Pre-Analysis Plan for Risky Mistakes and Revisions

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1 Introduction

The aim of this project is to fill in the gaps in previous literature and increase the understanding of why people make mistakes. If the randomness in choice we observe represents mistakes on the part of decision makers, these mistakes could lead to dramatic welfare losses. Thus, understanding the extent of these mistakes and the situations which cause them is valuable both for economists attempting to understand behavior and policy makers trying to make consumers better off.

Substantial empirical evidence has been documented of the fact that when making choices from the same set multiple times, subjects do not always make the same choice (Tversky, 1969; Hey and Orme, 1994; Agranov and Ortoleva, 2017). This is contrary to a standard assumption from many economic models: that individuals have stable preferences and when given the same choice set without any feedback or changes in environment make the same choice.

This project instead focuses on "mistakes" as a potential explanation for behavior which appears to be random. While some research has explicitly described stochastic choice as mistakes (Hey and Orme, 1994), this "noise" has usually not been studied directly, and is instead looked at as a barrier to uncovering the decision maker's "true" preferences (Hey, 2005). Here, we will call a decision a mistake if the decision maker would later revise that decision when offered the chance.

2 Experimental Design

For this project we use the risk elicitation pioneered in Andreoni and Harbaugh (2009). For a given task, their method elicits subjects' preferences over a set of two-outcome lotteries. These lotteries give $\$X$ with probability p and \$0 otherwise. Different tasks trade off p, the chance of a positive outcome, against $\$X$, the size of the positive outcome at different rates. We emphasize three advantages of using this methodology. First, it is a linear budget in the $(\$X, p)$ plane given by $r\$X + p = m$ and is thus amenable to standard consumer theory tests.

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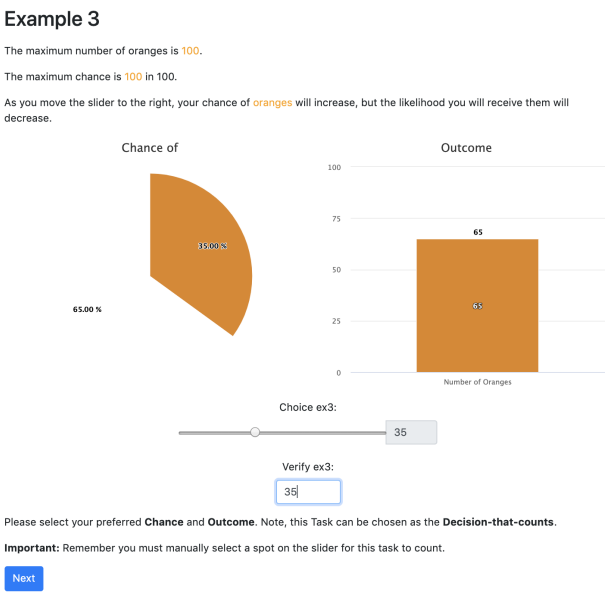
Second, as p and $\$X$ can be any non-negative numbers satisfying the constraint and choosing either equal to 0 is strictly dominated, choices will be mostly interior. Third, in contrast to other linear budgets over lotteries, for example Feldman and Rehbeck (2019) for probabilities or Choi et al. (2007) for outcomes, this method can identify both the utility of outcomes and deviations from linearity in the probabilities simultaneously.



(a) Example Task

Maximum Chance	Maximum Outcome
50 in 100 chance	$30
60 in 100 chance	$30
50 in 100 chance	$40
80 in 100 chance	$40
100 in 100 chance	$50
60 in 100 chance	$60
75 in 100 chance	$60
100 in 100 chance	$60
40 in 100 chance	$80
80 in 100 chance	$80
100 in 100 chance	$80
15 in 100 chance	$100
20 in 100 chance	$100
100 in 100 chance	$100
15 in 100 chance	$120
30 in 100 chance	$120
60 in 100 chance	$120
30 in 100 chance	$150
20 in 100 chance	$160
40 in 100 chance	$160
80 in 100 chance	$160
25 in 100 chance	$200
30 in 100 chance	$200
40 in 100 chance	$200
50 in 100 chance	$200

(b) Full Set of Distinct Tasks

Experimental instructions (Appendix A) feature examples (Figure 1a) that involve fruits to familiarize subjects with the interactive interface. They then learn about the full set of choices (Figure 1b) they will make before making any incentivized choices.

