Explaining Preference Reversals:
Treatment, Selection and Cognition

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Abstract: We identify a group of subjects prone to commit reversals in both a canonical preference reversal experiment and in a novel static preference reversal experiment. The latter experiment mimics a simple labor market and explicitly controls for anchoring, the most common explanation for the asymmetric pattern of reversals in canonical experiments. Subjects prone to reversal in both settings display a particular cognitive trait: they are less proficient at mentally adding numbers. These subjects tend to prefer one item in the choice set used in the static preference reversal experiment but are indifferent between the lotteries that compose the choice set in the canonical preference reversal experiment. We conclude that self-selection effects do not contribute to the asymmetric pattern of reversals observed in canonical preference reversal experiments but must be considered when projecting the implications of preference reversals to other areas of economic behavior.

Explaining Preference Reversals: Treatment, Selection and Cognition[1]

By Timothy Haab and Brian Roe[2]

Preference reversals occur when an individual's ordering of a set of goods differs across modes of eliciting preference. The canonical preference reversal experiment requires subjects to directly choose between a high-odds, low-stakes lottery (the *P*-bet) and an actuarially equivalent lottery with low odds and high stakes (the $-bet) and to place a monetary value on each lottery. A reversal occurs when lottery valuations contradict direct choice. It is commonly found that subjects who choose the *P*-bet in a direct comparison are more likely to commit a preference reversal than those choosing the $-bet. Neoclassical choice theories do not predict this asymmetric pattern of reversals and the existence of such reversals may suggest that ". . no optimization principles of any sort lie behind even the simplest of human choice (David Grether and Charles Plott, 1979, pg. 623)."

In this paper we identify a group of subjects prone to committing preference reversals in both a canonical preference reversal experiment and in a novel static preference reversal experiment designed to mimic a simple labor market. Subjects prone to reversals in both settings exhibit a common cognitive trait: they are less proficient at mentally adding numbers than subjects who do not commit preference reversals. Furthermore, in the static preference reversal experiment, we find that subjects prone to reversals prefer a

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task that involves typing words to a task that requires adding numbers. This self-selection yields an asymmetric pattern of reversals despite the explicit control of anchoring stimuli, which are the most common explanation of the asymmetric pattern of reversals in canonical preference reversal experiments.

Psychological explanations of the preference reversal phenomenon focus on how subjects process information across elicitation modes. We establish an empirical linkage between subject cognitive traits and preference reversals in different settings that aligns with these psychological explanations. Subjects with a particular cognitive weakness have greater difficulty processing information in heterogeneous elicitation settings, and this weakness leads to logical inconsistency of preference orderings.

The linkage between cognitive traits and direct choice within the reversal experiments helps to isolate the potential causes of the asymmetric pattern of reversals. In the case of our static preference reversal experiment, self-selection drives the asymmetric pattern: those with common cognitive traits prefer similar items within the choice set. Even though these are experiments, a subject's direct choice among items within a choice set is not random. Analysis must allow for self-selection. In the case of the canonical preference reversal experiment, however, we find subjects' cognitive traits are unrelated to preference across the types of lotteries, which rules out self-selection as a possible contributory factor in the asymmetric pattern of reversals often observed in these experiments.

I. An Overview

Anchoring is a popular cognitive explanation for the asymmetric pattern of canonical preference reversals (Sarah Lichtenstein and Paul Slovic, 1971). In the case of canonical preference reversals, a lottery's winning dollar amount serves as an anchor for the subject's formation of a value. The subject adjusts this value downward to compensate for the probability of winning. Because the $-bet has a higher winning payout, and because some subjects make incomplete adjustments, it follows that the $-bety will elicit a higher value than will the lower payout *P*-bet. Those that prefer the *P*-bet in a direct comparison tend to reverse because the anchoring impedes value formation in concordance with direct choice. The opposite is true for those who prefer the $-bet in a direct choice.

Implicit in the empirical results supporting treatment effect explanations for preference reversals is subject heterogeneity; not all subjects respond identically to the treatment. In many experimental settings, randomization allows the experimenter to control for subject heterogeneity. In the case of the preference reversal experiment, however, a subject's direct choice over lottery types cannot be randomized. Given that the effective treatment (anchoring) is asymmetrically embedded in the valuation questions, it is impossible to separate treatment effects from self-selection into pre-treatment groups.[3]

To explore anchoring and self-selection as causes of preference reversals, we develop a novel static preference reversal experiment. Subjects first directly choose between performing one of two tasks, typing words and mentally adding numbers, and then provide a minimum payment they would demand to perform each task. During the value elicitation protocol, a randomly selected subset of subjects is exposed to explicit anchors designed to induce preference reversals. Unlike the canonical preference

[3] To our knowledge, only John A. List (2002) has considered selection in the context of well documented economic anomalies such as preference reversals. In List's case, he found little evidence to support selection as the explanation for a lower disparity between willingness to pay and willingness to accept among more experienced market participants.

reversal experiment, we take great care not to introduce other information that might serve as an alternative anchor. The static preference reversal experiment explicitly divorces the initial preference over tasks from the anchoring treatment, thereby allowing a unique opportunity to separately test self-selection and anchoring as causes of preference reversals. In addition, we perform a canonical preference reversal experiment on a subset of subjects to test for correlation in reversals across experimental protocols.

