Eliciting temptation and self-control through menu choices: a lab experiment*

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Abstract

Unlike present-biased individuals, Gul and Pesendorfer (2001) agents may pay to restrict choice sets despite expecting to resist temptation, thus eliminating self-control costs. I design an experiment to identify these self-control types, where the temptation was to read a story during a tedious task. The identification strategy relies on a two-step procedure. First, I measure commitment demand by eliciting subjects' preferences over menus, which did or did not allow access to the story. I then implement their preferences using a random mechanism, allowing me to observe subjects who faced the choice, yet preferred commitment. A quarter to a third of subjects can be classified as self-control types according to their preferences. Of those facing the choice, virtually all self-control types behaved as they anticipated and resisted temptation. These findings suggest that policies restricting the availability of tempting options could have much larger welfare benefits than predicted by present bias models.

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1. Introduction

Models of dynamically inconsistent time preferences (Strotz [1956], Laibson [1997], O'Donoghue and Rabin [1999]) are by far the most popular framework in the literature on self-control problems. A central implication of these models is that present-biased agents may demand commitment devices to constrain the choices of their future selves. As an alternative approach, Gul and Pesendorfer (2001) (henceforth GP 2001) generate commitment demand by modeling agents whose preferences not only depend on final consumption but also on the most tempting alternative in the choice set. One key distinction between these theories pertains to the motives that drive a decision maker to restrict his choice set. While a present-biased agent will choose to eliminate a temptation from his choice set only if he expects to succumb to it, a GP agent may value commitment even if he expects to resist temptation, because commitment eliminates the cost of exerting self-control. The present paper takes a first step to quantify the importance of these "self-control types" who may prefer to remove a temptation from their choice set, despite expecting not to succumb to it.

Assessing the prevalence of self-control types is important from a policy perspective: if unchosen alternatives can affect welfare, then policies designed to reduce the availability of tempting options could have strong welfare effects. To see this, consider the welfare implications of introducing smoking bans in public spaces. Both of the above theories predict that current smokers who are trying to quit could benefit from a ban; what GP 2001 further suggests is that a ban could also increase the welfare of *former* smokers by alleviating the self-control costs of remaining smoke-free. Welfare calculations that fail to account for these costs could therefore substantially underestimate the welfare benefits of smoking bans. Ignoring self-control costs may not only bias our estimate of the *effect size* of a given policy but also our assessment of the *type* of policy tools likely to be most effective. If self-control is high so that tempted agents rarely succumb to temptation, then price policies such as proportional taxes or subsidies will be ineffective, for their aim is to alter consumption behavior.[1] On the other hand, policies that impose a cap on consumption of the tempting good may improve welfare even for those whose consumption would be below the cap in the absence of restrictions.

While the above discussion illustrates the importance of measuring self-control costs, it also

[1] See Krusell and Smith (2007, WP) who show in a dynamic general equilibrium model that proportional subsidies on investment are a useful policy tool only if self-control is low and agents usually succumb to the temptation to overconsume, as is the case of present-biased agents.

hightlights the empirical challenge pertaining to the identification of the population incurring these costs: to identify self-control types, one not only needs to observe whether they would prefer to restrict their choices, but also what they would do in a counterfactual world where no form of commitment is available. However, with naturally occurring data, we rarely observe individuals having a preference for a restricted choice set A and yet receiving a larger choice set B. To tackle this empirical challenge, I design an experimental method that tests for the prevalence of self-control types and implement it in a laboratory setting.

In the experiment, the potential temptation was to forego additional earnings to learn a sensational story while performing a tedious attention task for which subjects received payment. I adopt a two-step procedure to identify subjects who suffer from self-control costs. First, using an incentive compatible mechanism, I elicit subjects' preference ordering over a set of menus, which either did or did not allow access to the story during the task and classify subjects into types according to their menu preferences. A *self-control type* is a subject who would strictly prefer to (i) remove the temptation from his choice set instead of facing the choice; (ii) face the choice instead of receiving the tempting option for sure, as he expects to resist it. Second, I implement subjects' preferences using a random implementation rule. This mechanism allows me to observe the behavior of subjects who faced the choice, yet preferred commitment and to contrast *perceived* self-control with *actual* self-control. Finally, I gather two types of auxiliary data to provide additional evidence in favor of the GP model. First, I measure subjects' beliefs about their anticipated choice in the absence of commitment to study whether those classified as self-control types indeed expect to resist temptation. Second, I contrast the task performance of subjects who faced the choice with those who faced commitment to study whether the mere exposure to learning opportunities entailed a self-control cost in the form of a productivity loss.

Depending on how conservative one wants to be, I find that between 23% and 36% of subjects can be classified as self-control types according to their menu preferences, a proportion which is 3 to 4 times higher than what would be observed if subjects had ordered the menus at random. This is by far the most common preference pattern among those who preferred to restrict their access to the story; in contrast, only 2.5% of subjects exhibit menu preferences consistent with standard models of dynamic inconsistency. In line with the GP model, almost all self-control types predicted that they would resist the temptation to learn the story in the absence of commitment. Finally, *perceived* self-control, as measured by subjects' menu preferences and anticipated choices, almost entirely coincides with *actual* self-control when facing the choice: while 18% of subjects chose to learn the story when offered the choice, all but one subject with self-control preferences succumbed to the temptation to do so. At the same time, task performance in the full sample was lower in the absence of commitment, which provides suggestive evidence that resisting learning opportunities might have entailed a self-control cost.

To my knowledge, this is the first study specifically designed with the intention of identifying self-control types and measuring their prevalence in a controlled setting. As such, the present paper relates to a vast literature that explores the connections between self-control problems and commitment demand, both in laboratory experiments (Houser et al. [2010], Augenblick et al. [2015]) and in field settings (Ashraf at al. [2006], Kaur et al. [2010], John [2015], Sadoff et al. [2014]). This paper is also connected to a burgeoning literature studying commitment and flexibility through menu choice. Dean and McNeill (2015) explore the relationship between preference uncertainty and preference for larger choice sets by linking preferences over menus of work contracts to subsequent choices of contracts; they find no evidence of preference for commitment in their setting. In the context of a weight loss challenge, Toussaert (2016) studies participants' preferences over lunch reimbursement options differing in their food coverage and finds a strong demand for eliminating unhealthy foods from the coverage; however, the actual food selections were not observed.

The remainder of this paper is organized as follows. Section 2 introduces the theoretical framework on which the experiment is based. Section 3 outlines the experimental design and Section 4 presents the experimental results. Section 5 concludes. Additional results are reported in the Appendix at the end of this paper as well as in an Online Appendix (OA).

2. Temptation and self-control through menu choices

The analysis of this paper is grounded in the theory of menu choice of Gul and Pesendorfer (2001), which provides a framework for studying costly self-control. This section describes how temptation and self-control are elicited in GP 2001, explains key distinctions and connections with other models of temptation and discusses the restrictions imposed by the theory on choice behavior.

