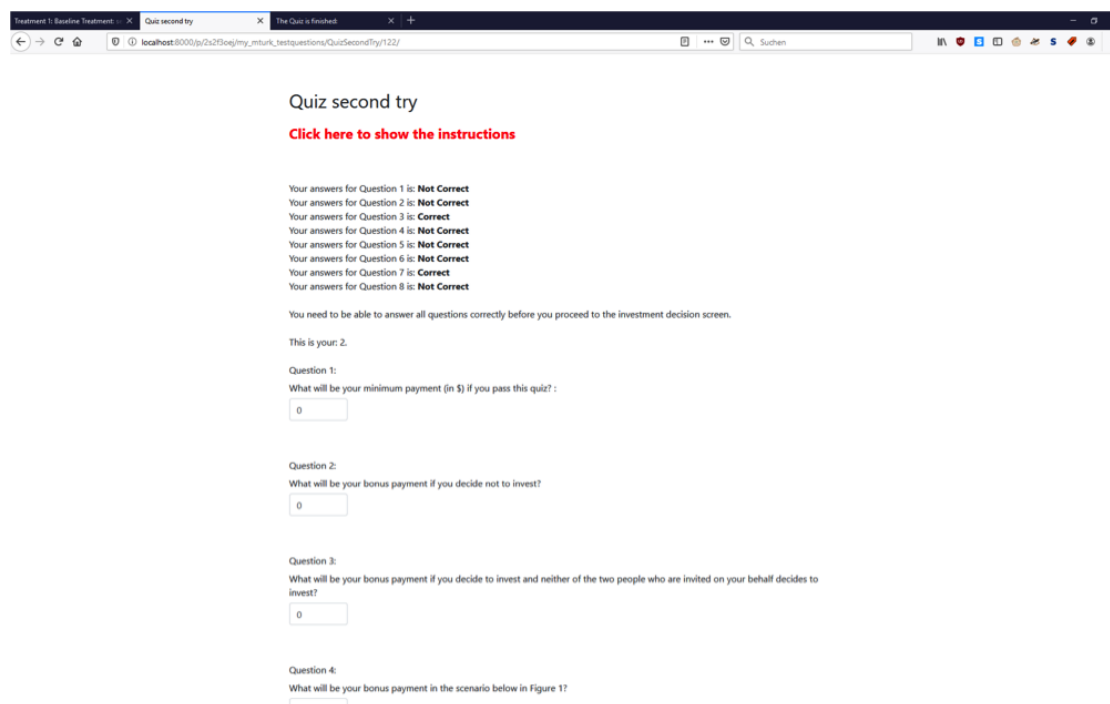


(h) Quiz: All correct

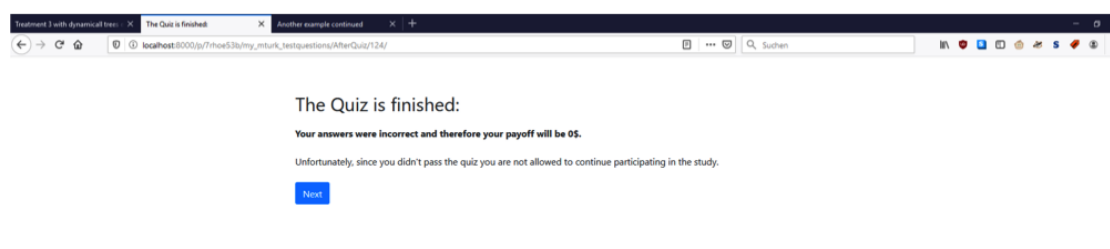
FIGURE A1. Screenshots: Instructions and quiz (continued)

The survey in the Final Part (Figure A10) includes the guessing question, which is taken to Main part 2 in the New Baseline Treatment. The screenshots here shows “2 participants”. In the actual experiment this was “200 participants”.

A.3. Payoff Distribution Treatment. The Payoff Distribution Treatment is based on the Old Baseline Treatment. Thus, it contains all the differences (from the New Baseline



(i) Quiz: Retry



(j) Quiz: Three failed attempts

FIGURE A1. Screenshots: Instructions and quiz (continued)

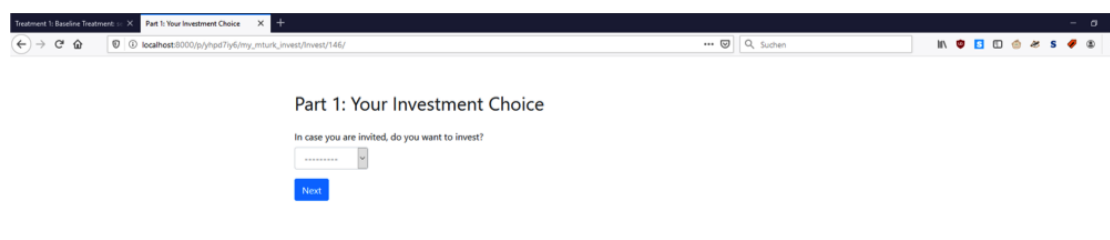
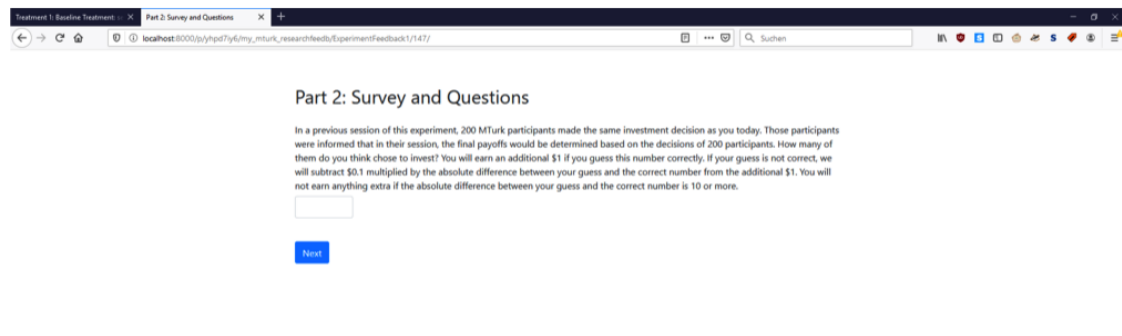
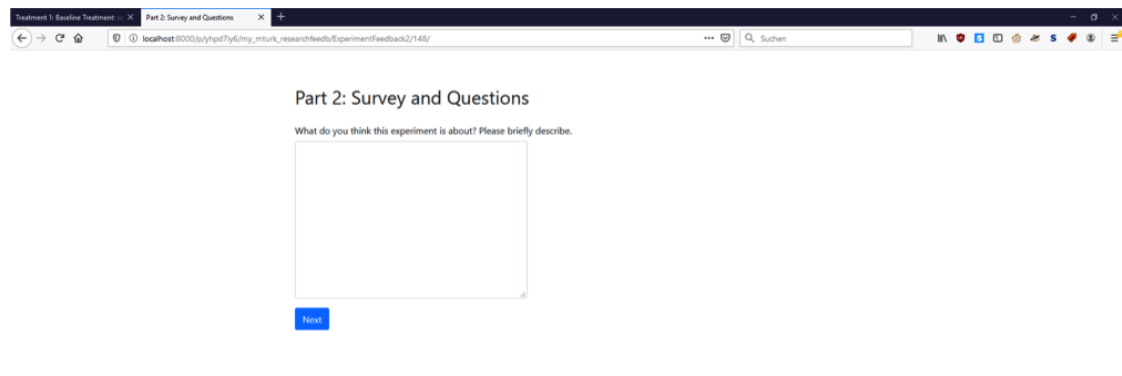


FIGURE A2. Screenshot: Investment decision

Treatment) in A.2. In addition, in the the introduction and quiz, subjects are given an opportunity to simulate some payoff distributions right before the quiz (Figure A1e). The screenshots for the simulation page can be found in Figure A11.