The experiment has two parts, choices and revisions. In Part 1, each subject makes choices from 25 randomly ordered budgets, then faces the same 25 budgets in a different random order. Subjects select their preferred lottery from the linear budget utilizing a slider. Before making the choice, no information is displayed on the subject's screen other than the maximum outcome and maximum chance. The subject must click the slider in order to activate it. After moving the slider to the preferred bundle, subjects confirm their selection separately. Figure 2 depicts a sample task.

In Part 2, subjects are allowed to revise a subset of their choices. We employ a 2×2 within design on the revision problems. One treatment dimension is whether or not the subject is reminded of the choice they are revising. The second treatment dimension is whether the subject revises both of the choices from a budget at a single time or revises a single decision. The subject makes six revisions in each condition, leading to 36 choices being revised from 24 unique budgets. The order of these treatments is also randomized.

Figure 2: Sample Task

Figure 3: Budgets

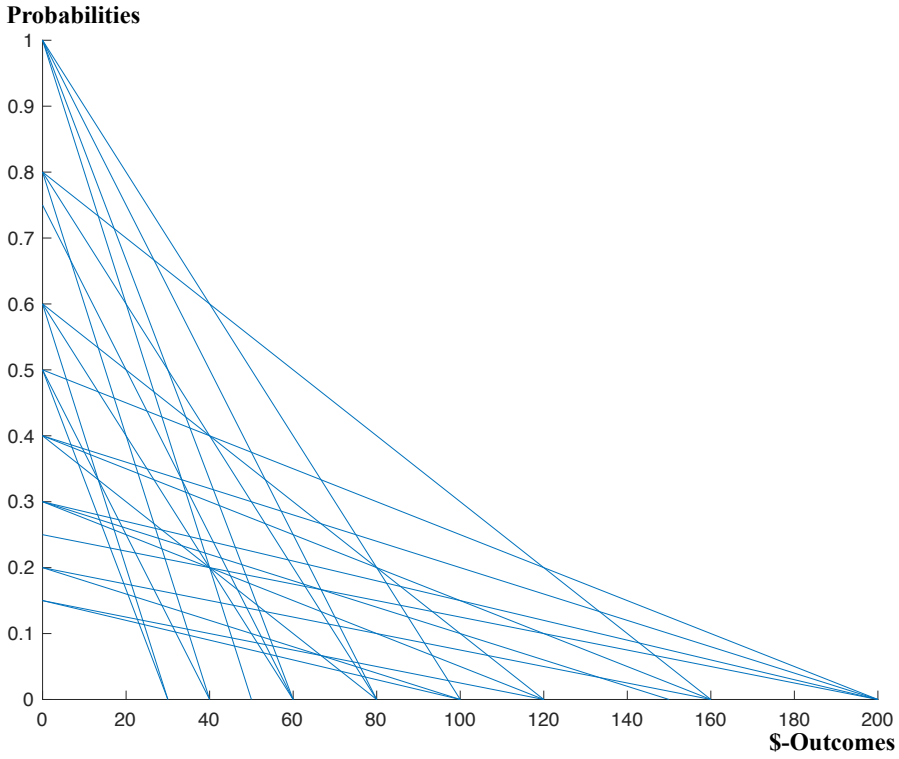


Figure 3 summarizes the budget sets used. The fact that the budgets cross allow for analysis of traditional rationality measures. The set also includes parallel budgets and pure price shifts to allow for analysis of income and substitution effects.

2.1 Data Collected

In addition to choice data, we collect the decision time for each choice. We also collect standard demographic data including gender, age, college major, etc. We supplement these data with a short cognitive reflection test.

