

Temptation and Commitment in the Laboratory

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Abstract: Temptation and self-control have received substantial attention in the theoretical economics literature. Recently, Fudenberg and Levine (2012) modeled behavior when a temptation is “persistent”. This type of temptation is ubiquitous, as it refers to any temptation that is present until one either gives in or makes a costly commitment decision to have it removed. Despite the practical importance and the theoretical advances, there remains little empirical evidence from controlled environments informing behavior in this environment. This paper fills that gap by reporting data from a novel laboratory study of economic decisions under persistent temptations. Subjects are repeatedly offered an option with instantaneous benefit that also entails a substantial reduction to overall earnings. We show that this option is “tempting” in the sense that a substantial fraction of our subjects incur pecuniary costs to eliminate the choice, and thus commit to not choosing this alternative. We use the timing of decisions to inform the theory of Fudenberg and Levine (2012). We find that commitment and giving in to temptation generally occur at the first opportunity, though a non-negligible fraction of our participants do delay either commitment or giving in to temptation. These patterns have direct implications for the economic theory of temptation.

Keywords: self-control; willpower; temptation; commitment; laboratory experiment

JEL classification: D11; C91

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1. Introduction

When temptation and immediate desires interfere with the attainment of long-term goals, the ability to resist them is a necessary skill. Very often, temptation appears not just once, but repeatedly. Thus, resisting repeated temptation requires repeated exercise of self-control. For example, saving money for the future requires consistently controlling the impulse to consume immediately. To complete a time consuming task often requires a continuous effort to resist the repeated temptation of procrastination. Common experience reveals that even one-time self-control is difficult, and, as a result, people frequently turn to external devices to assist them in resisting temptation. One common device is to intentionally exclude the tempting good from the choice set. For instance, a person trying to avoid eating meat may commit to dining only at vegetarian restaurants. People may also choose to set up a deadline to help overcome continuous procrastination problems (Ariely and Wertenbroch, 2002).

The question of when people choose a costly commitment device when facing a persistent temptation is of significant economic importance. In a series of papers, Fudenberg and Levine (2006, 2010, 2012) provide significant theoretical progress on this topic. A key insight developed in Fudenberg and Levine (2012) is that the timing of commitment to avoid temptation, or the time at which one succumbs to temptation, depends on how the marginal costs of self-control change with the use of self-control. In particular, if using self-control leaves subsequent use of self-control more costly, then it can be optimal (in a perfect-foresight environment) to delay commitment. Consequently, evidence regarding how people make decisions in repeat-temptation environments can provide direct evidence on appropriate specifications of models that analyze behavior under temptation. This paper provides such evidence by reporting data from a novel laboratory study of economic decisions under repeat temptations.¹

How people make decisions under temptation has long been a topic of interest in both psychology and economics (e.g., Thaler and Shefrin, 1981; Tversky and Shafir, 1992; O'Donoghue and Rabin, 1999, 2000; Prelec, 1989; Benabou and Tirole, 2004; McClure et al., 2004; Heidhues and Köszegi, 2009; Hare et al., 2009). A large literature, going back to Strotz (1955-1956), develops theoretical explanations for time-inconsistent decision-making (see also Laibson, 1997, and the survey by Caillaud and Jullien, 2000). Recently, it has been shown that

¹ An early draft of this paper (Houser et al., 2010) reported data from a similar design that included “surprise” temptation, as compared to the full-information design analyzed below. We are grateful to an anonymous referee for encouraging this alternative design and analysis.

temptation can be modeled in a fully time-consistent manner (e.g., Gul and Pesendorfer, 2001, 2004, 2005; Miao, 2008; Fudenberg and Levine, 2012). In addition, many have made efforts to formally model the role of commitment in environments with tempting goods (e.g., Noor, 2007, 2011; Ozdenoren et al., 2008; Dekel et al., 2009; Ali, 2011; Fudenberg and Levine, 2006, 2010, 2012).

These and related theoretical developments are grounded in a broad empirical literature demonstrating that humans are affected by temptation and sometimes succumb to it (e.g., Mischel et al., 1989; Hoch and Loewenstein, 1991; Ainslie, 1992; Loewenstein and Prelec, 1992; Baumeister et al., 1994; Metcalfe and Mischel, 1999; Ameriks et al. 2007; Charness and Gneezy, 2009; Casari, 2009; Augenblick et al., 2015; Bonein and Denant-Boémont, 2015; Corgnet et al., 2015; see also Bryan et al., 2010, for a survey)². Data from natural and field experiments provide evidence for the importance of temptation in real economic choices. For example, Della Vigna and Malmendier (2006) highlight that temptation preferences can lead people to pay not to go to the gym, while Houser et al. (2008) take advantage of a natural experiment to demonstrate that “tempting” goods are more likely to be purchased from the checkout aisle when the wait-time is longer (see also Burger et al., 2009, and Bucciol et al., 2009, for results from field experiments on temptation with adults and children, respectively). Moreover, experiments in psychology provide evidence that cognitive load (often interpreted as reducing one’s ability to exercise “willpower”) leaves subjects more likely to choose tempting goods (e.g., Shiv and Fedorikin, 1999; Baumeister et al., 1994; Baumeister and Vohs, 2003; Hinson et al., 2003; Dewitte et al., 2005; Vohs and Faber, 2007).

Difficulties in exercising self-control motivate people to use commitment devices for resisting temptation. These devices include restricting choices, for instance, by going to a restaurant with less tempting food (Wertenbroch, 1998), by using specific ordering strategies to pre-commit to watching “high-brow” movies (Read et al., 1999), by pre-committing not to have the chance to choose in the future (Casari, 2009), or by committing to saving plans (Ashraf et al., 2006; Benartzi and Thaler, 2004; Beshears, 2015). People also increase the cost of succumbing

² It is worth emphasizing that the early “marshmallow task” delay of gratification experiments (see the survey by Mitchell et al, 1989) as well as the later derivatives of these experiments (see, e.g., Bucciol et al, 2011, and cites therein) generally include a “persistent temptation” of the sort studied in this paper. The same is true of early studies of procrastination and deadlines (see, e.g., Lowenstein and Prelec, 1992, and cites therein). The advantage to our study is that it offers a carefully controlled environment that allows a more direct test of theory by narrowing the scope for alternative explanations for the patterns in our data.

to temptation (Schelling, 1992; Gine et al., 2010; Kaur et al. 2010; <http://www.stickk.com>³), distract themselves from temptation, or impose personal rules of conduct on themselves (see Baron, 2000; Elster, 2000, Ariely and Wertenbroch, 2002).

Given the vast empirical evidence on people's difficulties to resist temptation and their effort to use commitment devices, it is crucial for economists to develop an improved understanding of whether these devices are adopted with delay, and whether and how the timing of their use is affected by the value of the temptation and the cost of commitment (that is, to know more about the timing and elasticity of decisions under environments with persistent temptations). To shed light on this, we design a controlled laboratory environment where the cost of commitment and the cost of giving in to a temptation are manipulated exogenously and independently. Thus, the controlled environment is specifically designed to allow us to discover systematic dynamic patterns in commitment choices under temptation that might be difficult to uncover using field data.

Our experiment is related to Example 9 in Fudenberg and Levine (2012). This example considers an environment with "persistent" temptations, meaning that the temptation exists until one either gives in or pays to have it removed. With this example they show, as we detail further below, that it can be optimal, under perfect foresight, to delay one's decision to commit, depending on whether the benefits to cognitive resources are non-linear. In order to investigate decisions in such an environment, participants in our laboratory environment are exposed to the same tempting stimulus multiple times. On each exposure, they can either: (i) give in to the temptation; (ii) make a (perhaps costly) commitment decision that removes any future exposures to the temptation; or (iii) resist the temptation without choosing to commit, thus being exposed to it again in the future. Consequently, our data shed light on the type of delay in commitment that can occur in a perfect foresight environment.⁴

We find that the majority of our participants do not change their decisions under persistent temptations, a result consistent with Fudenberg and Levine (2006, 2010) as well as the linear specification in Fudenberg and Levine (2012). This behavior is also consistent with predictions from many other models of temptation, including Gul and Pesendorfer (2001), Noor

³ This is a webpage launched by Ian Ayres and Dean Karlan. A participant signs a contract requiring him/her to donate a self-specified amount of money to charity if he/she fails to achieve a self-specified goal.

⁴ Fudenberg and Levine (2012), at the conclusion of their Example 9, suggest the importance of data from these types of environments.