Analysis of the static reversal experiment data reveals that preference reversals are not independent of initial choice over the adding and typing tasks, and that anchoring effects are heterogeneous across subjects. Self-selection exists in the static reversal experiment, and those who prefer the typing task are more likely to reverse in the face of anchoring than are those who prefer adding. In the subset of subjects that participate in both the static and canonical preference reversal experiments, we find that the direct preference for typing and the tendency to reverse in the static preference reversal experiment are unrelated to the initial subject choice between the $-bet and the *P*-bet in the canonical reversal experiment. We therefore reject self-selection as an explanation for canonical preference reversals. However, the initial preference for typing does predict subject reversals in both the static and canonical preference reversal experiments. That is, those that self-select into the typing group tend to reverse in the canonical preference experiment, conditional on having chosen the P-bet. As such, we find that anchoring effects are heterogeneous across subjects. We further find that such effects are highly correlated with the initial choice between tasks in the static reversal experiment, but independent of the initial choice over lotteries in the canonical preference reversal experiment.

In the process of determining that anchoring effects are heterogeneous across subjects, we identify a powerful explanation for preference reversals that may prove more fundamental: heterogeneous cognitive abilities. Individuals with greater cognitive limitations in certain domains (specifically, those with lower proficiency in mentally adding numbers) are more prone to preference reversals, and the tendency for such individuals to select particular items during direct choice is choice set specific. That is, experimental subjects do not exhibit uniform responses when faced with behavioral treatments (such as anchors), but instead the effects of such treatments interact with individual characteristics to produce heterogeneous treatment effects.

II. The Static Reversal Experiment

Undergraduate and graduate students of several departments on campus were recruited to participate in a computer-based experiment. The experiment was carried out in two sessions that featured identical static reversal experiments; the second session also featured a canonical preference reversal experiment that was conducted upon completion of the static preference reversal experiment. Subjects were told they would have the opportunity to earn money in an experiment that guaranteed a minimum cash payout of $5 in session 1 and $8 in session 2[4]. The expected time commitment for session 1 was advertised as about 45 minutes, and for session 2 about one hour.

The static preference reversal experiment is fully computerized and automated. After starting, subjects have no communication with anyone other than for questions of clarification (a very rare occurrence). Fifty-eight subjects participated in session 1 and ninety-six subjects participated in session 2.

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[4] Subsequent analyses determined that the final results are independent of the guaranteed payout.

The introductory instructions tell subjects to think about and reveal their direct preference between two tasks: typing and adding. The exact tasks are typing a list of 475 words into the computer and mentally adding together 175 pairs of two-digit numbers and typing the sum into the computer. To familiarize subjects with the tasks and to allow them to form realistic expectations, each task is demonstrated, in random order, on a small scale. Subjects type a list of 30 words, and add together 10 pairs of numbers. We record the time to complete each of the demonstrations, and give subjects an estimate of the time necessary to complete the full tasks. Direct preference for tasks is elicited by asking subjects "If we were to pay you to either add 175 pairs of numbers, or type 475 words, which task would we have to pay you more to perform?"[5] The task that requires the lower payment represents the subject's *pre-treatment preference*.

Following the pre-treatment preference elicitation, a series of questions establishes the payment demanded for each task. The procedure for establishing the minimum payment demanded utilizes a Becker-DeGroot-Marshak (BDM) mechanism. No specifics are given to the subject regarding the distribution from which the random numbers are drawn as such information would dilute the effect of any subsequent anchoring treatments.[6] A series of follow-up screens repeats the procedure, and a quiz ensures subjects understand the procedure. Subjects are told that they have no incentive to reveal an amount other than their true lowest willingness to accept, and the reasons are explained.

[5] The number of words to be typed (475) and numbers to be added (150) were chosen based on pre-tests such that both tasks would take about 15 minutes to complete.
[6] Also, Peter Bohm et al. (1997) show that failing to quantify the bounds of the distribution helps alleviate some of the critiques lodged against the BDM procedure and yields bids equivalent to those elicited during a second price auction mechanism.

For the value elicitation questions, subjects are randomly assigned to one of two anchor-treatment groups: 30% (46 out of 154) receive a no anchor control treatment and 70% (108 out of 154) receive an anchoring treatment. The no anchor treatment asksthe following question: "What is the smallest amount we will have to pay you to add 175 pairs of numbers?" A similar question is asked for the 475 word typing task (and the order of the two questions is randomized across subjects).