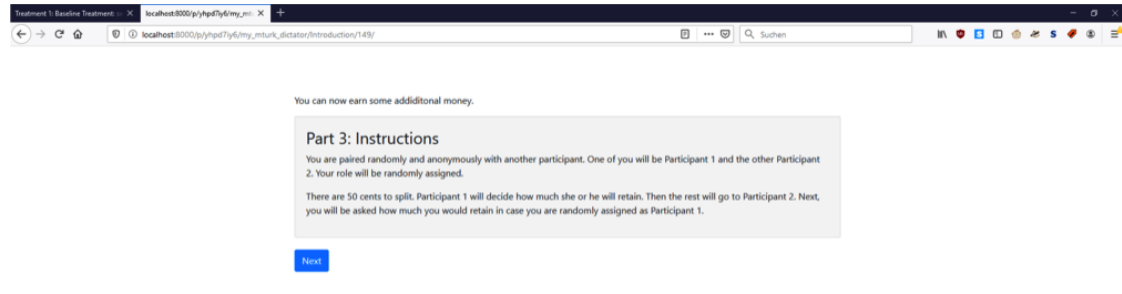


(a) Investing population guess

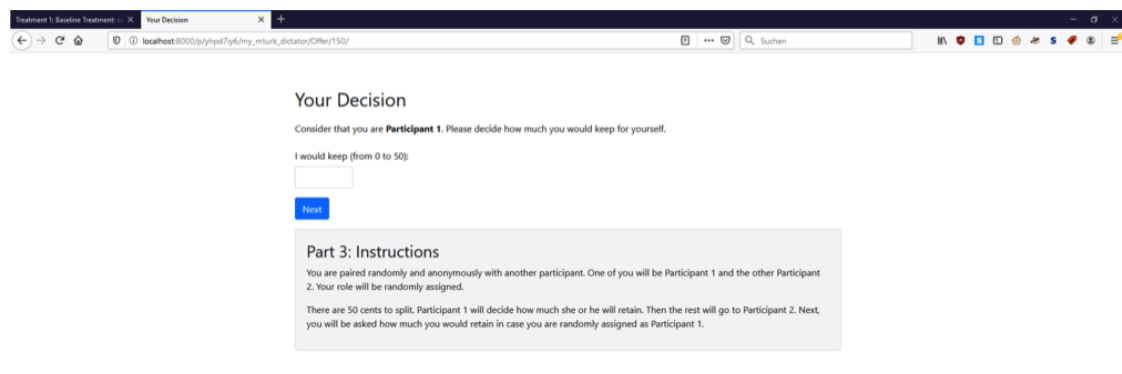


(b) Question about experiment

FIGURE A3. Screenshots: Guesses



(a) Dictator game: Instructions

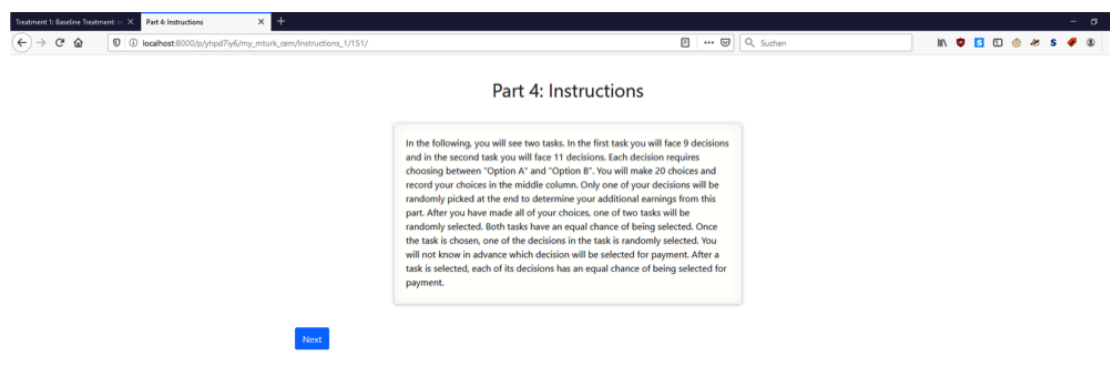


(b) Dictator game: Decision

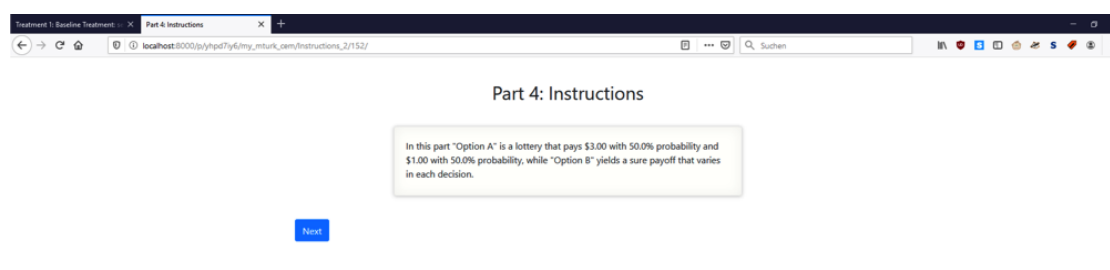
FIGURE A4. Screenshots: Dictator game

A.4. Examples Treatment. As in the Payoff Distribution Treatment, the Examples Treatment contains all the differences (from the New Baseline Treatment) in A.2.

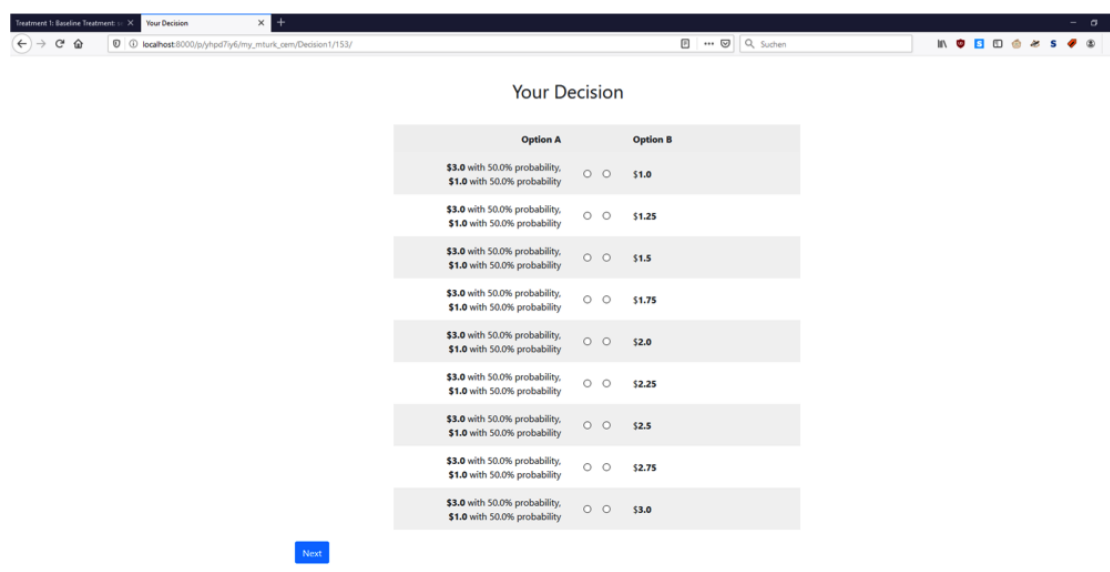
In addition, in the the introduction and quiz, subjects are given an opportunity to simulate some pyramid trees right before the quiz (Figure A1e). The screenshots for the simulation page can be found in Figure A12.