(2007, 2011), and in general models that rely on quasi-hyperbolic discounting (Strotz, 1955; Phelps and Pollack, 1968; Laibson, 1997; O'Donoghue and Rabin, 1999).⁵

At the same time, a non-trivial number of participants do delay their decisions. In particular, after initially resisting without commitment, many either give in or commit. This behavior, and particularly the fact that a statistically significant majority of the delayed decisions are to commit,⁶ can be explained by the non-linear cognitive depletion specification in Fudenberg and Levine (2012). Finally, we show that the demand for commitment is highly price elastic, a finding that could help to explain the paucity of markets for commitment devices.

The remainder of this paper is organized as follows. Section 2 illustrates a key finding from Fudenberg and Levine (2012) using a simple example. This also serves to motivate our experiment design. Section 3 describes the design of our experiment. In Section 4, we use the framework of Fudenberg and Levine (2012) to derive hypotheses for the behavior of the subjects in our experiment. Sections 5 and 6 contain results and discussion, respectively. The last section of the paper is devoted to a summary and suggestions for future research.

2. Theory and a Motivating Example

Our analysis is built on the idea that self-control is an “exhaustible resource”, in the sense that it may become more difficult to use over time. This insight is far from new (see, e.g., Hoch and Loewenstein, 1991; Shiv and Fedorikhin, 1999; Baumeister et al., 1994; Baumeister and Vohs, 2003; Hinson et al., 2003; Dewitte et al., 2005; Vohs and Faber, 2007; Ozdenoren et al. 2012). Key for our paper is the finding by Fudenberg and Levin (2012, henceforth, FL) that convex costs of self-control in dual-self models can imply rational delay of commitment or “giving in” decisions in temptation environments with perfect foresight.

The theory developed by FL is far too rich to summarize here, nor is it necessary to do so. It is sufficient to provide a simple example that both offers a flavor of their theory while also motivating our experiment design.

FL develop a dual-self model. There is a single patient long-run self along with a sequence of myopic short-run selves. The long and short-run selves share the same preferences

⁵ Fudenberg and Levine (2012) provide detailed discussion at various points in their paper regarding the connection between their framework and those of many others.

⁶ As detailed in the discussion surrounding our Hypothesis 2a below, in our specific environment commitment, but not giving in to temptation, can be rationalized by nonlinear cognitive depletion.

over stage outcomes, but differ in how they view the future. For the purposes of our example, we consider the case where the long-run selves have a positive discount rate over future periods, while short-run selves are perfectly myopic in that they care only about stage-game outcomes.⁷

FL model multi-period games, with each period consisting of two parts. In the first part of each period, the long-run self can exert self-control to affect the preferences (thus choices) of the short-run self. Exerting self-control is costly for both parties. In the period's second part, after preferences have been chosen, the short-run player makes the period's final decision. In FL's framework: (i) the long-run self cannot pre-commit for the entire dynamic game, but instead begins each new period needing to make a (costly) self-control decision; and (ii) the long-run self has the same stage-game preferences as the short-run selves, and so wishes to serve the interests of future short-run selves.

FL study the timing of giving in, committing or using self-control in environments with temptations. Their main finding is that behavior may include delay in the use of a commitment device, or giving in, depending on the how the costs of self-control evolve with its repeated use. Their point is rigorously developed but can be easily illustrated.

Consider a three period consumption/savings problem where each period a person can either save or consume some, part or all of their resource. Each unit saved doubles the next period, while a unit consumed provides a unit value. In this environment the short-run self will always prefer to consume everything immediately, while the long-run self will see the value of investing. For ease, suppose the long-run self does not discount future periods, so the consumption value at period three after the previous two periods of investment is four.

Suppose the long-run self can change the short-run self's preferences at a cost equal to a scalar multiple a of the short-run self's forgone period utility. It is easy to see that the long-run self will prefer to exercise self-control at both periods 1 and 2 whenever $a < 1$, and otherwise immediately succumbs to temptation.

Suppose now that, in addition, there is a commitment device available that can take the temptation to consume off the table at the beginning of a period and for all subsequent periods, before self-control needs to be exercised. Suppose this commitment device can be exercised at cost c in period 1 and $2c$ in period 2. It is easy to show that if $a > 1$ but $c < 0.75$ then it is optimal to commit immediately, while with larger c it is optimal to give in immediately.

⁷ Fudenberg and Levine (2006) develop this special case in detail, while their 2012 paper analyzes the general case where the short-run self may care about the future positively, but always less than the long-run self.

FL show that this sort of behavior, where a person either gives in or commits immediately, or else always uses self-control, is surprisingly general. So long as the environment is “linear”, in a way they make precise, then behavior will be stationary in the sense that it does not change after the first period. On the other hand, if the environment is nonlinear then they show that this result need not hold. They focus on cases where the cost of self-control can depend on whether it has been exercised previously.

Returning to our example, suppose self-control is costless ($a=0$) but can be exercised only once (say because cognitive resources are fully depleted and non-renewable after the first period). In this case it is easy to see that it is always optimal to exercise (free) self-control in the first period, and in the second period either commit (if $c<0.5$) or otherwise succumb to temptation.

FL emphasize that this non-stationarity in behavior occurs in a fully rational, perfect-foresight environment but, like our example, does require some sort of nonlinearity within the environment. Consequently, by examining individual decisions in an environment with persistent temptations, and in particular discovering whether there is delay in decisions to commit or succumb to temptation, one can provide direct evidence on the specifications appropriate for modeling temptation environments.

The goal of our experiment design is to shed light on decisions in an environment with persistent temptations. We are unable to use an environment as simple as the one described above, because in a relatively short laboratory experiment nobody would have trouble reinvesting until they have earned maximum profits. Our design takes a different tack but one that, we show, is effective at producing a tempting good. We first describe the design, and then form hypotheses of stationary behavior under the assumption of a linear environment. Evidence of non-stationary behavior in our environment is consistent with nonlinearities in cognitive resource depletion.

3. Experiment Design

We design a laboratory experiment that includes a tempting good and the (costly) option to commit not to choose this tempting good. Our design allows us to manipulate exogenously both the commitment cost as well as the benefits from resisting temptation. Finally, in order to test directly specific predictions FL, we observe subjects’ decisions over a sequence of repeated

exposures to a tempting good. We use a perfect foresight environment. Subjects are given full information about the number and timing of temptations they can experience as well as the consequences of succumbing (or not) to temptation. We create temptation by using an avoidable repeated counting task designed to be boring.

Counting task

In each repetition of the counting task, subjects are asked to count the number of ones in a series of nine digits, either zeros or ones, that are displayed on the computer screen for 15 seconds (see Figure A.1 for a screenshot). Counting tasks are displayed at random time intervals. Between counting tasks, subjects face an otherwise empty screen with a digital clock that displays the elapsed time of the experiment (see Figure A.2 for a screenshot). Subjects reported that they found this task distasteful.

The time between counting screens is either 1 minute, 2 minutes, or 3 minutes. To ensure that subjects focus their attention on the computer screen (and hence not get involved in other activities), they are informed that the lengths of these waiting periods are drawn randomly such that each of these time spells occurs, on average, equally often during the counting task (i.e., the waiting time can be considered as being drawn from a uniform distribution over the time spells).

At the beginning of each session, participants are informed that the experiment will last for 120 minutes and that they have to remain in the laboratory for the entire duration of the experiment. Then, the counting task and the random nature of the waiting periods between counting tasks are explained and participants are informed that their payoff is higher (up to an additional \$15), the more counting tasks they perform in the two hours on the condition that the accuracy rate is 70% or greater. To make more likely that subjects attended to the computer screen for the duration of the experiment, we told subjects that they would earn only \$3 in addition to their show-up fee if they provide less than 70% of correct responses.⁸ (see the instructions in Appendix for details)

The tempting good and the temptation screen

All subjects were required to deposit all backpacks, phones and any other items with the experimenter prior to the experiment beginning. Consequently, they were unable to access the

⁸ None of our participants nearly violated this restriction.

internet or become involved in any other electronic activity for the total duration of the experiment.

In our experiment, the tempting good is the option to stop performing the counting task and to instead obtain internet access. We refer to this temptation as “surfing the internet” in the sequel. The reason we chose this is that we expected all subjects to experience positive utility from internet access⁹: one can check e-mail, chat, visit social networks, read the news, or even study.

Surfing the internet is offered to subjects during the two-hour counting task at up to 12 specific points in time (depending on their decisions). The points in time at which the temptation screens would appear were announced to subjects in the instructions, at the beginning of the experiment. In this context, it is important to stress the following two details of our design. First, when subjects surf the internet, they lose the possibility to return to the counting task during the remainder of the experiment. Second, when subjects are offered the opportunity to surf, they are simultaneously offered the option to commit to counting for the remainder of the experiment. In particular, the use of this commitment device eliminates one’s ability to surf the internet during the experiment.