3 Empirical Analysis

The primary focus of the study is the effect of the treatment variables on subject revision behavior. Thus, the primary regression is

$$y_{i,t} = \beta_0 + \beta_1 \text{ Reminder}_{i,t} + \beta_2 \text{ Double}_{i,t} + \beta_3 \text{ Reminder}\times\text{Double}_{i,t} + \alpha_i + \eta_j + \varepsilon_{i,t} \qquad (1)$$

where i is the subject, j is the budget, and t the decision problem. The regression includes both treatments and their interaction, as well as both subject level and budget fixed effects. There are two dependent variables of interest: whether or not a revision was made, and the absolute value of the revision.

The experiment also allows for the study of how a decision problem's characteristics affect revision behavior. Here, the regression of interest is

$$y_{i,t} = \beta_0 + \beta_1 \text{Max X}_{i,t} + \beta_2 \text{Max P}_{i,t} + \beta_3 \text{ Decision Round}_{i,t} + \alpha_i + \varepsilon_{i,t} \tag{2}$$

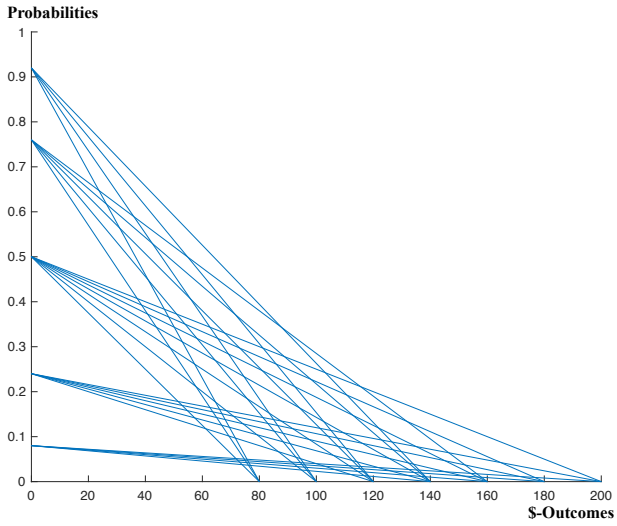
which includes subject fixed effects. The dependent variables will again be both whether or not a revision was made and the absolute value of the revision.

To evaluate decision quality, we consider two measures. First, we study whether revised decisions are more "rational" than the original decisions by comparing both the Afriat and Houtman-Maks indices for the original set of decisions and the revised set of decisions. Second, we will parametrically estimate the one parameter CRRA model of risk preferences using both the original and revised sets of decisions. With these two parametric estimates, we will compare the implied utility level (as a fraction of the maximum possible utility) of both the original and revised decisions.

3.1 Power Analysis

On June 3rd and 4th, 2019 we conducted a pilot session with a total of 33 subjects. The whole experiment took under an hour to complete and subjects spent an average of 19 seconds per task (15 s.d.). The original budgets were slightly different and appear in Figure 4. We modified the original set of choices to allow for the estimation of pure income effects. We also added more revisions (from 32 to 36 revised choices) to balance the number of revision problems per treatment.

Figure 4: Old Design Used for Pilot



(a) Budgets

Maximum Chance	Maximum Outcome
8 in 100 chance	$140
8 in 100 chance	$160
8 in 100 chance	$180
8 in 100 chance	$200
24 in 100 chance	$120
24 in 100 chance	$140
24 in 100 chance	$160
24 in 100 chance	$180
24 in 100 chance	$200
50 in 100 chance	$80
50 in 100 chance	$100
50 in 100 chance	$120
50 in 100 chance	$140
50 in 100 chance	$160
50 in 100 chance	$180
50 in 100 chance	$200
76 in 100 chance	$80
76 in 100 chance	$100
76 in 100 chance	$120
76 in 100 chance	$140
76 in 100 chance	$160
92 in 100 chance	$80
92 in 100 chance	$100
92 in 100 chance	$120
92 in 100 chance	$140

(b) Full Set of Distinct Tasks

Based on the results of a pilot study, we expect to have a final sample size which is between 160 and 200.