2.1 Costly self-control in GP 2001

GP 2001 consider a two-period expected utility model, $t \in \{1, 2\}$. Their primitive is a preference relation $\succeq_1$ defined on a set $\mathcal{M}$ of menus (of lotteries). In Period 1, a decision maker (DM) chooses among menus according to $\succeq_1$, with the interpretation that in Period 2, he will make a choice from the selected menu according to $\succeq_2$. In addition to the usual assumptions,[2] GP 2001 impose a new behavioral axiom on $\succeq_1$ called *Set Betweenness*, which states that for any two menus A and B,

$$A \succeq_1 B \text{ implies } A \succeq_1 A \cup B \succeq_1 B$$

This axiom allows to capture behaviorally the notions of temptation and self-control. To see how, consider a simple choice situation with two options a (for apple) and b (for brownie) and assume that the ex ante preferences of the DM are such that $\{a\} \succ_1 \{b\}$. A standard DM (STD) evaluates a menu by its best element(s) and is unaffected by the presence of dominated options, implying that $\{a\} \sim_1 \{a, b\} \succ_1 \{b\}$. On the other hand, a DM who is tempted by the brownie would prefer to commit to a menu that excludes b than to be facing the choice between a and b in Period 2. In other words, b is a *temptation* for a if $\{a\} \succ_1 \{a, b\}$. In this model, there are two reasons why a tempted DM may favor commitment to a. First, the DM may expect to give in to b if offered to choose from $\{a, b\}$, thus assigning the same value to $\{b\}$ and $\{a, b\}$. Alternatively, the DM may anticipate that he will resist b when facing $\{a, b\}$ by exerting self-control, which makes $\{a, b\}$ more valuable than $\{b\}$. In formal terms, say that (i) b is an *overwhelming temptation* if $\{a\} \succ_1 \{a, b\} \sim_1 \{b\}$ and (ii) b is a *resistible temptation* if $\{a\} \succ_1 \{a, b\} \succ_1 \{b\}$. In the experiment, a DM with the menu preferences $\{a\} \succ_1 \{a, b\} \succ_1 \{b\}$ will be called *self-control type*. GP 2001 show that under their axioms, $\succeq_1$ admits the following self-control representation

$$V_{GP}(A) := \max_{x \in A} [u(x) + v(x)] - \max_{y \in A} v(y)$$

The *commitment* utility u measures utility in the absence of temptation i.e. when committed to a singleton choice. The *temptation* utility v measures the temptation value of an alternative and $\max_{y \in A} v(y) - v(x)$ is the self-control cost of choosing x over the most tempting alternative in A.[3] In Period 2, the DM chooses as if he maximized the compromise utility $u + v$.

[2] $\succeq_1$ is required to be a weak order, which satisfies the standard expected utility axioms of Continuity and Independence adapted to a menu choice setting. These technical axioms are not tested in this paper and are treated as maintained assumptions. The requirement that $\succeq_1$ be a weak order is also assumed away in the experiment, for subjects are required to provide a full ranking (allowing for ties) of the alternatives, thus automatically satisfying completeness and transitivity. See Section 3.2 for more details.

[3] To see why u is a commitment utility, let $A = \{a\}$ and notice that $V_{GP}(A) = u(a)$. To see why v measures temptation, notice that if $u(a) > u(b)$ and $v(b) > v(a)$ then $V_{GP}(\{a\}) > V_{GP}(\{a, b\})$ i.e. the agent is tempted by b.

2.2 Connections and differences with other theories

The GP model presents several distinguishing features, which guide the identification of self-control types. First, commitment in the GP model can be rationalized through two channels: either by the DM's belief that he will give in to temptation or because commitment eliminates the cost of exerting self-control. In contrast, standard models of dynamic inconsistency can only rationalize the case of overwhelming temptation, $\{a\} \succ_1 \{a,b\} \sim_1 \{b\}$.[4] The reason is that the preferences of a present-biased agent only depend on final consumption and not on the specific set from which consumption is taken; as a result, commitment can only be valuable if the agent expects to deviate from the ex ante optimal consumption path. As such, models of present bias can be understood as a limit case of the GP model when the self-control cost becomes arbitrarily large, so that the agent never exercises self-control.[5]

Secondly, although observing the preference ordering $\{a\} \succ_1 \{a,b\} \succ_1 \{b\}$ is generally enough to distinguish the GP model from standard models of dynamic inconsistency, this is only true under the most common assumption that Period 2 choice is deterministic. To see this, suppose that the DM is uncertain about his future temptation: with probability p, he expects to succumb to temptation and select b, while with probability $(1-p)$, he believes that he will face no temptation and choose a. For such a DM, the preference ordering $\{a\} \succ_1 \{a,b\} \succ_1 \{b\}$ does not reflect costly self-control; rather, it is explained by a probability $p \in (0,1)$ of indulgent behavior.[6] Therefore, to be able to distinguish between these two interpretations (costly self-control versus random indulgence), it is necessary to enrich the dataset to include expectations about Period 2 choice from $\{a,b\}$: only a DM who suffers from random indulgence will expect to give in with positive probability.

Third, Gul and Pesendorfer model a sophisticated agent who correctly anticipates the choice he will make in Period 2 from the selected menu and chooses a menu in Period 1 accordingly. Formally, say that a DM is *sophisticated* if $A \cup \{x\} \succ_1 A$ implies $x \succ_2 y$ for all $y \in A$. In other words, if a DM

[4] By standard, I mean models that assume a fixed present bias parameter and degenerate beliefs about the size of this bias, the most common assumptions in this literature.

[5] GP 2001 show that the limit case in which the agent never exercises self-control can be obtained in their framework by relaxing continuity; in this case, the DM's preferences have a Strotz representation $V_S(A) := \max_{x \in A} u(x)$ subject to $v(x) \geq v(y)$ for all $y \in A$. In words, the DM chooses in Period 2 as if he lexicographically maximized the temptation utility and then the commitment utility. Under specific functional-form assumptions, Krusell et al. (2010) show that the GP model nests the multiple-selves model of Laibson (1997), which corresponds to the specific case in which their temptation strength parameter γ - governing the cost of self-control - tends to infinity.

[6] This point has been formally addressed by Dekel and Lipman (2012), who show that any menu preference $\succeq_1$ which admits a (possibly random) GP representation also has a random Strotz representation (see previous footnote), where the utility v is uncertain.

values the addition of an alternative x to menu A, it must be because he correctly anticipates that he will choose x over any element of A in Period 2. It can be shown that sophistication is a necessary condition for $\succeq_2$ to comply with the above interpretation of $\succeq_1$, that is, for $\succeq_2$ to be represented by the utility $u + v$ (Kopylov [2012], Thm 2.2). As a consequence, the GP model cannot capture the behavior of a (partially) naive agent for whom $\{a\} \succeq_1 \{a, b\} \succ_1 \{b\}$ and yet $b \succ_2 a$. In the experiment, it will be useful to distinguish *perceived* self-control (identified by $\{a\} \succ_1 \{a, b\} \succ_1 \{b\}$) from *actual* self-control (identified by $\{a\} \succ_1 \{a, b\} \succ_1 \{b\}$ *and* $a \succ_2 b$). This will be done by first eliciting subjects' menu preferences and then contrasting these preferences with the actual choices made from the flexible menu.

Finally, Set Betweenness imposes several restrictions on choice behavior, which preclude two interesting phenomena. First, a DM who behaves according to the GP model cannot exhibit a strict preference for flexibility (that is, $\{a, b\} \succ_1 \{a\}, \{b\}$). As a result, the GP model cannot accommodate the fact that an agent who feels uncertain about his future tastes may want to keep his options open, an idea originally motivated by Kreps (1979). Secondly, Set Betweenness gives a special structure to the form of temptation by excluding the possibility that $\{a\} \succ_1 \{b\} \succ_1 \{a, b\}$. Such a preference profile could be motivated by the agent's anticipated feeling of guilt if he chooses the tempting option b from $\{a, b\}$, while he could have acted virtuously by selecting a. Such an interpretation has been formalized by Kopylov (2012) who proposes a relaxation of the Set Betweenness axiom allowing to capture guilt. These preferences ($FLEX$, $GUILT$) will be incorporated in the taxonomy of types presented in the results section, the prevalence of which will be assessed against the one of self-control types.