We operationalize the surfing option by showing to the subjects an internet browser window, referred to as the “temptation screen” (for a screenshot see Figure A.3). This screen displays the payoff the subject has earned so far and offers her three choices represented by two buttons and a default option:

- *Continue*: Continue the counting task, having the chance to earn an additional payoff depending on their performance in the counting task, and keep the option to surf the internet.
- *Commit*: Continue the counting task, having the chance to earn an additional payoff depending on their performance in the counting task, but without being given the opportunity to surf the internet any more. Choosing this commitment option involves a cost that is taken from the subject’s total payoff.

⁹ The utility of surfing the internet might vary between subjects. Such preference heterogeneity does not affect our analysis as we randomly assign (i) opportunity costs of surfing; and (ii) commitment costs.

- *Surf*: Surf the internet right away. This is the default if no other choice is made by the time the temptation screen disappears (after 120 or 60 seconds).¹⁰

It is worth emphasizing that the instructions (see appendix) made subjects aware of the timing of the temptation screens as well as the three alternatives available on each temptation screen.

Phases of the experiment

A key advantage of our laboratory environment is the control it affords. For example, subjects might resist surfing the internet and perform the counting task for the entire two hours without using the commitment device even when it is free, suggesting that “surfing” is not sufficiently tempting to overcome subjects self-control. Alternatively, subjects could choose to commit to counting by removing the surfing option. Especially when commitment is costly, this suggests (as a result of the betweenness axiom) that surfing is indeed a tempting good. Yet another possibility is that subjects could choose to surf the internet at one of the pre-announced points of time, evidently giving up future rewards for an immediate benefit. As we will see below, the timing and presence of these possible behaviors informs economic theory.

Note that at the beginning of the experiment may not correctly anticipate neither the boredom associated with the counting task nor the disutility it creates. Our design minimizes this as a potential explanation for decisions by dividing the experiment into three phases which every subject passes through in the same order. In the first phase, phase 0, subjects perform the counting task—as described above—for 30 minutes, and, importantly, no surf or commitment options are provided; in this phase subjects receive repeated exposure to, and thus gain experience with, the counting task. The subsequent two phases, 1 and 2, offer surf and commitment options using the “temptation screen” at specific points in time, with various opportunity costs of surfing and commitment costs depending on the randomly assigned experimental conditions (see Experimental Conditions section below for details). In all experimental conditions payoffs are structured such that the total amount earned by a subject who performs the counting task successfully for the three phases of the experiment is \$15 (in addition to the show-up bonus). The timing of the experiment is summarized in Table 1.

¹⁰ Our interest is in showing that people will pay to avoid exposure to temptation. Because we wanted this to be an active choice, we chose surfing as the default option. Note that the default was almost never exercised. When the temptation screen appears for the first time, it is shown for 120 seconds, ensuring that subjects had enough time to understand the text and the payoffs. The remaining temptation screens are displayed for 60 seconds.

- *Phase 0* lasts for 30 minutes. In this phase, subjects are exposed to 15 counting tasks with empty screens shown in between the counting tasks, as described to them at the beginning of the experiment.
- *Phase 1* lasts for 45 minutes (i.e., it starts at minute 31 and ends after minute 75). Subjects are exposed to up to 12 counting tasks with empty screens appearing in between the counting tasks as described above. Additionally, in this phase there are six instances at which subjects are shown the temptation screen (described above). On this screen, subjects can choose whether they would like to continue performing the counting task, surf the internet, or use a commitment device that removes the opportunity to surf the internet for the remainder of the experiment. Subjects are made aware, at the beginning of the experiment, both that these screens will appear as well as the time at which each screen will appear.
- *Phase 2* lasts for another 45 minutes (i.e., it starts at minute 76 and ends after minute 120). As in phase 1, up to 12 counting tasks, separated by empty screens, are displayed. Additionally, subjects are shown the temptation screen at six instances. The temptation screen is identical with the temptation screen shown in phase 1, only the payoffs differ (see Tables 1 and 2). Again, subjects are made aware, at the beginning of the experiment, both that these screens will appear as well as the time at which each screen will appear.

** Include table 1 here **

** Include table 2 here **

When a subject enters a new phase, the payoff structure changes according to the description in Tables 1 and 2, enabling tests of the behavioral hypotheses developed in section 3. This change in the payoff structure, of course, only concerns those subjects who have not yet decided to surf the internet or use the commitment option. If a subject had already chosen to surf the internet in the previous phase, she would be required to continue to surf the internet for the entire remaining time of the experiment, without possibility to do the counting task or use the commitment option. Similarly, if a subject had already chosen the commitment option, she would continue with the counting task for the duration of the experiment without seeing further temptation screens.

Experiment conditions

At the beginning of the experiment, each subject is randomly assigned to one of 12 experimental conditions, denoted by G1 through G12. The condition determines the values of three design parameters—commitment cost (P), value of completing the counting task successfully in Phase 1, W_1 , and value of completing the counting task successfully in Phase 2, W_2 —which in turn determine the payoff a subject can achieve conditional on her performance in the counting task and additional decisions made during the experiment. Subjects are given complete information about their decision environment, but are not aware that there are multiple experiment conditions. The values of the design parameters are listed in Table 2.

These conditions serve two purposes: First, they allow us to test whether observed behavior is robust to differences in the parameterization. Second, they test whether the surfing option is a temptation and whether subjects understand the structure of the task: Specifically, in conditions G2, G5, G8, and G11, subjects receive the maximum additional payoff of \$15 already if they successfully complete the counting tasks through phase 1. That is, in those conditions, all subjects for whom surfing has more utility than counting should stop counting at beginning of Phase 2. Indeed, all subjects in these treatments did this.

Earnings and sample

All subjects received a show-up fee of \$5. Thus, the maximum amount that a subject could earn (by performing the counting task for the entire two hours with more than 70% correct answers and filling in the questionnaire) was \$20. The entire amount was paid in cash at the end of the experiment.

The experiment was conducted in the experimental laboratory of the Interdisciplinary Center for Economic Science (ICES) at George Mason University. A total of 108 subjects participated in 17 sessions; the corresponding descriptive statistics describing subjects' characteristics are reported in Table 3. The number of subjects within sessions was kept small to minimize distractions due to other subjects in the laboratory.

** Include table 3 here **

4. Hypotheses

To develop our hypotheses, note first that each phase of our game includes a finite number of periods, where each period is either a “counting” task or a “temptation” task, but not both.

Players know the exact number and distribution of the two tasks. Recall also that all subjects are exposed to a 30-minute phase 0 consisting of repeated counting tasks before moving to Phase 1 where they see the first temptation screen. In addition, all subjects have experience with surfing the internet. Hence, subjects know what utility they derive from counting, or from surfing. Players also know that if they finish all of the counting in a given phase (with some easy-to-obtain level of accuracy), they earn $W_H > 0$ at the end of the experiment, but if they choose instead to enjoy the internet, they earn $W_L < W_H$. (The payoffs W_L may change between Phase 1 and Phase 2, but for ease of exposition subscripts denoting this dependence are dropped). Players evaluate payoffs according to the strictly monotonically increasing and concave utility function $U(\cdot)$.

Participating in the counting task is the only alternative during a “counting” period. Denote the utility of counting in period t by $U(\text{count}_t)$. Without loss of generality, assume $U(\text{count}_t) = 0$ for all t .¹¹

Players have several choices during a “temptation” period. The temptation screen informs them that they may: (i) stop counting and surf the internet for the duration of the experiment; (ii) pay a one-time non-negative amount to make a commitment to count for the duration of the experiment; or (iii) continue counting without committing. Players’ decisions during a temptation period are modeled as follows.

We suppose the short-run self evaluates the temptation period perfectly myopically. It considers only the period utility of surfing the internet, in comparison to the period utility of deciding to count in the future (which they will not experience). Denote the utility of surfing in period t as $V_t(\text{surf})$. Because the utility of counting is zero, the short-run player will prefer to surf whenever $V_t(\text{surf}) > 0$. If surfing carries negative utility (is less enjoyable than counting), the short-run player is indifferent between continuing and committing when commitment cost is zero, and otherwise strictly prefers to continue without cost.

The long-run self uses all short-run selves’ period-utilities to evaluate decisions in this game. In any period t , the long-run value to finishing the counting task is equal to $U(W_H)$, the

¹¹ This assumes there is no risk of failure when performing the counting task. As an empirical matter, nobody failed to achieve the 70% accuracy rate required for success.

amount earned by the period t short-run player, plus $\tau(t)U(\text{count})$, where $\tau(t)$ is the number of counting periods a subject believes remain in the experiment at period t . However, because of the normalization $U(\text{count})=0$, the expectation term can be dropped and the long-run value of finishing the counting task reduces to $U(W_H)$. The long-run value of surfing is $U(W_L) + V_t(\text{surf})$, where $V_t(\text{surf})$ is the expected value of surfing from period t to the end of the experiment.