Regression results from a pilot version of the experiment can be found in Table (1). Based on these results, we again expect large and significant effect sizes for both the reminder and decision round. We aim to generate a sample which could identify the the effect of a double revision on the absolute revision level. Accounting for intra-subject correlation and using a target power level of 0.8, we find that the necessary sample size is 162.

This sample size will also be sufficient to identify improvements in utility and rationality measures. Pilot data indicated average proportion of maximum utility increase by .023 when using utility parameters based on the revised choices and .010 when using utility parameters based on original choices. The empirical standard deviation and intra-cluster correlation imply that for a power level of 0.8 to reject a null effect, 13 and 42 subjects are necessary, respectively. With the empirical standard deviation of Afriat Indices, a sample size of 91 is required to have 0.8 power of rejecting an effect size of 0.05.

Table 1: Results from pilot experiment. * $p < .10$, ** $p < .05$, *** $p < .01$. Errors (clustered at the subject level) are in parentheses.

	(1) Made Revision	(2) Absolute Revision	(3) Made Revision	(4) Absolute Revision
Reminder	-0.241***	-3.189***		
	(0.048)	(1.058)		
Double	0.010	-1.107		
	(0.029)	(0.824)		
Reminder × Double	0.001	0.822		
	(0.051)	(1.223)		
Max X			0.000	-0.001
			(0.000)	(0.010)
Max P			-0.045	-2.515
			(0.073)	(1.602)
Decision Round			-0.002**	-0.074***
			(0.001)	(0.025)
Constant	0.936***	10.695***	0.797***	11.065***
	(0.068)	(1.640)	(0.095)	(2.209)
N	1056.000	1056.000	1056.000	1056.000
Subject FE	X	X	X	X
Problem FE	X	X		

References

Agranov, M. and P. Ortoleva (2017). Stochastic choice and preferences for randomization. *Journal of Political Economy 125*(1), 40–68.

Andreoni, J. and W. Harbaugh (2009). Unexpected utility: five experimental tests of preferences for risk. *Unpublished Manuscript*.

Choi, S., R. Fisman, D. Gale, and S. Kariv (2007). Consistency and heterogeneity of individual behavior under uncertainty. *American Economic Review 97*(5), 1921–1938.

Feldman, P. and J. Rehbeck (2019). Revealing a preference for mixing: an experimental study of risk. *Unpublished Manuscript*.

Hey, J. D. (2005). Why we should not be silent about noise. *Experimental Economics 8*(4), 325–345.

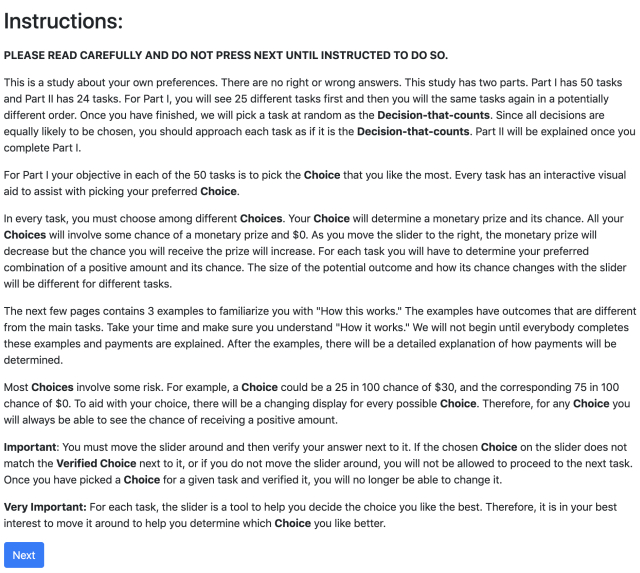
Hey, J. D. and C. Orme (1994). Investigating generalizations of expected utility theory using experimental data. *Econometrica: Journal of the Econometric Society*, 1291–1326.

Tversky, A. (1969). Intransitivity of preferences. *Psychological review 76*(1), 31.

A Screen-shots/Instructions

The full set of instructions appears below.

Figure 5: General Instructions



Instructions:

PLEASE READ CAREFULLY AND DO NOT PRESS NEXT UNTIL INSTRUCTED TO DO SO.