Subjects in the anchored treatment group receive an anchoring question prior to the open-ended elicitation for each task. For the adding task, the anchor question is: "Would you be willing to add 175 pairs of numbers for A$?" For the typing task, the anchor question is: "Would you be willing to type 475 words for $T?" The anchor amounts ($A and $T) vary depending on the pre-treatment preference. Each subject in the anchor treatment receives an anchor opposite of pre-treatment preference. For example, if the subject indicates a pre-treatment preference for typing, then the anchor treatment consists of a $12 anchor for typing and $2 anchor for adding.[7] After the anchoring treatment, subjects are asked to provide an open-ended elicitation identical to the no-anchor treatment question.

Following the value elicitation, the computer randomly determines the task to be offered and the price to be paid for the task. The price is randomly chosen from a uniform distribution over the range $2 to $12, though subjects are never made aware of this distribution. Depending on the payment demanded for each task, the subject either performs the full task for the announced price or does not perform the task and receives

[7] Unlike in Dan Ariely et al. (2003), who used digits from subjects' social security numbers to construct the anchors used in their experiment, no effort is made to make our anchors appear informative or uninformative. Indeed, in real market settings, such as bargaining or consumer marketing, sellers will often try to find informative anchors to improve their situation.

no payment for the task. Following the successful completion of the task, the total payment due subjects is calculated and subjects in session 1 are dismissed to the hallway for a simple game of chance to win an additional $20 (1/16 chance of success). Subjects in session 2 are dismissed to another room to participate in a canonical preference reversal experiment.

We designed the static reversal experiment with several goals in mind. First, to explore selection effects, we sought to divorce treatment from direct preference. We settled on anchoring as the desired treatment because many studies have confirmed anchoring and adjustment as at least a partial explanation for reversal asymmetry (e.g., Schkade and Johnson, Jacinto Braga and Chris Starmer) and because of recent interest in anchoring as a more fundamental challenge to neoclassical preference theory (Ariely et al., 2003). We chose to avoid lotteries as the focal items because of the anchors implicit within the winning dollar values. In addition, we avoid lotteries and other items used in previous work on preference reversals such as interpersonal wealth distributions (Sally Blount and Max H. Bazerman 1996) and time-differentiated payments (e.g., Amos Tversky and Richard Thaler, 1990) because each adds unnecessary complications.

Tasks were desirable focal items for several reasons. First, previous experiments have found that value elicitation experiments are more effective if they elicit subject willingness to accept to give up goods rather than the willingness to pay for non-endowed goods (Daniel Kahneman et al., 1991). We elicit values for a good with which all subjects are naturally endowed and intimately familiar: their time. No complicating issues of risk, explicit interpersonal considerations, or time delayed payments are involved. Furthermore, the experiment serves as a simple labor market in which the experimenter acts as an employer. The two tasks, typing and adding, were chosen not because of their differing cognitive requirements, which turned out to be a serendipitous bonus, but because subjects could perform each task on the same computer interface.

Of the 154 participants in the static reversal experiment, 43 displayed a reversal. Of the 108 subjects in the anchored treatment group, 37 (34 percent) reversed. For the no anchor treatment, 6 out of 46 (13 percent) reversed. The increase in static preference reversals is statistically significant. As designed, anchoring appears to be a mechanism that induces preference reversals.

Table 1 summarizes Probit results on static preference reversals where the dependent variable is a binary indicator for with-in subject preference reversals. Independent variables are indicator variables for directly elicited task preference, anchoring treatment by preference and a session control. The omitted category represents subjects who prefer typing and receive no anchor.

For those with a pre-treatment preference for typing, counter-balancing anchors induce a statistically significant increase in the probability of preference reversal relative to the no anchor treatment. For subjects with a pre-treatment preference for the adding task, the anchoring treatment produces no significant change in the probability of reversal relative to the no anchor treatment. Similar to the canonical preference reversal literature, an asymmetry exists; those with a direct preference for typing reverse more often than those who prefer adding.

Balancing treatment across groups with different direct preferences does not remove the asymmetry, which is congruent with a self-selection explanation. The anchoring treatment in combination with the initial selection of typing is driving the reversals. While the anchoring treatment does result in a slight increase in preference reversals among adders, the increase is smaller in magnitude than the increase for typers and is not statistically significant. Further, there is no significant difference in reversal behavior between pre-treatment preference groups for the no anchor treatment. It appears that subjects with a tendency to reverse in response to anchoring, self-select into the typing group.

One possible explanation for this self-selection is the differing cognitive abilities required for the adding and typing tasks. Individuals with a cognitive predilection toward mathematical reasoning are less likely to choose typing, and are less likely to reverse in the presence of counter-balancing anchors. This suggests that an index of bounded rationality may exist and can be quantified for each subject: i.e. rationality in the context of the preference reversal anomaly is heterogeneous and, to a degree, measurable. To investigate whether this propensity to reverse carries over to reversals in other settings, we conducted a canonical preference reversal experiment after the static reversal experiment in session 2.

