Essays on Misperceptions of Probabilities and Values

by

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Sumbitted in partial fulfillment of the requirements for
the degree of Doctor of Philosophy at
Central European University

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CENTRAL EUROPEAN UNIVERSITY
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Abstract

The thesis consists of three chapters. The first one investigates why people distort small probabilities under description and experience. The second chapter investigates how people's perception of money is changed through expectations. The third chapter investigates the speed of adjustment of the expectations-based reference point.

Chapter 1

Studies have shown that people tend to exhibit dual behavior towards small probability events when facing risky decisions. Under description people overweight them and under experience they underweight them (Barron and Erev, 2003; Hertwig et al., 2004). Numerous reasons have been suggested to explain this perplexing phenomenon, known as the description-experience gap. In this paper we conduct a study implementing a new design in order to identify the factors that contribute to this anomalous duality. The main finding is that difference in representation format in terms of summarized versus sequentially-learned information is the factor that causes this observed difference in people's behavior in risky decisions involving small probabilities.

Chapter 2

Studies have shown that utility is reference dependent (Kahneman and Tversky, 1979; Abeler et al., 2011; Kőszegi and Rabin, 2006). Thus, people care not only about the utility from consuming a good or service, but also about the degree to which it exceeds or falls short of expectations. If they are unable to disentangle the surprise factor from the intrinsic value of the outcome, they are predisposed to forming biased beliefs. This phenomenon called misattribution of reference-dependent utility has received little attention in the experimental literature. Through an online experiment on a platform called Prolific we test if people misattribute sensations of elation or disappointment to the underlying value of money. The major finding is that people do not exhibit misattribution of money.

Chapter 3

Through an online study we test the speed of adjustment of the expectations-based reference point by comparing participants' willingness to work across different treatment groups. More specifically, we exogenously manipulate participants' expectations about initial monetary endowments and vary the length of the time gap between receiving money and eliciting willingness to work. The major finding is that for higher

rewards the expectations-based reference point behaves sluggishly and fails to adjust immediately to new information. It takes between 10 and 15 minutes for the reference point to adjust to new information. This finding differs from some of the literature which argues that reference points adjust instantaneously for small-stake lotteries. For lower rewards there is also an inclination towards sluggish behavior, although its effect is not significant.

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Chapter 1

Small Probabilities and the Description-Experience Gap

1.1 Introduction

People behave as if they distort probabilities when making decisions involving risk. Small probabilities are subject to the highest distortions. People exhibit dual behavior towards small probabilities. In some cases they behave as if they overweight them and in other cases they behave as if they underweight them (Barron and Erev, 2003; Hertwig et al., 2004). Purchasing lottery tickets, purchasing insurance against unfavorable outcomes, and patient's fear after googling his or her chances of dying as a result of anesthesia are only few of numerous illustrative examples in which people overweight small probabilities. On the other hand, driving while talking on the phone, ignoring red light while driving, and death as a result of drugs abuse are all examples in which people underweight the small-probability detrimental outcome.

The existing literature has identified two contexts that determine whether people overweight or underweight small probabilities: description and experience. The description context is associated with an explicit presentation of the probabilities and outcomes of the lotteries. On the other hand, in the experience context probabilities and outcomes are learned through sequential sampling. The typical approach in the literature dealing with risky choices under description and experience is conducting studies in which participants make risky choices between two lotteries: one is usually safe and yields the same medium outcome all the time, while the other one is risky and yields a high outcome with a high probability and a low outcome with a low probability. A typical example is a choice between a risky lottery that gives \$4 with probability 80% and \$0 with probability 20% and a safe lottery that gives \$3 for sure (Hertwig et al., 2004; Camilleri and Newell, 2011b,a; Hau et al., 2008). Under the description format participants usually see the following on the screen:

Lottery 1 has 80% chance of earning $4 and 20% chance of earning $0. Lottery 2 yields $3 for sure. Which lottery do you choose?

Under the experience scenario, participants usually see two buttons on the screen labelled Lottery 1 and Lottery 2. These are the same two lotteries that participants in the description group choose from. Subjects in the experience group choose sequentially between both buttons and see the outcome associated with their choice. For example, participants choosing Lottery 1 see either an outcome of 4 with probability 80% or an outcome of 0 with probability 20%, while those choosing Lottery 2 see an outcome of 3 all the time. In some studies, participants also receive some payoffs associated with those outcomes (Camilleri and Newell, 2011b). The number of sequential choices in this so-called sampling phase varies in different studies. In some studies, participants are free to choose as many times as they would like (Hertwig et al., 2004; Hau et al., 2008), while in other studies they are forced to make a certain number of choices (Barron and Ursino, 2013; Barron and Erev, 2003; Camilleri and Newell, 2011b; Hau et al., 2010). Obviously, the larger the sample size is, the higher the precision of the probabilities becomes. In some cases participants choose with replacement, meaning that in each draw the probabilities of outcomes are the same (Hau et al., 2008; Camilleri and Newell, 2011b), and in other cases participants choose without replacement, meaning that each outcome unit of the lotteries can occur only one time (Barron and Ursino, 2013). At the end, they make a final choice between both lotteries for the same monetary rewards as subjects in the description group. Of course, in different studies probabilities and outcomes vary. The final goal of every study investigating the description-experience gap is to compare the final choices of participants in both contexts.

The direct comparison between the description and experience contexts entails some key issues. Both contexts differ in numerous dimensions. Therefore, it is difficult to identify which factors contribute to the description-experience gap. One major issue is related to the degree of certainty of the probability distribution of outcomes in both scenarios. In the experience context participants can never be certain of the probability distribution of outcomes unlike their counterparts in the description scenario. Even a Bayesian participant in the experience group would at best form confidence intervals around the true probability of outcomes. The situation is further exacerbated since people form biased beliefs when updating information sequentially. So, at the end of the sampling stage people are prone to inferring different information that could lead to different final choices.

Another issue is related to the endogeneity of the experience context. The intermediate choices (or the choices in the sampling phase) that participants make in the experience scenario are endogenous. For example, a risk-averse person might by pure luck get two bad outcomes in the beginning of the study. Because of that, he would stick to the safe option until the end. Thus, he would acquire different information from a person who is willing to explore and to take more risky decisions. Thus, information would not be identical not only across the description and experience contexts, but also within the experience context. That may undoubtedly influence people's final decisions.

This research project is interested in answering why people overweight and underweight small probabilities under description and experience. More specifically, it attempts to identify which of the following factors contribute to the description-experience gap: difference in content information (in terms of having more information versus having less information), difference in representation format (whether information is provided in a summarized or in a sequential format), the presence of intermediate monetary payoff, and the presence of intermediate consequential choice. An online study on a platform called Prolific is conducted in order to identify which of the above factors cause the gap. The major finding is that the crucial factor that is responsible for the gap is the difference in representation format (in terms of summarized versus sequentially learned information). The other factors that we test (difference in information content, the presence of intermediate consequential choice, and the presence of intermediate payoffs) are not responsible for the dual behavior of people towards small probabilities. These results hold even when we control for people's beliefs about the lotteries.

The rest of the chapter proceeds as follows. Section 1.2 presents the main findings in the literature regarding the description-experience gap. Section 1.3 presents the design of the experiment. Section 1.4 presents the regressions of interest for the study. Section 2.5 presents and discusses the results. Section 1.6 concludes.

1.2 Literature Review

The literature has come up with strong evidence that there is a description-experience gap. This means that there is a major difference in the share of risky choices of participants in both of these contexts. Research studies have come up with several important findings regarding the causes of the gap. According to Prospect Theory, low probability outcomes are overestimated or overweighted in decisions involving risk (Kahneman, 1979). However, the main application of this theory is only in descriptive choices where participants are presented explicitly with lotteries between which they have to choose.

In real life decisions are often taken based on previous experience. This fact has led to the emergence of studies that compare people's decisions in descriptive and experience scenarios. The earliest studies show that small probabilities are overweighted under description and underweighted under experience (Hertwig et al., 2004; Barron and Erev, 2003). Among the earliest and most prominent proposed causes for this gap are recency (Hertwig et al., 2004; Barron and Erev, 2003) and sampling error (Hertwig et al., 2004; Fox and Hadar, 2006; Hertwig et al., 2006; Rakow et al., 2008). Sampling error refers to a situation in which the small probability event is encountered more or less frequently than its true probability. For example, sampling error occurs when an event, whose true probability is 20%, is encountered either once or 3 times. Recency, on the other hand, refers to people's predisposition to attribute greater weight to recently sampled outcomes relative to earlier ones. Some studies establish that the gap does not vanish even when sampling error is removed (Hau et al., 2008, 2010; Barron and Ursino, 2013; Ungemach et al., 2009). However, according to other studies the gap exists when rare events are not experienced and vanishes when they are (Hadar and Fox, 2009). Among other important findings is that repeated, consequential choice is the crucial factor contributing to underweighting in experience (Camilleri and Newell, 2011b). That means that if people earn money while making choices in the sampling phase in the experience scenario, they will be predisposed to choosing the risky option at the end. In other words, even when participants encounter the rare event as frequently as its real probability, they still make more risky decisions compared to their "description" counterparts. The format of providing information has also been investigated as a potential culprit for the description-experience gap. Studies produce mixed findings regarding its effect. Rakow et al. (2008) find no role of representation format in explaining the gap. However, (Hau et al., 2010) show that for large samples the representation format does matter in explaining the gap. Last but not least, the description-experience gap applies not only to monetary gambles. Its significance has been shown in online product choices where different rating formats cause different decisions (Wulff et al., 2015). Overall, even though the description-experience gap is a firmly established phenomenon, there is much debate on the factors that cause it and the mechanisms that drive those factors.

1.3 Overview of the Study

300 participants completed the study on an online platform called Prolific. Due to the short duration of the study the attrition rate was extremely low: only two participants started, but did not finish it. Participants were assigned to five groups: a control

group and four treatment groups (60 people per group). The Control group and Treatment group 1 closely resemble the classical description and experience groups that are generally used in the literature. What is common for all groups is that all participants make a one-shot decision at the end between the same two lotteries (a risky and a safe lottery). The goal of the study is to compare the share of risky choices across groups. At the end, participants in the treatment groups are asked an additional question about their judged probability of the low outcome of the risky lottery. The importance of this question is discussed in Section 1.4. A detailed look at the special characteristics of each group is provided in the following subsections:

1.3.1 Control Group (description)

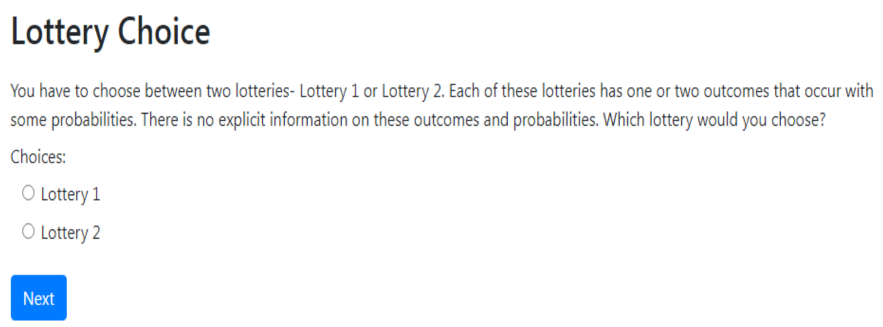
As already mentioned, this group is similar to the classical description scenario used in comparable studies. Participants are given the exact probability distributions and outcomes of the lotteries. Here is an example from the current study:

Lottery 1 has 80% chance of earning 2 euro and 20% chance of earning 0 euro. Lottery 2 yields 1.5 euro for sure. Which lottery do you choose?

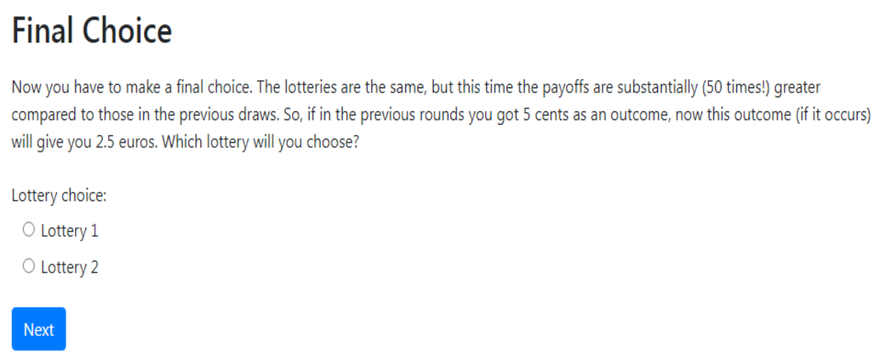
Basically, the only difference between the Control Group (description) and the baseline description group in the majority of studies in the literature lays in the double reduction of payoffs associated with the outcomes: 0, 1.5, and 2 euro instead of 0, 3, and 4 euro.

1.3.2 Treatment Group 1 (experience)

This group resembles the classical experience scenario that is generally used in the literature. The study for this group consists of two stages: a sampling stage and a final choice stage. In the sampling stage participants see two buttons on the screen labelled Lottery 1 and Lottery 2. They choose between the two lotteries sequentially 40 times and receive payoffs associated with the outcomes. Lottery 1 yields an outcome of 4 cents with probability 80% and an outcome of 0 cents with probability 20%. Lottery 2 yields an outcome of 3 cents with certainty. Participants do not know these probability distributions, they can only infer them through the outcomes of their choices. Here is a screenshot from the online study of what participants see in the sampling stage:



At the final choice stage, participants have to make a final choice between the same two lotteries for a 50 times greater payoff. So, they could get 0, 1.5 or 2 euro depending on their choice and luck. This is essentially the same choice that participants in the Control Group (description) make. Here is a screenshot from the online study of what participants see in the final choice stage:



The distinguishing and innovative feature of the study is that each participant in Treatment Group 1 (experience) is paired up with a random participant in each of the remaining treatment groups- their partner. That means that each participants' sequence of intermediate choices and outcomes in Treatment Group 1 (experience) is presented to each participant in the remaining treatment groups. Thus, participants in Treatment Group 2 (experience, no choice), Treatment Group 3 (sequential learning), and Treatment Group 4 (summarized learning) see the same information as their partners in Treatment Group 1 (experience). The purpose of this manipulation is to provide participants in all treatment groups with exactly the same information.

1.3.3 Treatment Group 2 (experience, no choice)

Participants in Treatment Group 2 (experience, no choice) see, but do not choose, the sequence of lotteries and outcomes of their partner in Treatment Group 1 (experience), and **receive** the payoffs associated with these outcomes. For example, they might see the following on the screen:

Round 1: Lottery 1 is chosen and yields an outcome of 4 cents. This amount is added to your earnings.

Then, on a separate page they see:

Round 2: Lottery 2 is chosen and yields an outcome of 3 cents. This amount is added to your earnings.

Then, again on a separate page they see:

Round 3: Lottery 1 is chosen and yields an outcome of 0 cents. This amount is added to your earnings.

This process continues until all 40 rounds are shown. At the end, participants have to make a final choice between the same two lotteries for a 50 times larger payoff. So, they could get 0, 1.5 or 2 euro depending on their choice and luck. This is essentially the same choice that participants in the Control Group (description) and Treatment Group 1 (experience) make.

1.3.4 Treatment Group 3 (sequential information)

This group is identical to Treatment Group 2 (experience, no choice) with the exception that participants **do not receive** the payoffs of the intermediate lotteries. Here is an example of what they could see on the screen:

Round 1: Lottery 1 is chosen and yields an outcome of 4 cents.

Then, on a separate screen they see:

Round 2: Lottery 2 is chosen and yields an outcome of 3 cents.

Then, again on a separate screen, they see:

Round 3: Lottery 1 is chosen and yields an outcome of 0 cents.

This process continues until all 40 rounds are shown. At the end, participants have to make a final choice between the same two lotteries for a 50 times larger payoff. So, they could get 0, 1.5 or 2 euro depending on their choice and luck. This is essentially the same choice that participants in the Control Group (description), Treatment Group 1 (experience), and Treatment Group 2 (experience, no choice) make.

1.3.5 Treatment Group 4 (summarized information)

This group is identical to Treatment Group 3 (sequential information), with the exception that participants are now presented with summaries of the realizations of the lotteries. What is meant by this is best illustrated by an example of what participants in this group might see on the screen:

There are two lotteries: Lottery 1 and Lottery 2. Lottery 1 has been chosen 10 times and Lottery 2 has been chosen 30 times. Lottery 1 produced an outcome of 2 euro in 9 of the cases and an outcome of 0 in 1 of the cases. Lottery 2 produced an outcome of 1.5 euro in all 30 cases. Which lottery do you choose?

As we can see, participants in Treatment Group 4 (summarized information) make the same final choice that participants in the other experimental groups make.

1.3.6 Summary Table

Table 1.1 gives a thorough overview of the main characteristics of the experimental groups.

Table 1.1: Main characteristics of the groups

Context	N	Info on p and X	Format	Chooses	Payoffs
TG 1(experience)	60	No	Sequential	Yes	Yes
TG 2(experience,no choice)	60	No	Sequential	No	**Yes**
TG 3(only sequential information)	60	No	Sequential	No	No
TG 4(only summarized information)	60	No	All at once	No	No
CG(description)	60	Yes	All at once	No	No

Several key points are easily noticeable in this table. Adjacent groups differ in only one dimension. For example, going from the bottom to the top, we can see that the Control Group (description) differs from Treatment Group 4 (summarized information) in the information content on probabilities and outcomes. Participants in the Control Group (description) have access to the full information on the probability distribution of the outcomes of the lotteries, while participants in Treatment Group 4 (summarized information) are provided with scarcer and incomplete information through a summary of the sampling realizations. Treatment Group 3 (sequential information) differs from Treatment Group 4 (summarized information) in the representation format in which information is provided (summarized vs sequential). Treatment Group 2 (experience, no choice) differs from Treatment Group 3 (sequential information) in the presence of intermediate payoffs in the sampling stage. Finally, Treatment Group 1 (experience) differs from Treatment Group 2 (experience, no choice) in the presence of intermediate consequential choices.

Thus, detecting a significant difference in the final choices of groups that differ in only one distinguishing feature would mean that this particular feature is an important factor for the gap. Of course, it might turn out that a certain feature works towards closing the gap. That could happen, for example, if Treatment Group 3 exhibits significantly more risky choices than Treatment Group 2. Then, the feature intermediate payoffs (or more precisely the lack of them) would actually expand the gap. So this feature would not be a factor that contributes to the gap. However, we see in Section 2.5 that such extreme cases were not observed in the conducted study.

1.4 Implementation

The main objective of the study is to test for significant differences in final choice across groups. In addition, we test if participants' beliefs contribute to such differences. The following linear probability model detects if there are significant differences in final choices across groups:

$$Y_i = \beta_0 + \beta_1 TG1_i + \beta_2 TG2_i + \beta_3 TG3_i + \beta_4 TG4_i + u_i \tag{1.1}$$

The dependent variable, Y_i, is the final choice that participant i makes. This is a binary variable, taking on a value of 1 if the risky lottery is chosen and 0 otherwise. The independent variables are $TG1$, $TG2$, TG_3, and TG_4. These are also binary variables taking on the value of 1 if subject i belongs to the respective treatment group and 0 otherwise. The error term u_i encompasses factors such as risk attitude, mood, memory, etc.

When the study was halfway completed, feedback was given that it would be helpful to know what judgement of the probability distribution participants in the treatment groups have. That has led to the addition of the following question at the end:

What do you think is the probability of receiving an outcome of 0 in Lottery 1?