(a) Lottery choices: Overall instructions

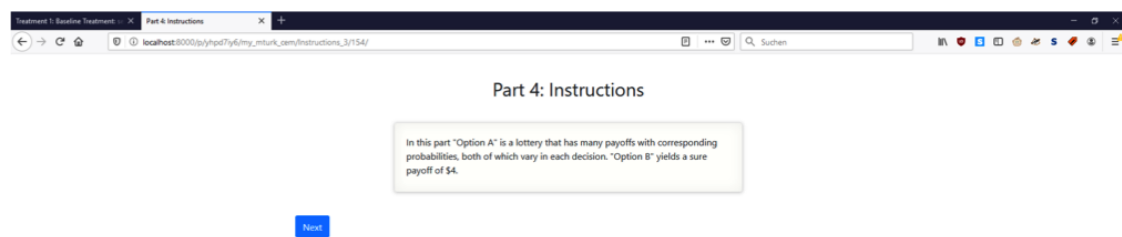


(b) Probability equivalence: Instructions

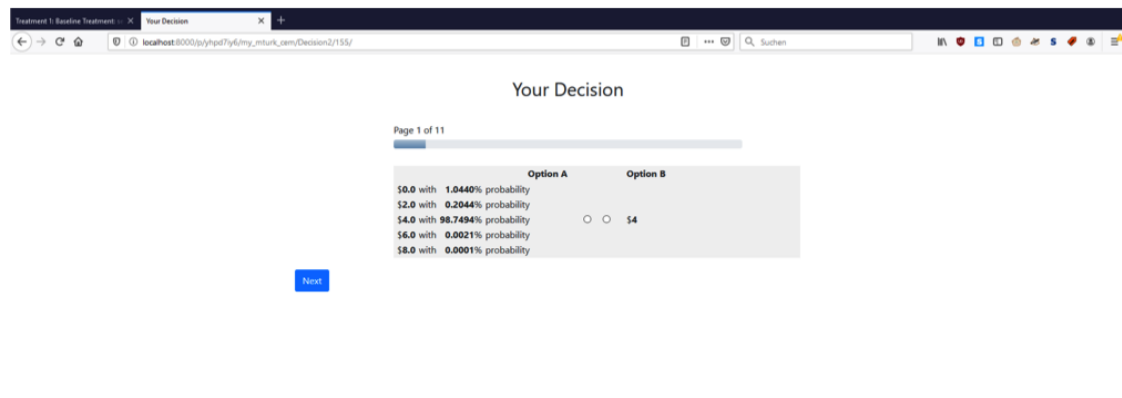


(c) Probability equivalence: Choices

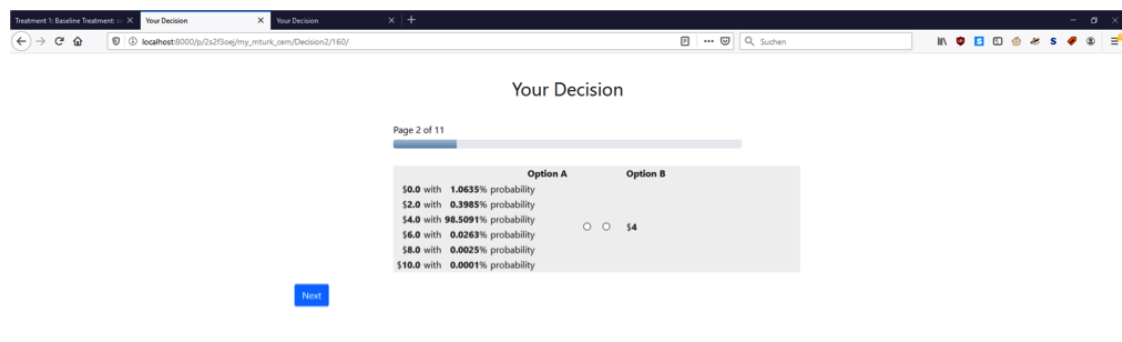
FIGURE A5. Screenshots: Lottery choices



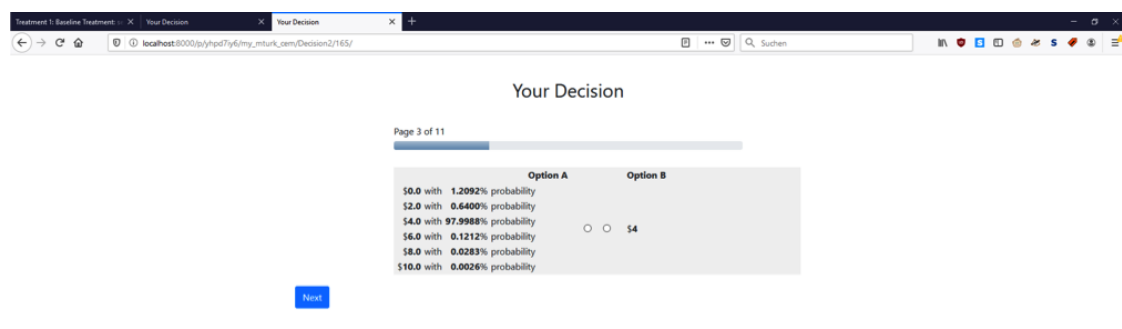
(d) Pyramid lotteries: Instructions



(e) Pyramid lottery: 20 investors

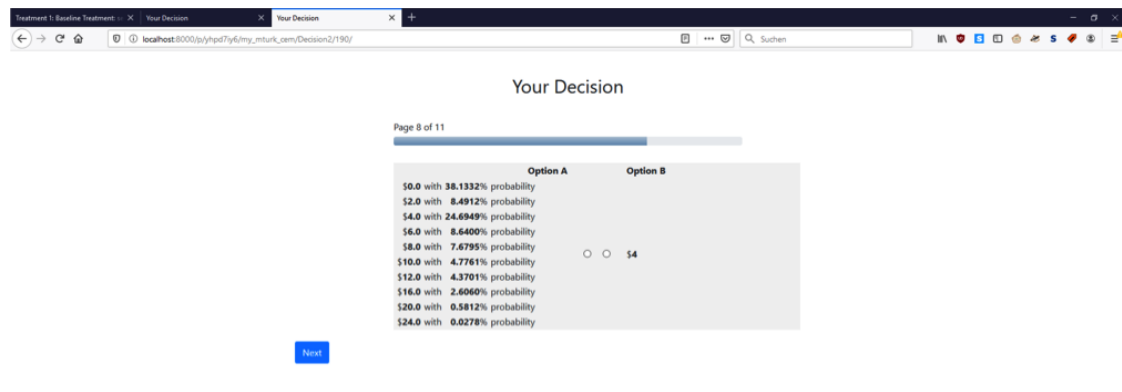


(f) Pyramid lottery: 40 investors

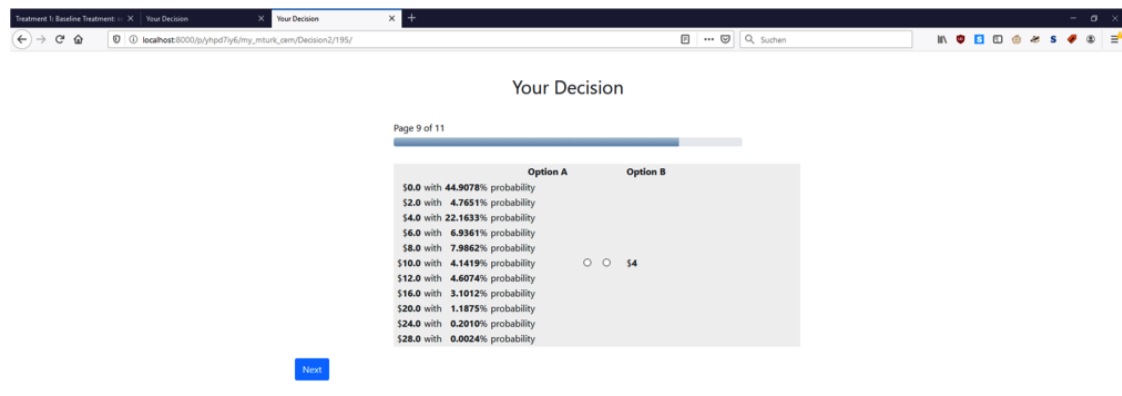


(g) Pyramid lottery: 60 investors

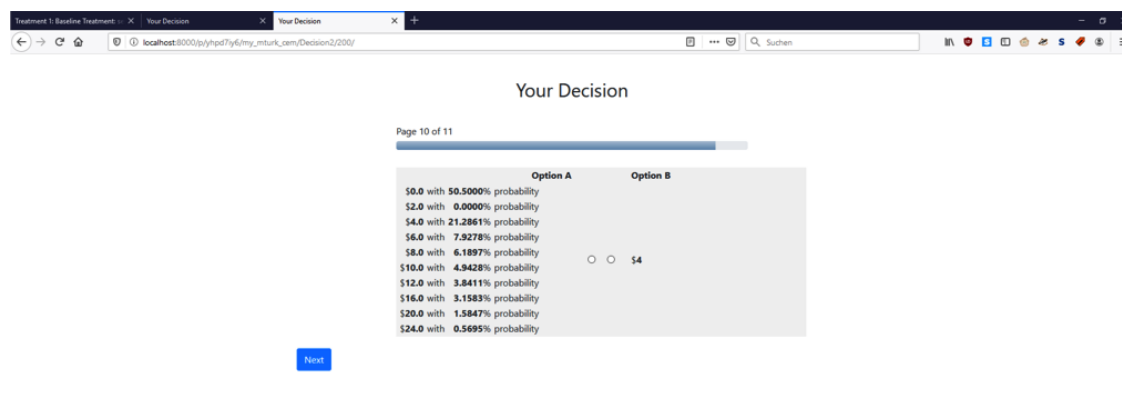
FIGURE A5. Screenshots: Lottery choices (continued)