III. Preference over Lotteries Experiment

Upon completion of the computer-based static preference reversal experiment, the 96 subjects in session 2 were dismissed to a separate room to participate in a preference reversal over lotteries experiment. Upon entering the room, subjects sat at a table across from an interviewer. The interviewer gave the subject a script for the experiment, and asked the subject to follow along as the experimenter read the script. Subjects were told that they would have the chance to earn some additional money by making some decisions over games of chance. They were assured that the money earned in the static reversal experiment was theirs to keep[8].

The preference over lotteries experiment is summarized as follows: Two games of chance are described to the subject in random order. Game A features 27 chances in 36 of winning $2 and 9 chances in 36 of winning $0 (the *P*-bet). Game B features 3 chances in 36 of winning $18 and 33 chances in 36 of winning $0 (the $-bet).[9] Subjects are also shown a pie graph of the chances of winning each game, and the relative payouts.

After considering the two games, the subject is asked for a direct preference between the games and is offered choices of Game A, Game B, or 'I have no preference.' The choice over gambles represents the pre-treatment preference. Of the 96 subjects, 45 (47%) have a pre-treatment preference for the *P*-bet, 45 (47%) have a preference for the $-bet, and 6 (6%) have no preference.

Following the pre-treatment preference elicitation, we implement a BDM value elicitation procedure identical to the procedure used in the static reversal experiment.

Subjects are then asked to reveal their value for each of the two games, independently. For example, the subject is asked: "Consider game A. We would like to know the smallest payment that you would accept to give up the chance to play game A. Game A features: 27 chances in 36 of earning $2 and 9 chances in 36 of earning $0. If you owned this game, what is the smallest amount of money we would have to pay you to give up the opportunity to play this game?" Subjects are asked to record their payment in the space provided. The same procedure is followed for the remaining game, the BDM is implemented, and subjects are paid accordingly.

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[8] Interviewer effects were tested for an rejected. The results of this section are independent of the interviewer.

[9] The labels A and B are switched depending on the order of the games in the experiment script.

The standard (nonstandard) preference reversal is defined as a subject that indicates a clear direct preference for the *P*-bet ($-bet), and then reveals a strictly higher payment demanded to give up the $-bet (*P*-bet). Of the 96 subjects participating, 26 (27%) exhibit a preference reversal. Within the group that prefers the $-bet, 3 out of 45 reverse preferences (7%), while for the *P*-bet, 23 out of 45 reverse (51%). The difference is significant at any reasonable significance level (χ^2=19.87). The standard preference reversal asymmetry exists in our experiment.

Of particular interest to the current work is the correlation between preference reversals in a static setting and preference reversals in a lottery setting. Tables 2a and 2b report the contingency tables for preference reversals in session 2. As is readily apparent from table 2a, there is no correlation between self-selection into the typing task and the P-bet (the two groups with a tendency for reversal). Within each of the task preference groups, exactly 50% prefer the *P*-bet and 50% prefer the $-bet. However, if we further break the table down by lottery reversals (table 2b), a different pattern emerges.

Subjects that directly prefer both typing and the *P*-bet, are significantly more likely to reverse in the lottery experiment than those that prefer adding and the *P*-bet (59% reversals for typers versus 31% reversals for adders). Those that prefer typing and the $-bet are slightly more likely to reverse than adders that prefer the $-bet (9% versus 0%) but the difference is not statistically significant.

Lending more credence to a heterogeneous cognition hypothesis (i.e. subjects differ in their cognitive abilities to process complex information) these results show that subjects with a predisposition for reversing when exposed to an anchoring treatment in the static setting (typers) are more likely to reverse in the lottery experiment when exposed to a similar anchor (the *P*-bet). It appears that a pre-treatment preference for typing is acting as an instrument for an individual specific index of heterogeneous rationality. But, the initial preference for typing does not act as a self-selection mechanism in the initial preference for lotteries.

Table 3 reports the results of a Probit estimated on lottery reversals accounting for initial preference of lottery, initial preference for typing, and other demographics.[10] In addition to the standard reversal effect of the anchoring treatment, we find a significant increase in reversals for those with an initial preference for typing in the static experiment. Also females and older subjects are associated with higher probabilities of preference reversal.

To understand why initial preference for typing might be acting as an instrument for an index of heterogeneous rationality, we run a Probit of the direct preference for typing on the same set of demographic variables in table 3, and an additional independent variable: The relative performance time on the adding and typing demonstration tasks in the static reversal experiment (recall these demonstrations are performed prior to any preference elicitation). It is expected that subjects with cognitive predilection for math will be more likely to perform well on the adding task and less likely to reverse preferences in the face of an anchoring treatment. As such, we should see subjects with better relative performance on the adding demonstration to be less likely to indicate a direct preference for typing. Table 4 bears this out. Subjects with a higher ratio of adding time to typing time (presumed to have lower mathematical cognitive abilities[11])

[10] Demographics are only available for participants in session 2. No demographics were available for one session 2 subject, resulting in a sample size of 95.