Thus, the long-run self compares $U(W_H)$ to $U(W_L) + V_t(\text{surf})$. If the value of surfing exceeds $U(W_H)$, then the long-run and short-run selves have aligned interests and the subject chooses to surf. However, if $U(W_H) > U(W_L) + V_t(\text{surf})$ then the long-run self might exercise self-control, at some utility (psychic) cost $C \geq 0$, in order to ensure that the short-run player does not surf. In particular, FL assumes that by exercising self-control, the long-run self can change the short-run self's choice set, in our case to ensure that surfing is viewed as less attractive than counting, so that $V_t(\text{surf}) < 0$.

Let $\tau'(t)$ denote the known remaining number of temptation screens in period t (including the current screen). Because self-control must be exercised at each temptation screen, and assuming additive separability and no time-discounting, the expected utility cost of exercising self-control each time it is necessary to do so throughout the remainder of the experiment is $\tau'(t)C$. Further, as we show in Hypotheses 1 and 2 below, any decision to commit or to surf occurs immediately in this linear environment. In view of this, it is straightforward to show that the long-run self is willing to use exercise self-control if

$$U(W_H) - \tau'(t)C \geq U(W_L) + V_t(\text{surf}).$$

During a temptation period, the long-run self might also prefer to commit. The long-run self is willing to choose commitment preferences for the short-run self whenever one of the two following conditions hold:

$$U(W_H - P) - C \geq U(W_H) - \tau'(t)C \geq U(W_L) + V_t(\text{surf}) \quad (1)$$

or

$$U(W_H - P) - C \geq U(W_L) + V_t(\text{surf}) \geq U(W_H) - \tau'(t)C \quad (2)$$

where $P \geq 0$ is the pecuniary price of the commitment device. People who satisfy (1) will count without surfing if the cost of commitment is sufficiently high, while people with preferences satisfying (2) will surf if the cost of commitment is sufficiently high.

Finally, note that because participants have full information about the way the environment will evolve, $\tau'(t)$ is strictly monotonically decreasing in t . Similarly, assume that $V_t(\text{surf})$ is strictly monotonically decreasing in t , implying that surfing for a shorter amount of time is less valuable than surfing longer.

We are now in a position to state our main hypotheses.

Hypothesis 0: *At least some people exhibit a demand for costly commitment.*

While we cannot observe individuals' preferences, support for Hypothesis 0 suggests that surfing is a temptation for at least some people. It is easy to see why. Suppose surfing is not tempting (is less enjoyable than counting), so that $V_t(\text{surf}) \leq 0$. For such a person, the short-run self will prefer to count, so that the long-run self does not incur self-control costs. Thus, because $U(W_H) > U(W_H - P)$, no such person would commit. It follows that any person who makes a costly commitment necessarily finds surfing a temptation. Note this is true regardless of whether there exist nonlinearities in the cost of self-control.

Hypothesis 1: *Under linear costs of self-control, any decision to commit occurs at the first opportunity. Under non-linear costs, it can be rational to delay commitment.*

To see this, note the value of committing at any time period t is $U(W_H - P) - tC$, which is maximized when t , the period when commitment occurs, is minimized. Consequently, in this linear model, commitment always pays the most when exercised at the first opportunity.

It is also easy to see that this result need not hold in the presence of nonlinearity in the costs of self-control. For example, if self-control can be exercised without cost once, but then becomes excessively costly, then a person would be indifferent between immediate and one-period delayed commitment. Further, it is easy to see that delaying would be strictly preferred if paying the commitment cost next period is less costly (say due to discounting) than paying this period.

Hypothesis 2: *Any decision to surf occurs at the first opportunity within a phase (either screen 1 or screen 7).*

The reason is that the decision to surf always pays the most when exercised immediately. This follows by reasoning exactly analogous to that above, and our assumption that $V_t(\text{surf})$ is

strictly decreasing in t . Further, while counting may be preferred to surfing in phase 1, after a payoff change in phase 2 surfing may be preferred to counting. This occurs, for example, when the experiment's entire earnings are realized at the conclusion of phase 1, or more generally if the person has a threshold earnings requirement and the realized amount meets or exceeds that threshold. In these cases, one would predict surfing to be chosen at the first phase 2 opportunity (screen 7). Finally, note that these predictions are invariant to nonlinearities in the cost of self-control. Because surfing always pays most when exercised earlier, any decision to surf should be made at the first opportunity (even when the costs of self-control are vanishingly small, and regardless of the presence of discounting).

Combining Hypotheses 1 and 2, we see that if the costs of self-control are linear, then any commitment should occur immediately (screen 1) and surfing decisions should occur on the first opportunity of Phase 1 or Phase 2 (screens 1 or 7). If the costs are non-linear, we expect surfing decisions on screen 1 or 7, while commitment could occur on any screen. We summarize this as Hypothesis 2a.

Hypothesis 2a: *Delayed commitment (any commitment after screen 1) should be at least as likely as delayed surfing (any surfing outside of screen 1 or screen 7).*

Hypothesis 3: *The frequency of commitment (weakly) monotonically decreases as its price increases.*

$$U(W_H - P) - C \geq U(W_H) - \tau'(t)C \geq U(W_L) + V_t(\text{surf})$$

This simple comparative static follows directly from (1) or (2). If people are heterogeneous with respect to their utility function, and in light of our assumption that utility is strictly increasing in its arguments, the fraction of the population for whom (1) or (2) is satisfied decreases monotonically as P increases, regardless of whether self-control costs exhibit nonlinearities.

Hypothesis 4: *The number of people who choose to surf will not decrease as commitment costs increase.*

It is easy to see that commitment costs can only affect surfing behavior when the following holds. Let commitment costs be ordered according to $P < P'$. Then, suppose

$$U(W_H - P) - C \geq U(W_L) + V_t(\text{surf}) > U(W_H - P') - C > U(W_H) - \tau'(t)C$$

Subjects with such preferences avoid surfing by committing, because the cost to them of expending willpower is very high. However, when commitment becomes sufficiently expensive, it is no longer an attractive option, and the subject surfs.

5. Results

In order to structure the discussion of our results, we begin by describing the frequency of commitment and surfing decisions in each phase of the experiment. It turns out there are seven patterns of interest (see Table 4). We first show that the treatments generate differences in the distribution of these seven behaviors. After establishing this, we return to test the hypotheses detailed above.

Table 4 shows that upon seeing the temptation screen for the first time, 20.4% used the commitment device (in Table 4, *Behavior 1*), while 13.9% of the subjects started to surf (*Behavior 2*). Together, 34.3% of the subjects made one of these two decisions at the first temptation screen. The next two lines of the table refer to subjects who used the commitment device (*Behavior 3*, 5.6% of all subjects) or started to surf (*Behavior 4*, 0.9%) later during phase 1 at one of the temptation screens 2 through 6. The fifth and sixth lines of the table list the subjects who used the commitment device in Phase 2 (*Behavior 5*, 3.7%), and the subjects (*Behavior 6*, 26.9%) who started to surf in Phase 2. This relatively large frequency of surfing at the beginning of Phase 2 is almost entirely due to subjects who had no remaining value for counting. The remaining 31 subjects (*Behavior 7*, 28.7%) never used a commitment device and resisted the temptation of surfing at all screens. For these subjects, utility from counting was not so low relative to that of surfing the internet to justify the lower payoff at the end of the experiment.

** Include table 4 here **

Table 4 also contains the test statistics and p -values for χ^2 -tests for the effects of the randomly assigned treatments on the distribution of stylized behaviors. There is statistically significant difference for the contrast between zero vs. positive commitment cost ($p=0.012$). There is no significant effect of the size of the additional payoff for counting to the end of phase 1 ($p=0.564$). Considering only phase 2, however, we see that for those still counting, there is a significant effect ($p<0.000$) of the additional payoff for counting to the end of phase 2. The

reason is that 25 of the 29 subjects who chose to surf in phase 2 had no remaining value for counting (three subjects with no remaining value counted to the end).

From the findings in Table 4, it is clear that our treatment manipulations have significant effects on the behaviors of subjects. In particular, an increase in commitment costs decreases the frequency of commitment (11.5% use commitment when it costs \$1, as compared to 28.6% when it is free), while an increase in the value of using the commitment device (i.e., an increase in R_I) increases the frequency of commitment (22.2% use commitment at the first temptation screen if the remaining value was \$7, and 18.5% if it was \$5).