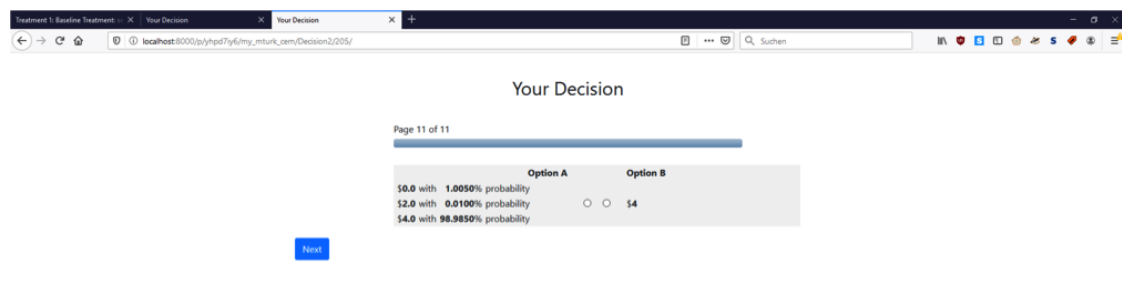
(l) Pyramid lottery: 160 investors



(m) Pyramid lottery: 180 investors

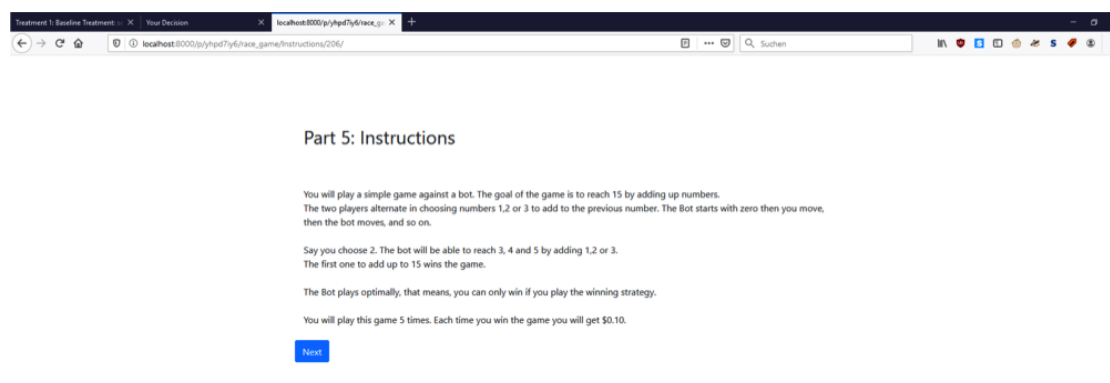


(n) Pyramid lottery: 200 investors

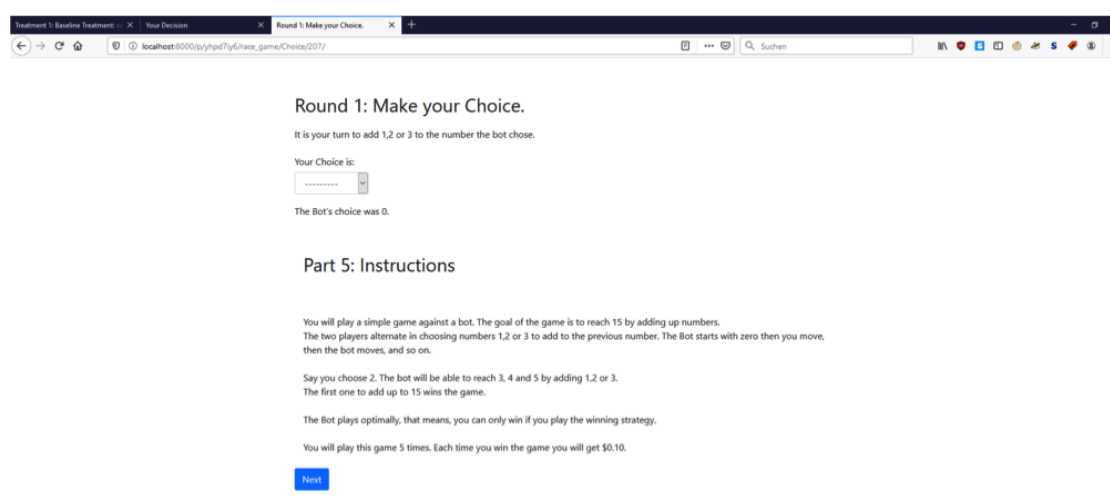


(o) Pyramid lottery: Guessed number

FIGURE A5. Screenshots: Lottery choices (continued)



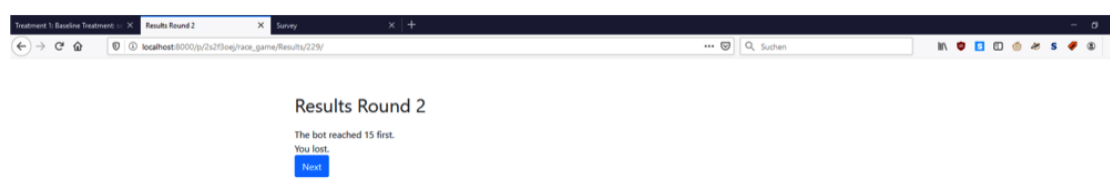
(a) Race game: Instructions



(b) Race game: Choices



(c) Race game: Winning



(d) Race game: Losing

FIGURE A6. Screenshots: Race game

Survey

Before the experiment is finished, we would like you to answer some questions about yourself.

What is your age?

What is your gender?
☐ Male
☐ Female

What is your annual income?

What is the highest degree that you achieved?
☐ Less than High School
☐ High School / GED
☐ Some College
☐ 2-year College Degree
☐ 4-year College Degree
☐ Masters Degree
☐ Professional Degree (JD, MD)
☐ Doctoral Degree

How many years of schooling have you had in total?

How often do you buy lottery tickets?
☐ More than once a week ☐ About once a week ☐ About once a month ☐ Once a year or less

When buying appliances how often do you purchase extended warranties?
☐ Always ☐ Most of the time ☐ Sometimes ☐ Never

Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?
☐ Most people can be trusted ☐ You can't be too careful

Do you think most people would try to take advantage of you if they got a chance, or would they try to be fair?
☐ Would try to take advantage of you ☐ Would try to be fair

How often do you lend personal possessions to friends?
☐ More than once a week ☐ About once a week ☐ About once a month ☐ Once a year or less

Do you currently hold any of these types of products?
Investment Account:
☐ Yes ☐ No

Mortgage:
☐ Yes ☐ No

Bank loan:
☐ Yes ☐ No

Savings account:
☐ Yes ☐ No

Stocks and shares:
☐ Yes ☐ No

For the two questions below, a correct answer will earn you an additional \$0.10 each.

Consider that you deposited \$10,000 in a bank account at 2% annual interest rate. How much money will you have in your account in 2 years if you do not withdraw from or add to this account any money?

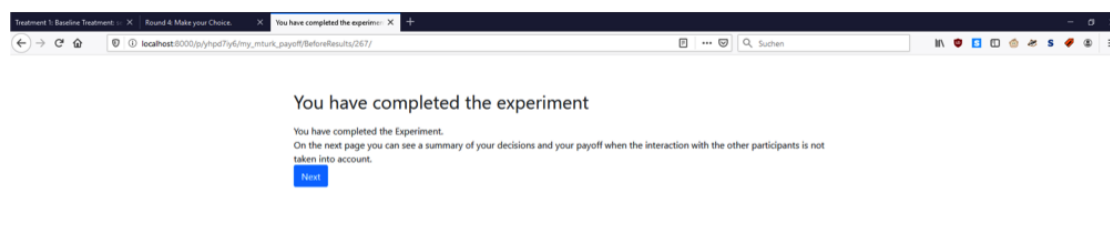
Let's assume that you saw a TV-set of the same model on sales in two different shops. The initial retail price of it was \$700. One shop offered a discount of \$150, and the other - 20% discount. Which one is a better bargain?
☐ \$150
☐ 20%

[Next](#)