[11] Using adding time relative to typing time allows a measure that controls for a subject's keyboard skills, i.e., a proficient adder who is slow at using a keyboard is still identified.

are more likely to choose typing. Following the natural sequence, these subjects are also more likely to reverse preferences in the presence of anchors in the static reversal experiment, and also more likely to reverse preferences in the presence of the anchoring treatment embedded in the P-bet from the lottery experiment.

IV. Discussion and Conclusion

From our analysis we forward several conclusions.

1. Our results support the long held notion that anchoring helps explain the asymmetric pattern of preference reversals.

2. We identify that asymmetric reversals occur in an entirely different, and arguably, simpler setting where the asymmetric anchor explanation is explicitly controlled.

3. We explicitly recognize and develop an empirical index for heterogeneous subject rationality along one avenue of cognitive ability. This index, measured as a subject's relative ability to perform addition, supports the explanation that asymmetric reversals in the static experiment arise from self selection while those in the canonical experiment are driven by subject heterogeneity in conjunction with the implicit, asymmetric anchors embedded in the valuation questions.

Further experimental work to investigate the robustness of our results is warranted. For example, unlike the preference reversal over gambles literature (e.g., James C. Cox and David M. Grether, 1996), our experimental work has not introduced repetition to see if increases in familiarity with the choice and bidding procedures limits either the extent or asymmetry of reversals. We leave this and other design augmentations to future work and would not be surprised if the asymmetry we uncover in static preference reversals follows the course of the asymmetries uncovered in preference reversals in gambles: they remain robust in many settings but, with enough market feedback and experience, they shrink to the boundary of significance. Further work is also warranted to refine our understanding of the individual cognitive characteristics that identify those prone to reversal. For example, is a subject's ratio of time needed for addition to time needed for typing an indicator of a cognitive ability or is it an indicator of cognitive style (i.e., quantitative versus verbal) or motivation (i.e., is adding numbers simply harder than typing words)? Improved knowledge on these fronts would forward our understanding of critical issues such as learning and feedback that will impact evolution and equilibrium of markets with such elements.

In terms of theories of bounded rationality, an index of cognitive ability is a small step toward providing evidence that this heterogeneity exists and is relevant, and, more generally, that anomaly-specific indices of subject heterogeneity can be constructed. Like previous work by David W. Harless and Colin F. Camerer (1994) and by John D. Hey and Chris Orme (1994) in the area of risky choice models, it could help quantify proportions of subjects for whom neoclassical theories of choice simply do not apply.

In terms of selection effects, our work may stimulate thinking about evolution of certain economic institutions and differences across labor market segments. While some thought has been given to such themes (e.g., Francine D. Blau and Lawrence M. Kahn (2001) find that heterogeneity in cognitive ability across countries partially explains heterogeneity in cross-country wage variation) there may be ties between self-selection in labor market segments within a country and cross sectional variation in wages, institutions and occupational norms. Looking towards future research, we ask: Is self-selection by cognitive ability a broader phenomenon in real markets and, if so, what institutions or social norms have arisen in response to such selection?

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Table 1: Explaining Static Preference Reversals Probit Model: Dependent Variable=1 if Static Preference Reversal

	Parameter Estimate (P-Value)
Constant	-1.23 (.00)
Initial Preference for Adding =1 if pre-treatment preference for adding	0.14 (.78)
Initial Preference for Typing and Anchored Opposite =1 if pre-treatment preference for typing and anchored	0.77 (.02)
Initial Preference for Adding and Anchored Opposite =1 if pre-treatment preference for adding and anchored	0.60 (.21)
Session 2 Dummy =1 if session 2	0.10. (.65)
Observations	154

Table 2a: Summary of Initial Task Preferences: Session 2

	Prefer Adding	Prefer Typing
Prefer P-Bet	13	32
Prefer $-Bet	13	32

Table 2b: Strict Gamble Reversals By Initial Task Preference

	Prefer Adding		Prefer Typing	
	Prefer P Bet (50%)	Prefer $ Bet (50%)	Prefer P Bet (50%)	Prefer $ Bet (50%)
Reverse	4 (31%)	0 (0%)	19 (59%)	3 (9%)
Don't Reverse	9 (69%)	13 (100%)	13 (41%)	29 (91%)

Table 3: Explaining Strict Gambles Reversals with Selection Effects
Probit: Dependent Variable=1 if Reversal

	Parameter Estimate (P-value)
Constant	-6.57
	(.00)
Prefer P Bet	1.98
	(.00)
Prefer Typing	0.94
	(.03)
Female=1	0.96
	(.01)
Age	0.15
	(.05)
GPA	0.15
	(.73)
Business or Science Major	0.08
	(.85)