This is a study about your own preferences. There are no right or wrong answers. This study has two parts. Part I has 50 tasks and Part II has 24 tasks. For Part I, you will see 25 different tasks first and then you will the same tasks again in a potentially different order. Once you have finished, we will pick a task at random as the **Decision-that-counts**. Since all decisions are equally likely to be chosen, you should approach each task as if it is the **Decision-that-counts**. Part II will be explained once you complete Part I.

For Part I your objective in each of the 50 tasks is to pick the **Choice** that you like the most. Every task has an interactive visual aid to assist with picking your preferred **Choice**.

In every task, you must choose among different **Choices**. Your **Choice** will determine a monetary prize and its chance. All your **Choices** will involve some chance of a monetary prize and $0. As you move the slider to the right, the monetary prize will decrease but the chance you will receive the prize will increase. For each task you will have to determine your preferred combination of a positive amount and its chance. The size of the potential outcome and how its chance changes with the slider will be different for different tasks.

The next few pages contains 3 examples to familiarize you with "How this works." The examples have outcomes that are different from the main tasks. Take your time and make sure you understand "How it works." We will not begin until everybody completes these examples and payments are explained. After the examples, there will be a detailed explanation of how payments will be determined.

Most **Choices** involve some risk. For example, a **Choice** could be a 25 in 100 chance of $30, and the corresponding 75 in 100 chance of $0. To aid with your choice, there will be a changing display for every possible **Choice**. Therefore, for any **Choice** you will always be able to see the chance of receiving a positive amount.

Important: You must move the slider around and then verify your answer next to it. If the chosen **Choice** on the slider does not match the **Verified Choice** next to it, or if you do not move the slider around, you will not be allowed to proceed to the next task. Once you have picked a **Choice** for a given task and verified it, you will no longer be able to change it.

Very Important: For each task, the slider is a tool to help you decide the choice you like the best. Therefore, it is in your best interest to move it around to help you determine which **Choice** you like better.

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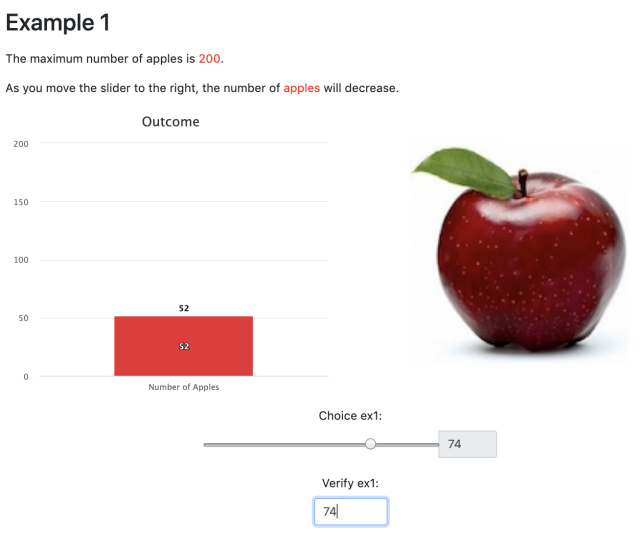
Figure 6: First Example



Example 1

The maximum number of apples is 200.

As you move the slider to the right, the number of apples will decrease.

Outcome

200
150
100
50
0

52
52

Number of Apples

Choice ex1:

74

Verify ex1:

74

Please select your preferred **Chance** and **Outcome**. Note, this Task can be chosen as the **Decision-that-counts**.

Important: Remember you must manually select a spot on the slider for this task to count.