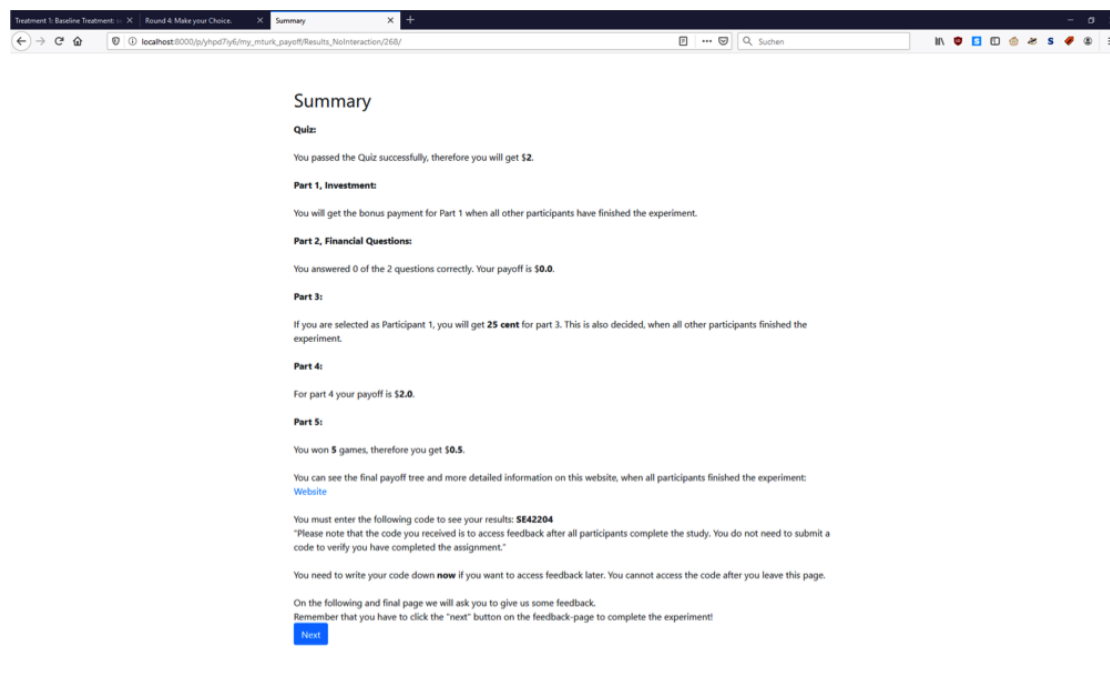
(b) Survey: Part 2

FIGURE A7. Screenshots: Survey and payoffs

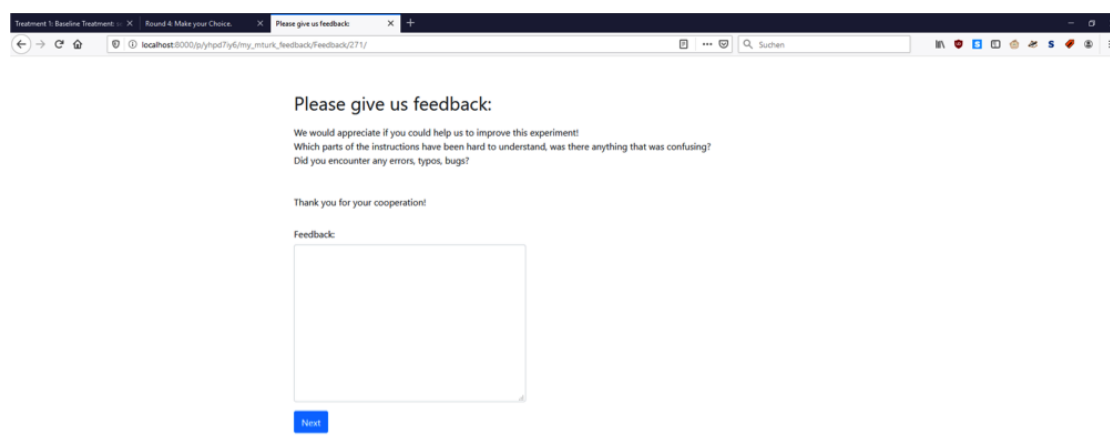
A.5. Backward Induction Treatment. The Backward Induction treatment follows the same structure as the New Baseline treatment (Section A.1), though the fourth paragraph of the consent page (in the New Baseline treatment) is omitted in the Backward Induction treatment (see Figure A13) since the data from this treatment is not shown in any other experiment.



(c) Experiment finished



(d) Initial payoff summary



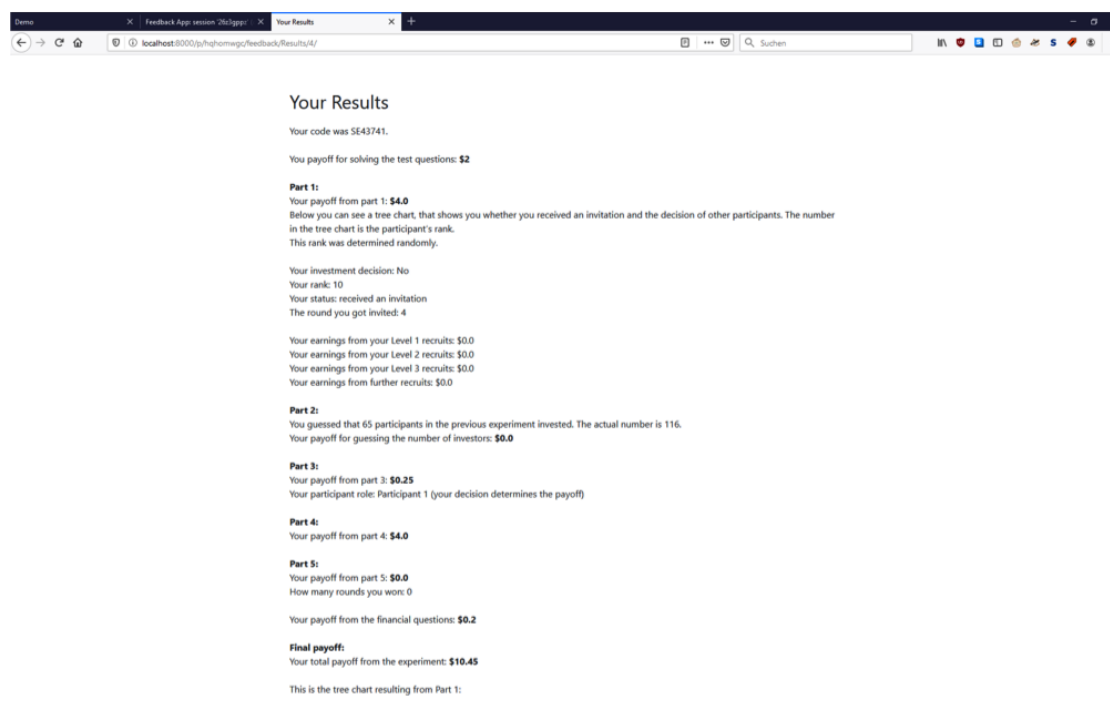
(e) Feedback page

FIGURE A7. Screenshots: Survey and payoffs (continued)

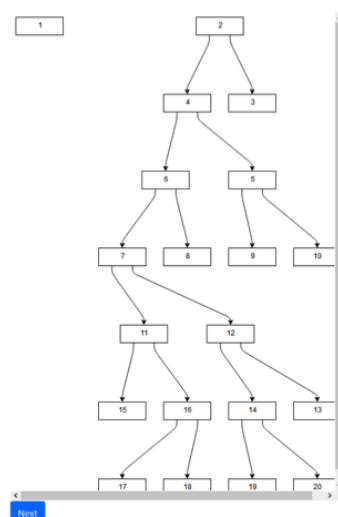
In the introduction and quiz part, but before main part 1, subjects are asked to calculate the payoffs at the leaves of a 200-investor pyramid tree (Figure A14a). This screen repeats until three of these questions are answered correctly or five wrong answers are



(f) Ending page



(g) Results days after: Payoff



(h) Results days after: Pyramid

FIGURE A7. Screenshots: Survey and payoffs (continued)

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Consent Form

This research aims to gain an understanding of human decision-making in an online setting. I understand that the entire experiment (including instructions) is expected to last less than forty minutes and that there is no conceivable physical or mental discomfort associated with participation.

I will be paid via MTurk at the end of the experiment. The amount of money that I will be paid depends in part upon the decisions I make. My participation is completely voluntary and I am free to leave the experiment at any time. If, prior to processing the data, I do not wish for my data to be included in the project, I may request to have my decisions withdrawn from the data set.

I understand that data from this experiment will be collected using randomly assigned identification numbers, so my choices will always remain anonymous. I also understand that confidentiality of data will be preserved subject to any legal requirements. I agree and understand that my results may be used and published, but my name will always remain anonymous.

If I have any questions about this research project, I can contact Dr. Kenan Kalayci at +61 7 334 67064, Office 510, School of Economics, Colin Clark Building at The University of Queensland. If I have any concerns about the treatment of research participants, I can contact the Human Ethics Unit at The University of Queensland, Australia (Phone: +61 7 336 53924).

→ If you are willing to participate in this study, please tick the button below and continue.

[Next](#)

FIGURE A8. Old Baseline Treatment Consent Page

Treatment: 1_HdJdJr_Uctior = 0.1 Your Decision

← → ↻ 🏠 https://localhost:8000/p/40w4g5lmy_mturk.com/Decisions/130/ 🔍 fuchien

Your Decision

Option A		Option B
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.00
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.25
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.50
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.75
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.00
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.25
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.50
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.75
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$3.00

[Next](#)

(a) Instructions

Treatment: 1_HdJdJr_Uctior = 0.1 Your Decision

← → ↻ 🏠 https://localhost:8000/p/40w4g5lmy_mturk.com/Decisions/130/ 🔍 fuchien

Your Decision

Option A		Option B
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.00
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.25
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.50
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$1.75
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.00
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.25
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.50
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$2.75
\$3.00 with 50.0% probability, \$1.00 with 50.0% probability	☐	\$3.00

[Next](#)

(b) Choices

FIGURE A9. Old Baseline: Probability Equivalence

Survey

Before the experiment is finished, we would like you to answer some questions about yourself.

What is your age?

What is your gender?

What is your annual income?

What is the highest degree that you achieved?

How many years of schooling have you had in total?

How often do you buy lottery tickets?

When buying appliances how often do you purchase extended warranties?

Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?

Do you think most people would try to take advantage of you if they got a chance, or would they try to be fair?

How often do you lend personal possessions to friends?

What do you think this experiment is about? Please briefly describe.

There were 2 people in this experiment. How many of them do you think chose to invest? You will earn an additional \$1 if you guess this number correctly. If your guess is not correct, we will subtract \$0.1 multiplied by the absolute difference between your guess and the correct number from the additional \$1. You will not earn anything extra if the absolute difference between your guess and the correct number is 10 or more.