95 Observations

Table 4: Explaining Initial Preference for Typing
Probit: Dependent Variable =1 for initial preference category

	Parameter Estimate (P-Value)
Constant	-1.34 (.51)
Initial Preference for P-bet	0.23 (.48)
Predicted Adding Time/Predicted Typing Time	1.31 (.01)
Female	-0.12 (.69)
Age	-0.03 (.66)
GPA	0.57 (.17)
Business or Science Major	-0.83 (.03)

95 Observations

Appendix A: Static Reversal Experiments Directions

Note: Session 1 consists only of the static reversal portion with appropriate modifications of the script.

Thank you for participating in this experiment. For showing up today, you are guaranteed a payment of <Fixed>. Throughout the experiment, you will have the opportunity to earn additional money depending on your responses to questions. The experiment consists of two parts:

- Part I is a computer based experiment. All instructions will be given to you on this computer screen. If at any point you have any questions, please raise your hand and the moderator will approach you. We ask that you have no communication with anyone other than the moderator. Part I of the experiment will take between 25 and 45 minutes.

- Upon completion of the computer experiment, you will be dismissed to a room across the hall where you will participate in Part II of the experiment and the chance to earn additional money. Part II of the experiment will take approximately 10 minutes.

As part of today's experiment you will be given the opportunity to be paid to perform a task that will last approximately 15 minutes.

In the following pages, we will briefly describe and demonstrate two tasks. Later, one of these two tasks will be randomly chosen and depending on your responses during the course of the experiment, we may pay you to complete the task and receive compensation. The payment will be paid to you in cash at the end of today's session.

Task 1 involves typing 475 words into the computer. To give you a better idea of what the complete 475 word typing task will be like, we would like you to try a sample of the task. A word will appear on your screen. When you see the word please type it in exactly as it appears at the prompt and then press ENTER. If you do not type in the word correctly, you will be prompted to type in the same word again. For this demonstration, 25 words will appear on your screen in total.

We will time how long it takes for you to complete these thirty words and give you an estimate of how long it will take for you to complete the entire list of 475 words. When you are ready to begin, please click the link below.

<subject completes typing demonstration>

Thank you! It took you <xx> seconds to complete the typing demonstration. At that rate it would take you <yy> minutes to type 475 words.

Based on your performance on this demonstration, we predict it will take you <yy> minutes to complete the full task of typing 475 words. We know that your performance on the demonstration is not always a good predictor of your performance on the full task. Based on how you performed on the typing demonstration, what do you think is the range of time it will take you to perform the full typing task?

____ minutes, _____ seconds is the shortest amount of time it will take me to type 475 words

____ minutes, _____ seconds is the longest amount of time it will take me to type 475 words

Task 2 involves adding 175 pairs of numbers that range from 5 to 49 and then entering the answer into the computer. To give you a better idea of what the complete 175 problem adding task will be like, we would like you to try a sample of the task.

A pair of numbers ranging from 5 to 49 will appear on your screen. Please add the two numbers in your head and type the answer in the prompted area and then press ENTER. If you do not type in the correct answer, you will be prompted to add the same two numbers again.

For the demonstration, 10 pairs of numbers will appear on your screen in total. We will time how long it takes you to complete these ten numbers and give you an estimate of how long it will take you to complete the entire 175 pairs. When you are ready to begin, click the link below.

Thank you! It took you <xx> seconds to complete the adding demonstration. At that rate it would take you <zz> minutes to add 175 pairs of numbers

Based on your performance on this demonstration, we predict it will take you <yy> minutes to complete the full task of 175 pairs of numbers. We know that your performance on the demonstration is not always a good predictor of your performance on the full task. Based on how you performed on the adding demonstration, what do you think is the range of time it will take you to perform the full adding task?

____ minutes, _____ seconds is the shortest amount of time it will take me to add 175 pairs of numbers

____ minutes, _____ seconds is the longest amount of time it will take me to add 175 pairs of numbers

Suppose we offered to pay you to either type 475 words, or add 175 pairs of numbers. We believe that if you prefer a task, you would be willing to accept a lower payment for that task. That is, we would have to pay you more to perform a less preferred task.

In answering the following question, keep in mind that based on your performance in the demonstrations, it is expected to take you <zz> minutes to add 175 pairs of numbers, and <yy> minutes to type 475 words. If we were to pay you to either add 175 pairs of numbers, or type 475 words, which task would we have to pay you more to perform?

<*Subject clicks one*>

We would now like to see what it is worth to you to perform these two tasks. We are going to ask you some questions to determine the smallest amount of money we would have to pay you to perform the tasks. We will refer to this as your 'payment demanded'.