The purpose of this question is to check if different final choices are due to different beliefs. Thus, a second regression is run in order to find this out:

$$Y_i = \beta_0 + \beta_1 TG1_i + \beta_2 TG2_i + \beta_3 TG3_i + \beta_4 TG4_i + Judged\_Probability_i + u_i \qquad (1.2)$$

It is essentially the same as the main regression, but we also control for each participant's judged probability of the low outcome of the risky lottery. The newly included variable can take on decimal values ranging from 0 to 1. Its presence takes into consideration that participants might have a very different perception of the probability of the low outcome of the risky lottery, which would inevitably impact their final choices.

The participants in the Control Group were not asked this question for a couple of reasons. First, they are explicitly told what the probabilities of the outcomes are and are supposed to make their decisions based on this information. Second, if they were asked this question at the end, there is a high possibility that they would think that something fishy is going on with the study. That could influence their judged probability, even if they made their decision based on the 20% low outcome. We admit, however, that attributing 20% to the Control Group could be a disadvantage of the secondary regression analysis. This regression uses the data of 30 participants in each treatment group (those who were asked this question) and the data of the last 30 participants in the Control Group in order to have equality among groups in terms of observations.

A third regression is run in order to test for significant differences across groups only for those participants who were asked about their judged probability of the low outcome of the risky lottery without including the judged probability as a variable. The goal of this regression is to test these participants' final decisions independent of their beliefs:

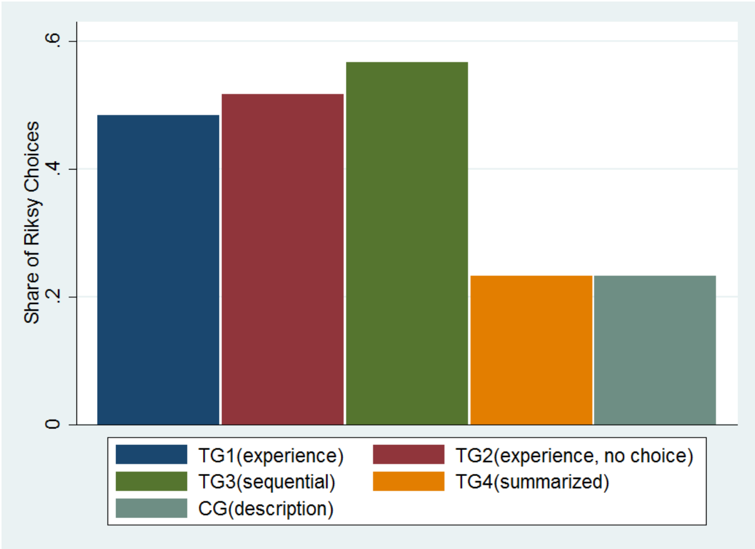
$$Y_i = \beta_0 + \beta_1 TG1_i + \beta_2 TG2_i + \beta_3 TG3_i + \beta_4 TG4_i + u_i \qquad (1.3)$$

1.5 Results and Interpretation

1.5.1 Results

Table 1.2 best illustrates the share of risky choices across groups.

Table 1.2: Share of risky choices across groups



Several observations can be made at first sight. It is interesting to note that the Control Group (description) and Treatment Group 4 (summarized information) yielded exactly the same share of risky choices. These two groups also differ substantially from the other treatment groups in terms of the share of risky choices. Finally, Treatment Group 1 (experience), Treatment Group 2 (experience, no choice), and Treatment Group 3 (sequential information) exhibit similar shares of risky choices.

1.5.2 Regression Analysis

Table 1.3 below elucidates further those conspicuous observations.

Table 1.3: Regression Results

	Dependent Variable: Risky Choice		
	Full Sample	Restricted Sample	
	(1)	(2)	(3)
TG1	0.25***	0.24*	0.23***
	(0.09)	(0.13)	(0.12)
TG2	0.28***	0.38***	0.37***
	(0.09)	(0.12)	(0.12)
TG3	0.33***	0.27**	0.27***
	(0.09)	(0.12)	(0.12)
TG4	0	0.04	0.03
	(0.08)	(0.12)	(0.12)
Judged_Prob		-0.09	
		(0.20)	
_cons	0.23***	0.28***	0.27***
	(0.06)	(0.09)	(0.08)
N	300	150	150
R^2	0.09	0.08	0.08

[1] Standard errors in parentheses

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[3] Notes: The second column reports the coefficients obtained after regressing final choice on the experimental groups for the whole sample. The third column reports the coefficients obtained after regressing final choice on the experimental groups and participants' judged probability for those who were asked about it. The fourth column reports the coefficients obtained from regressing final choice on the experimental groups only for participants who were asked about their judged probability of the low outcome of the risky lottery.

First of all, the results of the main regression confirm the general findings in the literature and the existence of a description-experience gap. This is illustrated by the coefficient in front of Treatment Group 1 (experience). It is significantly different from 0 even at the 1% significance level (t=2.93, p=0.00). This study, however, is not interested in the direct comparison between the Control Group (description) and Treatment Group 1 (experience). Instead, the coefficient in front of Treatment Group 4 (summarized information) is crucial for the study. It is not significantly different from 0 (t=0.00, p=1.00). Thus, we cannot reject the null hypothesis that the share of risky choices of Treatment Group 4 (summarized information) is not significantly different from the share of risky choices of the Control Group (description). Those two groups differ in only one dimension (information on probabilities and outcomes). Therefore, we cannot claim that difference in information content (in terms of having more information versus having less information) contributes to the description-experience gap. This is a rather surprising finding since it is intuitive to assume that being provided with explicit and full information would predispose participants to making different decisions from those participants provided with scarcer information.

Other crucial comparisons for our study are between adjacent treatment groups (Treatment Group 1 (experience) and Treatment Group 2 (experience, no choice), Treatment Group 2 (experience, no choice) and Treatment Group 3 (sequential information), and Treatment Group 3 (sequential information) and Treatment Group 4 (summarized information)). The equality tests between them yield $F(1, 295) = 0.13$ and $Prob > F = 0.72$, $F(1, 295) = 0.30$ and $Prob > F = 0.59$, and $F(1, 295) = 15.45$ and $Prob > F = 0.00$, respectively. Apparently, we cannot reject the null hypothesis that the share of risky choices of participants in Treatment Group 1 (experience) is not significantly different from the share of risky choices of participants in Treatment Group 2 (experience, no choice). The same conclusion follows for Treatment Group 2 (experience, no choice) and Treatment Group 3 (sequential information). Thus, we cannot claim that the presence of intermediate choices and the presence of intermediate payoffs contribute to the description-experience gap. However, we can firmly reject the null hypothesis that the share of risky choices of participants in Treatment Group 3 (sequential information) is not significantly different from the share of risky choices of participants in Treatment Group 4 (summarized information) even at the 1% significance level. Those treatment groups differ in only one dimension (summarized vs sequentially distributed identical information). Thus, the difference in representation format of providing information is the factor that contributes to the description-experience gap. This is the major finding of our study.

The results of the second regression are similar to those of the main regression although the coefficients are now less significant due to the smaller sample size and higher standard errors. The coefficient in front of Treatment Group 4 (summarized information) is still not significantly different from 0 (t=0.34, p=0.74) which supports the finding that difference in information content (in terms of having more information versus having less information) does not contribute to the description-experience gap. The comparisons between adjacent treatment groups still lead to the same general results as in the main regression. Comparing Treatment Group 1 (experience) and Treatment Group 2 (experience, no choice), Treatment Group 2 (experience, no choice) and Treatment Group 3 (sequential information), and Treatment Group 3 (sequential information) and Treatment Group 4 (summarized information) yields $F(1, 144) = 1.13$ and $Prob > F = 0.29$, $F(1, 144) = 0.66$ and $Prob > F = 0.42$, and $F(1, 144) = 3.29$ and $Prob > F = 0.07$, respectively. Thus, the presence of intermediate choice and the presence of monetary payoffs are not significant factors for the description-experience gap. We can also see that Treatment Group 3 (sequential information) is now significantly different from Treatment Group 4 (summarized information) in terms of the share of final risky choices only at the 10% significance level. This suggests that the effect of the representation format is weaker when we control for judged probability.

The next step is to investigate whether this weaker effect can be explained by participants' different judgments of the probability of the low outcome of the risky lottery. If participants' different beliefs were the only explanation for the final decisions, then in the second regression we should observe only coefficients in front of the treatment groups that are not significantly different from 0, while the coefficient in front of judged probability would be significantly different from 0. The table shows that this is not the case. The coefficient in front of judged probability is -0.09, and it is not significantly different from 0 (t=-0.44, p=0.67). On the other hand, the coefficients in front of Treatment Group 1 (experience), Treatment Group 2 (experience, no choice), and Treatment Group 3 (sequential information) are still significant (at the 10%, 1%, and 5% significance levels, respectively). Thus, judged probability can either have an indirect effect on people's final choices or no effect at all. Running our third regression throws more light on the contribution of the difference in people's beliefs to the weaker effect of the representation format.

The third regression produces results that are almost identical to those of the second regression. Treatment Group 4 (summarized information) is still not significantly different from the Control Group (description) in terms of the share of final risky choices (t=0.28, p=0.78). The equality tests between Treatment Group 1 (experience) and Treatment Group 2 (experience, no choice), Treatment Group 2 (experience, no choice) and Treatment Group 3 (sequential information), and Treatment Group 3 (sequential information) and Treatment Group 4 (summarized information) yield $F(1, 145) = 1.07$ and $Prob > F = 0.30$, $F(1, 145) = 0.60$ and $Prob > F = 0.44$, and $F(1, 145) = 3.44$ and $Prob > F = 0.07$, respectively. Based on these results, we reach the same conclusions as in the second regression. The representation format of providing information matters and contributes to the description-experience gap (at the 10% significance level), while the other factors that we investigate (the presence of intermediate choice, presence of intermediate payoffs, and difference in information content) are not significant factors. On top of that, the similarity of the results of the second and third regressions leads to the justifiable inference that the difference in people's beliefs does not even have an indirect effect on the difference in their final choices. The summary statistics for the judged probabilities for the treatment groups in Table 1.4 support that inference.

Table 1.4: Summary statistics of judged probability

Treatment Group	**N**	**Mean**	**Std. Dev.**	**Min**	**Max**
TG 1(experience)	30	23.4	17.34	2	80
TG 2(experience,no choice)	30	29.7	23.62	0	100
TG 3(only sequential learning)	30	23.63	20.14	3	90
TG 4(only summarized learning)	30	28.5	23.35	0	90

The average judged probabilities are close to the true probability of the low outcome (all four means are in the 20-30 range), so participants have decent conjectures about the probability distribution of the lottery. We can see from the table that on average participants in Treatment Group 1 (experience) and Treatment Group 3 (sequential information) are closest to the true probability of the low outcome of the risky lottery (23.63 and 23.4, respectively), while participants in Treatment Group 2 (experience, no choice) and Treatment Group 4 (summarized information) are furthest from the true probability (29.7 and 28.5). These higher average judged probabilities should contribute towards a more risk-averse behavior. It is indeed true that the share of risky choices of participants in Treatment Group 4 (summarized information) is the lowest compared to the other treatment groups. However, in both the second and third regression, the share of final risky choices of participants in Treatment Group 2 (experience, no choice) is the highest among all treatment groups. So, it cannot be stated conclusively that difference in judged probability influences final behavior in any specific uniform way. The standard deviations from the mean judged probabilities do not vary much across treatments, ranging from 17.34 to 23.62. The same could be said about the minimum and maximum judged probabilities, ranging from 0 to 3 and from 90 to 100, respectively. Thus, groups exhibit similar levels of uncertainty of the probability distribution of the risky lottery. Therefore, significant differences across groups in terms of final choices cannot be explained neither by differences in judged probabilities nor by different levels of uncertainty of the probability distribution of the risky lottery.

1.5.3 Alternative Regression

We could also run a regression that can directly test the effect of the factors that we investigate on final choices.

$$Y_i = \beta_0 + \beta_1 Int\_Choice_i + \beta_2 Int\_Payoff_i + \beta_3 Sequential_i + \beta_4 Full\_Info_i + u_i \quad (1.4)$$

The dependent variable Y_i is the final choice that participant i makes. This is a binary variable, taking on a value of 1 if the risky lottery is chosen and 0 otherwise. Int_Choice_i is a binary variable, taking on a value of 1 if participant i makes intermediate choices and 0 if not. Similarly, Int_Payoff_i is a binary variable that takes on a value of 1 if participant i receives intermediate payoffs and 0 if not, $Sequential_i$ is a binary variable that takes on a value of 1 if participant i sees information sequentially and 0 if not, and $Full\_Info_i$ is a binary variable that takes on a value of 1 if participant i is provided explicitly with the probability distribution of the outcomes and 0 if not.

Similar to the approach in the previous section, we include two additional regressions. One of them adds judged probability of the low outcome of the risky lottery as a control variable:

$$\begin{aligned} Y_i = \beta_0 + \beta_1 Int\_Choice_i + \beta_2 Int\_Payoff_i + \beta_3 Sequential\_i + \beta_4 Full\_Info_i \\ + \beta_5 Judged\_Prob_i + u_i \end{aligned} \quad (1.5)$$

The other one repeats the first regression (equation 1.4), but includes only participants whose subjective judgement of the probability of the low outcome was elicited. The results of these three regressions are displayed in Table 1.5.

Table 1.5: Alternative Regression Results

	Dependent Variable: Risky Choice		
	(1)	(2)	(3)
Int_Payoff	-0.05	0.11	0.10
	(0.09)	(0.13)	(0.13)
Int_Choice	-0.03	-0.14	-0.13
	(0.09)	(0.13)	(0.13)
Sequential	0.33***	0.23*	0.23*
	(0.08)	(0.13)	(0.13)
Full_Info	0	-0.04	-0.03
	(0.08)	(0.12)	(0.12)
Judged_Prob		-0.09	
		(0.20)	
_cons	0.23***	0.32***	0.30***
	(0.06)	(0.11)	(0.09)
N	300	150	150
R^2	0.09	0.08	0.08

[1] Standard errors in parentheses

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

[3] Notes: The second column report the coefficients obtained after regressing final choice on the factors intermediate choice, intermediate payoff, sequential information, and full information. The third column reports adds subjective judged probability of the low-probability outcome as a control variable. The fourth column is the same as the second column but only for participants whose judged probability was elicited.

The coefficient of the intercept is the share of risky choices of participants who see information in a summarized format. The results of the first regression show that sequential format of providing information is the only factor that has a significant effect on final choices (p= 0.00). Providing information in a sequential manner increases the probability of choosing the risky option with 33.3% compared to providing information in a summarized, descriptive format. The rest of the factors have a non-significant effect on final choices. In the second regression the sequential format is still a significant factor but only at the 10% significance level. Judged probability has no effect on final choices. The third regression leads only to a slight change in the coefficients. Thus, judged probability does not affect final choices even in an indirect way.

1.5.4 Possible Issues

Some possible issues that could somehow influence our results are related to computation and memory. Some of the groups have to compute the final outcomes due to the 50 times larger amounts associated with the two lotteries (Treatment Group 1 (experience), Treatment Group 2 (experience, no choice), and Treatment Group 3 (sequential information)). The remaining two groups (Control Group (description) and Treatment Group 4 (summarized information)) do not have to compute the final outcomes since they are explicitly provided with the amounts that the lotteries yield. However, Treatment Group 1 (experience), Treatment Group 2 (experience, no choice), and Treatment Group 3 (sequential information) are provided with examples that show how the transformation would look like. They are told that an outcome of 3 cents would now lead to 1.5 €, an outcome of 4 cents would now lead to 2 €, and an outcome of 0 cents would now lead to 0 €. Even though these examples are clear, we still admit that this extra computational step could lead to some distortions. In spite of this potential issue, the design achieves its main goal of keeping information identical across all treatment groups.

On the other hand, the duration of the study is longer for the groups that see information sequentially. Seeing 40 realizations of lotteries in a sequential manner takes longer than seeing the same realizations in a summarized format, although the information provided is exactly the same. Thus, more cognitive effort is required for those subjects in terms of memorizing and processing information. That leads to the necessity to control for memory or recency. A possible solution to that is to include an extra treatment group in which participants see information sequentially, but the previous outcomes are left on the screen. In this way participants don't have to remember them. That manipulation should be subject to further empirical research.

1.6 Conclusion

This paper identifies the causes of the description-experience gap through an online study. The important finding of the study is that the difference in representation format (whether information is summarized or presented sequentially) contributes to the description-experience gap. We cannot claim that the presence of intermediate monetary payoffs and intermediate choices are factors for the gap. Interestingly, a difference in information content (in terms of having more information versus having less information) is not a factor, either. Also, the difference in final choices across groups cannot be explained neither by differences in judged probabilities nor by different levels of uncertainty of the probability distribution of the risky lottery. The current empirical study also leaves room for further research in several directions. While we can claim that the difference in representation format causes the description-experience gap, we cannot distinguish whether the gap is due to the format itself or due to different levels of memory effort required. Besides, the study investigates entirely the gain domain. Participants face choices in which they will most likely earn something. In the worst case scenario, they would encounter the low probability bad outcome in their final choice and will receive no reward. However, if participants could lose money in their final choice, their attitude and decision could be affected. The literature has shown that in the loss domain participants treat small probabilities in a similar manner- they overweight them under description and underweight them under experience. So, in a choice between (-3, 1.0) and (-4, 0.8; 0, 0.2) participants in the description group stick to the risky option and those in the experience group stick to the safe option. However, those studies still compare directly groups that differ in many features. It is worth applying the design of the current study to the loss domain to see what factors contribute to the description-experience gap there. Along with that, it is worth using different values for probabilities and outcomes in order to detect how the gap intensifies or weakens as those parameters change.

Chapter 2

Misattribution of Money

2.1 Introduction

Previous studies have shown that utility is reference dependent (Kőszegi and Rabin, 2006; Abeler et al., 2011; Kahneman and Tversky, 1979). This means that individuals care not only about the intrinsic value of an outcome, but also about the degree to which it deviates from expectations. So, the total experienced utility also depends on this reference-dependent component. To illustrate this reference-dependence concept, let's consider the following examples. Eating dinner in a fine restaurant when expecting eating fast food feels particularly pleasant (Bushong and Gagnon-Bartsch, 2016b). This is because the outcome exceeds expectations and individuals experience a positive surprise. On the other hand, watching an average movie that was expected to be great feels particularly unpleasant. In this case, the outcome falls short of expectations and individuals experience a negative surprise. In both of these examples we can see how expectations affect individuals' total experienced utilities.

Rational behavior always leads to a correct disentanglement of the intrinsic value of an outcome or consumption from the surprise factor. In other words, referring to the above examples, rational individuals infer that the dinner was just good (and not great) and that the movie was average (and not bad). They infer the intrinsic utilities of the dinner and the movie. However, individuals might also fail to disentangle the intrinsic value of an outcome or consumption from the sensation of surprise. This phenomenon, known as misattribution, occurs when individuals attribute positive or negative surprises to the intrinsic value of an outcome or consumption. In other words, due to misattribution individuals underestimate the weight that surprises carry on total utility. This leads to distorted inferences on intrinsic utilities. Back to our illustrative examples, individuals who misattribute infer that the movie was bad (and not just average) and that the dinner was great (and not just good).