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Figure 7: Second Example

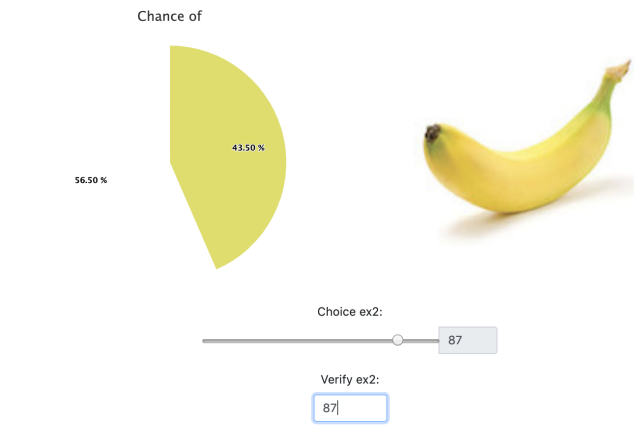


Figure 8: Third Example

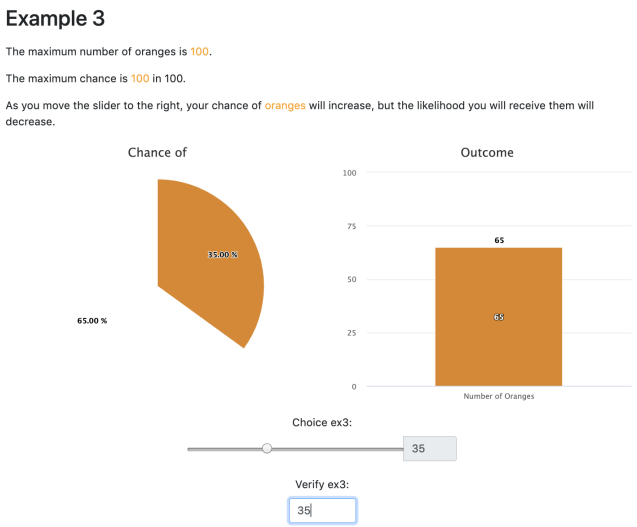


Figure 9: Earnings

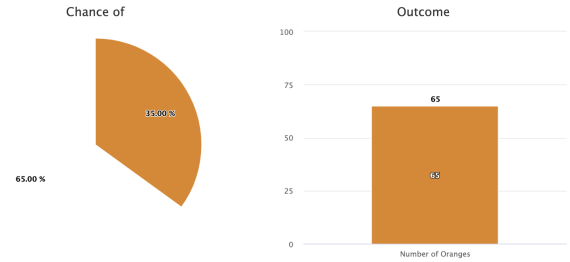
Earning Money:

PLEASE READ CAREFULLY AND DO NOT PRESS NEXT UNTIL INSTRUCTED TO DO SO.

After Parts I and II are completed, chance will determine your payment.

First, we will roll two ten-sided dice to determine the **Decision-that-counts**. One for the ten's digit and another for the one's digit. Any number up to 50, the number of tasks, will count. Therefore any ten's die that is more than five will have to be rerolled. A double zero will count as a hundred so this will also trigger a re-roll. In both cases, both dice will be rerolled.

Second, we will determine the chance of your payoff according to your selected **Choice**:



Therefore:

- You get 65.0 Oranges with a 35.0 in 100 chance.

- You get NOTHING with a 65.0 in 100 chance.

Next

Figure 10: I

Things to Remember:

PLEASE READ CAREFULLY AND DO NOT PRESS NEXT UNTIL INSTRUCTED TO DO SO.

- You may adjust the size of your screen at any moment. Pressing CTRL and + together will zoom in and CTRL and - will zoom out.

- You will receive a $10.00 participation payment.

- You will complete 50 tasks for Part I. Part II has 24 tasks and will be explained after Part I.

- For Part I you will face the same 25 tasks twice in a row, in a potentially different order.

- Different **Choices** can have a different chances of a different prize. All you have to do is pick the **Choice** you like the best.

- There is no right or wrong answer for any of these questions.

- Once all of your decisions have been made, we will choose one task and one decision as the **Decision-that-counts** and will implement your preferred **Choice**.

- Every decision is equally likely to be the **Decision-that-counts**. So, it is in your interest to treat each **Choice** as if it could be the one that determines your payoffs.

- For each task, you must move the slider and verify your preferred **Choice**. Failure to move the slider or not matching it will prevent you from moving to the next task.