After we have established your payment demanded for each task, the computer will randomly choose one of the two tasks. After the task is chosen, the computer will randomly select a price and announce it to you. ***Please note that the price chosen by the computer is completely random and does not depend on your payment demanded for each task.***

Depending on your payment demanded for the chosen task, and the announced price, you will be asked to either

a) perform the task for the announced price and receive payment upon completion of the task, or

b) not perform the task and receive no payment.

The remainder of this part of the experiment goes as follows:

1) We will ask some questions to establish the smallest payment you will accept to type 475 words or add 175 numbers.

2) The computer will randomly select which task is to be performed.

3) The computer will announce a random price. We will offer to pay you the announced price to perform the selected task.

4) If your payment demanded is less than or equal to the announced price, you will perform the task and be **paid the announced price** upon satisfactory completion of the task.

5) If your payment demanded is greater than the announced price, we will not hire you to perform the task.

To make sure you understand the procedure, suppose the computer chooses the typing task and announces a price. If your payment demanded is greater than the announced price you will (click one):

a) Perform the task and receive the announced price.

b) Perform the task and receive your payment demanded.

c) Not perform the task and receive the announced price.

d) Not perform the task and receive nothing for the task.

e) I'm not sure, I'd like to see the directions again.

If your payment demanded is less than or equal to the announced price you will (click one):

a) Perform the task and receive the announced price.

b) Perform the task and receive your payment demanded.

c) Not perform the task and receive the announced price.

d) Not perform the task and receive nothing for the task.

e) I'm not sure, I'd like to see the directions again.

<After answering both quiz questions correctly>

To summarize, if your payment demanded is less than or equal to the announced price for the randomly chosen task, you will receive the announced price in cash after you perform the task. If your payment demanded is more than the announced price for the randomly chosen task, you will receive no cash payment for the task, and you will not have to perform the task. **The announced price the computer chooses is completely random and is in no way influenced by your responses.**

Your best strategy for establishing your payment demanded is to carefully consider the lowest amount of money you would accept to perform each task, and base your answers on that amount. The payment you report is the smallest payment you will accept to perform the task. ***We do not want you to report an hourly wage.***

The payment you report will give us an indication of which task you prefer. The lower the payment demanded, the more you prefer the task. That is, if you are willing to perform a task for less money, then we will take that as an indication that you prefer that task.

There is no incentive to give any answer other than the true lowest amount of money you would accept to perform each task. If you report your payment too low, then you may have to perform the task for a price less than your true payment demanded. If you report your payment too high, then you might not be asked to perform the task and you will not be paid. If you have any questions about the procedure, please raise your hand and the moderator will come to you to answer the question.

Consider the typing task. We would like to know the smallest payment that you will accept to type 475 words.

[Anchor treatment only]

If we gave you $A, would you be willing to type 475 words?

YES NO

Keeping in mind that we want you to report the smallest amount of money you will accept to perform the task, **not an hourly wage**, what is the smallest payment you will accept to type 475 words?

$___.___

Consider the adding task. We would like to know the smallest payment that you will accept to add 175 pairs of numbers together.

If we gave you $2, would you be willing to add 175 pairs of numbers?

YES NO

Keeping in mind that we want you to report the smallest amount of money you will accept to perform the task, **not an hourly wage**, what is the smallest payment you will accept to add 175 pairs of numbers?

$___.___

Now that we have established your wage demanded for each task, the computer will randomly draw one of the two tasks. Click below to tell the computer to choose the task.

The task is <Task>

The computer will now randomly generate an announced price for the task.

The announced price is $<AP>

Your payment demanded for this task is $<PD>

<*Assign task and payment or dismiss to next section depending on responses*>

Appendix B: Preference Reversal Over Lotteries Instructions

- In this part of the experiment you will have a chance to earn some more money.
- The money you made in the first part of the experiment is yours to keep. Nothing you do from this point on will change that.
- To determine how much more money you might win, you will need to make several decisions.
- The decisions you make will involve one or more games of chance.
- Each game of chance will be described as the number of chances out of 36 of winning a prize in dollars.

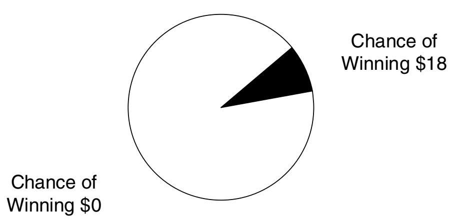
Please Record Your ID#_________________

We would like you to make decisions and answer some questions about two games of chance. Your decisions and answers to questions regarding these two games will determine whether you play one of the two games, and any additional amount you are paid at the end of the session.

Consider the two games of chance below:

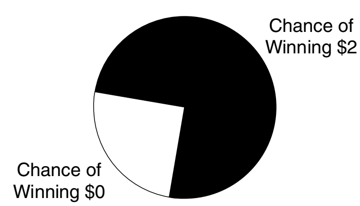
Game A features:

- 3 chances in 36 of winning $18
- 33 chances in 36 of winning $0



Game B features:

- 27 chances in 36 of winning $2
- 9 chances in 36 of winning $0



QUESTION: If you could play only one of these games of chance for real money, which game would you choose to play (Check one)?