There is scarce lab or field evidence in the literature on misattribution both on an empirical and on a theoretical level. The theoretical framework of misattribution is laid out by Bushong and Gagnon-Bartsch (Bushong and Gagnon-Bartsch, 2016a; Gagnon-Bartsch and Bushong, 2022). Empirically, the phenomenon of misattribution has been documented in performing effort-level tasks (Bushong and Gagnon-Bartsch, 2016b, 2020). In their online study, participants face an unfamiliar task that can be immediately experienced. These two factors facilitate testing whether people misattribute sensations of surprises to the intrinsic value of the task. Apart from that, to the best of our knowledge no other experiments on misattribution have been conducted. Thus, it remains unclear in what contexts and to what extent people can exhibit misattribution due to surprises. This paper takes this model to the extreme and tests whether people exhibit misattribution in a setting with a familiar good that cannot be directly consumed such as money. People use it in everyday transactions and have sufficient experience with it. On top of that, it cannot be directly consumed since it is a means to acquire consumption in future. Due to these features, it is unlikely that people exhibit misattribution towards monetary values. However, detecting misattribution in a monetary context could lead to huge implications for economic behavior. The idea that a simple difference in expectations could lead to different attitude towards money is disturbing and could lead to distorted spending patterns. The goal of this paper is to shed light on whether people misattribute sensations of elation or disappointment to the intrinsic utility of money. This is done through an online study on a platform called Prolific. First, we distribute initial endowments to participants either with certainty or through a coin-flip lottery. Then, they face a distraction task that varies in length. Then, we elicit participants' willingness to work on tasks for various monetary rewards. Finally, based on their stated willingness to work, participants may or may not work on tasks for additional rewards. The goal is to compare participants who received an initial endowment with certainty to those who received the same initial endowment through a coin-flip lottery in terms of willingness to work. Based on the results of the study, we cannot claim that people exhibit misattribution towards money. However, the findings are puzzling and could suggest that the expectations-based reference point behaves sluggishly even in the presence of small stakes. These findings are further investigated in Chapter 3.

2.1.1 Simple Money Example

The following example illustrates how a person might misattribute monetary values. Let's consider the following hypothetical situation which is closely related to the experimental setup. Let's suppose Alice and Bob are both reference-dependent agents, and they receive a particular amount of money. Alice receives 1€ with certainty, while Bob faces a coin-flip scenario in which he could either get 3€ if the coin turns heads or 1€ if the coin turns tails. Unfortunately, Bob is unlucky and the coin turns tails, so he receives 1€. Both people receive the same amount of money but in different ways.

As far as the total experienced utilities are concerned, Alice receives only the intrinsic utility of 1€. This is because there is no reference, thus no surprise is generated. Bob, on the other hand, receives the intrinsic utility of 1€ and disutility from the disappointment (since he could receive 3€ instead of 1€). The presence of the negative surprise factor makes Bob's total experienced utility smaller than the intrinsic utility of 1€. So, both people's total experienced utilities are different.

This difference in total experienced utilities might, however, influence their inferences about the intrinsic utility of the amount they have just received (1€). Alice always infers the intrinsic utility of 1€ due to the lack of surprise. For Bob there are two possible scenarios. If he is rational, he also infers the intrinsic utility of 1€ because he properly disentangles it from the reference-dependent component. However, if Bob is a misattributor, he infers a lower intrinsic utility of 1€ due to the negative surprise factor. This is because he attributes some part of the disappointment to the intrinsic value of 1€.

This hypothetical example can go in the opposite direction as well. Getting the high outcome from the coin-flip causes Bob who misattributes to infer a higher intrinsic utility of 3€ compared to both a rational Bob and Alice who also get 3€ (through a coin-flip and with certainty, respectively).

2.1.2 Literature Review

This subsection is devoted to literature evidence supporting the main assumptions of the misattribution model. The first key assumption is that utility is reference dependent. The earliest known paper to illustrate this phenomenon has shown through a series of simple lottery choices that people generally perceive outcomes as gains and losses rather than as final states of wealth (Kahneman and Tversky, 1979). Their ideas serve as a basis for the emergence of subsequent theoretical frameworks (Kőszegi and Rabin, 2006; Tversky and Kahneman, 1991; Sugden, 2003). On an empirical level, there is solid evidence that people exhibit reference-dependent behavior in diverse settings. An example for such behavior is shown in work decisions among taxi drivers (Camerer et al., 1997; Thakral and Tô, 2021; Crawford and Meng, 2008). Another example in a stock market setting shows evidence of a change in people's risk attitudes based on previous outcomes (Post et al., 2008). In another context the importance of reference-dependence is documented through a series of choices involving a trade-off between travel cost and travel time (De Borger and Fosgerau, 2008).

The second key assumption of the misattribution model is that reference points are expectations-based. The literature has convincing experimental and theoretical evidence about that. Theoretically, Kőszegi and Rabin (2006) have introduced the idea that individuals form reference points based on their rational expectations about possible outcomes. Empirically, it has been shown that effort is a function of expectations over wages (Abeler et al., 2011). Other lab studies point out towards the importance of expectations over monetary rewards in affecting risk attitudes (Gill and Prowse, 2012; Song, 2016). On the other hand, there is evidence that setting daily income targets is a typical behavior for New-York taxi drivers (Farber, 2005; Camerer et al., 1997). Overall, the literature supports the importance of expectations in determining reference points.

The third crucial assumption is that attribution bias plays a role. This term is defined as the tendency to attribute a temporary state to a stable property of a consumption good (Gagnon-Bartsch and Bushong, 2019). Evidence in the literature can be seen in diverse settings. For example, a study shows that a transient shock like weather affects subsequent preferences of admissions officers and prospective students (Simonsohn, 2010). According to another study, an unfamiliar beverage is valued more by thirsty participants than by sated ones (Haggag et al., 2019). According to it, fatigue experienced during a course plays a role in students' choice whether to major in a field relevant to this course. These examples provide a clear picture that it is not uncommon for people to attribute external temporary factors to the intrinsic value of a good. This justifies the intention in this paper to explore whether a temporary factor like individual's expectations about an endowment could impact his or her valuation of that endowment.

The rest of the paper proceeds as follows. Section 2.2 presents the misattribution model. Section 2.3 gives a detailed overview of the design of the study. Section 2.4 focuses on the predictions of the misattribution model in our experimental setting. Section 2.5 presents and discusses thoroughly the empirical results of the study. Section 2.6 presents final conclusive remarks.

2.2 Misattribution Model

This model is essentially based on the Kőszegi and Rabin (2006) model. According to it, total utility consists of two components: an intrinsic utility and a reference-dependent utility (also known as a gain-loss utility):

$$u(x|r) = x + \eta n(x|r) \tag{2.1}$$

The intrinsic utility denoted by x is simply the utility an individual receives from consuming the good or service. The reference-dependent component reflects the utility an individual incurs from the degree to which the intrinsic utility of the good or service compares to expectations. It is commonly assumed that the reference-dependent utility is a piece-wise linear function taking on the following form:

$$n(x|r) = \begin{cases} x - r & if \quad x \geq r \\ \lambda(x - r) & if \quad x < r \end{cases}$$

The utility of the expectations-based reference point is denoted by r. The degree of loss aversion is captured by the parameter $\lambda \geq 1$. Loss aversion incorporates the idea that losses loom larger and hurt more than gains of equal size are pleasant. The parameter $\eta > 0$ measures the weight that elation or disappointment carries on total utility.

The misattribution model deviates from the standard reference-dependent model in the additional assumption that the decision maker attributes sensations of surprises (gains or losses) to the intrinsic utility of an outcome. Decision makers correctly recall total utility, but underestimate the contribution of surprises to total utility. This behavior leads to a biased learning and distorted beliefs about the intrinsic value of the outcome. In mathematical terms, elation and disappointment are weighted by a factor $\hat{\eta} \in [0; \eta)$.

Therefore, the decision maker infers the following utility:

$$u(x|r) = \hat{u}(x|r) = \hat{x} + \hat{\eta} n(\hat{x}|r) \tag{2.2}$$

Then, the inferred outcome is given by:

$$\hat{x} = \begin{cases} x + \frac{\eta - \hat{\eta}}{1 + \hat{\eta}}(x - r) & if \quad x \geq r \\ x + \lambda \frac{\eta - \hat{\eta}}{1 + \lambda \hat{\eta}}(x - r) & if \quad x < r \end{cases}$$

An agent who misattributes infers a higher intrinsic utility of the outcome if it exceeds expectations. Similarly, he or she infers a lower intrinsic utility of the outcome if it falls short of expectations. Then, when the agent makes a subsequent decision, he or she maximizes utility based on the inferred intrinsic utility of the outcome.

2.3 Overview of the Experiment

2.3.1 General Overview

A total of 248 participants started and completed the study on an online platform called Prolific. The attrition rate was relatively high: 61 people started the study but did not finish it. In this study participants were divided into two main groups and were endowed money (1€ or 3€). The main difference between the two groups is in the way the amounts were distributed. Expectations over the monetary amounts were manipulated. The first group (called the certainty group for simplicity) received money with certainty. In other words, they were told that they would get a specific amount in the beginning of the study. Half of the participants in this group received 1€ with certainty, while the other half received 3€ with certainty. The second group (called the coin-flip group for simplicity) received money through a coin-flip scenario (1€ with probability 50% and 3€ with probability 50%). So, participants in the second group (coin-flip group) were aware of the existence of both options, while participants in the certainty group were only aware of the existence of the amount to which they were exposed (1€ or 3€, respectively). This issue, related to information difference, is dealt with in Section 2.3.4. The fact that participants in both groups received either 1€ or 3€ led to the emergence of four subgroups: *Cert1*, *Cert3*, *CF1*, *CF3* (standing for participants belonging to the certainty group who received 1€ and 3€, and for those in the coin-flip group who received 1€ and 3€, respectively). These abbreviations are used throughout the chapter for simplicity.

After being endowed a monetary amount, participants faced a distraction activity which took at least 10 minutes to complete. Its significance is explained in Section 2.3.2. Finally, upon completing the distraction activity, participants were asked to solve tedious tasks for various amounts of money.

The goal of the study is to test if participants in the coin-flip scenario misattribute the surprise factor from the outcome to the intrinsic utility of money. To do that, we measure and compare participants' valuation of money by eliciting their willingness to work on tedious tasks. That approach relies on the justified basic assumption that willingness to work and valuation of monetary amounts are positively correlated. In other words, the more a participant values a particular monetary amount, the more he or she is willing to work for it.

2.3.2 Distraction Activity

In essence, the distraction activity is a reading comprehension task in which participants have to read a couple of texts on different topics. It takes place right after participants are endowed a monetary amount. The distraction task functions as a time gap to rule out short-term mood effects caused by the resolution of the coin-flip. The existence of short-term mood effects has been documented in the literature. External factors such as international soccer results and weather can significantly affect investor's mood and behavior (Edmans et al., 2007; Hirshleifer and Shumway, 2003). In a similar fashion the outcome of the coin-flip can potentially lead to transient changes in participants' behavior. For example, getting the low outcome of the lottery could irritate participants and lead to risk-taking attitude immediately after the coin-flip. In addition, the time gap helps readjust participants' reference point. It has been shown that reference points over monetary outcomes adapt within 10 minutes when stakes are low (Song, 2016). This study also revolves around small monetary stakes. Thus, a length of time of minimum 10 minutes for the distraction activity looks like a reasonable choice.

Proceeding from the distraction activity to the tedious task stage of the online study is only allowed after the allotted time has passed. There is a timer on the bottom of the page that displays the remaining time. Participants can stay longer on the page than the allotted time if that is their wish. They are also allowed to take notes.

2.3.3 Tedious Tasks

The purpose of this stage is to see how much participants value monetary amounts. In this stage, participants are first consecutively asked to state the maximum number of tasks (from 1 to 60) that they would do for various monetary amounts (1,2,3, and 4 €), and then depending on their stated willingness to work, they either work on tedious tasks for a reward or do not work and do not receive a reward. In this experiment, a tedious task is counting how many times 1 is used alone in a box in a matrix full of numbers. Here is an example of such a matrix:

0	1	1	1	11	0	1	1	00	10	1	1
0	1	0	1	0	0	0	1	1	1	1	1
0	1	10	1	10	1	1	1	0	1	11	10
0	0	11	1	1	1	1	0	00	1	1	1
1	0	1	00	00	1	1	1	0	1	0	1
1	00	1	1	11	1	0	11	1	10	1	00
1	11	1	1	1	1	0	0	0	0	0	11
10	10	1	1	1	0	1	1	1	1	10	1

Participants have to enter the correct number of times 1 is used alone in a box. They are allowed to make 3 mistakes at most when working on the tasks in order to claim their bonus reward at the end. This restriction makes the tasks tedious and urges participants to be careful when they count.

After stating their willingness to work, the computer randomly selects one of the four possible monetary amounts (1,2,3, or 4 €). Let's call this amount *a*. Then, the computer randomly selects an integer $i \in [1,60]$. Through a standard Becker-Degroot-Marschak method it is determined how many tasks the participant will do for the randomly selected amount *a* €. If that participant's indicated maximum number of tasks for *a* € is greater than *i*, the participant will do *i* tasks in order to receive *a* €. Otherwise, the participant will do no tasks and will receive no reward.

2.3.4 Supplementary Study

The design laid out above may encounter a couple of potential problems. There is information difference between the certainty groups and the coin-flip groups. Those who belong to the certainty groups are aware of the existence of the amount they are directly endowed in the beginning of the study. On the other hand, those who belong to the coin-flip group are aware of the existence of both alternatives (1€ and 3€). This information difference, on the other hand, induces contrast effects. Since participants in the coin-flip group face a range [1,3], they may be prone to either overvaluing 3 relative to 1 or undervaluing 1 relative to 3. These factors can influence participants' prior beliefs about the value of money which could result in either exacerbating or attenuating the effect of misattribution.

In order to address this concern, we add two high-probability groups. In the first high-probability group participants receive 1€ with probability 99% and 3€ with probability 1%. In the second high-probability group participants receive 3€ with probability 99% and 1€ with probability 1%. For simplicity these groups are called *HP1* and *HP3* where the numbers signify the amount participants receive in the high-probability scenario. Participants in both high-probability groups who receive the low-probability outcome are not considered in the analysis. For example, if a participant is assigned to *HP1* and receives 3€ through the lottery, he or she will not be considered in the final analysis. The goal is to compare participants' willingness to work in the high-probability groups to participants' willingness to work in the certainty groups (*HP1* to *Cert1* and *HP3* to *Cert3*). A lack of significant difference in both comparisons would indicate that the potential problems related to difference in information and range would not impact participants' willingness to work across groups. However, detecting a significant difference in either comparison, would suggest that factors such as information difference, contrast effects, or probability weighting might play a role in participants' stated effort levels and have to be addressed.

2.3.5 Data collection

At the end of the study, participants were required to answer some survey questions. These questions ranged from demographic data to subjective ratings on the tediousness of the tasks (from 1 to 10). The demographic data was used in the form of binary control variables to complement the main regressions of the study. *Gender* takes on the value of 1 if the observation relates to a male and 0 if it relates to a female, *Education* takes on the value of 1 if the participant has acquired at least a Bachelor's degree and 0 if not, *Employment* takes on the value of 1 if the participant is currently employed and 0 if not. In addition, participants were asked to choose whether to accept or reject 8 lotteries in a row. The lotteries were associated with earning and losing specific amounts with equal probabilities (50%). The magnitude of the loss was held fixed throughout all the lotteries (-0.5€), while the gain varied from 0.3€ to 2€ in small increasing intervals. These lottery questions aimed to elicit participants' degree of loss aversion. This coefficient varies on the scale from 1 to 8 depending on the number of rejections participants select. For example, rejecting all 8 lotteries labels the respective participant as extremely loss averse, while accepting all 8 lotteries means that loss aversion is not a factor for him or her. In many situations, we observed a lack of monotonicity: participants rejected more favorable lotteries and accepted less favorable. For these cases, we did not assign any coefficient to loss aversion. That results in much fewer observations in our regression analysis that controls for loss aversion.

2.4 Theoretical Predictions

This section shows how a misinferrence of the intrinsic utility of money in our experimental setup leads to different effort levels across groups.[1] We apply the model to the following environmental framework. Let $e_{j,i}$ be the effort level that participant j exerts when he receives an initial endowment i ($i \in \{h(3€), l(1€)\}$). The effort level is observed through willingness to work in terms of the maximum number of tasks the respective participant would do for various amounts under the BDM mechanism whose support is on [0,60]. Let $G_j(e_{j,i})$ be the subjective cumulative distribution func-

[1] In Appendix B.1 we also show the theoretical predictions of the expected utility and the reference-dependent models in order to clearly distinguish them from the misattribution model.

tion over the effort the participant exerts as a result of the BDM mechanism and $g_j(e_{j,i})$ be the probability density function over the effort the participant exerts as a result of the BDM mechanism ($g_j(e_{j,i})$ is the derivative of $G_j(e_{j,i})$ with respect to $e_{j,i}$). Let $c(e_{j,i})$ be cost of effort given an endowment i ($c(\cdot)$ is an increasing function in $e_{j,i}$). Let $\tilde{e}_{j,i}$ be the planned effort level of participant j given endowment i. Participants form their plans in the beginning of the experiment while reading the instructions and stick to their plans after receiving the initial endowment. Thus, participants in the certainty groups form only one plan (since they know about the existence of only one endowment), while participants in the coin-flip groups form two separate plans depending on the possible realizations of the coin-flip (one if they get the low outcome and one if they get the high outcome from the coin-flip). Finally, let m denote the utility from the monetary reward participants receive for working on the tasks. We apply the theoretical model from Section 2.2 and assume linear utility on the monetary dimension. [2]

We start with the low-endowment certainty group. The utility of participants from the initial endowment is given by:

$$U = 1 + \eta n(1|1) = 1 \tag{2.3}$$

Total experienced utility is recalled correctly and then used to infer the intrinsic value of the endowment. In mathematical terms, this is given by:

$$U = 1 = \hat{U} = \hat{x} + \hat{\eta} n(\hat{x}|1) \tag{2.4}$$

Thus, $\hat{x} = 1$. Regardless of the degree of misattribution, participants who receive 1€ with certainty as an initial endowment always infer the intrinsic utility of 1€ due to the absence of surprise.

Next, we consider the high-endowment certainty group. The utility of participants from the initial endowment is given by:

$$U = 3 + \eta n(3|3) = 3 \tag{2.5}$$

Total experienced utility is recalled correctly and then used to infer the intrinsic value of the endowment. In mathematical terms, this is given by:

$$U = 3 = \hat{U} = \hat{x} + \hat{\eta} n(\hat{x}|3) \tag{2.6}$$

[2]This is a plausible assumption in the presence of small and moderate stakes (Kőszegi and Rabin, 2007; Rabin, 2000). Rabin shows that even a small degree of risk aversion for modest stakes would lead to an absurd degree of risk aversion over large stakes.

Thus, $\hat{x} = 3$. Regardless of the degree of misattribution, participants who receive 3€ with certainty as an initial endowment always infer the intrinsic utility of 1€ due to the absence of surprise.

Next, we consider the coin-flip groups. The utility of participants in the low-endowment coin-flip group from the realization of the lottery is given by:

$$U = 1 + 0.5\eta n(1|3) + 0.5\eta n(1|1) \tag{2.7}$$

The equation above reduces to $U = 1 - \eta\lambda$. Total experienced utility is recalled correctly and is then used to infer the intrinsic value of the endowment. In mathematical terms, this is given by:

$$U = \hat{U} = \hat{x} + 0.5\hat{\eta}n(\hat{x}|1) + 0.5\hat{\eta}n(\hat{x}|3) \tag{2.8}$$

This reduces to $\hat{x} = 1 - \lambda(\eta - \hat{\eta})$. Thus, a misattributor infers a lower intrinsic value of 1€.