We next analyze the behavior in the first phase in more detail. Figure 1 shows, by temptation screen, the *fraction* of subjects who decided to commit or surf, respectively, during Phase 1 of the experiment. Figure 2 shows, by temptation screen, the *hazard rates* of subjects who committed and began surfing, respectively. Both figures are stratified by commitment cost (P) and the value of counting (R_I). These figures convey the five key findings that emerge from our data.

First, the two top panels of Figures 1 and 2 show that a substantial fraction of subjects pay the commitment costs and hence are willing to pay to remove the surfing option from their choice set. This supports Hypothesis 0.

Second, a majority of commitment decisions are taken at the first opportunity (in temptation screen 1); the increase in the share of commitment on screens 2 to 6 is small as compared to the large fraction of commitment decisions at screen 1. From Hypothesis 1, this suggests that costs of self-control are linear for most participants. Third, surfing decisions are almost always taken at the first opportunity, thus supporting Hypothesis 2.

However, Figures 1 and 2 further indicate that in Phase 1 a number of subjects (a total of seven) do make commitment ($n=6$) and surfing ($n=1$) decisions after screen 1. Moreover, if we include those in Phase 2 whose decisions were payoff relevant (that is, those who could still earn positive amounts in Phase 2), we find three delayed commitment decisions (two at screen 11, one at screen 12) and one delayed surfing decision (at screen 8). Overall then, we observed a total of 11 payoff-relevant delayed decisions, 9 of which were to commit. With the caveat that the sample is small, this difference (9 vs. 2) is statistically significant (two-tail proportions (z) test against the null of 0.5, $p<0.01$). The finding that delayed commitment is substantially more likely than delayed surfing confirms Hypothesis 2a, and is additional evidence supporting nonlinear costs of self-control.

Fourth, supporting Hypothesis 3, we observe that the frequency of commitment decreases with an increase in commitment cost. Finally, we observe that the fraction of people who choose to surf increases with an increase in commitment cost, supporting Hypothesis 4.

** Include figure 1 here **

** Include figure 2 here **

In Table 5, we present results from six multivariate Probit regressions that corroborate all our findings above.¹² They include as independent variables a set of dummies for the randomly assigned treatments, as well as controls for the socio-demographic characteristics of the subjects: female, age above 20 years, and major (natural sciences, economics or business, and social sciences, with reference category “other”). The dependent variables are binary and capture the decisions to surf and commit at three different points in the experiment: (i) At the first temptation screen; (ii) at one of the other five temptation screens in phase 1; and (iii) by the end of the experiment (i.e., after Phase 2).

Table 5 reports marginal effects. The personal characteristics are expressed as dummy variables, so that their coefficients correspond to the effect of a change of the dummy from zero to one, again expressed in percentage points. Finally, the commitment cost and value variables are expressed in dollars, so their coefficients measure the percentage-point effect of a one-unit change.

The first row in Table 5 shows that the commitment cost dummy is statistically significant in all regressions with commitment as the dependent variable. Commitment is less likely when it involves a positive cost. The impact is sizeable; changing commitment costs from zero to one dollar reduces the probability of ever *committing* during the experiment by about 29 percentage points (column 6). Commitment costs are also statistically significant predictors of choosing to surf at the first temptation screen (column 1). In the other two regressions (columns 2 and 3), commitment costs have no significant effect on the likelihood of choosing to surf. The reason is that, in line with hypotheses 1 and 2, virtually all decisions are made immediately. To summarize, the regression results with respect to commitment costs are in line with Hypotheses 3 and 4, derived in section 3.

** Include table 5 here **

¹² Each participant made independent individual decisions, and there was no communication among people within a session. Consequently, each regression reports results from N=108 independent observations at the individual level.

We see from Table 5 that, in Phase 1, there is an insignificant effect of the remaining value to counting R_1 on the decision to commit. On the other hand, the remaining value of resisting temptation R_2 is a powerful predictor of whether subjects complete Phase 2 counting. The reason, as noted above, is that 29 participants faced a zero value of counting in phase 2, and nearly all of them chose to surf in this case.

6. Discussion

The majority of decisions we observe are consistent with FL's linear specification. In addition to the qualitative patterns described by Hypotheses 1-4, all of which found support in our data, the FL linear framework has the stark prediction that commitment decisions should be made at the first screen in Phase 1 (screen 1), while surfing decisions should be made either at the first Phase 1 screen or the first screen of Phase 2 (screen 7). Indeed, from Table 4 one observes that of the 44 total surfing or commitment decisions made in Phase 1, 37 (84%) were made at the first screen. In Phase 2, of the 29 people who had no remaining value for participating in the game, 22 chose to surf on the first screen. Further, of the seven people in the second phase who chose to surf or commit and who had positive earnings available from counting, three made their decisions on the first screen (all to surf).

It is worthwhile to emphasize that our participants knew the precise distribution of future temptations and were never surprised by the occurrence of a temptation screen. Further, the initial 30 minute "training" phase helped to ensure subjects were aware of the distasteful nature of the counting task prior to making decisions in Phase 1. Consequently, the decision to commit implies surfing is a tempting good, particularly when there is a positive commitment cost.

A possible alternative explanation for commitment is that the "temptation" screen could perhaps be perceived as an annoyance people will pay to remove. In contrast to Hypothesis 1, this would suggest that commitment decisions should monotonically increase with the number of exposures to the temptation screen. It turns out that while we do observe some delay in commitment decisions, commitment does not increase over time, and thus this alternative possibility does not seem to explain the patterns in our data.

While we have emphasized that delay in commitment can be a rational response to nonlinearities in cognitive depletion, there are other potential explanations for our data. For example, a subject may be unsure about whether she will be able to maintain concentration, or

whether boredom will become worse over the course of the experiment. In order to gain more certainty regarding the correct decision, it may be better to wait. A related idea, and one explored by Noor (2011), is that commitment itself may require self-control. In particular, a subject may believe that committing is optimal and yet may be tempted to maintain the surfing option. Resolving this internal conflict may take time, making it look like the subject delayed the decision. Our design narrows the scope for these explanations by giving participants full information at the beginning of the experiment regarding the way temptation and opportunities to commit will evolve over time, as well as giving them 30 minutes of exposure to the environment prior to any exposure to temptation.

Finally, Tables 4 and 5 make clear that the demand for commitment is relatively low even when its price is zero, and also highly price elastic. While we are cautious in generalizing from this single experiment, it is worth noting that these findings may help to explain why the market for commitment devices has been slow to emerge, and leaves as an open question the importance of self-control in driving economic behavior in natural environments¹³.

7. Conclusion

We presented results from a novel laboratory experimental design involving persistent temptations: Subjects were paid to pursue a distasteful counting task, but tempted to forgo their wage for counting and instead surf the internet. Subjects were also offered the option to commit to counting by choosing to remove the option to surf. We found that surfing as well the commitment device are both normal goods, in the sense that succumbing to temptation is more likely when the cost of doing so is lower, and further that the price elasticity of the demand for commitment is high. In particular, when commitment comes at zero cost, 28.6% of subjects choose to eliminate the surfing option at the first opportunity. When the cost is \$1, this fraction decreases to 11.5%.

We used the patterns in our data to test predictions derived from the dual-self model detailed by Fudenberg and Levine (2012). Under regularity conditions including that the cost of self-control (cognitive depletion) is linear, the model makes the stark prediction that commitment or giving in to temptation should occur at the first opportunity (as noted earlier, this prediction is

¹³ We thank anonymous referees for suggesting this and several of the alternative explanations for commitment and delay in commitment noted in this section.

common to many models in the literature, particularly those that assume quasihyperbolic discounting). If self-control costs display nonlinearities, then the FL model can rationalize both delay in commitment as well as delay in giving in to temptation. In our particular framework, we show that nonlinearities could explain commitment delay, but giving in should still occur at the first opportunity. Consequently, observing substantially more delayed commitment than delayed surfing decisions is evidence in favor of the FL nonlinear model.

The majority of our surfing and commitment decisions were made immediately, consistent with the linear model of decisions under temptation. At the same time, a non-negligible fraction of our participants delayed their decision to surf or to commit. Moreover, significantly more of these delayed (payoff relevant) decisions were to commit, which is predicted by the FL model under nonlinear costs of self-control.

As indicated in the discussion surrounding Hypothesis 1, delay to commit in our environment can be rationalized if self-control rapidly changes from very easy to very difficult (see also the example in Section 2). In the FL framework, this could perhaps be consistent with rapid cognitive depletion combined with very slow replenishment. It seems valuable to know more about this process, and particularly how it might differ among individuals. For example, Table 5 reveals that females are significantly less likely to surf than males in Phase 1, a finding consistent with the other research showing that females display greater self-control than males in various economic environments (Houser et al, 2012).