____ Game A
____ Game B
____ I have no preference (if you check this option a coin will be flipped to determine the outcome)

V1

We would now like to see what it is worth to you to have the opportunity to play these games. The remainder of the experiment goes as follows:

1. I will ask you some questions to establish the smallest payment you will accept to give up the opportunity to play each of the games described in items A and B. We will call this your payment demanded. These games will be treated independently, since you will only have the opportunity to play one of the two games.

2. After we establish your payment demanded, you will flip a coin to see which game you may play or have the opportunity to sell to us. If the coin flip comes up heads, you will own the opportunity to play game A. If the coin flip comes up tails, you will own the opportunity to play game B.

3. We will then try to buy back the opportunity to play the game from you. You will blindly choose an announced price from a bucket of possible prices. We will offer to buy the chosen game from you at the announced price. **The announced price chosen from the price bucket is completely random and is in no way influenced by your responses.**

4. If your payment demanded is less than or equal to the announced price, we will buy the opportunity to play the game from you and you will be **<u>paid the announced price</u>** at the end of the session. When we buy the game from you, you will receive the announced price with certainty.

5. If your payment demanded is greater than the announced price for the game you own, you will play the game at the end of the session and receive your winnings from playing the game.

- Do you have any questions about the procedure?

- The payment you report will give us an indication of which game you prefer. The higher your payment demanded for a game, the more you like the game: That is, we would have to pay you more to give up the game you prefer more.

- There is no reason to give any answer other than the true lowest amount of money you would accept to give up the opportunity to play the game.

- If you report your payment demanded too low, then you may lose the opportunity to play the game and receive too low of a price.

- If you report your payment demanded too high, then you might have to play the game of chance when you really would have preferred the guaranteed payment instead.

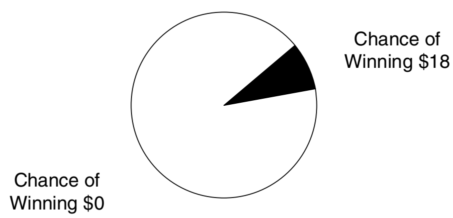
- Do you have any questions before we begin the game?

Please Record Your ID#________________

Consider Game A

We would like to know the smallest payment that you will accept to give up the chance to play game A. Game A features:

- 3 chances in 36 of earning $18
- 33 chances in 36 of earning $0



QUESTION: If you owned this game, what is the smallest amount of money we would have to pay you for you to give up the opportunity to play this game?

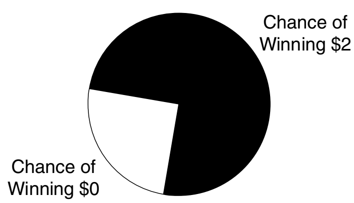
$________.__________

Please Record Your ID#________________

Consider Game B

We would like to know the smallest payment that you will accept to give up the chance to play game B. Game B features:

- 27 chances in 36 of earning $2
- 9 chances in 36 of earning $0



QUESTION: If you owned this game, what is the smallest amount of money we would have to pay you for you to give up the opportunity to play this game?

$________.__________

V1

GAME PLAY AND EXIT SCRIPT:

- To determine which game we will try to buy from you, I would like you to flip a coin. If the coin comes up Heads, we will attempt to buy game A from you. If the coin comes up Tails, we will attempt to buy game B from you.

- Please flip the coin now.
- Ok, you now own game <fill in appropriate game>. We will now attempt to buy game <fill in appropriate game> from you.

Choosing the Announced Price:

- To determine the price at which we will offer to buy this game from you, we would like you to reach into the price bucket and choose a chip. The number on that chip represents the price at which we will offer to buy the game from you.
- Please choose a chip now.
- The announced price is $<Insert announced price>
- Your payment demanded for this game was $<INSERT PD>, and the announced price is $<INSERT AP>.
- IF AP>=PD: Because your payment demanded to give up this game is less than or equal to the announced price, we will buy the game from you for an additional $AP. RECORD PAYMENT AND DISMISS.
- IF PD>AP: Because your payment demanded to give up this game is greater than the announced price, we will not buy the game from you, and you will now play the game of chance.
    - To play Game <INSERT GAME>, we would like you to try to choose a <COLOR> ball from this bucket. In the bucket there are <#> <COLOR> balls and <#> white balls.
    - Please inspect the bucket to make sure you agree.
    - We will mix the bucket, and then ask you to blindly choose a ball.
    - If the ball you pull out is <COLOR>, you will receive an additional payment of $<INSERT>
    - If the ball you pull out is white, you will receive no additional money.
    - RECORD PAYMENT AND DISMISS