- Once you have selected your preferred **Choice** and verified it, you may not be able to change it.

- The slider is a tool to help you determine your preferred **Choice**. Therefore, it is in your best interest to use it to evaluate all potential alternatives.

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Figure 11: Full Set of Budgets

Set of Unique Tasks:

PLEASE READ CAREFULLY AND DO NOT PRESS NEXT UNTIL INSTRUCTED TO DO SO.

- The set of tasks you will complete appears below.

- The column on the left gives the maximum amount of money available for each task

- The column on the right gives the maximum amount of chance available for each task

- Your **Choice** in each task will be some combination of this maximum outcome and chance

Maximum Chance	Maximum Outcome
8 in 100 chance	$140
8 in 100 chance	$160
8 in 100 chance	$180
8 in 100 chance	$200
24 in 100 chance	$120
24 in 100 chance	$140
24 in 100 chance	$160
24 in 100 chance	$180
24 in 100 chance	$200
50 in 100 chance	$80
50 in 100 chance	$100
50 in 100 chance	$120
50 in 100 chance	$140
50 in 100 chance	$160
50 in 100 chance	$180
50 in 100 chance	$200
76 in 100 chance	$80
76 in 100 chance	$100
76 in 100 chance	$120
76 in 100 chance	$140
76 in 100 chance	$160
92 in 100 chance	$80
92 in 100 chance	$100
92 in 100 chance	$120
92 in 100 chance	$140

Next

Figure 12: Sample Task

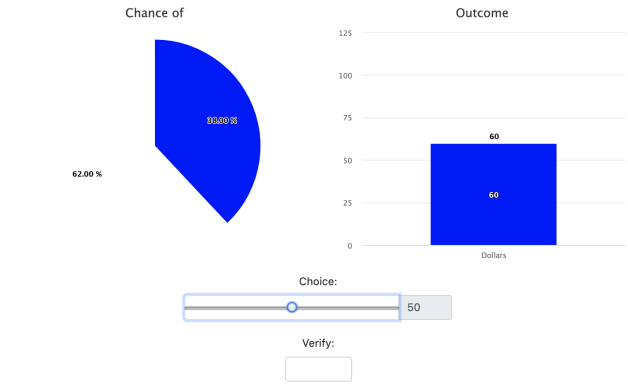
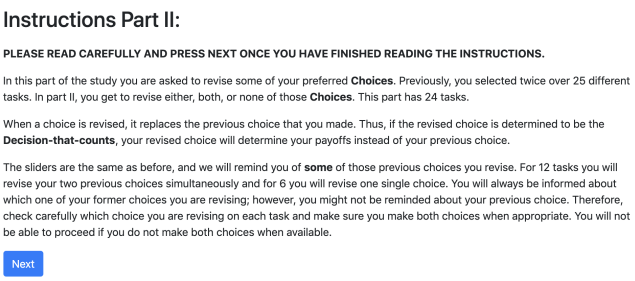


Figure 13: Instructions Part 2



Instructions Part II:

PLEASE READ CAREFULLY AND PRESS NEXT ONCE YOU HAVE FINISHED READING THE INSTRUCTIONS.

In this part of the study you are asked to revise some of your preferred **Choices**. Previously, you selected twice over 25 different tasks. In part II, you get to revise either, both, or none of those **Choices**. This part has 24 tasks.

When a choice is revised, it replaces the previous choice that you made. Thus, if the revised choice is determined to be the **Decision-that-counts**, your revised choice will determine your payoffs instead of your previous choice.

The sliders are the same as before, and we will remind you of **some** of those previous choices you revise. For 12 tasks you will revise your two previous choices simultaneously and for 6 you will revise one single choice. You will always be informed about which one of your former choices you are revising; however, you might not be reminded about your previous choice. Therefore, check carefully which choice you are revising on each task and make sure you make both choices when appropriate. You will not be able to proceed if you do not make both choices when available.