Submit

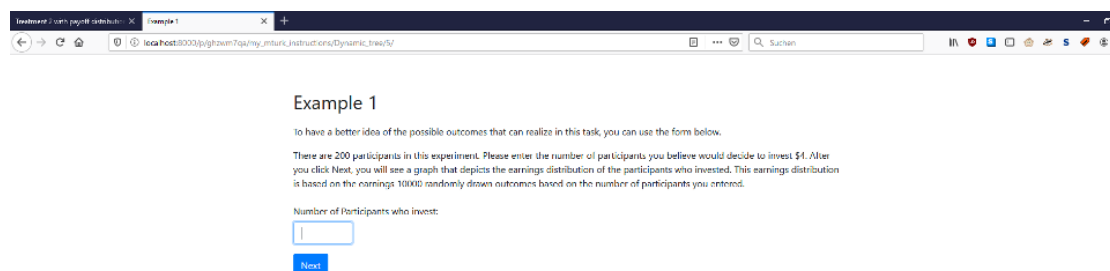
(a) Part 1

(b) Part 2

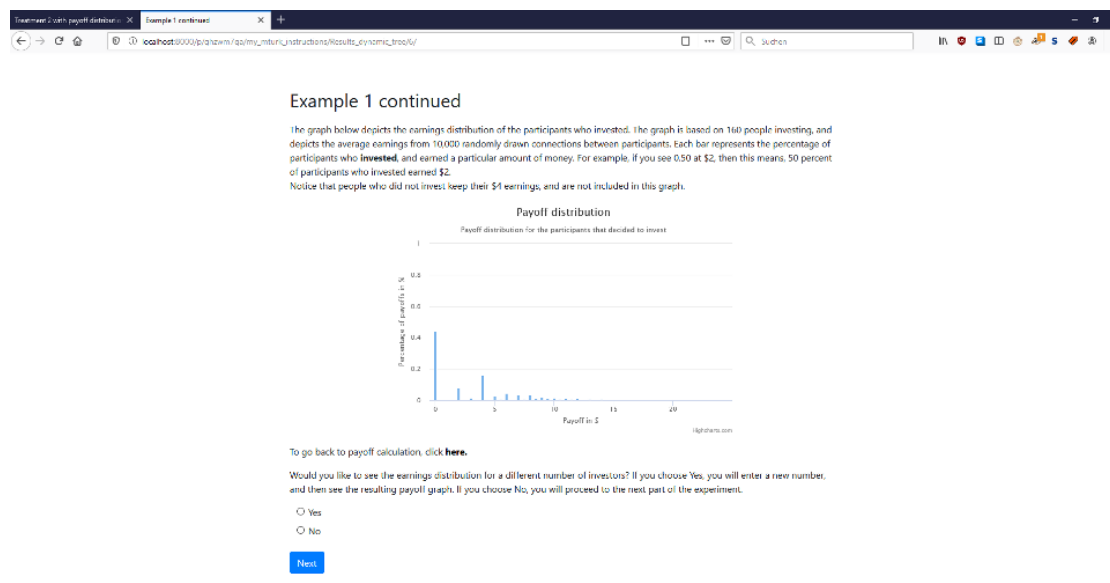
FIGURE A10. Old Baseline: Survey

given. Each new question refers to a differently colored node until all colored levels are done. Next the subjects see an explanation screen that provides the solutions and explanations to the solutions (Figure A14b).

In main part 2 of the experiment, subjects are asked to make a guess about the participants in the same session (rather than in a previous session as in the New Baseline Treatment). The screenshot provided here (Figure A15) says “2 participants”. In the screen that subjects actually sees, it says “200 participants”.



(a) Part 1



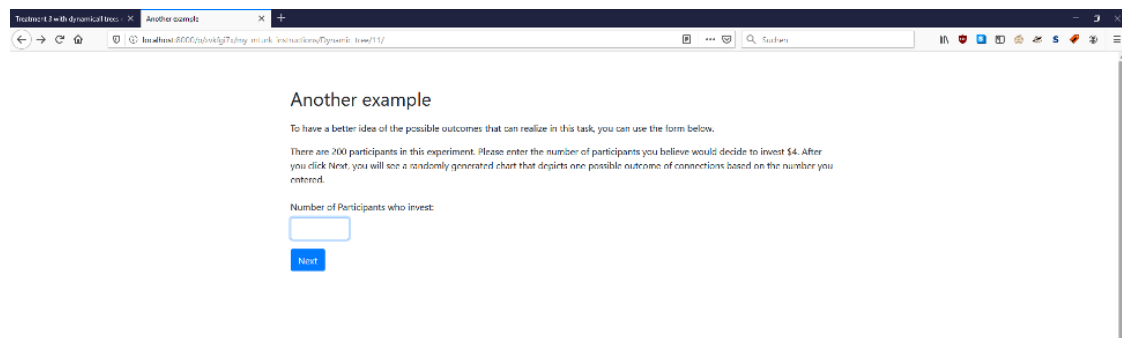
(b) Part 2

FIGURE A11. Payoff Distribution: Simulations

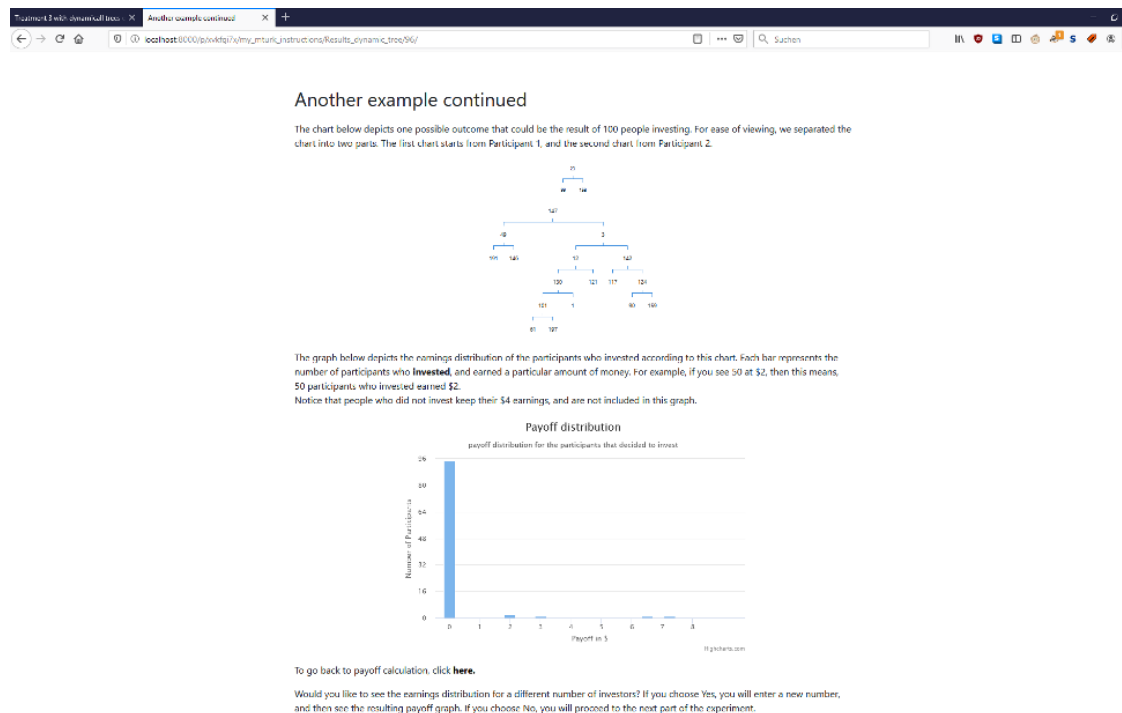
A.6. Small Pyramid Treatment. The Small Pyramid Treatment follows the same structure as the New Baseline Treatment (Section A.1), though the fourth paragraph of the consent page (in the New Baseline Treatment) is omitted in the Small Pyramid Treatment (see Figure A16) since the data from this treatment is not shown in any other experiment.

In the introduction and quiz part, but before main part 1, subjects are asked to make an investment decision at each of the eight positions in an eight-person pyramid tree (Figure A17).

The payoff screen (Figure A18) is slightly different from the Baseline to take the decision in the eight-person tree into account.



(a) Part 1



(b) Part 2

FIGURE A12. Examples: Simulations

Consent Form

This research aims to gain an understanding of human decision-making in an online setting. I understand that the entire experiment (including instructions) is expected to last less than forty minutes and that there is no conceivable physical or mental discomfort associated with participation.

I will be paid via MTurk at the end of the experiment. The amount of money that I will be paid depends in part upon the decisions I make. My participation is completely voluntary and I am free to leave the experiment at any time. If, prior to processing the data, I do not wish for my data to be included in the project, I may request to have my decisions withdrawn from the data set.

I understand that data from this experiment will be collected using randomly assigned identification numbers, so my choices will always remain anonymous. I also understand that confidentiality of data will be preserved subject to any legal requirements. I agree and understand that my results may be used and published, but my name will always remain anonymous.

If I have any questions about this research project, I can contact Dr. Kenan Kalayci at +61 7 334 67064, Office 510, School of Economics, CofG Clerk Building at The University of Queensland. If I have any concerns about the treatment of research participants, I can contact the Human Ethics Unit at The University of Queensland, Australia (Phone: +61 7 336 53924).

→ If you are willing to participate in this study, please tick the button below and continue. You have 60 minutes to complete the experiment.