The utility of participants in the high-endowment coin-flip group from the realization of the lottery is given by:

$$U = 3 + 0.5\eta n(3|3) + 0.5\eta n(3|1) \tag{2.9}$$

It reduces to $u = 3 + \eta$. Total experienced utility is correctly recalled and is used to infer the intrinsic value of the endowment. In mathematical terms, this is:

$$U = \hat{U} = \hat{x} + 0.5\hat{\eta}n(3|1) + 0.5\hat{\eta}n(3|3) \tag{2.10}$$

The equation above reduces to $\hat{x} = 3 + (\eta - \hat{\eta})$. Thus, a misattributor would infer a higher intrinsic value of 3€.

The misattribution of the intrinsic value of the outcome of the coin-flip may translate to a distorted perception of other monetary amounts. Misattributors would therefore treat the utility of the monetary amount m as $\hat{m} > m$ if they received the high initial endowment from the coin-flip and as $\hat{m} < m$ if they received the low initial endowment from the coin-flip.

After the initial endowment phase participants state their willingness to work for additional monetary rewards. That leads to the addition of a second dimension in our reference-dependent framework: effort. Then, the total utility is given by: [3]

[3]Here, we impose a couple of assumptions. The first one is that the expectations-based reference point has readjusted after the time-gap. The evidence in the literature supports the fast adjustment (within 10 minutes) of the reference point in the presence of small stakes (Buffat and Senn, 2015; Song, 2016). In the third chapter of the thesis we delve into the possibility that the reference point exhibits

$$U_j = u_j(i) + \hat{m}G_j(e_{j,i}) - \int_0^{e_{j,i}} c(e')g(e')\,de' \tag{2.11}$$

The first-order condition with respect to effort is given by: $\hat{m}g_j(e_{j,i}) - g_j(e_{j,i})c(e_{j,i}) = 0$. Thus, the optimal effort level would be $c(e^*_{j,i}) = \hat{m}$. For the low-endowment coin-flip group that would be $c(e^*_{j,l}) < m$ and for the high-endowment coin-flip group that would be $c(e^*_{j,h}) > m$. For the certainty groups, the optimal effort level is always given by $c(e^*_{j,l}) = m$ due to the lack of surprise. Therefore, the misattribution model shows that participants in the coin-flip group who receive 3€ would exert greater effort than participants in both certainty groups, while participants in the coin-flip group who receive 1€ would exert a lower effort level than participants in both certainty groups.

2.5 Results and Interpretation

Of the 248 participants who took part in the study and completed it, 165 were assigned to the main study, and 83 were assigned to the supplementary study. The distribution of participants in the main study is the following: 42 took were placed in the certainty group with an initial endowment 1€ (*Cert1*), 39 were placed in the certainty group with an initial endowment 3€ (*Cert3*), 45 were placed in the coin-flip group and received an initial endowment 1€ (*CF1*), and 39 were placed in the coin-flip group and received an initial endowment of 3€ (*CF3*). The distribution of participants in the supplementary study is the following: 43 were placed in the high-probability group with a 99% chance to receive 1€ as an initial endowment (*HP1*), and 41 were placed in the high-probability group with a 99% chance to receive 3€ as an initial endowment (*HP3*). One participant in *HP1* was dropped from the analysis due to receiving 3€ from the lottery.

This section first presents the statistical results, and then a thorough interpretation of the results follows. The results and the interpretation apply for the pooled data (all the data is combined and analyzed all together). The regression results and a thorough analysis for the non-pooled data (when the data for each amount is presented separately) are provided in appendix B.2. The main pooled data regression is given by:

sluggish properties and still incorporates uncertainty from the realization of the coin-flip even after the distraction activity is over. The second assumption is that the reference point on both the effort and money dimensions is the expected value as per Bell(1985). A stochastic reference point as per Kőszegi and Rabin (2006) that accounts for all hypothetical outcomes stemming from the BDM mechanism would lead to huge complications and would not lead to different predictions compared to the case with a fixed reference point (Bushong and Gagnon-Bartsch, 2020). We stick to a deterministic reference point when we show the derivations for alternative models in Appendix B.1.

$$Y_j = \beta_0 + \beta_1 Cert3 + \beta_2 CF1 + \beta_3 CF3 + \beta_4 HP1 + \beta_5 HP3 + \gamma_1 Am2 + \gamma_2 Am3 + \gamma_3 Am4 + u_j \tag{2.12}$$

The independent variables $Cert3$, $CF1$, $CF3$, $HP1$, $HP3$ are all dummy variables taking on the value of 1 if participant j belongs to the respective group and 0 if not. The variables $Am2$, $Am3$, $Am4$ are also dummy variables taking on the value of 1 if the observation is relevant for the respective monetary amount and 0 if not. The dependent variable Y_j is the maximum number of tasks that an individual j would do for each amount. When we pool the data, there are four observations per individual, which results in the necessity to cluster standard errors at the individual level.

2.5.1 Results

Table 2.1 summarizes the results of the pooled data regression with and without additional controls like tediousness, loss aversion, and various demographic data. However, due to a lack of monotonicity in responses eliciting participants' degree of loss aversion, a non-negligible portion of the observations has been dropped from the analysis when controlling for loss aversion.

Table 2.1: Pooled Data Results

	Dependent Variable: WTW				
	(1)	(2)	(3)	(4)	(5)
Cert3	8.42**	8.31**	8.62**	6.35	6.35
	(3.66)	(3.62)	(3.56)	(4.24)	(4.39)
CF1	0.86	0.67	1.56	2.89	1.06
	(3.72)	(3.70)	(3.76)	(4.48)	(4.44)
CF3	0.13	0.35	1.22	-0.43	-0.73
	(3.72)	(3.64)	(3.68)	(4.25)	(4.34)
HP1	2.99	3.13	3.21	5.06	3.74
	(3.52)	(3.46)	(3.47)	(3.83)	(4.00)
HP3	0.07	0.05	0.75	3.34	2.448
	(3.69)	(3.68)	(3.55)	(4.22)	(4.45)
Am2	5.10***	5.10***	5.12***	5.26***	5.26***
	(0.52)	(0.52)	(0.52)	(0.57)	(0.56)
Am3	10.57***	10.57***	10.62***	10.75***	10.75***
	(0.79)	(0.79)	(0.79)	(0.92)	(0.92)
Am4	15.93***	15.93***	16.00***	16.83***	16.83***
	(0.99)	(0.99)	(0.99)	(1.19)	(1.18)
Tediousness		-0.66	-0.61	-0.44	
		(0.40)	(0.41)	(0.48)	
Gender			0.93	-0.03	
			(2.35)	(2.57)	
Education			-2.00	-4.78*	
			(2.44)	(2.86)	
Employment			-2.38	-1.77	
			(2.36)	(2.70)	
Loss Aversion				0.14	
				(0.44)	
_cons	21.83***	24.92***	26.29***	26.28***	21.78***
	(2.41)	(3.02)	(3.46)	(4.52)	(3.05)
N	992	992	988	760	760
R^2	0.11	0.12	0.13	0.14	0.11

[1] Standard errors in parentheses are clustered at the individual level.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[3] Notes: The second column reports the coefficients obtained after regressing WTW on the experimental groups and the reward amounts for the whole sample. The third, fourth, and fifth column add different control variables. The sixth column reports the coefficients from the same regression as in the second column but only for participants whose degree of loss aversion was elicited.

The comparisons of interest for the main study are between *Cert3* (the high-endowment certainty group) and *CF3* (the high-endowment coin-flip group) and between *Cert1* (the low-endowment certainty group) and *CF1* (the low-endowment coin-flip group). In technical terms, that reduces to the coefficient in front of *CF1*, and an equality test between *Cert3* and *CF3*. In none of the regression versions is the coefficient in front of *CF1* significantly different from 0. Thus, we cannot reject the null hypothesis that there is no significant difference between *Cert1* and *CF1* in terms of willingness to work (effort level). However, the F-test of equality between *Cert3* and *CF3* leads to some interesting findings regarding the willingness to work across those two groups. The statistics with and without additional control variables are provided in Table 2.2.[4]

Table 2.2: Statistics for the equality test between *Cert3* and *CF3*

Additional Control	**F-statistic**	**Prob>F**
None	4.32	0.04
Tediousness	4.08	0.04
Demographics + Tediousness	3.45	0.06
Demographics + Tediousness + Loss Aversion	2.31	0.13
None (Reduced Sample)	2.51	0.11

In the case when we add no additional control variables, the high-endowment certainty group exceeds significantly the high-endowment coin-flip group in terms of willingness to work at the 5% significance level. When we add demographic variables and/or tediousness, the difference between these two groups is significant only at the 10% significance level. However, the difference between these two groups is no longer significant when loss aversion is added as a control variable in combination with demographic data and tediousness (p= 0.13). We should check if this drop in significance is due to the smaller sample size or due to the degree of loss aversion. Table 2.1 shows that the coefficient in front of loss aversion is not significantly different from 0 when it is used as a control variable (the fifth column in Table 2.1). Thus, it has no direct effect on willingness to work. The last regression in Table 2.1 is run to test if the degree of loss aversion affects willingness to work indirectly. However, the coefficients in the sixth column do not change significantly compared to the coefficients in the fifth column. This suggests that loss aversion has neither a direct nor an indirect effect on willingness to work. Thus, the smaller sample size when loss aversion is used

[4]Demographics encompasses Gender, Education, and Employment.

as a control variable is responsible for the drop in significance of the difference between the high-endowment certainty and coin-flip groups in terms of willingness to work.

Turning our attention to the supplementary study, we can see some surprising results. Theoretically, the high-probability groups (*HP1* and *HP3*) should not differ substantially from the certainty groups (*Cert1* and *Cert3*) in terms of willingness to work. Indeed, participants in the high-probability group who receive 1€ with probability 99% do not differ from participants in the certainty group who get 1€ in terms of willingness to work in neither of the regressions. That is demonstrated by the coefficients in front of *HP1* in Table 2.1. In none of the regressions is this coefficient significantly different from 0. However, the F-test of equality between *Cert3* and *HP3* shows very interesting results. The statistics with and without additional control variables are provided in Table 2.3.

Table 2.3: Statistics for the equality test between *Cert3* and *HP3*

Additional Control	**F-statistic**	**Prob>F**
None	4.43	0.04
Tediousness	4.30	0.04
Demographics + Tediousness	4.10	0.04
Demographics + Tediousness + Loss Aversion	0.46	0.50
None (reduced sample)	0.73	0.39

Similar to the main study, when we do not control for loss aversion, the high-endowment certainty group exceeds significantly the high-endowment high-probability group in terms of willingness to work at the 5% significance level. When loss aversion is added as a control variable, this difference plummets sharply (p= 0.5). We already established that based on the last regression in Table 2.1, loss aversion does not affect willingness to work neither directly nor indirectly. This suggests that the smaller sample size when loss aversion is used as a control variable is responsible for the drop in significance of the difference between the high-endowment certainty and coin-flip groups in terms of willingness to work. However, the sharp drop in significance indicates that for some reason in the reduced sample participants in the high-endowment high-probability group behave more closely to the high-endowment certainty group. This behavior deserves further attention but is not the main topic of this study.

2.5.2 Discussion

The study was launched as an attempt to investigate whether people misattribute surprises about endowments to the intrinsic value of money. According to the results, we cannot claim that misattribution is a significant factor in this monetary context. First of all, participants in the high-endowment certainty group exhibit on average a significantly greater willingness to work than their counterparts in the high-endowment coin-flip group. Second, participants in the low-endowment certainty group and in the low-endowment coin-flip group do not differ significantly from each in terms of willingness to work. These two results do not allow us to claim that there is a significant misattribution effect.

Even though the null hypothesis is the main contribution of the paper, the experimental results are surprising mainly due to the significant difference between the two certainty groups in terms of willingness to work. These results cannot even be explained by alternative models like the expected utility and the reference-dependent model (presented in Appendix B.1). In Chapter 3 we explore further this finding by investigating the speed of adjustment of the expectations-based reference point. There we show that the results point out towards sluggish properties of the reference point even in the context of small stakes. That finding differs from Song (2016) and Buffat and Senn (2015) who claim that it adjusts fast (within 10 minutes). A thorough discussion on that follows in Chapter 3.

The other surprising finding of the current study is the significant difference between participants in the high-endowment certainty group and participants in the high-endowment high-probability group in terms of willingness to work. The inclusion of a 1% chance of receiving a different outcome should not change the participants' willingness to work substantially. Thus, factors such as probability weighting, contrast effects, or exposure to uncertainty should be taken into consideration in finding out why the high-probability groups resemble the coin-flip groups in terms of willingness to work.

2.6 Conclusion

This paper is the first experimental attempt to investigate whether people misattribute the intrinsic value of money. This is done through manipulating participants' expectations about the endowment they would receive in the beginning of the study and subsequently eliciting their willingness to work for potential monetary rewards. Based on the results, we cannot claim that people misattribute feelings of elation or disappointment to the intrinsic value of money. The misattribution effect cannot be observed in an extreme setting involving a familiar good like money that cannot be immediately consumed. In an economics sense, this is a reassuring finding that would not bring about distortions in spending and buying patterns. For now, the misattribution mechanism is pertinent only to situations involving an unfamiliar good that can be immediately consumed (like effort-level tasks in Bushong and Gagnon-Bartsch's innovative experiment). Although the surprising findings of the main study are addressed in Chapter 3, the supplementary study also yields surprising results that deserve further exploration, particularly on the influence of factors such as exposure to uncertainty, possible contrast effects, and probability weighting in effort decisions.

Chapter 3

The speed of adjustment of the expectations-based reference point

3.1 Introduction

The behavioral economics literature has firmly established the importance of reference points in decisions involving uncertainty (Kahneman and Tversky, 1979). Multiple popular theoretical models use recent expectations as individuals' reference points (Kőszegi and Rabin, 2006, 2009; Bushong and Gagnon-Bartsch, 2016b). However, in a multi-period setting expectations might undergo changes, which can then affect final choices. Thus, it becomes particularly important to know how quickly the expectations-based reference point changes. The empirical evidence on the expectations-based reference point adjustment is scarce, and provides mixed results. In a setting where expectations are exogenously manipulated, studies find that the reference point adjusts within minutes for small stakes (Song, 2016; Buffat and Senn, 2015). In high-stake lottery scenarios, however, or in more crucial life decisions like looking for a job, the reference point tends to be sluggish and needs longer time to reset (Post et al., 2008; DellaVigna et al., 2017; Thakral and Tô, 2021). On top of that, some of the findings in Chapter 2 indicate that the expectations-based reference point might not adjust instantaneously even for small stakes.

This paper tests the speed of the expectations-based reference point adjustment. This is done through an online study on a platform called Prolific. First, we distribute initial endowments to participants either with certainty or through a coin-flip lottery. Then, participants face a distraction activity that varies in length (also called a time gap scenario). Then, we elicit their willingness to work on tasks for various monetary rewards. Finally, based on their stated willingness to work, participants may or may not work on tasks for additional rewards. The goal is to compare participants who received an initial endowment with certainty to those who received the same initial endowment through a coin-flip lottery in each time gap scenario. Although the time difference of 10 and 15 minutes is not sufficient to properly test the dynamics of the reference point, it may allow seeing a difference in its behavior. Our findings suggest that the expectations-based reference point might exhibit sluggish properties even in the presence of small stakes. That contradicts some of the evidence in the literature that support a quick readjustment of the reference point (within 10 minutes) (Song, 2016; Buffat and Senn, 2015).

The paper contributes to the literature not only by evaluating thoroughly the adjustment of the expectations-based reference point in the context of small stakes. It also investigates the dynamics of the expectations-based reference point in an innovative, two-dimensional setting: money and effort. For small stakes, the reference point has only been investigated in the literature over the money dimension (Song, 2016; Buffat and Senn, 2015). DellaVigna et al. (2017) investigate its speed of adjustment over income and effort but in the context of job search in Hungary rather than in a small-stake environment. To the best of our knowledge, the existing literature has not undertaken any steps towards a detailed analysis of the behavior of the expectations-based reference point in the context of small stakes in a two-dimensional setting.

This paper builds thoroughly on the Kőszegi and Rabin (2006) model about reference-dependent preferences. This model is associated with several key assumptions that are supported by extensive empirical and theoretical evidence. The first one is that utility is reference dependent. The earliest known paper to illustrate this phenomenon has shown through a series of simple lottery choices that people generally perceive outcomes as gains and losses rather than as final states of wealth (Kahneman and Tversky, 1979). Kahneman and Tversky's ideas serve as a basis for the emergence of subsequent theoretical frameworks (Kőszegi and Rabin, 2006; Tversky and Kahneman, 1991; Sugden, 2003). On an empirical level, there is solid evidence that people exhibit reference-dependent behavior in diverse settings. An example for such behavior is illustrated by work decisions among taxi drivers (Camerer et al., 1997; Thakral and Tô, 2021; Crawford and Meng, 2008). Another example in a stock market setting shows evidence of a change in people's risk attitudes based on previous outcomes (Post et al., 2008). In another context the importance of reference-dependence is documented through a series of choices involving a trade-off between travel cost and travel time (De Borger and Fosgerau, 2008).

The second key assumption is that reference points are expectations-based. Theoretically, Kőszegi and Rabin (2006) have introduced the idea that individuals form reference points based on their rational expectations about possible outcomes. Empirically, it has been shown that effort is a function of expectations over wages (Abeler et al., 2011). Other lab studies point out towards the importance of expectations over monetary rewards in affecting risk attitudes (Gill and Prowse, 2012; Song, 2016). On the other hand, there is evidence that setting daily income targets is a typical behavior for New-York taxi drivers (Farber, 2005; Camerer et al., 1997). Overall, the literature supports the importance of expectations in determining reference points.

The rest of the paper proceeds as follows. Section 3.2 gives a detailed overview of the design of the study. Section 3.3 focuses on the theoretical predictions of the reference-dependent model. Section 3.4 presents the empirical results of the study. Section 3.5 discusses thoroughly the results. Section 3.6 presents final conclusive remarks.

3.2 Overview of the Experiment

3.2.1 General Overview

A total of 165 participants started and completed the study on an online platform called Prolific [1]. The attrition rate was relatively high: 37 people started the study but did not finish it. In this study participants were divided into two main groups and were endowed money (1€ or 3€). The main difference between the two groups is in the way the amounts were distributed. Expectations over the monetary amounts were manipulated. The first group (called the certainty group for simplicity) received money with certainty. In other words, they were told that they would get a specific amount in the beginning of the study. Half of the participants in this group received 1€ with certainty, while the other half received 3€ with certainty. The second group (called the coin-flip group for simplicity) received money through a coin-flip scenario (1€ with probability 50%, and 3€ with probability 50%). The fact that participants in both groups received either 1€ or 3€ led to the emergence of four subgroups: *Cert1*, *Cert3*, *CF1*, *CF3* (standing for participants belonging to the certainty group who received 1€ and 3€, and for those in the coin-flip group who received 1€ and 3€, respectively). These abbreviations are used throughout the chapter for simplicity.

After being endowed a monetary amount, participants faced a distraction activity. Its significance is explained in Section 3.2.2. Approximately, half of the participants in each treatment group faced a distraction activity that lasted at least 10 minutes, and the other half faced a distraction activity that lasted at least 15 minutes. Finally, upon completing the distraction activity, participants were asked to solve tedious tasks

[1]The whole study actually recruited 248 participants. 83 participants, however, took part in a supplementary study which is discussed in Chapter 2

for various amounts of money. The goal of the study is to compare participants' willingness to work on tedious tasks across the certainty and coin-flip groups in the 15-min and in the 10-min time gap scenario.