3. Experimental design

The experiment was divided in two periods, followed by an exit survey. Period 1 comprised 5 sections (A-E) described below, pertaining to the elicitation of a potential temptation (Sections A and B), of menu preferences (Sections C and D) and of beliefs about choices in Period 2 (Section E). Details about the exit survey are provided at the end of this section, as well as a summary of the structure of the experiment (Fig.1); see OA-E for the instructions.

3.1 Description of the tempting good

The first part of the experiment was devoted to the elicitation of a potential temptation. Generating temptation in the lab poses several challenges. First, it appears difficult to find a good that is tempting to a majority of subjects, that is, a good that subjects think they should not consume and yet find enticing.[7] Secondly, the tempting goods commonly considered in the literature such as surfing the Internet (Houser et al. [2010], Bonein and Denant-Boemont [2015]) or watching an entertaining TV show (Bucciol et al. [2013]) can be easily obtained outside the lab, which reduces their immediate appeal. In this experiment, I exploit subjects' curiosity and, in particular, the human tendency to like gossiping and hearing gossip about others, which is virtually present in all human societies (Dunbar [2004]).

The potential temptation was to forfeit money to learn a personal story from one subject in the room, while performing a tedious task. In Section A, subjects were asked to describe an incredible or strange life event that they personally experienced. As an aid, they were given three hypothetical examples. Subjects were given 10 minutes to write their story by hand on a blank form and place it back in an unnumbered envelope. The stories were then collected by an assistant would selected the story she considered to be the most incredible and recorded it in the system (see OA-F for the selected stories).[8] Finally, subjects were informed that a new envelope containing a secret code would be distributed in Period 2 and this code could potentially allow them to read the story on their screen.

In Section B, subjects were introduced to the main task of Period 2. For a period of up to 60 minutes, subjects were instructed to focus on a four-digit number that was updated on their screen every second.[9] At random times, they received a prompt to enter the last number they saw and the number was reinitialized after every prompt. All subjects were sent a total of 5 prompts and could receive $2 per correct answer. After describing the task, subjects were told that two options could be potentially available in Period 2 depending on their choices in later sections:

[7] For instance, note that for chocolate to be a tempting good, it is not enough that most subjects find chocolate appealing, they should also perceive that consuming chocolate should be avoided.

[8] Notice that subjects' curiosity for the selected story could have been due to 1) their eagerness to read about the personal story of someone else in the room and/or 2) their desire to know whether the story was theirs. 70% of subjects declared to be at least somewhat interested in learning the story for one of these two motives, with the first motive being the primary source of curiosity (see OA-B).

[9] During the first session, Period 2 was announced to last exactly 60 minutes; however, given the boredom experienced by most subjects and the overall length of the session, the duration of the task was reduced to 45 minutes. The other 5 sessions had the same task duration of 45 minutes with random prompts occurring at the same time; the only difference was that subjects were told that the task could last "up to" 60 minutes. Since no major differences in behavior were observed relative to Session 1, all sessions will be pooled in the data analysis.

"No Learning" (0): do the task without learning the story and receive payment for all 5 prompts.

"Learning" (1): learn the story during the task and receive payment for 4 of the 5 prompts selected at random.

Regardless of the option, subjects worked on the task for the same duration and received feedback about their performance and earnings only at the end of the experiment. To minimize communication opportunities after the experiment, subjects were told that they would be requested to leave the lab one at a time; furthermore, no student could a priori know who learned the story in their session. As a result, it was difficult for a subject to satisfy his curiosity for this specific piece of information outside of the context of the experiment. Finally, subjects practiced with the task for 2 minutes and received feedback about their performance during that practice period.

3.2 Elicitation of menu preferences

To identify temptation and perceived self-control, Sections C & D elicited subjects' preferences over a list of three "menus", one of which was assigned to them at the start of Period 2:

Menu "Pre-Select No Learning" $\{0\}$: eliminates the chance to learn the story in Period 2 and pays for all 5 prompts; practically, the box where the secret code could be entered to access the story was removed from the subject's screen.

Menu "Pre-Select Learning" $\{1\}$: commits to learning the story in Period 2 and pays for only 4 of the 5 prompts; the story could be accessed at any time during the task but was automatically displayed at the end if not displayed before.

Menu "Decide in Period 2" $\{0, 1\}$: offers the opportunity to decide during the attention task whether and when to learn the story by entering the secret code.

The elicitation of subjects' weak ordering $\succeq_1$ over the set $\mathcal{M} = \{\{0\}, \{1\}, \{0, 1\}\}$ was performed in two steps (Sections C & D). In Section C, subjects were asked to assign a rank number 1, 2 or 3 to the three menus presented in a list.[10] To allow for the expression of indifferences, subjects could assign the same rank number to two or all three menus. Before providing their ranking, subjects

[10] To minimize order effects, subjects were randomly assigned to one of two list orders: $l_1 = (\{0, 1\}, \{1\}, \{0\})$ or $l_2 = (\{1\}, \{0\}, \{0, 1\})$, meaning that the flexible menu was presented either at the top or at the bottom, and $\{0\}$ never appeared at the top. Because options listed first are in general more likely to be assigned rank 1 than those listed last, this design feature should have if anything reduced the likelihood of observing temptation (understood as a strict preference for $\{0\}$). Ranking differences across the two lists were not found to be significant.

were told that they would be assigned a menu at the start of Period 2 based on the following procedure:

1. With probability 1/2, a subject received $\{0, 1\}$ regardless of his ranking.

2. With probability 1/2, a subject's ranking was implemented stochastically such that the odds of receiving a given menu were increasing in its ranking, as displayed in the following table:

Ranking of (X,Y,Z)	% chance of being drawn (%$_X$,%$_Y$,%$_Z$)
(1,2,3)	(50,30,20)
(1,1,2)	(40,40,20)
(1,2,2)	(50,25,25)
(1,1,1)	(33.3,33.3,33.3)

The above elicitation procedure has two important properties. First, it makes it incentive compatible for a subject with a strict rank ordering $\succ_1$ to report his true preferences. Secondly, because the menu preferences are only implemented probabilistically, one can observe the behavior of subjects who faced the flexibility of choice and yet preferred commitment. As a result, one can contrast perceived self-control, as revealed by subjects' rank ordering, with actual self-control when facing the flexible menu.

So far this procedure however does not strictly incentivize subjects to report indifferences since a DM who is indifferent between two menus would also take any probability distribution over these menus.[11] To disentangle indifferences from strict preferences, one needs to obtain a cardinal measure of preferences. Such a measure was collected in Section D by asking subjects for their willingness to pay (WTP) to replace their second choice with their top choice and their last choice with their second choice. In case a subject was indifferent between two menus, one of them was selected to be the replaceable option. Subjects were randomly assigned within a session to express their WTP either in terms of money or in terms of time via a multiple price list mechanism:[12]

- For the \$ WTP, subjects made 8 decisions between [*their second (last) choice*] and [*their top (second) choice* - \$$X$] where $X = \{0.01, 0.02, 0.05, 0.10, 0.20, 0.30, 0.40, 0.50\}$.