In view of our results, it would perhaps be useful to model cognitive resource depletion using flexible functional forms that nest linear within non-linear specifications, and that accommodate heterogeneity at the individual level. Such approaches are widely used in modeling beliefs and expectations (see, e.g., Houser et al, 2004). We believe these same methods might be profitably applied to the analysis of willpower, self-control and decisions under temptation.

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Table 1: Phases of the experiment and design parameters characterizing each phase.

Phase	Duration	Number of counting tasks	Number of temptation screens	Commitment cost [in \$]	Final payoff if surfing [in \$]	Additional payoff for continuing to count to end of experiment [in \$]
0	30 min	15	0			
1	45 min	12	6	P	W_{L1}	$R_1=15 - W_{L1}$
2	45 min	12	6	P	W_{L2}	$R_2=15 - W_{L2}$

Note: P , W_{L1} and W_{L2} are design parameters whose values are randomly assigned to the 12 experimental conditions. As described in the model in Section 4, P is the cost of commitment, and the values of W_{L1} and W_{L2} are the “low” payoff values associated with choosing to surf in Phase 1 or Phase 2, respectively. In all experiment conditions, the payoff for counting to the end of the experiment is $W_H=\$15$.

Table 2: Experimental design: values of design parameters by experimental condition

Experimental condition G	Commitment cost (P)	If completing phase 0 but surfing in phase 1		If completing phase 0 and 1 but surfing in phase 2		N
		Final payoff (W_{L1})	Foregone additional payoff (R_1)	Final payoff (W_{L2})	Foregone additional payoff (R_2)	
1	\$ 0	\$ 10	\$ 5	\$ 10	\$ 5	8
2	\$ 0	\$ 10	\$ 5	\$ 15	\$ 0	8
3	\$ 0	\$ 8	\$ 7	\$ 12	\$ 3	8
4	\$ 1	\$ 10	\$ 5	\$ 10	\$ 5	10
5	\$ 1	\$ 10	\$ 5	\$ 15	\$ 0	9
6	\$ 1	\$ 8	\$ 7	\$ 12	\$ 3	9
7	\$ 0	\$ 8	\$ 7	\$ 10	\$ 5	12
8	\$ 0	\$ 8	\$ 7	\$ 15	\$ 0	9
9	\$ 0	\$ 10	\$ 5	\$ 12	\$ 3	11
10	\$ 1	\$ 8	\$ 7	\$ 10	\$ 5	7
11	\$ 1	\$ 8	\$ 7	\$ 15	\$ 0	9
12	\$ 1	\$ 10	\$ 5	\$ 12	\$ 3	8

Note: The total number of subjects is 108. The values of W_{L1} and W_{L2} are the “low” payoff values associated with choosing to surf in Phase 1 and Phase 2, respectively, as described in the model in Section 4. The “high” payoff W_H is always \$15.

Table 3: Descriptive statistics on subjects' characteristics

Variable	Value	<i>N</i>	%
Age	18–20	40	37.0
	21–29	68	63.0
Sex	Male	62	57.4
	Female	46	42.6
Major subject	Economics or business	18	16.7
	Natural sciences or mathematics	40	37.0
	Social sciences	21	19.4
	Other	29	28.9

Note: The total number of subjects is 108.

Table 4: Frequency of behaviors, overall and by values of treatment variables

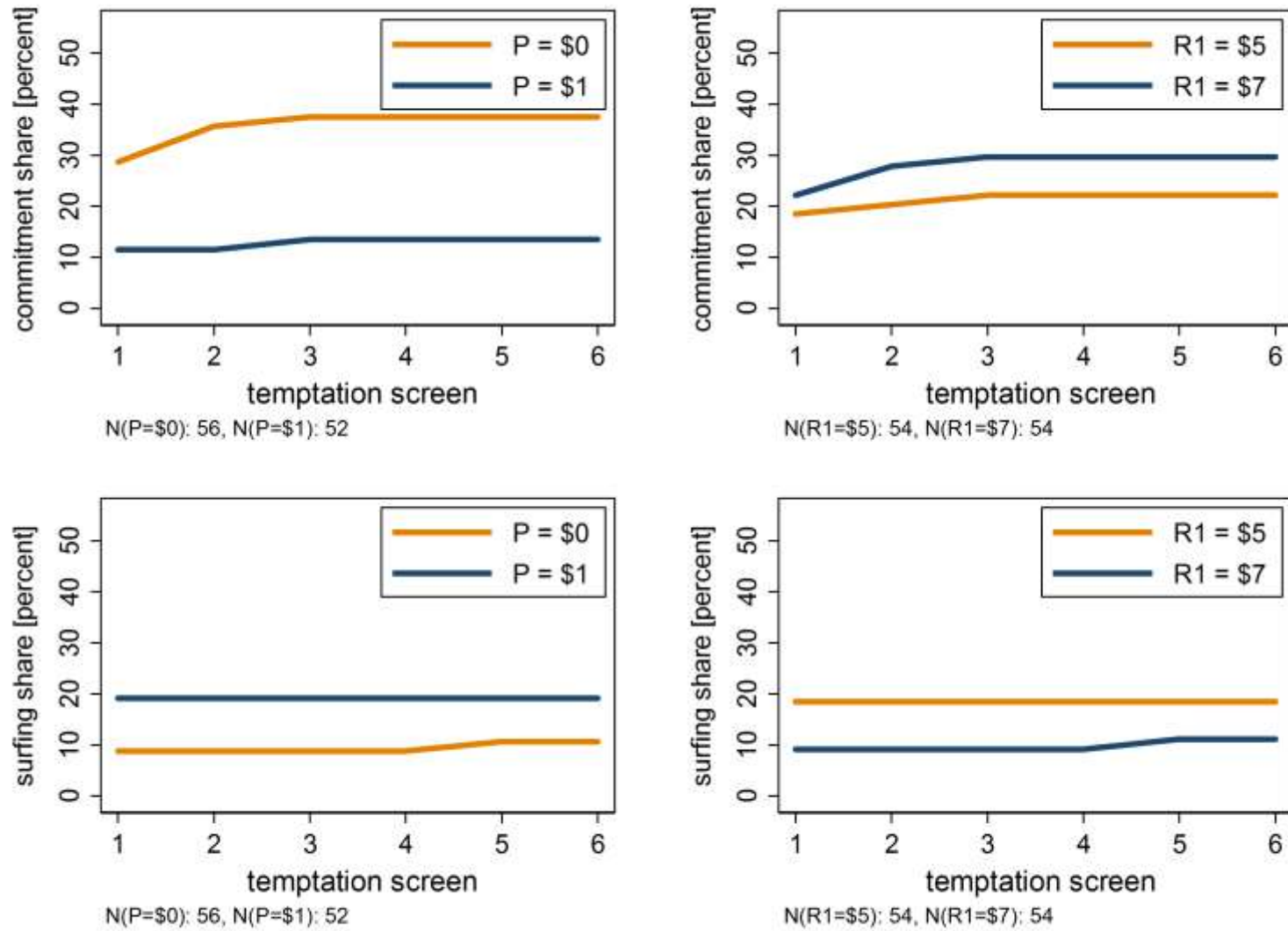
		Commitment cost (<i>P</i>)				Additional payoff in phase 1 (<i>R</i> ₁) for counting to end of experiment				Additional payoff in phase 2 (<i>R</i> ₂) for counting to end of experiment							
		\$ 0		\$ 1		\$ 5		\$ 7		\$ 0		\$ 3		\$ 5			
Behavior		<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%		
1	Committed at first temptation screen	22	20.4	16	28.6	6	11.5	10	18.5	12	22.2						
2	Surfed at first temptation screen	15	13.9	5	8.9	10	19.2	10	18.5	5	9.3						
3	Committed at later screen in Phase 1	6	5.6	5	8.9	1	1.9	2	3.7	4	7.4						
4	Surfed at later screen in Phase 1	1	0.9	1	1.8	0	0	0	0	1	1.8						
5	Committed in Phase 2	4	3.7	4	7.1	0	0	3	5.6	1	1.8	1	3.4	0	0		
6	Surfed in Phase 2	29	26.9	14	25.0	15	28.9	15	27.8	14	25.9	25	86.2	4	20.0		
7	Never committed and never surfed (so counted) at all screens	31	28.7	11	19.6	20	38.5	14	25.9	17	31.5	3	10.3	16	80.0		
Column total		108		56		52		54		54		29		20		15	
Test for independence of columns		$\chi^2(6) = 16.4, p = 0.012$				$\chi^2(6) = 4.8, p = 0.564$				$\chi^2(4) = 42.4, p < 0.000$							