3.2.2 Distraction Activity

In essence, the distraction activity is a reading comprehension task in which participants have to read a couple of texts on different topics. It takes place right after participants are endowed a monetary amount. The distraction task functions as a time gap to rule out short-term mood effects caused by the resolution of the coin-flip. The existence of short-term mood effects has been documented in the literature. External factors such as international soccer results and weather can significantly affect investor's mood and behavior (Edmans et al., 2007; Hirshleifer and Shumway, 2003). In a similar fashion the outcome of the coin-flip can potentially lead to transient changes in participants' behavior. For example, getting the low outcome of the lottery could irritate participants and lead to risk-taking attitude immediately after the coin-flip. In addition, the time gap helps readjust participants' reference point. The different lengths of the distraction activity (10 and 15 minutes, respectively) serve to indicate to what extent the expectations-based reference point has readjusted after the resolution of the coin-flip.

Proceeding from the distraction activity to the tedious task stage of the online study is only allowed after the allotted time has passed (10 or 15 minutes, respectively). There is a timer on the bottom of the page that displays the remaining time. Participants can stay longer on the page with the texts than the allotted time if that is their wish. They are also allowed to take notes.

3.2.3 Tedious Tasks

The purpose of this stage is to see how much participants value monetary amounts. In this stage, participants are first consecutively asked to state the maximum number of tasks (from 1 to 60) that they would do for various monetary amounts (1,2,3, and 4 €), and then depending on their stated willingness to work, they either work on tedious tasks for a reward, or do not work and do not receive a reward. In this experiment, a tedious task is counting how many times 1 is used alone in a box in a matrix full of numbers. Here is an example of such a matrix:

0	1	1	1	11	0	1	1	00	10	1	1
0	1	0	1	0	0	0	1	1	1	1	1
0	1	10	1	10	1	1	1	0	1	11	10
0	0	11	1	1	1	1	0	00	1	1	1
1	0	1	00	00	1	1	1	0	1	0	1
1	00	1	1	11	1	0	11	1	10	1	00
1	11	1	1	1	1	0	0	0	0	0	11
10	10	1	1	1	0	1	1	1	1	10	1

Participants have to enter the correct number of times 1 is used alone in a box. They are allowed to make 3 mistakes at most when working on the tasks in order to claim their bonus reward at the end. This restriction makes the tasks tedious and urges participants to be careful when they count.

After stating their willingness to work, the computer randomly selects one of the four possible monetary amounts (1,2,3, or 4 €). Let's call this amount a. Then, the computer randomly selects an integer $i \in [1,60]$. Through a standard Becker-Degroot-Marschak method it is determined how many tasks the participant will do for the randomly selected amount a €. If that participant's indicated maximum number of tasks for a € is greater than or equal to i, the participant will do i tasks in order to receive a €. Otherwise, the participant will do no tasks and will receive no reward.

3.2.4 Data collection

At the end of the study, participants were required to answer some survey questions. These questions ranged from demographic data to subjective ratings on the tediousness of the tasks (from 1 to 10). The demographic data was used in the form of binary control variables to complement the main regressions of the study. *Gender* takes on the value of 1 if the observation relates to a male and 0 if it relates to a female, *Education* takes on the value of 1 if the participant has acquired at least a Bachelor's degree and 0 if not, *Employment* takes on the value of 1 if the participant is currently employed and 0 if not. In addition, participants were asked to choose whether to accept or reject 8 lotteries in a row. The lotteries were associated with earning and losing specific amounts with equal probabilities (50%). The magnitude of the loss was held fixed throughout all the lotteries (-0.5€), while the gain varied from 0.3€ to 2€ in small increasing intervals. These lottery questions aimed to elicit participants' degree of loss aversion. This coefficient varies on the scale from 1 to 8 depending on the number of rejections participants select. For example, rejecting all 8 lotteries labels the respective participant as extremely loss averse, while accepting all 8 lotteries means that loss aversion is not a factor for him or her. In many situations, we observed a lack of monotonicity: participants rejected more favorable lotteries and accepted less favorable. For these cases, we did not assign any coefficient to loss aversion. That results in much fewer observations in our regression analysis that controls for loss aversion.

3.3 Reference-Dependent Preferences Model

This section outlines the theoretical predictions of the Kőszegi and Rabin model, one of the leading models using expectations as reference points. The model shows that depending on the speed of the reference point adjustment, we could observe differences in willingness to work across treatments. If the reference point assimilates immediately new information (adjusts fast), the predictions of the Kőszegi and Rabin model show no difference in the effort level (willingness to work) across treatments in the respective time gap scenario. However, if the reference point does not assimilate immediately new information (exhibits sluggishness), then we might observe a difference between the coin-flip and certainty groups in terms of effort level (willingness to work) in the respective time gap scenario. We show consecutively the predictions of the model for an instantaneously-adjusting and for a sluggish reference point. Before we show how the predictions are derived, we lay out the basic framework of the reference-dependent preferences model along with the design-specific environment.

3.3.1 Setup

According to the the reference-dependent preferences model, the overall utility consists of two components: an intrinsic utility and a reference-dependent utility (also known as a gain-loss utility):

$$u(x|r) = u(x) + \eta n(x|r) \tag{3.1}$$

The intrinsic utility denoted by x is simply the utility an individual receives from consuming the good or service. The reference-dependent component reflects the utility an individual incurs from the degree to which the intrinsic utility of the good or service compares to expectations. It is commonly assumed that the reference-dependent utility is a piece-wise linear function taking on the following form:

$$n(x|r) = \begin{cases} x - r & if \quad x \geq r \\ \lambda(x - r) & if \quad x < r \end{cases}$$

The utility of the expectations-based reference point is denoted by r. The degree of loss aversion is captured by the parameter $\lambda \geq 1$. Loss aversion incorporates the idea that losses loom larger and hurt more than gains of equal size are pleasant. The parameter $\eta > 0$ measures the weight that elation or disappointment carries on total utility.

The reference-dependent preferences model is applied to the following environment. Let $e_{j,i}$ be the effort level (willingness to work) that participant j states when he receives an initial endowment i ($i \in \{l(1€), h(3€)\}$). Let $G_j(e_{j,i})$ be the subjective cumulative distribution function over the effort the participant states as a result of the BDM mechanism and $g_j(e_{j,i})$ be the probability density function over the effort the participant states as a result of the BDM ($g_j(e_{j,i})$ is the derivative of $G_j(e_{j,i})$ with respect to $e_{j,i}$). Let $c(e_{j,i})$ be cost of effort given an endowment i ($c(\cdot)$ is an increasing function in $e_{j,i}$). Let $\tilde{e}_{j,i}$ be participant j's planned effort level given endowment i. Participants form their plans in the beginning of the experiment while reading the instructions and stick to their plans after receiving the initial endowment. Thus, participants in the certainty groups form only one plan (since they know about the existence of only one endowment), while participants in the coin-flip groups form two separate plans depending on the possible realizations of the coin-flip (one if they get the low outcome and one if they get the high outcome from the coin-flip). Finally, let m denote the utility from the monetary reward participants receive for working on the tasks.

3.3.2 Predictions

For simplicity we show the predictions of a fully adjusted reference point and a fully sluggish reference point. Based on these predictions we could state whether our results lie closer to an instantaneously adjusting or a sluggish reference point

Instantaneously adjusting reference point

A fast adjusting reference point adapts to new information immediately. For example, in our setup that would mean that upon receiving the initial endowment the expectations-based reference point of participants belonging to the coin-flip group sets to the outcome of the lottery and does not incorporate any more uncertainty stemming from the coin-flip. In our setup we could only infer about the dynamics of the reference point when participants' willingness to work is elicited after the distraction task takes place. If the reference point adjusts between receiving the endowment and eliciting willingness to work (i.e. within the length of the time gap scenario), participants in the coin-flip groups face no gain-loss utility terms neither on the money nor on the effort dimension. Participants in the certainty groups are not affected by the speed of adjustment of the reference point since they face no lottery and no surprise when they receive their initial endowment. Due to the absence of surprise they also do not face gain-loss utility terms on neither dimension. Thus, participants in both groups derive utility only from consumption.

Participant *j* who has been endowed an amount *i* chooses an optimal effort level $e_{j,i}$ to maximize the following expected reference-dependent utility [2]:

$$E[u_j(e_{j,i})] = [1 - G_j(e_{j,i})]u_j(i) + G_j(e_{j,i})u_j(i+m) - \int_0^{e_{j,i}} c(e')g(e')\,de' \qquad (3.2)$$

Assuming linear utility on the money dimension this would reduce to [3]:

$$E[u_j(e_{j,i})] = i + mG_j(e_{j,i}) - \int_0^{e_{j,i}} c(e')g(e')\,de' \qquad (3.3)$$

The first-order condition with respect to $e_{j,i}$ is given by: $mg_j(e_{j,i}) - c(e_{j,i})g_j(e_{j,i}) = 0$. That leads to an optimal effort level (willingness to work) $c(e^*_{j,i}) = m$. Expectations over money do not affect learning, so the effort level does not depend on whether the participant received the endowment through a coin-flip or with certainty. Thus, participants in all groups exert the same effort.

Sluggish reference point

A sluggish reference point fails to assimilate new information immediately. For example, in our setup that would mean that upon receiving the initial endowment the expectations-based reference point of participants belonging to the coin-flip group does not set to the outcome of the lottery and still incorporates uncertainty stemming from the coin-flip. Participants in the certainty groups are not affected by the stickiness of the reference point since they face no lottery and no surprise when they receive their initial endowment. Thus, they choose an effort level that maximizes the same expected utility as in the case with an instantaneously adjusting reference point ($c(e^*_{j,i}) = m$). Therefore, in our experimental setup participants in the certainty groups exhibit the same effort level regardless of the time gap scenario.

However, for the coin-flip groups the presence of a sluggish reference point induces gain-loss utility terms that can have a substantial impact. The gain loss-utility on the

[2]Here, we rely heavily on the assumption that the reference point on both the effort and money dimensions is the expected value as per Bell (1985). A stochastic reference point as per Kőszegi and Rabin(2006) that accounts for all hypothetical outcomes stemming from the BDM mechanism would lead to huge complications and would not lead to different predictions compared to the case with a fixed reference point(Bushong and Gagnon-Bartsch, 2020)

[3]This is a plausible assumption in the presence of small and moderate stakes (Kőszegi and Rabin, 2007; Rabin, 2000). Rabin shows that even a small degree of risk aversion for modest stakes would lead to an absurd degree of risk aversion over large stakes.

money dimension is given by:

$$GL_{money,j} = 0.5\eta n[mG_j(e_{j,i}) + i - mG_j(\tilde{e}_{j,l}) - 1] + 0.5\eta n[mG_j(e_{j,i}) + i - mG_j(\tilde{e}_{j,h}) - 3]$$

Similarly, on the effort dimension the gain-loss utility takes on the following form:

$$GL_{effort,j} = 0.5\eta n[-\int_0^{e_{j,i}} c(e')g(e')\,de' + \int_0^{\tilde{e}_{j,l}} c(e')g(e')\,de']$$
$$+ 0.5\eta n[-\int_0^{e_{j,i}} c(e')g(e')\,de' + \int_0^{\tilde{e}_{j,h}} c(e')g(e')\,de']$$

Let's look at each coin-flip group separately and see how their beliefs affect their total utilities and optimal effort levels. The total expected reference-dependent utility is formed by adding the gain-loss utilities on the money and effort dimension to the expected consumption utilities on the money and effort dimension.

Low-endowment coin-flip group (*CF1*)

The total utility of participants in this group is given by:

$$U_j = 1 + mG_j(e_{j,l}) - \int_0^{e_{j,l}} c(e')g(e')\,de' + 0.5\eta n[1 + mG_j(e_{j,i}) - 3 - mG_j(\tilde{e}_{j,h})]$$

$$+ 0.5\eta n[-\int_0^{e_{j,l}} c(e')g(e')\,de' + \int_0^{\tilde{e}_{j,h}} c(e')g(e')\,de'] \tag{3.4}$$

There are five distinct cases about participants' planned effort levels that impact the optimal effort level:

1. $\tilde{e}_{j,l} < \tilde{e}_{j,h}$

The first-order condition is then: $mg_j(e_{j,l}) - g_j(e_{j,l})c(e_{j,l}) + 0.5\eta\lambda m g_j(e_{j,l}) - 0.5\eta g_j(e_{j,l})c(e_{j,l}) = 0$. Thus, the optimal effort level is: $c({e^*}_{j,l}) = \frac{m(1+0.5\eta\lambda)}{(1+0.5\eta)}$. In that case, in the presence of loss aversion ($\lambda > 1$), participants in the coin-flip group who receive 1€ exert greater effort than their counterparts in the certainty group who also receive 1€.

2. $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) = 3 + mG_j(\tilde{e}_{j,h})$

The first-order condition is then: $mg_j(e_{j,l}) - g_j(e_{j,l})c(e_{j,l}) - 0.5\eta\lambda c(e_{j,l})g_j(e_{j,l}) = 0$. Thus, the optimal effort level is: $c({e^*}_{j,l}) = \frac{m}{(1+0.5\eta\lambda)}$. In that case, in the presence of loss aversion ($\lambda > 1$), participants in the coin-flip group who receive 1€ exert less effort than their counterparts in the certainty group who also receive 1€.

3. $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) < 3 + mG_j(\tilde{e}_{j,h})$

The first-order condition is then: $mg_j(e_{j,l}) - g_j(e_{j,l})c(e_{j,l}) + 0.5\eta\lambda mg_j(e_{j,l}) - 0.5\eta\lambda g_j(e_{j,l})c(e_{j,l}) = 0$. Thus, the optimal effort level is: $c(e^*{}_{j,l}) = m$. In that case, participants in both the low-endowment coin-flip and the low-endowment certainty groups exert the same effort level.

4. $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG(\tilde{e}_{j,l}) > 3 + mG(\tilde{e}_{j,h})$

The first-order condition is then: $mg_j(e_{j,l}) - g_j(e_{j,l})c(e_{j,l}) + 0.5\eta mg_j(e_{j,l}) - 0.5\eta\lambda g_j(e_{j,l})c(e_{j,l}) = 0$. Thus, the optimal effort level is: $c(e^*{}_{j,l}) = \frac{m(1+0.5\eta)}{(1+0.5\eta\lambda)}$. In that case, in the presence of loss aversion ($\lambda > 1$), participants in the coin-flip group who receive 1€ exert less effort level than their counterparts in the certainty group who also receive 1€.

5. $\tilde{e}_{j,l} = \tilde{e}_{j,h}$

The first-order condition with respect to $e_{j,l}$ is then: $mg_j(e_{j,l}) - c(e_{j,i})g_j(e_{j,l}) + 0.5\eta\lambda mg_j(e_{j,l}) = 0$. Thus, the optimal effort level is: $c(e^*_{j,l}) = m(1 + 0.5\eta\lambda)$. In that case, participants in the coin-flip who receive 1€ exert more effort than their counterparts in the certainty group who also receive 1€.

High-endowment coin-flip group (*CF3*)

The total utility of participants in this group is given by:

$$U_j = 3 + mG_j(e_{j,h}) - \int_0^{e_{j,h}} c(e')g(e')\,de' + 0.5\eta n[3 + mG_j(e_{j,h}) - 1 - mG_j(\tilde{e}_{j,l})]$$

$$+0.5\eta n[-\int_0^{e_{j,h}} c(e')g(e')\,de' + \int_0^{\tilde{e}_{j,l}} c(e')g(e')\,de'] \tag{3.5}$$

The five distinct cases about participants' planned effort levels are:

1. $\tilde{e}_{j,l} < \tilde{e}_{j,h}$

The first-order condition is then: $mg_j(e_h) - g_j(e_h)c(e_{j,h}) + 0.5\eta mg_j(e_{j,h}) - 0.5\eta\lambda g_j(e_{j,h})c(e_{j,h}) = 0$. Thus, the optimal effort level: $c(e^*{}_{j,h}) = \frac{m(1+0.5\eta)}{(1+0.5\eta\lambda)}$. In that case, in the presence of loss aversion ($\lambda > 1$), participants in the coin-flip group who receive 3€ exert less effort than their counterparts in the certainty group who also receive 3€.

2. $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) = 3 + mG_j(\tilde{e}_{j,h})$

The first-order condition is then: $mg_j(e_{j,h}) - g_j(e_{j,h})c(e_{j,h}) - 0.5\eta\lambda c(e_{j,h}) = 0$. Thus, the optimal effort level is: $c({e^*}_{j,h}) = \frac{m}{(1+0.5\eta\lambda)}$. In that case, in the presence of loss aversion ($\lambda > 1$), participants in the coin-flip group who receive 3€ exert less effort than their counterparts in the certainty group who also receive 3€.

3. $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) < 3 + mG_j(\tilde{e}_{j,h})$

The first-order condition is then: $mg_j(e_{j,h}) - g_j(e_{j,l})c(e_{j,h}) + 0.5\eta m g_j(e_{j,h}) - 0.5\eta g_j(e_{j,h})c(e_{j,h}) = 0$. Thus, the optimal effort level is: $c({e^*}_{j,h}) = m$. In that case, participants in both the coin-flip and certainty group who receive 3€ exert the same effort.

4. $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) > 3 + mG_j(\tilde{e}_{j,h})$

The first-order condition is then: $mg_j(e_{j,h}) - g_j(e_{j,h})c(e_{j,h}) + 0.5\eta\lambda m g_j(e_{j,h}) - 0.5\eta g_j(e_{j,h})c(e_{j,h}) = 0$. Thus, the optimal effort level is: $c({e^*}_{j,h}) = \frac{m(1+0.5\eta\lambda)}{(1+0.5\eta)}$. In that case, in the presence of loss aversion ($\lambda > 1$), participants in the coin-flip group who receive 3€ exert greater effort than their counterparts in the certainty group who also receive 3€.

5. $\tilde{e}_{j,l} = \tilde{e}_{j,h}$

The first-order condition is then: $mg_j(e_{j,h}) - c(e_{j,h})g_j(e_{j,h}) + 0.5\eta m g_j(e_{j,h}) = 0$. Thus, the optimal effort level is: $c(e^*_{j,h}) = m(1+0.5\eta)$. In that case, participants in the coin-flip who receive 3€ exert more effort than their counterparts in the certainty group who also receive 3€.

In summary, participants' planned effort levels in the different endowment scenarios might lead to different optimal effort. According to the derivations above, for $\tilde{e}_{j,l} \leq \tilde{e}_{j,h}$ participants in the low-endowment coin-flip group would exert greater effort than their counterparts in the low-endowment certainty group, for $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) \geq 3 + mG_j(\tilde{e}_{j,h})$ participants in the low-endowment coin-flip group would exert less effort than their counterparts in the low-endowment certainty group, and for $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) < 3 + mG_j(\tilde{e}_{j,h})$ participants in the low-endowment coin-flip group and in the low-endowment certainty group would exert the same effort. In the high-endowment scenario, for $\tilde{e}_{j,l} < \tilde{e}_{j,h}$ or for $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) = 3 + mG_j(\tilde{e}_{j,h})$, participants in the high-endowment coin-flip group would exert less effort than their counterparts in the high-endowment certainty group, for $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) > 3 + mG_j(\tilde{e}_{j,h})$ or for $\tilde{e}_{j,l} = \tilde{e}_{j,h}$ participants in the high-endowment coin-flip group would exert greater effort than their counterparts in the high-endowment certainty group, and for $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) < 3 + mG_j(\tilde{e}_{j,h})$ participants in both the high-endowment coin-flip group and in the high-endowment certainty group would exert the same effort.