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Figure 14: Revisions with Reminders

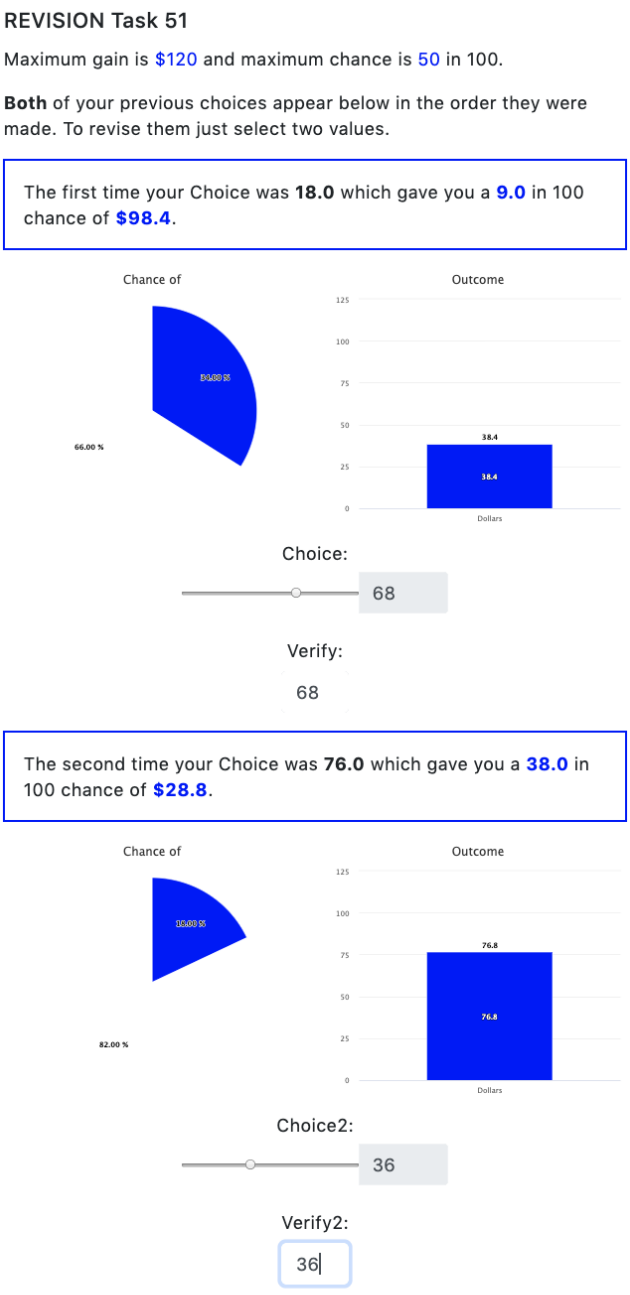

Figure 15: Revisions without Reminders

Figure 16: One Revision with Reminders

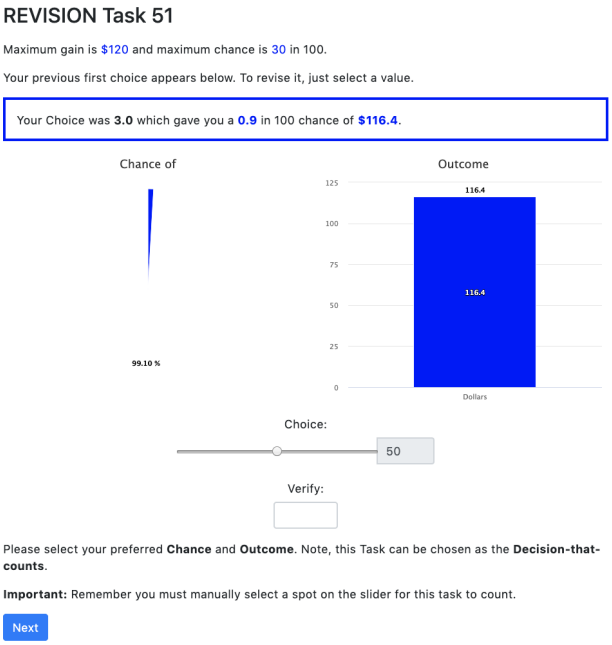

Figure 17: One Revision without Reminders