- For the time WTP, subjects made 8 decisions between [*their second (last) choice*] and [*their top (second) choice + N minutes on the attention task*] where $N = \{1, 2, 3, 4, 5, 6, 8, 10\}$.

[11] Note that this statement is only true under the assumption that the DM satisfies the Independence Axiom (as is assumed in the Gul and Pesendorfer model, although in a different form).

[12] In the \$ WTP condition, the money was taken from the subjects' show-up fee of \$10. In the time WTP condition, subjects were asked to spend additional minutes on the attention task for no additional payment.

To enforce monotonicity, subjects were not allowed to make multiple switches between the two options. If a subject's ranking was implemented and their second (last) choice was drawn, then one of the 8 decisions was chosen for implementation, thus ensuring incentive compatibility.

The purpose of contrasting willingness to pay for time versus money was to assess the extent to which the expression of a strict preference (in particular, for commitment) might be sensitive to the unit of payment. Indeed, so far very few studies have found that individuals are willing to pay even the smallest amount of money for commitment.[13] For instance, Augenblick et al. (2015) find that while 59% of their subjects favor commitment when it is free, the demand is close to zero at a price as low as $0.25. Although these findings could raise the concern that a demand for commitment at a price of zero does not reveal a true preference for commitment, another interpretation is that individuals think differently about money and time (Ellingsen and Johannesson [2009]) and would have been more willing to pay in terms of their time. Testing for differences in the willingness to pay across domains therefore offers a way to assess the robustness of the procedure used in this paper to identify indifferences.

3.3 Elicitation of beliefs

Finally, Section E gathered data on subjects' beliefs about their likelihood to learn the story in Period 2 if offered $\{0, 1\}$. The measurement of these beliefs served two objectives. First, although beliefs about ex post choice are generally not a primitive of models of menu preferences, they play a central role in the interpretation of those models. A GP agent with the preference ordering $\{0\} \succ_1 \{0, 1\} \succ_1 \{1\}$ must expect to resist the temptation to read the story if offered $\{0, 1\}$ (that is, $0 \succ_2 1$), while a DM who suffers from random indulgence should expect to succumb some of the time. Similarly, a "Krepsian" DM with a preference for flexibility $\{0, 1\} \succ_1 \{0\}, \{1\}$ must be uncertain about his willingness to learn the story if offered $\{0, 1\}$. Therefore, gathering belief data allows to gain further insights into the interpretation of subjects' preference orderings.

A second reason to collect belief data is to obtain a measure of the gap between predicted and actual behavior. So far, very few papers in the self-control literature have attempted to measure sophistication, understood as the ability to predict one's own behavior in the future. Yet, the prediction that agents with self-control problems should demand commitment crucially relies on the assumption of sophistication. It is therefore important to understand the degree to which subjects mispredict their future behavior and how this might affect their menu preferences.

[13] Two exceptions are Milkman et al. (2014) and Schilbach (2015).

The elicitation of individuals' predictions about their future behavior however poses a methodological challenge. Indeed, any payment scheme designed to incentivize subjects to truthfully report their beliefs will also incentivize changes in the behavior to be predicted. This point has been acknowledged by Acland and Levy (2015) in one of the rare papers to propose an incentivized procedure to elicit an individual's beliefs about his future behavior.[14] An alternative route for measuring sophistication is through the use of an unincentivized survey instrument such as the one proposed in Ameriks et al. (2007) and adopted by Wong (2008) and John (2015).

In this paper, I propose a third, incentivized, method to elicit an individual's beliefs about his future choices. The idea of the method is to instrument beliefs about oneself with beliefs about a similar other. More precisely, each subject was asked to guess the future choice (Learning or No Learning) of another participant in the room who provided the same ranking as them in Section C. Provided there was such a participant and he could make a choice from $\{0,1\}$ in Period 2, a subject received \$2 for a correct guess and 0 otherwise. A priori, there are two reasons to believe that incentivized beliefs about the future behavior of a similar other could be a strong predictor of beliefs about one's own behavior. First, if subjects interpret menu rankings in a way consistent with theories of menu choice, then one should observe a higher proportion of Learning guesses for rankings where $\{0,1\} \succ_1 \{0\}$ and/or $\{0,1\} \sim_1 \{1\}$ relative to rankings where $\{0,1\} \succ_1 \{1\}$ and/or $\{0,1\} \sim_1 \{0\}$; therefore, the belief of a subject who conditions his guess on a ranking identical to his own should be highly correlated with what he expects his future choice to be. Secondly, there is large evidence in economics and psychology that beliefs about others are subjected to a false consensus effect, which refers to an individual's tendency to extrapolate from his own type the behavior of others (Ross et al. [1977], Ellingsen et al. [2010], Butler et al. [2013], Rubinstein and Salant [2015]). As a result, subjects are likely to form their guess regarding the other participant assuming similarity on other - possibly unobservable - dimensions than the preference ordering.

To test the strength of the above instrument, subjects were also asked an unincentivized question about their likelihood to learn the selected story in Period 2 if given the chance. Answers were expressed on a five-point scale (*very unlikely*, *quite unlikely*, *unsure*, *quite likely*, *very likely*); thus the structure of this question differed from the binary choice frame adopted for the incentivized

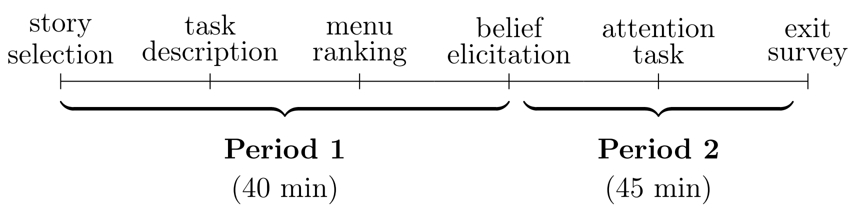
[14] In their paper, the authors seek to measure predictions about future gym attendance by eliciting subjects' willingness to pay for a coupon that pays contingent on attending the gym. With this mechanism, a sophisticated individual with self-control problems may have an incentive to overstate his willingness to pay for the coupon as a commitment device to attend the gym more often than initially expected, thus providing a biased estimate of expected gym attendance. See also Augenblick and Rabin (2015) who use accuracy payments to elicit beliefs about future task completion.

question. This should have minimized the chances of observing a mechanical correlation between answers simply due to subjects' exposure to identically-framed questions.[15]

3.4 Exit survey

At the end of the session, subjects replied to a short survey designed to better understand (*i*) their ranking of the menus, and (*ii*) their interest for the story. In addition, the survey gathered some basic demographic and academic information (gender, major, GPA) and subjects were evaluated on three psychometric scales designed to measure self-control and trait curiosity. A description of the exit survey variables as well as summary statistics are presented in OA-B.3 and -E.

Figure 1: Timeline of the Experiment



4. Results

In this section, I present results using data from 6 sessions conducted at the Center for Experimental Social Science (CESS) of New York University with a total of 120 subjects recruited from the student population. Including a $10 show-up fee, average earnings were $18.70 for a little less than two hours.

The first part of this section studies perceived self-control by analyzing the distribution of menu preferences elicited in Period 1 through the initial rank ordering procedure and subsequent WTP decisions, and by relating these preferences to subjects' beliefs about Period 2 choice. The second part turns to actual self-control by confronting subjects' menu preferences and beliefs to their actual choices in Period 2, and by studying task performance under commitment versus flexibility.