In our experimental setup the comparisons of interest are between the equally-endowed certainty and coin-flip groups in terms of effort level (willingness to work) in each time gap scenario. Within the reference-dependent framework, a significant difference between these groups in any of the time gap scenarios would indicate that for that time gap scenario the reference point has still not adjusted to the new information after the resolution of the coin-flip. On the other hand, a lack of significant difference could indicate either a fast adjustment to the new information or sluggishness for $\tilde{e}_{j,l} > \tilde{e}_{j,h}$ and $1 + mG_j(\tilde{e}_{j,l}) < 3 + mG_j(\tilde{e}_{j,h})$. Thus, detecting no significant difference between the coin-flip and certainty groups would not allow us to state confidently whether the reference point is sluggish or adjusts fast. In such a situation we would stick to the prevailing evidence in the literature that the reference point readjusts fast (Buffat and Senn, 2015; Song, 2016).

3.4 Results

165 participants took part in the online study and completed it. The distribution of participants in the study is the following: 42 were placed in the certainty group with an initial endowment 1€ (*Cert1*), 39 were placed in the certainty group with an initial endowment 3€ (*Cert3*), 45 were placed in the coin-flip group and received an initial endowment 1€ (*CF1*), and 39 were placed in the coin-flip group and received an initial endowment of 3€ (*CF3*). Out of the 165 participants who took part in the study, 22 in *Cert1*, 19 in *Cert3*, 21 in *CF1*, and 20 in *CF3* were exposed to the 10-min distraction activity, while the remaining 20 in *Cert1*, 20 in *Cert3*, 23 in CF1, and 19 in *CF3* faced the 15-min distraction activity.

Tables 3.1 and 3.2 below present the regression results for the 10-min and 15-min time gap scenarios.

Table 3.1: Regression Results (10-min time gap)

	Dependent Variable: WTW				
	(1)	(2)	(3)	(4)	(5)
Cert3	3.62	3.62	3.56	0.14	-0.54
	(5.45)	(5.46)	(5.58)	(7.19)	(7.07)
CF1	-1.65	-1.38	-1.39	0.29	-0.54
	(5.48)	(5.60)	(5.65)	(7.21)	(7.00)
CF3	-1.17	-1.23	-0.11	-1.33	-1.10
	(4.98)	(4.94)	(5.15)	(6.69)	(6.42)
Am2	5.20***	5.20***	5.26***	4.51***	4.51***
	(0.91)	(0.91)	(0.92)	(1.02)	(1.01)
Am3	10.57***	10.57***	10.70***	10.58***	10.58***
	(1.16)	(1.16)	(1.17)	(1.38)	(1.37)
Am4	15.56***	15.56***	15.75***	16.58***	16.58***
	(1.82)	(1.83)	(1.85)	(2.35)	(2.32)
Tediousness		0.21	0.47	1.46	
		(0.75)	(0.79)	(1.10)	
Gender			0.45	-3.11	
			(4.64)	(5.89)	
Education			0.84	-3.01	
			(4.29)	(5.77)	
Employment			1.12	-0.12	
			(4.48)	(5.80)	
Loss Aversion				1.36	
				(0.99)	
_cons	20.12***	19.11***	16.64**	10.88	19.95***
	(3.14)	(5.05)	(6.36)	(9.65)	(4.81)
N	328	328	324	228	228
R^2	0.09	0.09	0.10	0.14	0.09

[1] Standard errors in parentheses are clustered at the individual level.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[3] Notes: The second column reports the coefficients obtained after regressing WTW on the experimental groups and the reward amounts for participants facing the 10-min time gap. The third, fourth, and fifth column add different control variables. The sixth column reports the coefficients from the same regression as in the second column but only for the fraction of participants whose degree of loss aversion was elicited.

Table 3.2: Regression Results (15-min time gap)

	Dependent Variable: WTW				
	(1)	(2)	(3)	(4)	(5)
Cert3	12.71***	12.16***	13.59***	12.91**	11.52**
	(4.59)	(4.44)	(4.30)	(4.89)	(5.02)
CF1	2.66	3.66	5.59	6.13	2.47
	(5.08)	(4.81)	(4.91)	(5.50)	(5.66)
CF3	1.41	2.03	1.25	-0.14	-0.25
	(5.52)	(5.06)	(5.32)	(5.86)	(5.96)
Am2	5.01***	5.01***	5.01***	5.32***	5.32***
	(0.91)	(0.91)	(0.91)	(0.95)	(0.94)
Am3	11.35***	11.35***	11.35***	11.90***	11.90***
	(1.19)	(1.20)	(1.20)	(1.32)	(1.31)
Am4	16.83***	16.83***	16.83***	17.74***	17.74***
	(1.48)	(1.49)	(1.49)	(1.64)	(1.62)
Tediousness		-1.59**	-1.60**	-1.40*	
		(0.65)	(0.66)	(0.75)	
Gender			3.11	3.03	
			(3.99)	(4.33)	
Education			-4.11	-4.84	
			(4.42)	(5.30)	
Employment			-4.36	-4.47	
			(4.03)	(4.94)	
Loss Aversion				-0.17	
				(0.64)	
_cons	23.39***	30.47***	32.96***	32.55***	22.98***
	(3.70)	(4.46)	(5.05)	(5.97)	(3.96)
N	332	332	332	276	276
R^2	0.18	0.24	0.27	0.27	0.19

[1] Standard errors in parentheses are clustered at the individual level.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[3] Notes: The second column reports the coefficients obtained after regressing WTW on the experimental groups and the reward amounts for participants facing the 15-min time gap. The third, fourth, and fifth column add different control variables. The sixth column reports the coefficients from the same regression as in the second column but only for the fraction of participants whose degree of loss aversion was elicited.

We are interested in comparing the certainty groups to the coin-flip groups that receive the same initial endowment in each time gap scenario. That means that in Tables 3.1 and 3.2 we are interested in the coefficients in front of *CF1* and in the F-tests of equality between *Cert3* and *CF3* in each time gap scenario. The coefficients in front of *CF1* are not significantly different from 0 neither in the 10-min time gap scenario nor in the 15-min time gap scenario in any of the regression versions. However, in the 10-min time gap case they vary from -1.65 to 0.29 while in the 15-min time gap case the range is from 2.47 to 6.13. There is a clear move towards an increase in effort (willingness to work) in the 15-min time gap scenario in spite of the insignificant effect. However, the F-test of equality between *Cert3* and *CF3* yields more interesting results. In the 10-min time gap case, the equality test between these two groups indicates no significant difference in terms of willingness to work in neither of the regressions (p-values range from 0.41 to 0.94). However, in the 15-min time gap case, the equality test between these two groups indicates a significant difference in terms of willingness to work at the 5% significance level in any of the regressions (p-values range from 0.02 to 0.04).

3.5 Discussion

The results do not fully fit the predictions of the reference-dependent framework. The main reason for this is that the different certainty groups do not exert the same effort. Thus, we will compare separately the certainty and coin-flip groups in each time gap scenario. Then, detecting a significant difference in terms of willingness to work would be indicative of a sluggish behavior.

For the low-endowment groups, although there is no significant difference between the certainty and coin-flip groups neither in the 10-min time gap scenario nor in the 15-min time gap scenario in terms of willingness to work, the increase of the coefficients in front of *CF1* as the time gap lasts longer points out towards a sluggish reference point. It should be noted that the high variation of the dependent variable (ranging from 1 to 60) compared to the low variation of the independent dummy variables (taking on values of 0 or 1) makes it harder to detect a significant difference between the certainty and coin-flip groups in terms of willingness to work when the sample is not large. Increasing the sample size of participants, especially those exposed to the low initial endowment, would give us a greater confidence about the behavior of the reference point in the low-endowment context. We could still observe a sluggish reference point when there is no significant difference between the certainty and coin-flip groups in terms of willingness to work. However, based on the current findings, we cannot reject a fast-adjusting reference point in the low-endowment scenario.

For the high-endowment groups, the results seem more interesting. There is a huge jump in willingness to work for participants in the high-endowment certainty group from the 10-min time gap to the 15-min time gap in any of the regressions. In addition, there is a significant difference in willingness to work between participants in the certainty group and participants in the coin-flip group in the 15-min time gap scenario. These results point out towards a sluggish reference point, and suggest that it undergoes a serious change between the 10^{th} and the 15^{th} minute during the distraction activity. On the other hand, the lack of significant difference in willingness to work between participants in the certainty group and participants in the coin-flip group in the 10-min time gap scenario is in line with a fast adjustment within a period of 10 minutes. However, it is highly implausible for the reference point to adjust fast (within 10 minutes) after the realization of the coin-flip, and then deviate again to incorporating the coin-flip lottery when there are no resolutions of uncertainty in between. A plausible explanation that accounts for our findings is that the reference point does not immediately adjust to the lottery of the coin-flip. In other words, participants still have some persistent priors from before the experiment. Then, between the 10^{th} and the 15^{th} minute during the distraction activity the reference point adjusts to the lottery of the coin-flip.

It has already been suggested in the literature that the reference point takes time to respond to new information (Thakral and Tô, 2021). They show that taxi drivers gradually incorporate earlier incomes during the day into their reference point. However, our finding differs from previous empirical works investigating the speed of the reference point in the context of small stakes. Song (2016) and Buffat and Senn (2015) claim that the reference point adjusts within 10 minutes in the presence of small stakes. It should be noted here that their designs differ substantially from ours, which could bring about differences in results. For example, Song informs participants 24 hours in advance what amounts they would receive from the study and in what way (with certainty or through a lottery). In our study, information on probabilities of the outcomes is immediately followed by the outcome. The different timing of the instructions could explain why in Song's study participants who receive money through a lottery exhibit different risk attitudes depending on the time they are elicited. Song's investigation of the speed of the reference point gives more time to participants to assimilate the probability distribution of the outcomes and thus update their expectations accordingly. On the other hand, Buffat and Senn (2015) resort to an empirical study in which participants play a lottery approximately 15 minutes after reading the instructions and their willingness to pay for a second lottery is elicited almost immediately after that. Still, they find a fast adjustment of the reference point supported by a lack of difference in willingness to pay for the second lottery across treatment groups. Both of these empirical papers test the speed of the reference point in a one-dimensional monetary context. Participants interact only with monetary endowments and lotteries. In our study, we add effort level as an additional complication (due to its possible interaction with monetary rewards) to test the speed of the reference point. That could be a possible explanation for the different behavior of the expectations-based reference point in our study.

It is worthwhile discussing what could drive our results in both endowment scenarios. More specifically, we should discuss why participants' reference point behaves sluggishly in the high-endowment scenario and seems to instantaneously adjust in the low-endowment scenario (although a sluggish reference point cannot be completely ruled out) in the context of a reference-dependent framework. One possible explanation could be due to an interaction between the reference point and the initial endowment. Negative surprise caused by the coin-flip may lead to a desire to stop feeling the sensation of disappointment quickly. Thus, people tend to adjust their reference point faster to the new information (outcome = 1€). Positive surprise, on the other hand, may lead to a desire to prolong the feeling of being lucky. Thus, participants tend to adjust their reference point more slowly, so that they can enjoy the pleasant surprise for a longer period. Thus, instead of adjusting to the new information (outcome = 3€), the reference point still incorporates uncertainty from the lottery.

The theoretical framework discussed in the previous section assumes that participants form priors about how much they will work on the tasks in the beginning (while reading the instructions) and will stick to their plans when they receive the endowment. Allowing participants to deviate from their plans could explain our puzzling difference in willingness to work between the different certainty groups. The predictions of a reference-dependent model that allows participants to deviate from their initial plans upon receiving their endowment is presented in Appendix C. However, it should be noted that any results could be explained within that framework, and thus it does not provide a tight explanation for our findings. Further research should aim at investigating the plausibility of including the element of deviations from initial plans in the reference-dependent model.

3.6 Conclusion

This paper is the first empirical attempt to investigate the speed and evolution of the expectations-based reference point in a two-dimensional setting: money and effort. This is done through manipulating participants' expectations about the endowment they would receive in the beginning of the study, varying the length of the time gap after the endowment, and eliciting participants' willingness to work after the gap. Even though the findings do not completely fit the predictions of the reference-dependent framework, they indicate a sluggish reference point in the high-endowment scenario. The most plausible explanation is that in the high-endowment scenario the reference point does not immediately adjust to the lottery of the coin-flip. Then, between the 10^{th} and the 15^{th} minute during the distraction activity the reference point adjusts to the coin-flip lottery. In the low-endowment scenario there is also a tendency towards deviation of the reference point between 10 and 15 minutes after the coin-flip outcome, although its effect is insignificant. The finding in the high-endowment scenario deserves specific attention because it contradicts the predominant claims in the literature that for small-stake lotteries the reference point adjusts instantaneously. Whether the specific nature of our design focusing on two dimensions of the reference point is at least partially responsible for that could be a topic for further research. Additional direction for future work is investigating how long it would take the reference point to readjust back to its initial state- something that we could not observe in the current paper. Last but not least, the idea of explaining the results within the reference-dependent framework by allowing deviations from initial plans should be investigated further.

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Appendices

Appendix A

Appendix for Chapter 1

This section presents the complete text of the instructions that participants in each experimental group faced. The square brackets indicate places where participants make a choice or enter a number, alternative outcomes depending on lottery choices, or information pertinent to the specific treatment group. Rewards from lottery decisions are labeled with X,Y,W, or Z due to the variability of outcomes. The additional question for Treatment Group 1,2, and 3 that comes after the final choice was included in the experiment only when it was halfway complete.

A.1 CG (Description)

Instructions

In this experiment you will have to choose between two lotteries. The participation reward is 0.5 €. You will get this amount of money regardless of your choice. Depending on your choice, you could get more money in addition to this amount. Please, proceed to the next section where you will be presented with a description of the lotteries between which you have to make a choice.[NEXT]

Final Choice Stage

You have to choose between two lotteries. Lottery 1 pays 2 € with probability 80% and 0 € with probability 20%. Lottery 2 pays 1.5 € with certainty. Which lottery would you choose?

[ ] Lottery 1 [ ] Lottery 2

The outcome is X. Your total earnings from the experiment are Y €. Thank you for your participation!

A.2 TG1 (Experience)

Instructions

In this experiment you will have to choose between the same two lotteries 40 times in a row. Each lottery has either one or two outcomes that occur with some probabilities. Depending on the outcome of the lottery, you might receive some small payoff in each round. For example, in round 1 you choose Lottery 1 and you get 10 cents, in round 2 you choose Lottery 2 and you get 15 cents, in round 3 you choose Lottery 2 and you get 7 cents, and so on until you complete 40 rounds.

After completing 40 rounds, you will make a final choice between the same two lotteries for a much greater (50 times!) payoff. For example, if an outcome of a particular lottery has given you an outcome of 5 cents in any of the 20 rounds, now this outcome will give you 2.5 €.

The participation reward is 50 cents. You will get this amount of money regardless of your choices. Your choices will certainly increase this amount. You may also use pen and paper to keep track of the lotteries and their outcomes. Please, proceed to the next section where you will start choosing between the two lotteries.[NEXT]

Sampling Stage [EACH CHOICE IS REPEATED 40 TIMES IN A ROW]

You have to choose between two lotteries- Lottery 1 or Lottery 2. Each of these lotteries has one or two outcomes that occur with some probabilities. There is no explicit information on these outcomes and probabilities. Which lottery would you choose?

[ ] Lottery 1 [ ] Lottery 2

The outcome is X. X cents are added to your earnings.

Final Choice Stage

Now you have to make your choice for a 50 times greater reward compared to the payoffs in any of the previous 40 rounds. For example, if a particular lottery produced 5 cents, now this lottery would give you 2.5 € if the same outcome is realized. Which lottery would you choose?

[ ] Lottery 1 [ ] Lottery 2

The outcome is Y €. This amount is added to your earnings. Your total earnings from the experiment are W €. This includes the participation reward as well.[NEXT]

Additional Question (no consequences on your earnings)

What do you think that the probability of getting 0 (in %) is if you choose Lottery 1? Please, insert a number between 0 and 100.[ ]

Thank you for your participation!

A.3 TG2 (Experience, No Intermediate Choice)

Instructions

In this experiment you will see and receive the outcomes of two lotteries in a sequential manner. Each lottery has either one or two outcomes that occur with some probabilities. In each round only the realization (outcome) of one of the lotteries will be given. Think of it as someone else making a choice and you observe the choice and the outcome. For example, you might see something like 'Lottery 1- outcome 10 cents'. That means that you get a payoff of 10 cents. Or if you something like 'Lottery 2- outcome 5 cents', then you get a payoff of 5 cents.

In each round you will receive the outcome that is yielded from the respective lottery. You will see and receive 40 outcomes in total. After that you will make a final choice between the two lotteries for a 50 times greater payoff. For example, if an outcome of the lottery has given you 5 cents in any of the 40 rounds, now the same outcome (if realized) will give you 2.5 €. The participation reward is 50 cents. You will get this amount of money regardless of your choices. Depending on your choice after the 40 rounds, you might significantly increase your earnings. You may also use pen and paper to keep track of the lotteries and their outcomes.

Please, proceed to the next section where you will see a realization of one of the lotteries. After that, on a separate page, you will see a realization of another lottery, and so on until all 40 rounds are complete.[NEXT]

Sampling Stage

Round 1. Lottery 1[2] yields an outcome of 4[0][3] cents. This amount of money is added to your earnings. Currently, you have X €.

Round 2. Lottery 1[2] yields an outcome of 4[0][3] cents. This amount of money is added to your earnings. Currently, you have X €.

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Round 40. Lottery 1[2] yields an outcome of 4[0][3] cents. This amount of money is added to your earnings. Currently, you have X €.[NEXT]

Final Choice Stage

Now you have to make your choice for a 50 times greater reward compared to the payoffs in any of the previous 40 rounds. For example, if you got 5 cents from a particular lottery, now this lottery would give you 2.5 € if the same outcome is realized. Which lottery would you choose?

[ ] Lottery 1 [ ] Lottery 2

The outcome is Y €. This amount is added to your earnings. Your total earnings from the experiment are W €. This includes the participation reward as well.

Additional Question (no consequences on your earnings)

What do you think that the probability of getting 0 (in %) is if you choose Lottery 1? Please, insert a number between 0 and 100.[ ]

Thank you for your participation!

A.4 Treatment Group 3 (Only See Sequential Outcomes)

Instructions

In this experiment you will see the outcomes of two lotteries in a sequential manner. Each lottery has either one or two outcomes that occur with some probabilities. In each round, only the realization (outcome) of one of the lotteries will be given. Think of it as someone else making a choice and you observe the choice and the outcome. For example, you might see something like 'Lottery 1- outcome 10' or 'Lottery 2- outcome

5′.

You will see 40 outcomes in total. After that you will make a final choice between the two lotteries for a real payoff. The participation reward is 0.5 €. You will get this amount of money regardless of your choice. Depending on your choice after the 40 rounds, you might significantly increase your earnings. You may also use pen and paper to keep track of the lotteries and their outcomes.

Please, proceed to the next section where you will see a realization of one of the lotteries. After that, on a separate page, you will see a realization of another lottery, and so on until all 40 rounds are complete.[NEXT]

Sampling Stage

Congratulations! Before continuing with the experiment you will receive a bonus of 1.2 €. This amount will be added to your current earnings. Currently, you have 1.7 €.[NEXT]

Round 1: Lottery 1[2] is chosen and yields an outcome of 4[0][3] cents.