Table 5: Probit regressions of the decision to surf or commit

	Surfing 1 st screen (1)	Surfing screens 2-6 (2)	Surfing at end (3)	Committed 1 st screen (4)	Committed screen 2-6 (5)	Committed at end (6)
Commitment cost ($P=1$)	0.129* (0.0659)	0.0888 (0.0734)	0.0544 (0.114)	-0.151* (0.0771)	-0.205** (0.0831)	-0.291*** (0.0832)
Additional payoff for counting to end (R_1)	-0.0290 (0.0305)	-0.0242 (0.0330)	-0.0727 (0.0577)	0.0193 (0.0365)	0.0272 (0.0409)	-0.00403 (0.0415)
Additional payoff for counting to end (R_2)			-0.148*** (0.0285)			0.0792*** (0.0221)
Female	-0.133** (0.0570)	-0.112* (0.0635)	-0.0178 (0.111)	-0.0374 (0.0793)	0.0303 (0.0912)	0.0163 (0.0931)
Age: older than 20	0.0251 (0.0593)	-0.00814 (0.0688)	-0.0481 (0.116)	0.0679 (0.0800)	0.0678 (0.0933)	0.0298 (0.0973)
Natural sciences	-0.0769 (0.0653)	-0.0846 (0.0753)	-0.248* (0.136)	-0.00137 (0.100)	0.127 (0.116)	0.127 (0.125)
Economics or business	-0.0619 (0.0605)	-0.0714 (0.0690)	-0.164 (0.143)	0.172 (0.148)	0.235 (0.165)	0.139 (0.172)
Social sciences	-0.0615 (0.0618)	-0.0172 (0.0878)	0.123 (0.158)	0.0534 (0.126)	0.0654 (0.143)	0.0565 (0.150)
Log Likelihood	-38.13	-41.77	-53.09	-50.58	-55.61	-52.40
Pseudo R^2	0.12	0.08	0.27	0.07	0.10	0.20
Observations	108	108	108	108	108	108

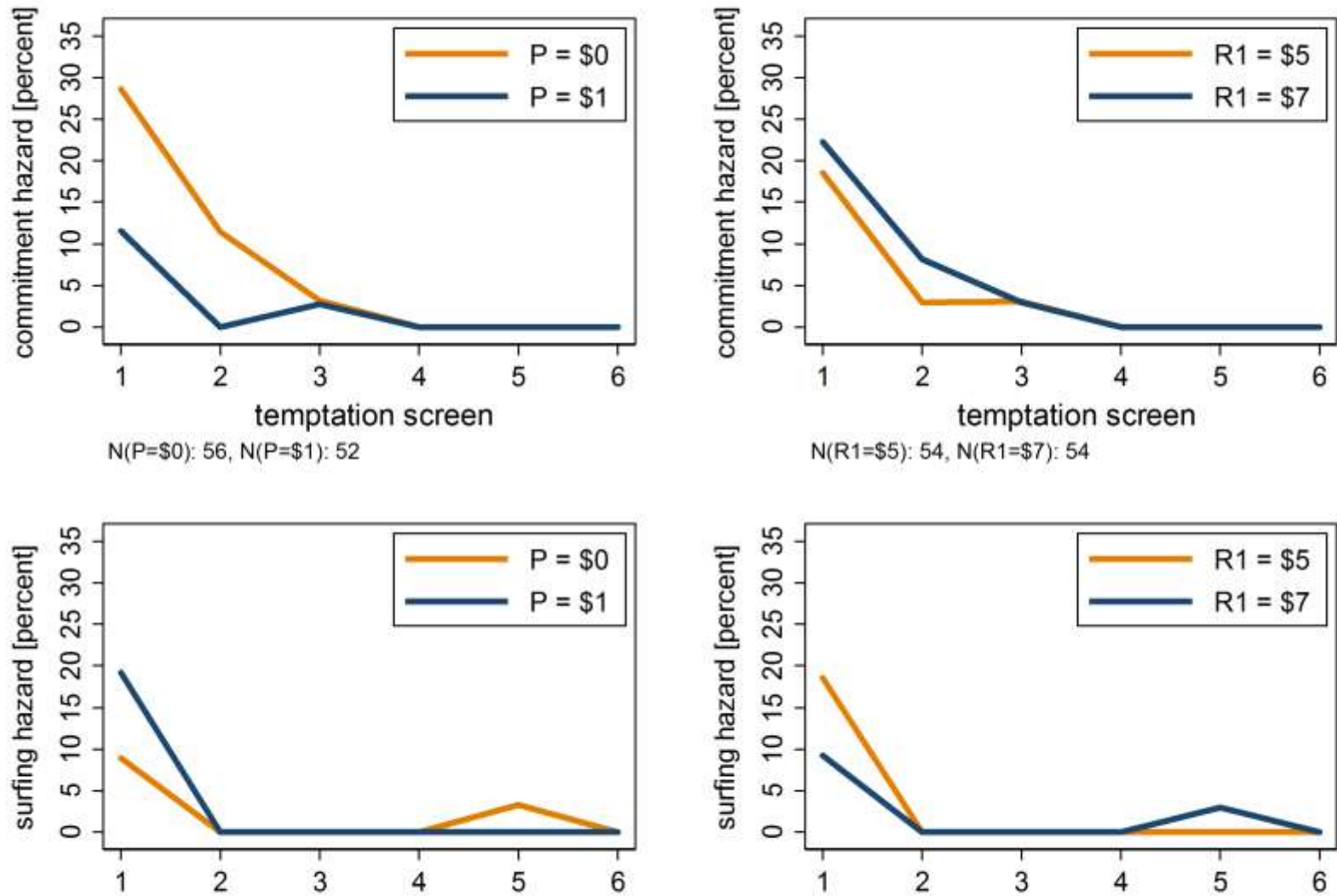
Notes: Coefficients are expressed as marginal effects; for continuous covariates, they are evaluated at their means, for binary covariates, they correspond to a discrete change from 0 to 1. The symbol * denotes statistical significance at the 10% level; ** at the 5% level; and *** at the 1% level.

Figure 1: Shares of commitment and surfing in Phase 1, by commitment cost and additional payoff for counting to end.



Legend: P = Commitment costs [in \$]; R1 = *Additional* payoff gained from counting to the end of the experiment [in \$].

Figure 2: Hazard rates of commitment and surfing in Phase 1, by commitment cost and additional payoff for counting to end.



Appendix: Instructions provided at the beginning of the experiment

Thank you for coming. You have already earned a show-up bonus of \$5 for arriving on time. These instructions explain how you can earn more money during the experiment.

Today's experiment involves a counting task. From time to time you will see a screen which we call the "*counting screen*". This screen displays nine digits, either zeros or ones. Your task is to count the number of ones, and report that number in a box provided. You will have 15 seconds to provide an answer. Not providing an answer, or providing an incorrect answer, is counted as a mistake. If you make mistakes on more than 30% of the counting screens that are presented to you during the counting task, you will earn \$3.

If your share of mistakes remains below 30%, then your earnings depend on how much time you spend on the counting task: **[P1]** if you spend less than 75 minutes on the counting tasks; **[P2]** if you spend more than 75 minutes but less than 120 minutes on the counting tasks; or **\$15** if you spend 120 minutes on the counting tasks. These payments are in addition to your show-up bonus.

In addition to the *counting screen*, another kind of screen is displayed up to 12 times during the experiment. This "*choice screen*" will appear for the first time after about 33 minutes, and it may appear again around minutes 41, 51, 58, 64, 69, 78, 83, 89, 97, 109, and 114 of the experiment, depending on which options you choose. Whenever the *choice screen* appears, it will present you with the following three options:

1. You can end the counting tasks. For the remaining time of the experiment, you can surf the internet on the computer here in the laboratory room. If you choose

- this option, the *choice screen* will not appear again during the experiment. You select this option by not pressing any of the buttons on the *choice screen*.
2. You can decide to continue the counting tasks. If you choose this option, you may see the *choice screen* again, as indicated by the timeline described above. You select this option by pressing the corresponding button on the *choice screen*.
 3. You can decide to continue the counting tasks with the following change: in contrast to option 2, the *choice screen* will never appear again for the rest of the experiment. Choosing this option reduces your earnings by [C]. You select this option by pressing the corresponding button on the *choice screen*. Choosing this option means that the counting task will continue until the end of the experiment.