Next

FIGURE A13. Backward Induction Treatment Consent Page

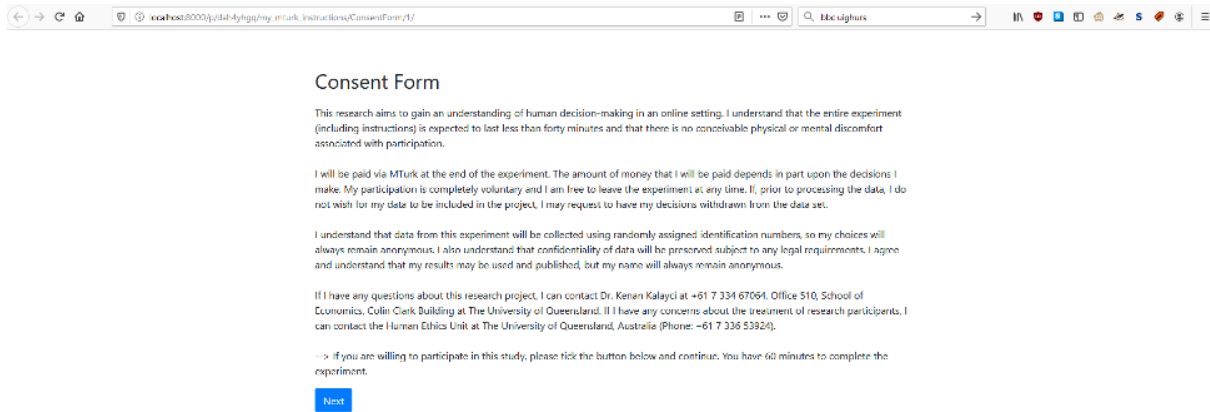


FIGURE A15. Backward Induction Treatment: Investing population guess

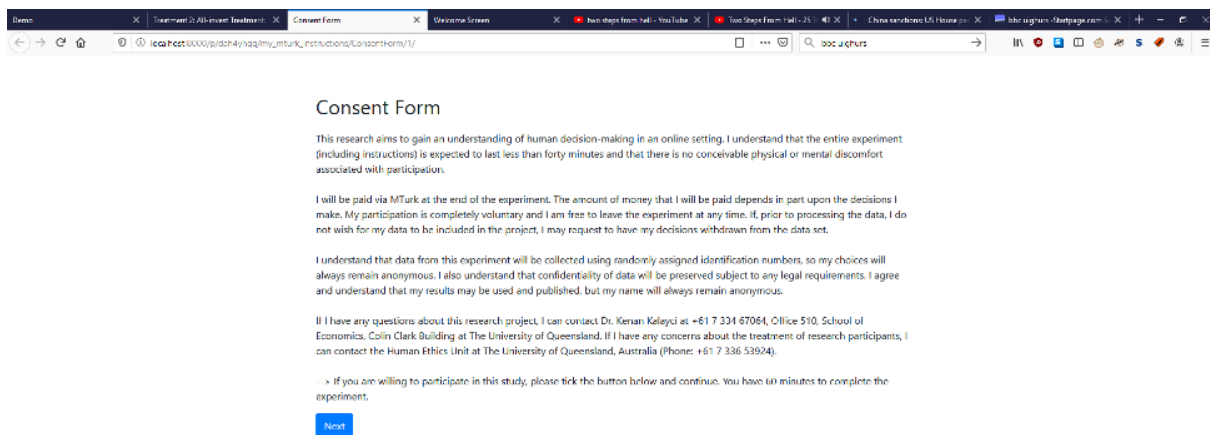
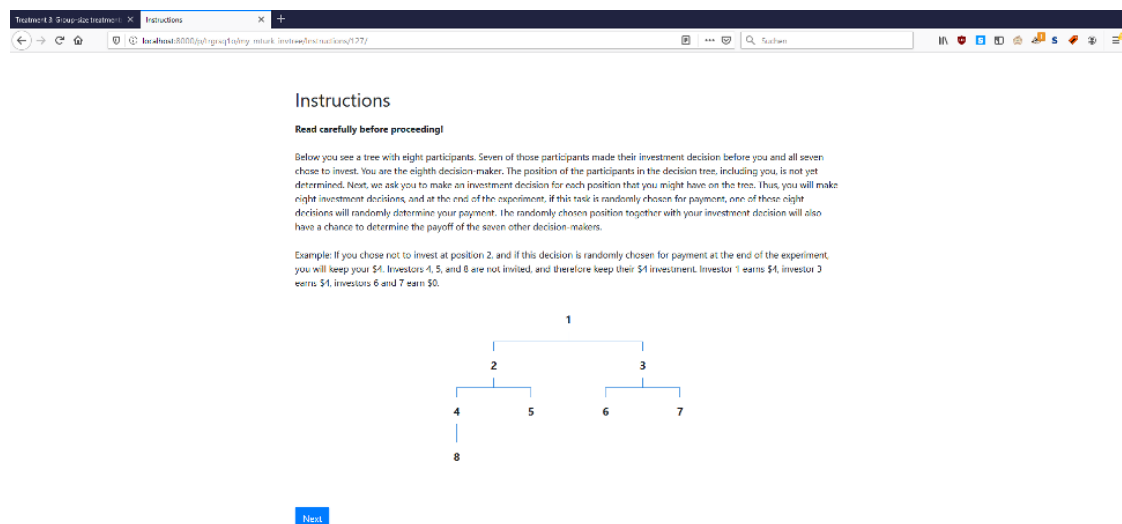


FIGURE A16. Small Pyramid Treatment Consent Page



(a) Instructions

FIGURE A17. Small Pyramid: Decisions on an eight-person tree

Investments

Now make your investment decision for each position. Keep in mind that for each position you make the decision for, all participants in the other positions invested.

Position 1 investment:

Position 2 investment:

Position 3 investment:

Position 4 investment:

Position 5 investment:

Position 6 investment:

Position 7 investment:

Position 8 investment:

Next

(b) Decisions, page 1

(c) Decisions, page 2

FIGURE A17. Small Pyramid: Decisions on an eight-person tree (continued)

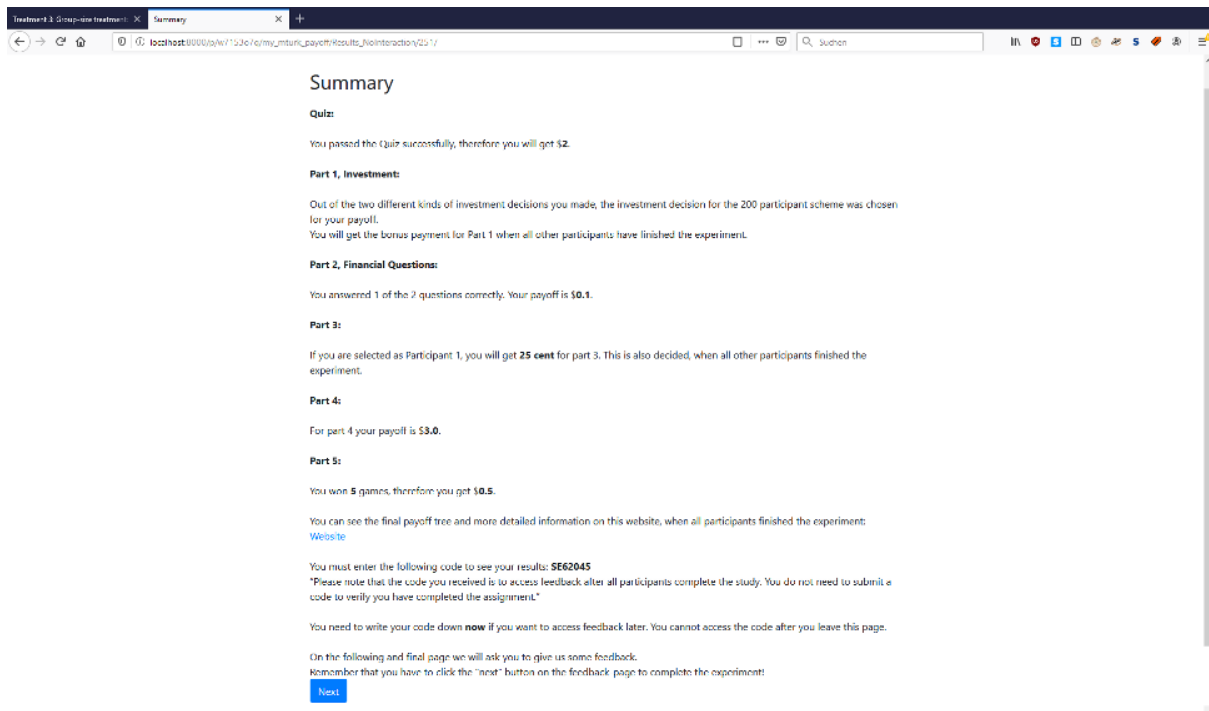


FIGURE A18. Small Pyramid Treatment Payoff Screen

Your Results

Your code was S69346.

You payoff for solving the test questions: **\$2**

Part 1:

Due to an error in the result page at the end of the study everyone but one person has been shown that the 200 participant scheme was chosen for payoff. But in your case the eight position tree was actually chosen. The bug only concerned the display page. The payoff was calculated correctly.

Your payoff from part 1: **\$4.0**

The eight position tree was chosen for your payoff.

Position chosen for payoff: 8

Investment decision for this position: Invested

The information below concerns your investment decision in the 200 participant scheme. The earnings per level below only influence your payoff if the 200 participant scheme was chosen for your payoff.