Round 2: Lottery 1[2] is chosen and yields an outcome of 4[0][3] cents.

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.

.

Round 40: Lottery 1[2] is chosen and yields an outcome of 4[0][3] cents.

Final Choice Stage

Now you have to make your choice for a 50 times greater reward compared to the payoffs in any of the previous 40 rounds. For example, if you got 5 cents from a particular lottery, now this lottery would give you 2.5 € if the same outcome is realized. Which lottery would you choose?

[ ] Lottery 1 [ ] Lottery 2

The outcome is X €. This amount is added to your earnings. Your total earnings from the experiment are W €. This includes the participation reward as well.

Additional Question (no consequences on your earnings)

What do you think that the probability of getting 0 (in %) is if you choose Lottery 1? Please, insert a number between 0 and 100.[ ]

Thank you for your participation!

A.5 TG4 (Only See Summarized Information)

Instructions

In this experiment you will have to choose between two lotteries. The participation reward is 0.5 €. You will get this amount of money regardless of your choice. Depending on your choice, you could get more money in addition to this amount. Please, proceed to the next section where you will be presented with a description of the lotteries between which you have to make a choice.[NEXT]

Final Choice Stage

Congratulations! Before continuing with the experiment you will receive a bonus of 1.2 €. This amount will be added to your current earnings. Currently, you have 1.7 €.

There are two lotteries- Lottery 1 and Lottery 2. Out of 40 choices, Lottery 1 has been chosen X times and Lottery 2 has been chosen Y times. Lottery 1 produced an outcome of 2 € in Z of the cases and an outcome of 0 euro in X-Z of the cases. Lottery 2 produced an outcome of 1.5 € in all Y cases. Which lottery will you choose?

[ ] Lottery 1 [ ] Lottery 2

The outcome is X €. This amount is added to your earnings. Your total earnings from the experiment are W €. This includes the participation reward as well.

Additional Question (no consequences on your earnings)

What do you think that the probability of getting 0 (in %) is if you choose Lottery 1? Please, insert a number between 0 and 100.[ ]

Thank you for your participation!

Appendix B

Appendix for Chapter 2

B.1 Alternative Models

This section derives the predictions of some alternative models regarding participants' willingness to work: the expected utility theory model and the reference-dependent preferences model (also known as the Kőszegi and Rabin model). These models are applied to the same environmental framework as in Section 2.4. Based on the assumption that the reference point adjusts fast to new information (within the length of the distraction activity), the reference-dependent model would incorporate no gain-loss utility terms neither on the money nor on the effort dimension in the utilities of participants belonging to the coin-flip groups. Participants in the certainty groups do not face any surprise when receiving the initial endowment, so their utilities also do not incorporate gain-loss utilities. Therefore, in both of the models all participants would derive utility only from consumption. In both models, participant j who has been endowed an amount i chooses an optimal effort level $e_{j,i}$ to maximize the following expected utility:

$$E[u_j(e_{j,i})] = [1 - G_j(e_{j,i})]u_j(i) + G_j(e_{j,i}) \cdot u_j(i + m) - \int_0^{e_{j,i}} c(e')g(e')\, de' \tag{B.1}$$

Assuming linear utility on the money dimension this would reduce to:

$$E[u_j(e_{j,i})] = i + G_j(e_{j,i}) \cdot m - \int_0^{e_{j,i}} c(e')g(e')\, de' \tag{B.2}$$

Therefore, the first-order condition with respect to $e_{j,i}$ gives: $mg_j(e_{j,i}) - c(e_{j,i})g_j(e_{j,i}) = 0$. Thus, the optimal effort level is: $c(e^*_{j,i}) = m$. The optimal choice is setting total cost equal to total payment. In both models, expectations do not affect learning, so the effort level does not depend on whether the participant learned of the exact endowment through a coin-flip or with certainty. Thus, according to the expected utility theory and the reference-dependent models all groups exhibit the same effort level.

B.2 Non-pooled Data

The data could be analyzed for each of the reward amounts separately. Then, the following regression detects if there are significant differences across treatment groups in terms of willingness to work (effort level):

$$Y_j = \beta_0 + \beta_1 Cert3 + \beta_2 CF1 + \beta_3 CF3 + \beta_4 HP1 + \beta_5 HP3 + u_j \tag{B.3}$$

This regression is run for each amount (1,2,3, and 4€) separately. The independent variables $Cert3$,$CF1$,$CF3$,$HP1$,$HP3$ are all dummy variables taking on the value of 1 if participant j belongs to the respective group and 0 if not. The dependent variable Y_j is the maximum number of tasks that individual j would do for the respective amount. Other control variables (like demographics, tediousness, and loss aversion) could also be added to the above regression as well in order to detect further relationships. The tables below summarize the results from running the regression without pooling the data for each of the reward amounts (1, 2, 3, and 4€) separately.

Table B.1: Non-pooled data (1€)

	Dependent Variable: WTW				
	(1)	(2)	(3)	(4)	(5)
Cert3	9.42**	9.30**	9.70**	6.84	6.93
	(3.93)	(3.89)	(3.84)	(4.49)	(4.59)
CF1	2.41	2.21	3.19	3.69	2.29
	(3.80)	(3.76)	(3.76)	(4.55)	(4.55)
CF3	-0.30	-0.07	1.08	1.03	0.03
	(3.54)	(3.47)	(3.49)	(4.25)	(4.27)
HP1	4.10	4.24	3.98	5.15	4.83
	(3.67)	(3.62)	(3.62)	(4.18)	(4.27)
HP3	1.03	1.01	1.97	4.45	3.59
	(3.86)	(3.85)	(3.74)	(4.65)	(4.79)
Tediousness		-0.69*	-0.65	-0.37	
		(0.41)	(0.41)	(0.51)	
Gender			0.91	-0.23	
			(2.38)	(2.69)	
Education			-0.15	-1.84	
			(2.41)	(2.89)	
Employment			-3.86*	-3.81	
			(2.32)	(2.72)	
LAnew				0.16	
				(0.45)	
_cons	21.12***	24.37***	25.43***	24.76***	20.97***
	(2.54)	(3.21)	(3.65)	(4.92)	(3.19)
N	248	248	247	190	190
R^2	0.03	0.05	0.05	0.04	0.02

[1] Standard errors in parentheses.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[3] Notes: The second column reports the coefficients obtained after regressing WTW for 1€ on the experimental groups for the whole sample. The third, fourth, and fifth column add different control variables. The sixth column reports the coefficients from the same regression as in the second column but only for the fraction of participants whose degree of loss aversion was elicited.

Table B.2: Non-pooled data (2€)

	Dependent Variable: WTW				
	(1)	(2)	(3)	(4)	(5)
Cert3	10.16***	10.03***	10.34***	8.32*	8.47*
	(3.82)	(3.78)	(3.73)	(4.51)	(4.64)
CF1	2.99	2.77	3.62	4.47	3.03
	(3.96)	(3.93)	(4.00)	(4.74)	(4.73)
CF3	1.85	2.11	3.24	2.30	1.34
	(3.83)	(3.73)	(3.77)	(4.43)	(4.44)
HP1	4.93	5.09	5.15	6.78	6.14
	(3.60)	(3.54)	(3.54)	(4.15)	(4.21)
HP3	1.79	1.77	2.45	6.91	6.07
	(3.92)	(3.91)	(3.83)	(4.61)	(4.82)
Tediousness		-0.76*	-0.71	-0.43	
		(0.43)	(0.43)	(0.51)	
Gender			-0.25	-1.19	
			(2.48)	(2.73)	
Education			-1.09	-2.74	
			(2.52)	(2.95)	
Employment			-2.40	-3.07	
			(2.45)	(2.84)	
LAnew				0.15	
				(0.46)	
_cons	25.43***	28.99***	30.31***	29.59***	25.00***
	(2.48)	(3.15)	(3.68)	(4.87)	(3.23)
N	248	248	247	190	190
R^2	0.03	0.04	0.05	0.05	0.03

[1] Standard errors in parentheses.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[3] Notes: The second column reports the coefficients obtained after regressing WTW for 2€ on the experimental groups for the whole sample. The third, fourth, and fifth column add different control variables. The sixth column reports the coefficients from the same regression as in the second column but only for the fraction of participants whose degree of loss aversion was elicited.

Table B.3: Non-pooled data (3€)

	Dependent Variable: WTW				
	(1)	(2)	(3)	(4)	(5)
Cert3	8.14**	8.04**	8.31**	6.96	6.99
	(3.89)	(3.86)	(3.84)	(4.67)	(4.75)
CF1	1.12	0.95	1.68	3.46	2.04
	(4.16)	(4.16)	(4.24)	(5.08)	(5.00)
CF3	0.76	0.95	2.18	1.06	0.16
	(4.22)	(4.15)	(4.22)	(4.99)	(4.97)
HP1	2.17	2.29	2.25	4.66	3.64
	(3.98)	(3.94)	(3.97)	(4.47)	(4.57)
HP3	-0.14	-0.15	0.47	2.09	1.45
	(4.23)	(4.22)	(4.17)	(4.96)	(5.06)
Tediousness		-0.59	-0.53	-0.50	
		(0.45)	(0.46)	(0.53)	
Gender			0.71	-0.01	
			(2.64)	(2.93)	
Education			-1.01	-3.06	
			(2.70)	(3.18)	
Employment			-2.31	-1.63	
			(2.66)	(3.10)	
LAnew				0.20	
				(0.51)	
_cons	32.48***	35.27***	36.13***	35.95***	32.28***
	(2.67)	(3.38)	(3.96)	(5.13)	(3.40)
N	248	248	247	190	190
R^2	0.02	0.03	0.03	0.03	0.02

[1] Standard errors in parentheses.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[3] Notes: The second column reports the coefficients obtained after regressing WTW for 3€ on the experimental groups for the whole sample. The third, fourth, and fifth column add different control variables. The sixth column reports the coefficients from the same regression as in the second column but only for the fraction of participants whose degree of loss aversion was elicited.

Table B.4: Non-pooled data (4€)

	Dependent Variable: WTW				
	(1)	(2)	(3)	(4)	(5)
Cert3	5.78	5.68	5.91	3.18	3.08
	(4.10)	(4.08)	(4.07)	(4.90)	(4.91)
CF1	-3.32	-3.49	-2.87	-1.92	-3.12
	(4.32)	(4.32)	(4.43)	(5.34)	(5.09)
CF3	-2.04	-1.84	-0.60	-3.86	-4.44
	(4.49)	(4.44)	(4.47)	(5.19)	(5.12)
HP1	0.55	0.67	0.56	1.16	0.36
	(4.20)	(4.16)	(4.22)	(4.70)	(4.66)
HP3	-2.66	-2.67	-2.12	-0.82	-1.35
	(4.45)	(4.45)	(4.37)	(5.17)	(5.26)
Tediousness		-0.59	-0.52	-0.35	
		(0.47)	(0.47)	(0.55)	
Gender			2.39	1.51	
			(2.78)	(3.02)	
Education			-1.61	-3.50	
			(2.77)	(3.28)	
Employment			-2.08	-1.15	
			(2.75)	(3.16)	
LAnew				-0.17	
				(0.53)	
_cons	40.14***	42.91***	43.46***	45.43***	41.72***
	(2.86)	(3.52)	(3.97)	(5.20)	(3.48)
N	248	248	247	190	190
R^2	0.02	0.03	0.03	0.03	0.02

[1] Standard errors in parentheses.

[2] * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[3] Notes: The second column reports the coefficients obtained after regressing WTW for 4€ on the experimental groups for the whole sample. The third, fourth, and fifth column add different control variables. The sixth column reports the coefficients from the same regression as in the second column but only for the fraction of participants whose degree of loss aversion was elicited.

In none of the tables is the coefficient in front of *CF1* significantly different from 0 regardless of whether we use additional controls or not. The results of the F-test of equality between *Cert3* and *CF3* are displayed in the following table.

Table B.5: F-test of equality between *Cert3* and *CF3* (Statistics)

Additional Control	**1€**		**2€**		**3€**		**4€**	
	F	p	F	p	F	p	F	p
None	6.27	0.01	4.06	0.05	2.92	0.09	2.98	0.09
Tediousness	5.91	0.02	3.79	0.05	2.75	0.10	2.80	0.10
Demographics + Tediousness	4.84	0.03	2.97	0.09	2.02	0.16	2.09	0.15
Demographics + Tediousness + Loss Aversion	1.72	0.19	1.69	0.20	1.37	0.24	1.80	0.18
None (Reduced Sample)	2.51	0.11	2.49	0.12	1.93	0.17	2.17	0.14

The tables above show that the difference between the two groups in terms of willingness become less pronounced as the reward amounts increase. This pattern is noticed for the full sample scenarios where loss aversion does not enter as a control variable. For 1€ the p-values range from 0.01 to 0.03 for the specifications without control variables, with tediousness only as a control variable, and with tediousness and demographic data (gender, education, and employment) as control variables. For 2€ the p-values for these specifications range from 0.05 to 0.09. For 3€ and 4€ the p-values for these specifications range from 0.09 to 0.16. This pattern seems plausible since people would tend to exert more effort for higher amounts regardless of how they have received their initial endowment. In the scenarios where loss aversion is included as a control variable and in the reduced sample (the last regression in the tables), the difference between the high-endowment certainty and the high-endowment coin-flip groups in terms of willingness to work loses significance. The p-values range from 0.11 to 0.24 for the different reward amounts.

The non-pooled data results for the supplementary experiment emulate those of the pooled data that are presented and discussed in the main paper. In none of the regressions for any of the reward amounts is the coefficient in front of *HP1* significantly different from 0. However, we can see that the coefficients decrease in value as the reward amounts increase. The results of the F-test of equality between *Cert3* and *HP3* are displayed in the following table:

Table B.6: F-test of equality between *Cert3* and *HP3* (Statistics)

Additional Control	**1€**		**2€**		**3€**		**4€**	
	F	p	F	p	F	p	F	p
None	4.05	0.05	3.95	0.05	3.65	0.06	3.53	0.06
Tediousness	3.91	0.05	3.81	0.05	3.55	0.06	3.42	0.07
Demographics + Tediousness	3.48	0.06	3.54	0.06	3.32	0.07	3.29	0.07
Demographics + Tediousness + Loss Aversion	0.24	0.62	0.08	0.77	0.95	0.33	0.59	0.44
None (Reduced Sample)	0.47	0.49	0.24	0.62	1.23	0.27	0.71	0.40

Now the difference between the two groups undergoes only a slight loss of significance as the reward amounts increase. Again, this relates to the full sample scenarios in which loss aversion is not included as a control variable. The p-values range from 0.05 to 0.07 for the different reward amounts. This is also plausible since people would tend to exert more effort for higher amounts regardless of how they received their initial endowment. Interestingly, in the scenario in which loss aversion is included as a control variable and in the reduced sample, there is a rapid drop in the significance of the difference between the high-endowment certainty and the high-endowment high-probability groups in terms of willingness to work. The p-values range from 0.24 to 0.77. Such a rapid drop was also noticed in the pooled data scenario, indicating that for the sample of participants whose loss aversion was elicited, the high-endowment certainty and high-endowment high-probability groups exhibit similar behavior in terms of willingness to work.

B.3 Experimental Instructions (Chapter 2 and 3)

This section presents the complete text of the instructions that participants faced in each distinct stage. The square brackets indicate either instructions that are unique for specific treatment groups, places where participants make a choice or enter a number, or alternative outcomes depending on previous choices. When there are no additional directions after the [NEXT] button, the participant proceeds reading or goes to the next stage if the current stage is finished. In the sections in which participants work on tasks (in the beginning to get familiar with them and in the actual working stage) only one task is given as an example. In the 'Reading Task' stage the full texts are not given and are replaced by 'Text 1' and 'Text 2' due to their irrelevance to the main study. For the complete list of tasks or the full texts in the reading comprehension task, please contact the author.

B.3.1 Instructions

Welcome to the study! It consists of six distinct stages. Here is a description of the activities that you will be asked to do in each of the stages.

1. You will do several tasks and answer some questions about the tasks. You might opt to quit the study after this stage. In that case, you will walk away with the participation reward of 1 € only.

2. [*Certainty Groups*: If you decide to proceed with the study, you will find out what bonus you will receive for completing the study.]

[*Coin-flip Groups*, *High-Probability Groups*: If you decide to proceed with the study, you will find out what bonus you will receive for completing the study. The bonus will be determined through a lottery.]

3. You will read texts on different topics for at least 10 [15] minutes.

4. You will choose how many extra tasks you are willing to do for various bonus amounts.

5. You will do extra tasks for money depending on your choices over extra tasks.

6. You will answer a question on the texts you read in step 3 for extra rewards and complete a short demographic survey.

More details about each stage of the study will be provided once you reach the respective stage. Now, please proceed to the first stage of the study by clicking "Next".[NEXT]

B.3.2 First Stage: Attempt a Task

In this stage you will do 3 sample tasks to familiarize yourself with them. If you do not continue with the study after the 3 sample tasks, you will receive only the participation reward. If you decide to continue with the study, you can receive additional bonuses in the task stage only if you make no more than 3 mistakes when doing the tasks. If you make 4 mistakes, the study automatically ends, and you receive only the participation reward of 1 €.

In each task you will count how many times the digit 1 is used alone in a box in a grid full of numbers. You do not count the boxes in which 1 is used in a combination with a different number (for example, if you see 10 or 01, 11 in a box, you do not count these).

Please, proceed to the next page to start working on the sample tasks.[NEXT]

You are presented with a matrix filled with numbers. How many times is 1 entered alone in a box in the following matrix?