[15] At the end of Section E, subjects were also asked questions about their personal interest for the story; see OA-B.

4.1 Perceived self-control: menu preferences

4.1.1 Initial rank orderings

Using data from the rank assignments performed in Section C, I classified subjects into menu types, the distribution of which is presented in Table 1. In principle, subjects could have ranked the three menus $\{0\}, \{1\}$ and $\{0, 1\}$ in 13 different ways.[16] In actuality, 90% of the subjects can be grouped in one of 7 menu types. As a benchmark, the observed frequencies of menu types are contrasted with the frequencies that would be expected if subjects picked a rank ordering at random.

Table 1: Main preference orderings

Preference ordering	menu type	% subjects	(N)	random benchmark	p-value
$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$	SSB_{-0}	**35.8%**	**(43)**	7.7%	< 0.001
$\{1\} \succ_1 \{0,1\} \succ_1 \{0\}$	SSB_{-1}	4.2%	(5)	7.7%	0.171
$\{0,1\} \succ_1 \{0\} \succ_1 \{1\}$	$FLEX_{-0}$	**20.8%**	**(25)**	7.7%	< 0.001
$\{0,1\} \succ_1 \{1\} \succ_1 \{0\}$	$FLEX_{-1}$	7.5%	(9)	7.7%	1.000
$\{0,1\} \succ_1 \{1\} \sim_1 \{0\}$	$FLEX_{-0\vee 1}$	5.8%	(7)	7.7%	0.605
$\{0,1\} \sim_1 \{0\} \succ_1 \{1\}$	STD_{-0}	9.2%	(11)	7.7%	0.494
$\{0\} \succ_1 \{1\} \succ_1 \{0,1\}$	$GUILT$	6.7%	(8)	7.7%	0.863
other ordering		10.0%	(12)	46.1%	< 0.001
Total		100%	(120)	100%	

Notes: The reported p-values correspond to the result of a two-sided binomial test that the observed frequency is equal to the benchmark frequency of selecting one of the 13 rank orderings at random. Option 0 (resp. 1) refers to No Learning (resp. Learning).

The first two types ranked $\{0, 1\}$ strictly in between the other two menus and are labelled SSB_{-i}, for *Strict Set Betweenness* with singleton $i \in \{0, 1\}$ ranked first. Consistent with the intuition that learning the story is the source of temptation in this experiment, 90% of subjects who satisfy Strict Set Betweenness are of type SSB_{-0}. This self-control type is also the most represented category, with a proportion more than 4 times larger than what would be observed in a random sample (35.8% versus 7.7%; $p < 0.001$). The second category of types denoted $FLEX_{-i}$ corresponds to the subjects who expressed a strict preference for $\{0, 1\}$ with $i \in \{0, 1, 0 \vee 1\}$ as their second best choice.

[16] In addition to the indifference ordering (1,1,1), there are 6 permutations of the ranks (1,2,3), 3 permutations of (1,1,2) and 3 permutations of (1,2,2).

Relative to the benchmark of random choice, only the proportion of $FLEX_{-0}$ is significantly higher than what would be expected by chance (20.8% versus 7.7%; $p < 0.001$). The last two categories corresponding to the standard DM with no temptation to learn, STD_{-0}, and the flexibility-averse type $GUILT$ represent a small fraction of the sample. Interestingly, the rank ordering capturing temptation with no self-control $\{0\} \succ_1 \{0,1\} \sim_1 \{1\}$ (included in the "other ordering" category) is underrepresented in this sample (2.5%; $p = 0.026$ against benchmark). In this respect, standard models of present-biased preferences - which can only rationalize the ordering $\{0\} \succ_1 \{0,1\} \sim_1 \{1\}$ but not $\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$ - have a low explanatory power in this environment.

4.1.2 Refinement of menu rankings through *WTP* decisions

The above classification may overestimate the proportion of subjects with a strict preference ordering as it is solely based on the initial ranking procedure, which does not strictly incentivize subjects to truthfully report an indifference. To obtain a lower bound estimate on the proportion of self-control types, I now examine WTP decisions for replacing the second (last) choice in the ranking with the top (second) choice.

In total, 67 (53) subjects were assigned to the \$ (time) WTP condition. No significant differences were observed across conditions: subjects had a positive WTP in 70% (75%) of the menu comparisons in the money (time) condition (F-stat $= 0.52$; $p = 0.472$); the average switching point in the list of 8 decisions was 4.01 for money and 3.69 for time (F-stat $= 0.56$; $p = 0.456$). Appendix Fig.4 shows the full distribution of WTP decisions by condition and by comparison of ranks; differences appear to be quite marginal across conditions. For the rest of the analysis, I therefore convert the time WTP into a \$ WTP in order to evaluate decisions on a single scale. For each of the 7 major preference orderings, Table 2 shows the average WTP to replace one menu with a (weakly) better ranked menu, as well as the percentage of subjects who had a positive WTP.

Overall, there is a high degree of consistency between subjects' initial ordering ($\succ_1$ or $\sim_1$) and subsequent WTP (> 0 or $= 0$), which are coherent with each other in more than 70% of the cases. First, 62% (87%) of subjects who ranked their top (second) choice strictly above their second (last) choice also had a strictly positive WTP. For all types except $FLEX_{-0}$, a majority of subjects were willing to pay for an option they strictly ranked higher. In particular, 58% of the self-control types of Table 1 were willing to pay to receive $\{0\}$ instead of $\{0,1\}$; furthermore, their WTP for commitment is increasing in their level of curiosity for the story (see OA-B.1). Secondly, as would be expected from subjects who are indifferent, those who gave the same rank to their top (bottom) two options had a significantly lower WTP than subjects with a strict preference for their top (second best) option ($p = 0.005$ for top and $p = 0.074$ for bottom on a two-sided t-test).[17]

Table 2: Distribution of WTP by rank ordering

	top choice versus second choice		**second choice versus last choice**	
Preference ordering	average WTP (all)	% with $WTP > 0$ (freq.)	average WTP (all)	% with $WTP > 0$ (freq.)
$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$	**\$0.14**	**58.1% (25/43)**	\$0.31	88.4% (38/43)
$\{1\} \succ_1 \{0,1\} \succ_1 \{0\}$	\$0.30	80.0% (4/5)	\$0.38	80.0% (4/5)
$\{0,1\} \succ_1 \{0\} \succ_1 \{1\}$	\$0.07	40.0% (10/25)	\$0.28	96.0% (24/25)
$\{0,1\} \succ_1 \{1\} \succ_1 \{0\}$	\$0.23	88.9% (8/9)	\$0.11	88.9% (8/9)
$\{0,1\} \succ_1 \{1\} \sim_1 \{0\}$	\$0.10	57.1% (4/7)	\$0.25	85.7% (6/7)
$\{0,1\} \sim_1 \{0\} \succ_1 \{1\}$	\$0.06	27.3% (3/11)	\$0.37	81.8% (9/11)
$\{0\} \succ_1 \{1\} \succ_1 \{0,1\}$	\$0.25	100.0% (8/8)	\$0.20	62.5% (5/8)
Strict ranking	\$0.15	**62.4% (63/101)**	\$0.28	**87.0% (94/108)**
Indifference	\$0.05	31.6% (6/19)	\$0.17	83.3% (10/12)

Notes: Average WTP computed as subjects' mean WTP pooling dollar and time conditions; the time WTP was converted into dollars according to the following formula: $\tilde{WTP}$= 0.01 (=0.50) if WTP_t=1 (=10) and $\tilde{WTP}$= 0.01 + $0.5(\frac{t-1}{10-1})$ if $WTP_t \in \{2,3,4,5,6,8\}$. "Strict ranking" refers to subjects who assigned rank 1 and 2 (resp. 2 and 3) to their top (bottom) two choices, while "Indifference" refers to those who gave rank 1 (2) to their top (bottom) two choices. Option 0 (resp. 1) refers to No Learning (resp. Learning).