This experiment will end at different times for different participants. Please do not leave the room, talk or otherwise distract other participants in any way until you are told that all participants have completed the experiment and you have left the laboratory.

Figure A.1: Counting screen

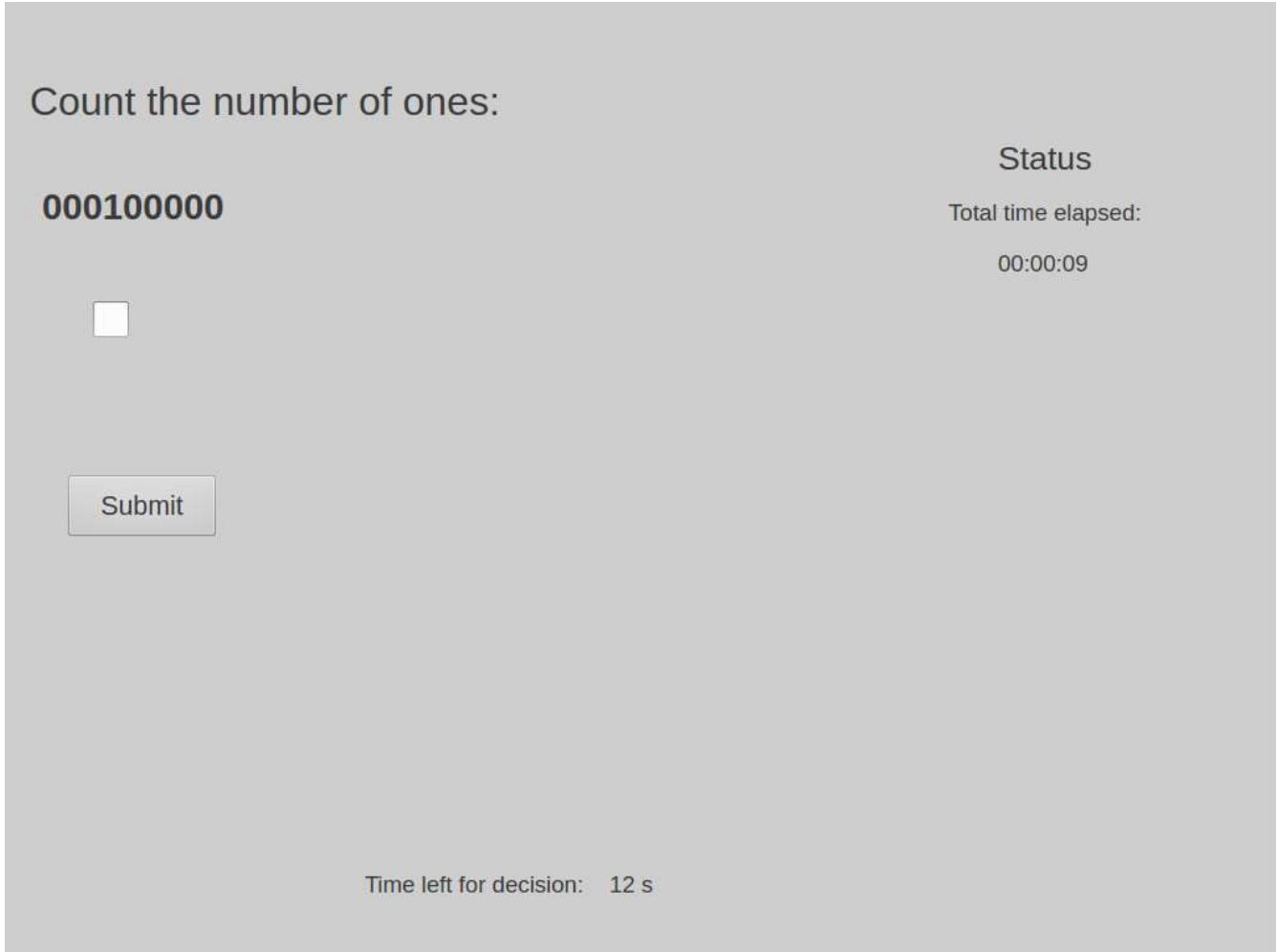


Figure A.2: Empty screen

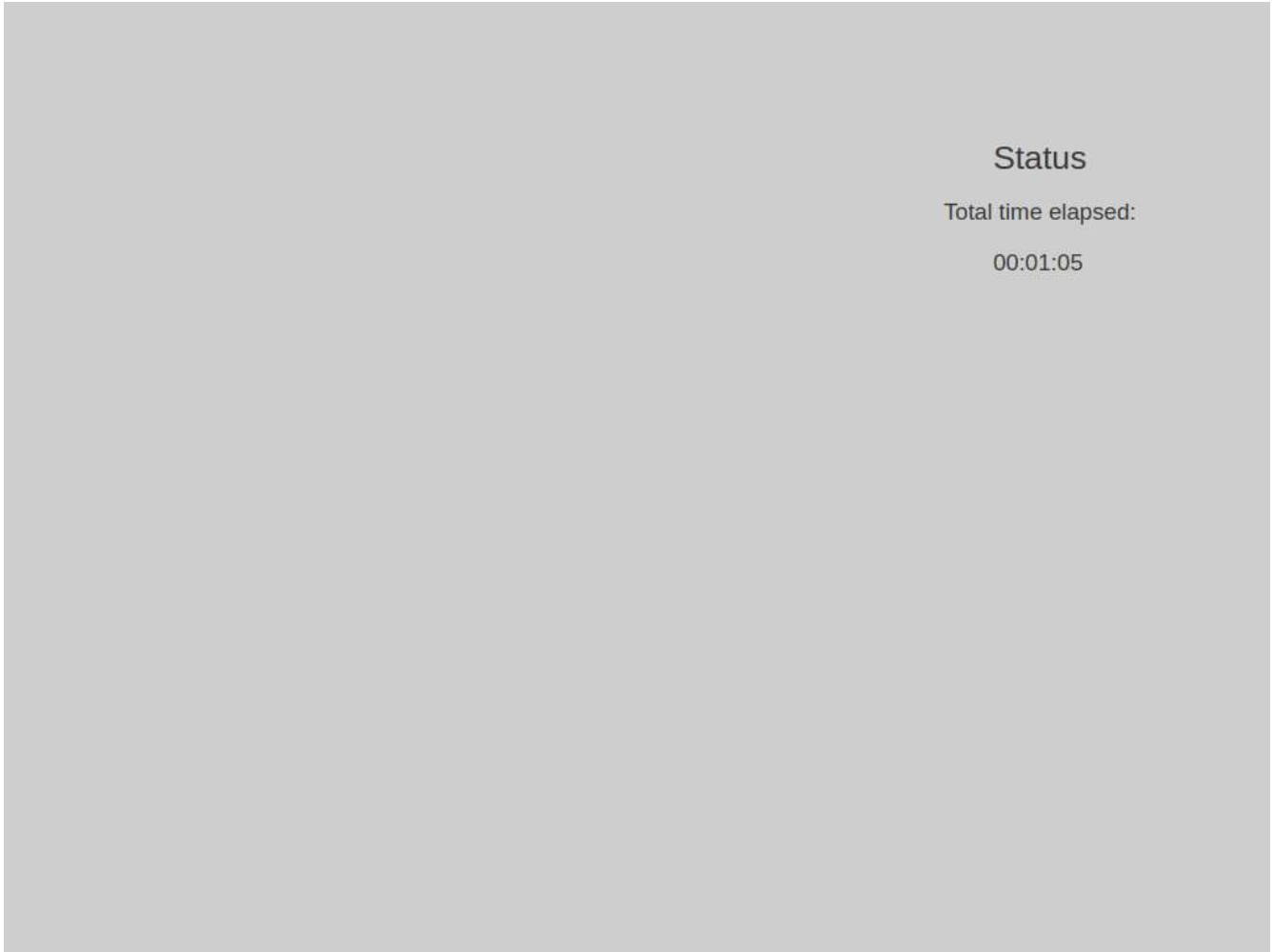


Figure A.3: Temptation screen

Thank you for participating in today's experiment. If you have answered at least 70% of the counting tasks correctly, your earnings are \$10.

Status

You will now be given access to the internet, so that you can pass the time until the Total time elapsed: experiment ends for all participants. If you like, you can also continue with the counting experiment. If you continue with the counting experiment you can earn up to an additional \$5. You will be given access to the internet unless you press one of the two buttons below. 00:41:40

Continue Counting

Click here if you want to continue counting without any more opportunities to access the internet. There is a \$1 charge for clicking this button. You will continue counting until the experiment ends. You can earn up to \$5 in addition to your current earnings.

Continue Counting and Remove Internet-Option

Time left for decision: 96 s