0	1	1	1	11	0	1	1	00	10	1	1
0	1	0	1	0	0	0	1	1	1	1	1
0	1	10	1	10	1	1	1	0	1	11	10
0	0	11	1	1	1	1	0	00	1	1	1
1	0	1	00	00	1	1	1	0	1	0	1
1	00	1	1	11	1	0	11	1	10	1	00
1	11	1	1	1	1	0	0	0	0	0	11
10	10	1	1	1	0	1	1	1	1	10	1

[CORRECT RESPONSE: Your answer is correct! Please, move on to the second matrix.[NEXT]]

[INCORRECT RESPONSE: Your answer is wrong. The correct answer is 22. Please, move on to the second matrix.[NEXT]]

B.3.3 Proceed With the Study or Not

Do you wish to participate in the study?
[YES: Thank you for continuing! On a scale from 1 to 10, how tedious do you find the tasks that you have just attempted? (1- not tedious at all, 10- extremely tedious. Please, use only integer numbers).[ ] [NEXT] On a scale from 1 to 10, how tedious do you find the tasks that you have just attempted? (1- not tedious at all, 10- extremely tedious. Please, use only integer numbers).[ ] [NEXT]]

[NO: We are very sorry that you decided to abandon the study. Please, proceed to the next page to close the study and claim your participation reward of 1 Euro.[NEXT (Redirected to Stage 'The End')]]

B.3.4 Money Endowment

[*Certainty Groups*: If you complete the study, independent of how many tasks you choose to do and whether you complete them correctly or not, you will receive an additional 1 [3] € bonus on top of the participation reward of 1 €. Thus, by completing the study you will receive at least 2 [4] €.[NEXT (Redirected to Stage 'Reading Task']]

[*Coin-flip Groups*: In this stage, a lottery will be played by the computer. With probability 50% you will receive 1 €, and with probability 50% you will receive 3 €. Please, click on 'Next' to see the outcome of the lottery on the next page.[NEXT]]

[*Low-endowment High-probability Group*: In this stage, a lottery will be played by the computer. With probability 99% you will receive 1 €, and with probability 1% you will receive 3 €. Please, click on 'Next' to see the outcome of the lottery on the next page.[NEXT]]

[*High-endowment High-probability Group*: In this stage, a lottery will be played by the computer. With probability 1% you will get 1 €, and with probability 99% you will get 3 €. Please, click on 'Next' to see the outcome of the lottery on the next page.[NEXT]]

B.3.5 Coin-flip Outcome

The outcome is 1 [3]. You receive 1 [3] € in addition to the participation reward of 1 €. If you complete the study, independent of how many tasks you choose to do and whether you complete them correctly or not, you will receive an additional 1 [3] € bonus on top of the participation reward of 1 Euro. Thus, by completing the study you will receive at least 2 [4] €. Please, proceed to the next stage.[NEXT]

B.3.6 Reading Task

In this stage, you will read a couple of texts on different topics for at least 10 [15] minutes. There will be a timer at the bottom of the page that will display the time remaining until the 10 [15] min (600 [900] seconds) have expired. Only then you will be allowed to proceed to the next stage of the study. You can also stay longer on the page if you are not finished reading the texts or if you want to go over them again. You are advised to carefully read the texts because at the end of the study (in the sixth stage) there will be a question related to the content of one of the texts. You will receive an additional monetary reward of 1 € for a correct answer. Go on to the next page to start the reading task.[NEXT]

Text 1

Text 2

[NEXT]

B.3.7 Working on Tasks

In this stage, you will be asked to do tasks for money. Please, remember that you are allowed to make no more than 3 mistakes when doing the tasks in order to receive a monetary reward for the task stage. The system works as follows. First, you will be asked how many tasks you are willing to do at most for a fixed amount of money. The minimum number of tasks that you can select is 1 and the maximum number is 60. The amounts are 1,2,3, and 4 €. So, you will enter four consecutive numbers for each amount separately.

Only one of your choices will count for real money. For that, the computer will randomly select an amount (1,2,3, or 4 €). Then, a random number will be drawn between 1 and 60. If your answer for the randomly selected amount is less than the randomly drawn number, you will do no tasks and will receive no reward. However, if your answer is greater than or equal to the randomly drawn number, you will do as many tasks as the randomly drawn number is. Upon successful completion of these tasks (if you do not make more than 3 mistakes) you will receive the randomly selected amount.

Examples:

1. For the amounts 1,2,3,and 4 € you consecutively select 33, 40, 50, 58 as maximum numbers of tasks you would do. Then, the computer randomly selects 1 Euro and 40 tasks. Since 33 < 40, you will do no tasks and will not receive an additional reward of 1 € for completing these tasks.

2. For the amounts of 1,2,3, and 4 € you consecutively select 40, 50, 56, and 60 as maximum number of tasks you would do. Then, the computer randomly selects 3 € and 32 tasks. Since 56 > 32, you will proceed with doing 32 tasks and upon successful completion you will receive an additional reward of 3 Euro.

Please, proceed to the next section to choose the maximum number of tasks you would do for the different amounts of money.[NEXT]

B.3.8 Eliciting WTW

Please, enter the maximum number of tasks you would do for 1 € (Remember that 1 is the minimum, 60 is the maximum).[NEXT]

Please, enter the maximum number of tasks you would do for 2 € (Remember that 1 is the minimum, 60 is the maximum).[NEXT]

Please, enter the maximum number of tasks you would do for 3 € (Remember that 1 is the minimum, 60 is the maximum).[NEXT]

Please, enter the maximum number of tasks you would do for 4 € (Remember that 1 is the minimum, 60 is the maximum).[NEXT]

B.3.9 Amount and Number of Tasks Randomly Selected

The amount z is randomly selected. Go on to the next page to see how many tasks the computer will randomly select.[NEXT]

The computer has randomly selected n tasks.[NEXT]

B.3.10 Determining Whether to Work on Tasks

[The stated maximum number of tasks for amount $z \geq n$: The number of tasks you will have to complete for z euro is n. Please, remember that you are allowed to make only 3 mistakes. That is why you are advised to carefully check your answer before submitting it. Go on to the next page to start working on the tasks.[NEXT]]

[The stated maximum number of tasks for the amount $z < n$: You will not work on any tasks since you have indicated a low maximum number of tasks that you are willing to do for amount z. Please, proceed to the final stage of the study.[NEXT (Redirected to Stage 'Final Stage']]

B.3.11 Working on Tasks

[THE PARTICIPANT WORKS ON 'n' TASKS UNLESS HE MAKES 4 MISTAKES]

How many times is 1 entered alone in a box in the following matrix?

0	1	1	1	11	0	1	1	00	10	1	1
0	1	0	1	0	0	0	1	1	1	1	1
0	1	10	1	10	1	1	1	0	1	11	10
0	0	11	1	1	1	1	0	00	1	1	1
1	0	1	00	00	1	1	1	0	1	0	1
1	00	1	1	11	1	0	11	1	10	1	00
1	11	1	1	1	1	0	0	0	0	0	11
10	10	1	1	1	0	1	1	1	1	10	1

[CORRECT RESPONSE: Your answer is correct! You move on to the next task.[NEXT]]

[INCORRECT RESPONSE (but less than 4 mistakes): Your answer is wrong. You have made 1[2][3] mistake(s) until now. Please, be careful from now on. You move on to the next task.[NEXT]]

[INCORRECT RESPONSE (exactly 4 mistakes): Unfortunately, you have made too many errors. As a result, you are not eligible to receive any additional money for the task exercise.[NEXT]]

B.3.12 Final Stage

You have completed the task stage. Please, go to the next page to answer a some additional questions.[NEXT]

B.3.13 Additional Questions

Before proceeding to the demographic questions and completing the study, you have the option to play a lottery. The system works as follows. Below are listed 8 lotteries that you can either accept or reject. Then, the computer will randomly choose one of the lotteries. If you have chosen to accept that lottery, it will be played and you will receive (or lose) the respective outcome. If you have rejected the randomly chosen lottery, you do not play it, thus you will not receive or lose anything.

Please, select which lotteries you would like to accept or reject before proceeding to the next page.

Lottery 1: You win 0.3 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept
[ ] Reject

Lottery 2: You win 0.5 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept

[ ] Reject

Lottery 3: You win 0.8 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept

[ ] Reject

Lottery 4: You win 1 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept

[ ] Reject

Lottery 5: You win 1.3 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept

[ ] Reject

Lottery 6: You win 1.5 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept

[ ] Reject

Lottery 7: You win 1.8 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept

[ ] Reject

Lottery 8: You win 2 euro with probability 50% or you lose 0.5 euro with probability 50%.

[ ] Accept

[ ] Reject

[NEXT]

B.3.14 Demographic Data

Please, fill in the following fields with your background information to complete the study.

1. Gender

[ ] Male

[ ] Female
[ ] Other

2. Education
   [ ] High School Diploma
   [ ] Bachelor's Degree
   [ ] Master's Degree
   [ ] Doctoral Degree

3. Employment
   [ ] Unemployed/Student
   [ ] Part-Time JOb
   [ ] Full-Time Job

   [NEXT]

B.3.15 The End

Congratulations! You have successfully completed the study. Your total payoff from the study is X €.

Appendix C

Appendix for Chapter 3

Theoretical Derivations (deviations from priors allowed)

Mathematically, the reference-dependent theoretical framework is extended by additionally accounting for effort level plans that participants form while reading the instructions (captured by $\tilde{e}_{j,i,0}$). Now, even participants in the certainty groups would face gain-loss utility terms on both the effort and money dimensions. Thus, they choose an effort $e_{j,i,1}$ that maximizes the total expected reference-dependent utility [1]:

$$U_j = i + mG_j(e_{j,i}) - \int_0^{e_{j,i,1}} c(e')g(e')\,de' + \eta n[mG_j(e_{j,i,1})$$

$$\text{-}\,m\mathrm{G}_j(\tilde{e}_{j,i,0})] + \eta n[-\int_0^{e_{j,i,1}} c(e')g(e')\,de' + \int_0^{\tilde{e}_{j,i,0}} c(e')g(e')\,de'] \tag{C.1}$$

There can be five different optimal effort levels for the certainty groups regardless of the initial endowment. These are: 1. $c(e^*) = m$, 2. $c(e^*) = \frac{m}{(1+\eta)}$, 3. $c(e^*) = \frac{m(1+\eta\lambda)}{(1+\eta)}$, 4. $c(e^*) = \frac{m(1+\eta)}{(1+\eta\lambda)}$, 5. $c(e^*) = m(1+\eta)$. These cases entail a range of possibilities for the planned effort levels for the low and high initial endowment before receiving it and after receiving it.

Before listing the possible planned effort levels that comply with the experimental results, it is worthwhile eliminating the cases that do not seem reasonable. Starting with the certainty groups, it wouldn't make sense to have a combination of $\tilde{e}_{h,1} > \tilde{e}_{h,0}$ and $\tilde{e}_{l,1} \leq \tilde{e}_{l,0}$ [2]. The logic is simple. If participants in the high-endowment certainty group are on average unhappy with their reward and decide on a plan to work more, then it is implausible for participants in the low-endowment certainty group to be on average neutral or happy with their reward by deciding to work less or as much as initially planned. Therefore, $\tilde{e}_{h,1} > \tilde{e}_{h,0}$ must be accompanied by $\tilde{e}_{l,1} > \tilde{e}_{l,0}$. However,

[1] As in Chapter 3, we assume linear utility on the money dimension

[2] For simplicity we drop the j subscript.

this combination results in the same optimal effort level for both groups ($c(e^*) = \frac{m(1+\eta)}{(1+\eta\lambda)}$). Therefore, we can fully eliminate the case where $\tilde{e}_{h,1} > \tilde{e}_{h,0}$. That means that for the high-endowment certainty group (*Cert3*) the optimal effort level cannot be given by: $c(e^*) = \frac{m(1+\eta)}{(1+\eta\lambda)}$ (case 4. in the previous paragraph).

Another combination that we can eliminate is $\tilde{e}_{h,1} = \tilde{e}_{h,0}$ and $\tilde{e}_{l,1} = \tilde{e}_{l,0}$. It leads to the same optimal effort level for both groups ($c(e^*) = \frac{m}{(1+\eta)}$). A third combination that does not seem plausible is $\tilde{e}_{h,1} = \tilde{e}_{h,0}$ and $\tilde{e}_{l,1} < \tilde{e}_{l,0}$. This is because we cannot have participants being more satisfied with getting 1€ than with getting 3€. Overall, for the certainty groups $\tilde{e}_{h,1} = \tilde{e}_{h,0}$ must always come together with $\tilde{e}_{l,1} > \tilde{e}_{l,0}$, while $\tilde{e}_{h,1} < \tilde{e}_{h,0}$ can be combined with any possible relationships between $\tilde{e}_{l,1}$ and $\tilde{e}_{l,0}$.
Participants in the coin-flip groups choose an effort $e_{j,i,1}$ that maximizes the total expected reference-dependent utility:

$$
\begin{aligned}
U_j = {} & i + mG_j(e_{j,i}) - \int_0^{e_{j,i,1}} c(e')g(e')\,de' + 0.5\eta n[i + mG_j(e_{j,i,1}) - 1 - mG_j(\tilde{e}_{j,l,0})] \\
& + 0.5\eta n[i + mG_j(e_{j,i,1}) - 3 - mG_j(\tilde{e}_{j,h,0})] + 0.5\eta n[-\int_0^{e_{j,i,1}} c(e')g(e')\,de' + \\
& \int_0^{\tilde{e}_{j,l,0}} c(e')g(e')\,de'] + 0.5\eta n[-\int_0^{e_{j,i,1}} c(e')g(e')\,de' + \int_0^{\tilde{e}_{j,h,0}} c(e')g(e')\,de']
\end{aligned}
\tag{C.2}
$$

The analysis for the coin-flip groups is more challenging due to the presence of more possible optimal effort levels. However, similar to the analysis for the certainty groups, we can eliminate some cases. Let's start with the case in which both groups are satisfied with their endowments and decide to work less than initially planned ($\tilde{e}_{l,1} < \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} < \tilde{e}_{h,0}$ for *CF1* and $\tilde{e}_{h,1} < \tilde{e}_{h,0}$ and $\tilde{e}_{h,1} < \tilde{e}_{l,0}$ for *CF3*). [3] The optimal effort level for the low-endowment coin-flip group is given by: $c(e^*) = \frac{m(1+\eta\lambda)}{(1+\eta)}$. This effort level can only be surpassed in magnitude by $c(e^*) = m(1+\eta)$ for $\lambda < 2 + \eta$. That means that for the high-endowment certainty group we need to have $c(e^*) = m(1+\eta)$. However, that effort level is only valid for $\tilde{e}_{h,1} = \tilde{e}_{h,0}$, which can only be combined with $\tilde{e}_{l,1} > \tilde{e}_{l,0}$ for the low-endowment certainty group. In that case the optimal effort level for the low-endowment certainty group is given by: $c(e^*) = \frac{m(1+\eta)}{(1+\eta\lambda)}$. So, we have different optimal effort levels for *Cert1* and *CF1*. Therefore, we can eliminate the case in which both groups are satisfied with their endowments and decide to work less than initially planned.

We can also eliminate the cases when participants have the same priors about their planned effort level in the high and in the low-endowment scenario and their beliefs

[3] For simplicity we drop the j subscript.

do not change after receiving the endowment. For the low-endowment coin-flip group $\tilde{e}_{l,1} = \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} = \tilde{e}_{h,0}$ leads to an optimal effort level $c(e^*) = \frac{m}{(1+\eta\lambda)}$. This optimal effort level can only match the optimal effort level for the low-endowment certainty group for values of λ that would make it the highest possible effort level among the treatment groups. That scenario does not fit the experimental results. Similarly, for the high-endowment coin-flip group $\tilde{e}_{h,1} = \tilde{e}_{l,0}$ and $\tilde{e}_{h,1} = \tilde{e}_{h,0}$ leads to an optimal effort level $c(e^*) = \frac{m}{(1+0.5\eta)}$. That optimal effort level does not match any of the possible optimal effort levels for the low-endowment certainty group.

Next, we can eliminate the implausible cases $\tilde{e}_{l,1} > \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} < \tilde{e}_{h,0}$ for *CF1* and $\tilde{e}_{h,1} > \tilde{e}_{l,0}$ and $\tilde{e}_{h,1} < \tilde{e}_{h,0}$ for *CF3*. It does not make sense for participants in the high-endowment coin-flip group to become upset after receiving the endowment and form a plan to work more than their prior in the low endowment, while being satisfied enough to want to work less than their prior in the high endowment. The reverse logic applies for the low-endowment coin-flip group. It is implausible for that group to be upset after receiving the endowment and form a plan to work more than their prior in the low endowment, while being satisfied enough to want to work less than their prior in the high endowment. So, we can rule out these scenarios.

Let's look at the cases when participants are somewhat satisfied with their endowment. We can eliminate $\tilde{e}_{l,1} < \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} = \tilde{e}_{h,0}$ for *CF1*. The optimal effort level that it yields is $c(e^*) = \frac{m(1+\eta\lambda)}{(1+0.5\eta}$. This effort level can only match the scenario when $c(e^*) = \frac{m}{(1+\eta)}$ for $\lambda = 1.5 + 0.5\eta$. However, for that value of λ, $c(e^*) = \frac{m}{(1+\eta)}$ would yield the highest possible effort level. The experimental results show that the coin-flip groups and the low-endowment certainty group can not have the highest effort levels. Therefore, the scenario $\tilde{e}_{l,1} < \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} = \tilde{e}_{h,0}$ for *CF1* is not possible. The rest of the scenarios when participants in the coin-flip groups are somewhat satisfied with their endowments are possible (in some cases for specific values of λ only). The scenarios in which participants in the coin-flip groups are unhappy with their endowments ($\tilde{e}_{l,1} > \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} > \tilde{e}_{h,0}$ for *CF1* and $\tilde{e}_{h,1} > \tilde{e}_{h,0}$ and $\tilde{e}_{h,1} > \tilde{e}_{l,0}$ for *CF3*) are also possible under specific conditions.

We can now list all possible cases for the coin-flip groups and the various combinations that can exist between them. The possible cases when participants in *CF3* are somewhat happy with their endowment are:

1. $\tilde{e}_{h,1} > \tilde{e}_{h,0}$ and $\tilde{e}_{l,0} = \tilde{e}_{l,0}$
2. $\tilde{e}_{h,1} = \tilde{e}_{h,0}$ and $\tilde{e}_{h,1} < \tilde{e}_{l,0}$

3. $\tilde{e}_{h,1} > \tilde{e}_{h,0}$ and $\tilde{e}_{h,1} < \tilde{e}_{l,0}$

The possible scenarios when participants in *CF1* are somewhat happy with their endowment are:

1. $\tilde{e}_{l,1} < \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} > \tilde{e}_{h,0}$
2. $\tilde{e}_{l,1} = \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} > \tilde{e}_{h,0}$

The only scenario when participants in *CF3* are unsatisfied with their endowment is when $\tilde{e}_{h,1} > \tilde{e}_{l,0}$ and $\tilde{e}_{h,1} > \tilde{e}_{h,0}$. The only scenario when participants in *CF1* are unsatisfied with their endowment is when $\tilde{e}_{l,1} > \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} > \tilde{e}_{h,0}$.

We cannot have scenarios in which participants in *CF3* are unhappy with their endowment and participants in *CF1* are somewhat happy at the same time. The scenarios in which participants in *CF3* are somewhat satisfied with the endowment can be combined with scenarios in which participants in *CF1* are either somewhat satisfied or unsatisfied with their endowment. The scenario in which participants in *CF3* are not happy with their endowment can be combined only with the scenario in which participants in *CF1* are not happy with their endowment either. For example, a combination of $\tilde{e}_{h,1} > \tilde{e}_{h,0}$ and $\tilde{e}_{l,0} = \tilde{e}_{l,0}$ for *CF3* and $\tilde{e}_{l,1} > \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} > \tilde{e}_{h,0}$ for *CF1* is possible. A combination of $\tilde{e}_{h,1} > \tilde{e}_{l,0}$ and $\tilde{e}_{h,1} > \tilde{e}_{h,0}$ for *CF3* and $\tilde{e}_{l,1} = \tilde{e}_{l,0}$ and $\tilde{e}_{l,1} > \tilde{e}_{h,0}$ for *CF1* is not possible.

Overall, the range of possible scenarios that comply with the results of the study show that participants in *Cert3* can be either satisfied with their endowment ($\tilde{e}_h < \tilde{e}_0$) or can be unaffected by it ($\tilde{e}_h = \tilde{e}_0$). Participants in *Cert1* can vary in terms of satisfaction from the endowment, but can never be more satisfied than the participants in *Cert3* ($\tilde{e}_{l,1} < \tilde{e}_{l,0}$ cannot coexist with $\tilde{e}_{h,1} \geq \tilde{e}_{h,0}$, and $\tilde{e}_{h,1} = \tilde{e}_{h,0}$ cannot coexist with $\tilde{e}_{l,1} < \tilde{e}_{l,0}$). On the other hand, participants in the coin-flip groups can be either somewhat satisfied with their endowment or unsatisfied with the endowment. However, participants in *CF1* can never be partially satisfied with their endowment while participants in *CF3* are unsatisfied with their endowment. We can also see a tendency participants in the coin-flip groups to be either more unsatisfied with their rewards or at least as satisfied as participants in the certainty groups.