Table 3 presents an alternative classification, which accounts for subjects' WTP decisions by replacing $\succ_1$ with $\sim_1$ whenever $WTP = 0$ and $\sim_1$ with $\succ_1$ whenever $WTP > 0$. The fraction of subjects with temptation and self-control preferences SSB_{-0} drops to 23.3% (relative to 35.8% in Table 1), but remains about 3 times higher than what would be observed in a random sample. The standard DM with no temptation to learn, STD_{-0}, is now the most represented category (30% of the sample), while the proportion of subjects with a preference for flexibility is divided by two. In particular, the category $FLEX_{-0\vee 1}$ almost disappears from the sample and is replaced in the

[17] However, 10 of the 12 subjects who gave the same rank to their bottom two options reported a positive WTP for one of the options. This high percentage is mostly due to subjects with menu type $\{0,1\} \succ_1 \{0\} \sim_1 \{1\}$ who might have expressed their indecisiveness (rather than an indifference) by assigning the same rank to $\{0\}$ and $\{1\}$. Some comments from these subjects give substance to this interpretation:
- "I was undecided so I ranked to make my decision later." (Session 3, ID 31)
- "I had put Decide in period 2 first so that I could have some choice and effect on which menu I would receive. I ranked the other two options both as 2 because I was unsure at the time of which menu I wanted." (Session 3, ID 40)

table by subjects classified as indifferent (IND). However, besides STD_{-0} and SSB_{-0}, no other menu type is present in a proportion significantly higher than what would be obtained by chance. Finally, as with the initial classification, the rank ordering capturing temptation with no self-control $\{0\} \succ_1 \{0,1\} \sim_1 \{1\}$ remains underrepresented (2.5%; $p = 0.026$ against benchmark).[18]

Table 3: Alternative classification accounting for WTP choices

Preference ordering	menu type	% subjects	(N)	random benchmark	p-value
$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$	SSB_{-0}	**23.3%**	**(28)**	7.7%	< 0.001
$\{1\} \succ_1 \{0,1\} \succ_1 \{0\}$	SSB_{-1}	4.2%	(5)	7.7%	0.171
$\{0,1\} \succ_1 \{0\} \succ_1 \{1\}$	$FLEX_{-0}$	10.8%	(13)	7.7%	0.226
$\{0,1\} \succ_1 \{1\} \succ_1 \{0\}$	$FLEX_{-1}$	5.8%	(7)	7.7%	0.605
$\{0,1\} \sim_1 \{0\} \succ_1 \{1\}$	STD_{-0}	**30.0%**	**(36)**	7.7%	< 0.001
$\{0\} \succ_1 \{1\} \succ_1 \{0,1\}$	$GUILT$	8.3%	(10)	7.7%	0.732
$\{0\} \sim_1 \{1\} \sim_1 \{0,1\}$	IND	9.2%	(11)	7.7%	0.494
other ordering		8.3%	(10)	46.1%	< 0.001
Total		100%	(120)		

Notes: The reported p-values correspond to the result of a two-sided binomial test that the observed frequency is equal to the benchmark frequency of selecting one of the 13 rank orderings at random. Option 0 (resp. 1) refers to No Learning (resp. Learning).

The next findings will be presented for the full sample and for both types of classifications (based on the initial ranking and based on WTP). It is indeed important to note that although it was not strictly incentive compatible for subjects to truthfully report an indifference with the initial rank ordering procedure, it was nevertheless a weakly dominant strategy; furthermore, it remains to understand how one should interpret a zero WTP, for instance if specific dimensions of the elicitation procedure such as the unit of payment or the range of the WTP affect WTP behavior.[19]

[18] OA-A.2 presents the distribution of types for two alternative classifications. The first one excludes the 16 subjects who assigned the same rank to two menus and yet were willing to pay for one over the other, i.e. ($\sim_1$, $WTP > 0$), since this behavior can be regarded as anomalous if subjects' preferences are complete and respect monotonicity in money. The second classification excludes the 60 subjects who presented some inconsistency between their initial rank ordering and their WTP behavior i.e. subjects for whom either ($\sim_1$, $WTP > 0$) or ($\succ_1$, $WTP = 0$) at least once; since the incentive structure a priori allowed for ($\succ_1$, $WTP = 0$), this is a much stricter requirement. Nonetheless, the previous findings are robust to these alternative classifications with respectively 24.0% and 41.7% of subjects classified as self-control types, percentages which are significantly higher than what would be observed by chance.

[19] Although one might question the informational content of a demand for commitment at a price of 0, Augenblick et al. (2015) find that subjects who prefer commitment over flexibility when both are free are more likely to exhibit

4.1.3 Link between menu preferences and beliefs about Period 2 behavior

Another way to refine the interpretation of the preference orderings elicited in this experiment is to study subjects' beliefs about their likelihood of learning the story if offered menu $\{0, 1\}$ in Period 2. Remember that beliefs about Period 2 behavior were measured in two ways by asking subjects to: (i) guess the Period 2 choice of someone with the same rank ordering as them (incentivized); (ii) report their own subjective likelihood on a 5-item scale (*very unlikely*, *somewhat unlikely*, *unsure*, *somewhat likely*, *very likely* - unincentivized).

As shown in the Appendix (Figure 5 & Table 6), subjects' answers between the two questions are highly correlated. Excluding those who reported being unsure, close to 90% (91/102) of the subjects made guesses (Learning or No Learning) consistent with their own subjective likelihood of learning (likely or unlikely). For each menu type of the original classification, Table 4 shows the proportion of subjects who expected Learning to be chosen in Period 2, both for the incentivized and the unincentivized measure; a similar table is presented in the Appendix for the alternative classification based on WTP (see Table 7). As a benchmark, the third column reports the distribution of Period 2 choices inferred from $\succeq_1$ under the assumptions of *Sophistication* (S) *and No Preference Reversals* (NPR). To define these notions in a general (possibly stochastic) environment, denote by λ_x the DM's propensity to choose x from $\{0, 1\}$ in Period 2, that is $\lambda_x = \mathbb{P}\{x \in c(\{0, 1\}, \succeq_2)\}$ where $c(A, \succeq_2) := \{x \in A \,|\, x \succeq_2 y, \ \forall y \in A\}$. Then *Sophistication* means that $\{x, y\} \succ_1 \{y\}$ implies $\lambda_x > 0$, with the additional restriction that $\lambda_x = 1$ in a deterministic world such as the one of Gul and Pesendorfer (2001).[20] In other words, a DM who strictly values the addition of an option to a menu must choose this option at least some of the time. In addition, say that the DM exhibits *No Preference Reversals* between Period 1 & 2 if $\{x\} \succ_1 \{y\}$ implies $\lambda_x > \lambda_y$, which is equivalent to $\{x\} \succ_1 \{y\}$ implies $x \succ_2 y$ in a deterministic setting.