Below you can see a tree chart, that shows you whether you received an invitation and the decision of other participants. The number in the tree chart is the participant's rank. This rank was determined randomly.

Your investment decision: Yes

Your rank: 48

Your status: received an invitation

The round you got invited: 15

Your earnings from your Level 1 recruits: \$4.0

Your earnings from your Level 2 recruits: \$3.0

Your earnings from your Level 3 recruits: \$2.5

Your earnings from further recruits: \$4.0

Part 2:

You guessed that 125 participants would invest. The actual number is 125.

Your payoff for guessing the number of investors: **\$1.0**

Part 3:

Your payoff from part 3: **\$0.5**

Your participant role: Participant 1 (your decision determines the payoff)

Part 4:

Your payoff from part 4: **\$3.0**

(a) Page 1

Part 5:

Your payoff from part 5: **\$0.1**

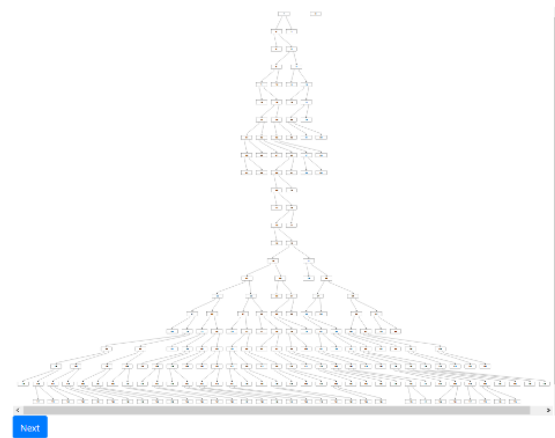
How many rounds you won: 1

Your payoff from the financial questions: **\$0.2**

Final payoff:

Your total payoff from the experiment: **\$10.80**

This is the tree chart resulting from Part 1. Zoom in to see the player ranks. You may need to activate scripts in your browser if you have an add-on that blocks them.



(b) Page 2

FIGURE A19. Small Pyramid Treatment Results Screens

APPENDIX B. SUPPLEMENTARY FIGURES AND TABLES

This appendix contains auxiliary figures and tables that are mentioned in the main text.

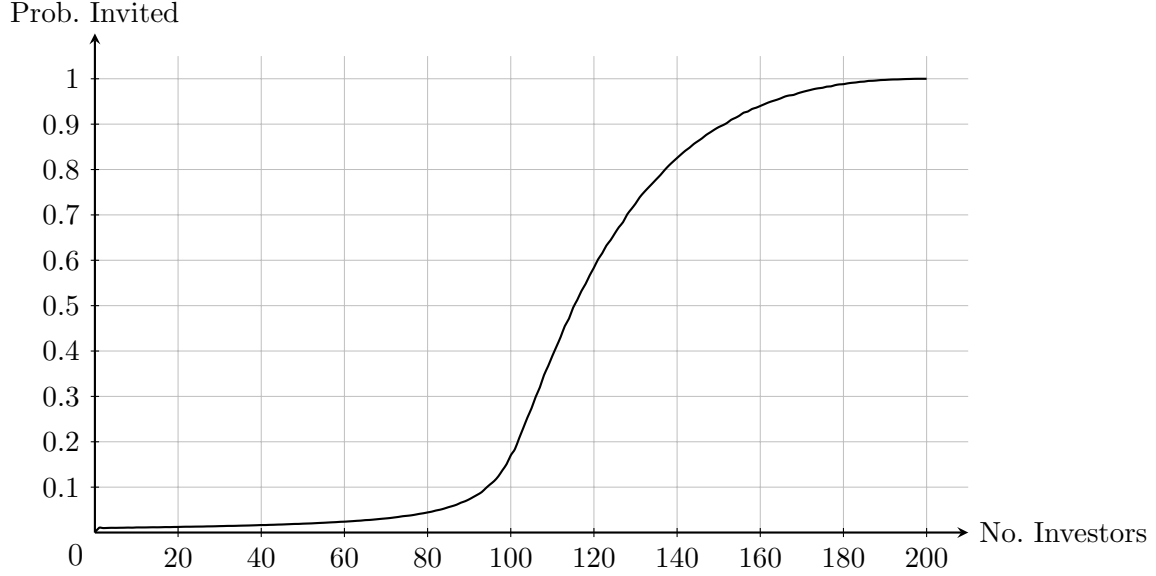


FIGURE B1. Probability of being invited into the scheme

TABLE B1. Investment in the Small Pyramid Treatment

Investor in G8 = 1	0.299*** (0.068)
Investor in G8 = 2	-0.506*** (0.114)
Constant	0.386** (0.198)
R ²	0.410
Controls	Yes
Observations	193

Notes: OLS estimates. The dependent variable takes value 1 if a participant chose to invest, and zero otherwise. Controls include all of the background characteristics collected, performance in the race game, dictator game giving, number of quiz attempts, and risk measures. Investor in G8=0 if in the eight-investor pyramid, participants chose to invest in money-earning positions and not invest in money-losing positions. Investor in G8=1 if participants chose to invest in money losing positions in the eight-investor pyramid, and Investor in G8=2 if participants never invested. Numbers in parentheses are standard errors. ***, ** and * indicates statistical significance at the 1%, 5% and 10% levels respectively.

TABLE B2. Investment in the Backward Induction Treatment

Calculations correct	−0.218*** (0.083)
Constant	0.390 (0.380)
R ²	0.204
Controls	Yes
Observations	191

Notes: OLS estimates. The dependent variable takes the value of 1 if a participant chose to invest, and zero otherwise. Controls include all of the background characteristics collected, performance in the race game, dictator game giving, number of quiz attempts, and risk measures. Calculations Correct is 1 if participants calculated the payoffs in the bottom three layers of the 200-investor tree within three attempts, and 0 otherwise. Numbers in parentheses are standard errors. ***, ** and * indicates statistical significance at the 1%, 5% and 10% levels respectively.

TABLE B3. Pyramid Lottery Choices by Treatment

	Baseline	Backward Induction	Small Pyramid	Total
Pyramid Lottery 20	0.100 (0.308)	0.160 (0.368)	0.170 (0.377)	0.162 (0.369)
Pyramid Lottery 40	0.0500 (0.224)	0.175 (0.381)	0.185 (0.389)	0.174 (0.379)
Pyramid Lottery 60	0.100 (0.308)	0.175 (0.381)	0.195 (0.397)	0.181 (0.385)
Pyramid Lottery 80	0.250 (0.444)	0.220 (0.415)	0.245 (0.431)	0.233 (0.423)
Pyramid Lottery 100	0.200 (0.410)	0.205 (0.405)	0.180 (0.385)	0.193 (0.395)
Pyramid Lottery 120	0.350 (0.489)	0.140 (0.348)	0.130 (0.337)	0.145 (0.353)
Pyramid Lottery 140	0.250 (0.444)	0.150 (0.358)	0.135 (0.343)	0.148 (0.355)
Pyramid Lottery 160	0.200 (0.410)	0.0850 (0.280)	0.140 (0.348)	0.117 (0.321)
Pyramid Lottery 180	0.100 (0.308)	0.0750 (0.264)	0.120 (0.326)	0.0976 (0.297)
Pyramid Lottery 200	0.150 (0.366)	0.0700 (0.256)	0.140 (0.348)	0.107 (0.310)
Pyramid Lottery Guess	0.200 (0.410)	0.244 (0.430)	0.217 (0.413)	0.229 (0.421)
Observations	20	200	200	420

Notes. Each row depicts the percentage of participants who chose one particular lottery across treatments. For example, Pyramid Lottery 20 is equivalent to the lottery participants would have faced when deciding whether to invest in the pyramid game with 20 investors out of 200 participants. Pyramid Lottery Guess is based on their guessed number of investors. Standard deviations in parentheses.

TABLE B4. Risk Preferences by Treatment

	Baseline	Distributions	Examples	Backward I.	Small Pyramid	Total
Always Safe	4.59	5.05	3.52	8.25	4.10	5.08
2	2.75	0.51	2.51	1.55	2.56	1.99
3	8.72	7.58	7.54	10.31	13.33	9.46
4	19.27	18.18	20.10	22.68	18.97	19.82
Risk Neutral	54.59	54.04	51.76	43.30	46.67	50.20
6	5.50	6.57	9.55	8.76	7.69	7.57
7	3.67	5.56	3.02	4.64	5.13	4.38
8	0.00	0.51	1.51	0.52	1.03	0.70
9	0.92	0.51	0.50	0.00	0.51	0.50
Always Risky	0.00	1.52	0.00	0.00	0.00	0.30
Observations	218	198	199	194	195	1004

Notes. Participants made nine lottery decisions in which they chose between Option A and B. Option A gave a 50% chance of winning \$1 or \$3 and Option B varied between a certain payment of \$1 and \$3 in increments of \$0.25. Each row depicts the percentage of participants who switched to the risky option after the corresponding row in their decisions. For example, Always Safe depicts the percentage of participants who always chose the safe option, and 2 depicts the percentage of participants who switched to the safe option after choosing the risky option in the first row. Those who switched multiple times are excluded from this table.