Subjects' beliefs are overall consistent with the restrictions imposed by *Sophistication* and *No Preference Reversals*. Almost all SSB_{-0} subjects expected to choose not to read the story in Period 2, while the opposite is true of SSB_{-1} subjects. As such, the finding that virtually no SSB_{-0} type expected to succumb to the temptation to learn the story provides support for the interpretation of $\{0\} \succ_1 \{0, 1\} \succ_1 \{1\}$ as reflecting costly self-control rather than random indulgence (see Section 2.2). Secondly, for all $FLEX$ types, the fraction of subjects who expected not to learn the story

present bias in effort.

[20] This condition is also referred to as Consequentialism in the model of Ahn and Sarver (2013), which connects the DM's desire for flexibility to his preference uncertainty.

Table 4: Relationship between initial preference ordering and beliefs

Preference ordering $\succeq_1$ on $\mathcal{M}$	menu type	dist. of Period 2 choices under S and NPR	% (N) with belief $1 \in c(\{0,1\}, \succeq_2)$ *Incentivized*	*Unincentivized*
$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$	SSB_{-0}	$\lambda_0 > \lambda_1 \geq 0$	2.3% (1/43)	2.3% (1/43)
$\{1\} \succ_1 \{0,1\} \succ_1 \{0\}$	SSB_{-1}	$\lambda_1 > \lambda_0 \geq 0$	100.0% (5/5)	100.0% (5/5)
$\{0,1\} \succ_1 \{0\} \succ_1 \{1\}$	$FLEX_{-0}$	$\lambda_0 > \lambda_1 > 0$	12.0% (3/25)	12.0% (3/25)
$\{0,1\} \succ_1 \{1\} \succ_1 \{0\}$	$FLEX_{-1}$	$\lambda_1 > \lambda_0 > 0$	66.7% (6/9)	77.8% (7/9)
$\{0,1\} \succ_1 \{1\} \sim_1 \{0\}$	$FLEX_{-0\vee 1}$	$\lambda_0, \lambda_1 > 0$	71.4% (5/7)	71.4% (5/7)
$\{0,1\} \sim_1 \{0\} \succ_1 \{1\}$	STD_{-0}	$\lambda_1 = 0$	0.0% (0/11)	0.0% (0/11)
$\{0\} \succ_1 \{1\} \succ_1 \{0,1\}$	$GUILT$	$\lambda_0 > \lambda_1 \geq 0$	12.5% (1/8)	25.0% (2/8)

Notes: *Incentivized* measures a subject's belief that someone with the same rank ordering will choose to learn the story if offered {0,1} in Period 2 (i.e. $1 \in c(\{0,1\}, \succeq_2)$). *Unincentivized* takes value = 1 (= 0) if a subject reported being somewhat or very likely (unlikely) to learn the story if offered {0,1} in Period 2; for subjects reporting being "unsure", answers to the *Incentivized* question are used as a tie breaker. The distribution of Period 2 choices inferred from $\succeq_1$ relies on the assumptions of *Sophistication* (S) and *No Preference Reversals* (NPR).

is strictly positive and below one; furthermore, those who preferred {0} over {1} (resp. {1} over {0}) were more likely to expect No Learning (resp. Learning). Finally, all subjects with standard preferences and no temptation to learn, STD_{-0}, expected to choose No Learning, which was also the case of most subjects with $GUILT$ preferences.[21] The above findings therefore provide reassuring evidence that the rank orderings elicited in this experiment indeed reflect subjects' preferences rather than their confusion about the nature of the elicitation procedure.

4.2 Actual self-control: Period 2 behavior

In this subsection, I confront perceived self-control to actual self-control by first examining the relationship between the menu preferences elicited in Period 1 and subjects' actual propensity to learn the story in Period 2. I then investigate whether there is a cost of self-control beyond the one of succumbing to the temptation to learn the story by examining the extent to which subjects' productivity during the attention task was affected by the mere presence of learning opportunities.

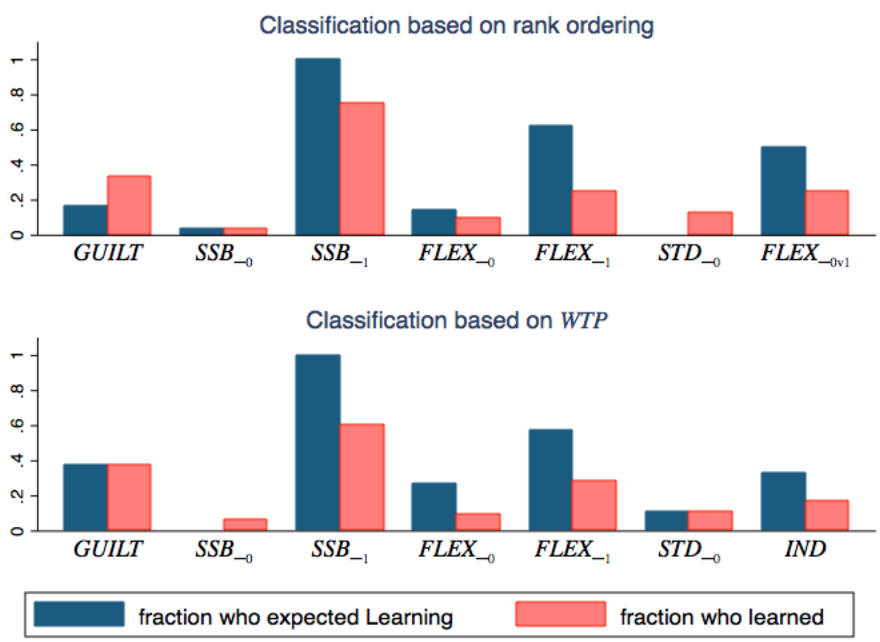
[21] As an aside, note that only *No Preference Reversals* (but not *Sophistication*) imposes a consistency requirement on the distribution of choices for the $GUILT$ type category and the model of Kopylov (2012) allows a DM for whom $\{0\} \succ_1 \{1\} \succ_1 \{0,1\}$ to choose either option from $\{0,1\}$. On the other hand, NPR is an additional restriction for models of preference for flexibility, which typically do not rely on this assumption.

4.2.1 Link between menu preferences and propensity to learn in Period 2

Out of the 120 subjects, 87 were asked to make a choice from the flexible menu $\{0, 1\}$; of the remaining subjects, 29 received menu $\{0\}$, which removed all learning opportunities, while the last 4 subjects were assigned to learn the story for sure by receiving menu $\{1\}$. The analysis of this subsection focuses on the 87 subjects who were offered to make a choice from $\{0, 1\}$.

Overall, 18.4% (16/87) of the subjects assigned $\{0, 1\}$ chose to read the story at some point during the attention task, with some heterogeneity in the timing of learning (see OA-C for learning dynamics). For both of the classifications presented earlier, Figure 2 shows the proportion of subjects who chose to learn the story during the task as a function of their menu preferences; as a benchmark, actual learning is contrasted with subjects' expectations of learning.

Figure 2: Learning expectations (incentivized) versus actual learning by menu type



Notes: "fraction who expected Learning" refers to the proportion of subjects who guessed that someone with the same rank ordering as them would choose to learn the story if offered {0,1}; patterns are very similar for the unincentivized belief measure (see OA Fig.10). Means were computed for each menu type using the classifications presented in Table 1 (for top panel) and Table 3 (for bottom panel). See OA-D.2 for the number of observations in each menu type category ($N \geq 4$ in each bin).

As is immediately apparent from the figure, there is a lot of heterogeneity in the propensity to learn the story across types and this observed heterogeneity is fairly consistent with what would be expected under the restrictions of *Sophistication* and *No Preference Reversals* (see column 3 Table

4). In line with *No Preference Reversals*, subjects with preference $\{1\} \succ_1 \{0\}$ (such as SSB_{-1} and $FLEX_{-1}$) were significantly more likely to choose Learning than those with preference $\{0\} \succ_1 \{1\}$ (such as SSB_{-0} and $FLEX_{-0}$), although No Learning remained the most popular option even among the former category.[22] Of the 7 menu types, only $FLEX_{-1}$ violates *No Preference Reversals* (i.e. $\{1\} \succ_1 \{0\}$ implies $\lambda_1 > \lambda_0$), with a significantly higher proportion of subjects who chose not to learn the story, while only STD_{-0} shows a minor departure from *Sophistication*, with a strictly positive fraction of subjects who chose to learn the story. Importantly, the fraction of subjects with self-control preferences who read the story is almost zero: of the 27 (16) subjects classified as SSB_{-0} in the initial (WTP) classification, only one subject chose to learn. The pattern of behavior of the SSB_{-0} subjects is also very consistent with their ex ante beliefs about their propensity to learn the story. In other words, perceived self-control almost entirely translated into actual self-control, as would be expected under *Sophistication*.

This unique combination of data on menu preferences, beliefs about Period 2 behavior and actual Period 2 behavior provides a way to disentangle the theory of costly self-control of GP 2001 from other theories of temptation. In the next table, I contrast the data with the predictions made by four classes of temptation models under the assumption of sophisticated behavior. To make comparisons, I look at the subset of 54 subjects who ex ante preferred not to learn the story but expressed being tempted by it (i.e. for whom $\{0\} \succ_1 \{1\}$ and $\{0\} \succ_1 \{0, 1\}$); among them, 35 made a choice from $\{0, 1\}$ in Period 2.[23] The first class of models corresponds to standard models of dynamic inconsistency with no uncertainty (Strotz [1956], Laibson [1997], O'Donoghue and Rabin [1999]). As discussed in Section 2.2, present-biased agents who are sophisticated will choose to restrict their choice set if and only if they expect to succumb to temptation. The next two classes are deterministic models of costly self-control à la Gul and Pesendorfer (2001) and models of random indulgence in which temptation is uncertain so that the DM only succumbs with probability p (Bénabou and Pycia [2002], Chatterjee and Krishna [2009], Eliaz and Spiegler [2006], Duflo et al. [2011]). As explained in Section 2.2, both classes of models can rationalize the ordering $\{0\} \succ_1 \{0, 1\} \succ_1 \{1\}$, but models of random of indulgence also predict a strictly positive probability of giving in. Finally, the model of Kopylov (2012), which nests GP 2001 as a special case, can rationalize a form of temptation induced by guilt or fear of making the wrong choice (see OA-D.3).

[22] For the classification based on the initial rank ordering, 40.0% of subjects with preference $\{1\} \succ_1 \{0\}$ chose to learn compared to 9.4% of those with preference $\{0\} \succ_1 \{1\}$ (t-stat = 2.25, $p = 0.039$). For the alternative classification based on WTP, the corresponding numbers are 42.9% and 13.8% (t-stat = 2.02, $p = 0.061$).

[23] Results are presented for the classification based on the initial rank ordering; the corresponding results for the WTP classification can be found in OA-D.3 (Table 11).

Table 5: Explanatory power of existing temptation models

Temptation model	menu preferences	expected propensity to learn λ_1	actual propensity to learn ρ_1
Dynamic Inconsistency (Strotz preferences)	$\{0\} \succ_1 \{0,1\} \sim_1 \{1\}$	$\lambda_1 = 1$	$\rho_1 = 1$
Costly Self-Control (GP 2001)	$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$	$\lambda_1 = 0$	$\rho_1 = 0$
Random Indulgence (Stochastic Dual-Self models)	$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$	$\lambda_1 \in (0,1)$	$\rho_1 \in (0,1)$
Temptation with Guilt (Kopylov 2012)	$\{0\} \succ_1 \{1\} \succ_1 \{0,1\}$	$\lambda_1 \in \{0,1\}$	$\rho_1 \in \{0,1\}$
Observed	$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$ for 79.6% (43/54)	$\lambda_1 = 0.023$ (1/43)	$\rho_1 = 0.037$ (1/27)
	other temptation ranking for 20.4% (11/54)	$\lambda_1 = 0.091$ (1/11)	$\rho_1 = 0.25$ (2/8)

Notes: Predictions and findings for the set of 54 subjects for whom $\{0\} \succ_1 \{1\}$ and $\{0\} \succ_1 \{0,1\}$ according to the initial rank ordering classification. Observed frequency λ_1 corresponds to the proportion of tempted subjects who predicted that someone with the same ranking would learn the story and ρ_1 is the fraction of tempted subjects who indeed learned the story.

As can be seen from the table, the only two theories consistent with the data as a whole are those of costly self-control and random indulgence. However, for the latter to rationalize observed behavior, the (perceived) probability of indulgence would have to be very close to zero (see Table 4 & Figure 2), thus making temptation uncertainty a less compelling rationalization than costly self-control. The next findings provide further evidence in favor of the theory of costly self-control.

4.2.2 Is there a cost of self-control?

Even though relatively few subjects end up learning the story, the GP model suggests that resisting temptation may involve psychic costs, despite remaining silent about the nature of those costs. One indirect way to test for the presence of self-control costs is to measure their impact on productivity. Indeed, if self-control has to be exercised in order to avoid thinking about the possibility to learn the story and entirely focus on the task, then subjects' task performance should be higher when all learning opportunities are removed. In other words, subjects should have a higher productivity when assigned the commitment menu $\{0\}$ rather than the flexible menu $\{0, 1\}$. Figure 3 shows the percentage of subjects with a perfect score of 5 correct answers (left panel) and the average number of correct answers (right panel) depending on the menu assigned (see OA-C.2 for additional information on the distribution of productivities).

Figure 3: Productivity and menu assignment

Notes: *% with perfect score* refers to the percentage of subjects who provided a correct answer for each of the 5 prompts received during the attention task. $N = 87$ (resp. $N = 29$) for those assigned {0,1} (resp. {0}).

Subjects assigned $\{0\}$ were almost 20 percentage points more likely to obtain a perfect score than those who faced $\{0, 1\}$ ($p = 0.037$, one-sided t-test); furthermore, they gave 0.4 more correct answers on average ($p = 0.048$, one-sided t-test). However, Figure 3 does not present a purely experimental comparison since assignment to $\{0\}$ or $\{0, 1\}$ is exogenous only conditional on the initial rank ordering and WTP choices made by a subject, which influence his ex ante odds of receiving a given menu. Table 8 in the Appendix presents the results of regressions that control for the odds of being assigned each menu given a subject's rank ordering and WTP decisions. The above findings are robust to the inclusion of these controls in the full sample.[24] Although these results should be interpreted with caution, they appear to be consistent with a large literature in

[24] On the other hand, the effect of being assigned $\{0, 1\}$ instead of $\{0\}$ is not significant on the subsample of SSB_{-0} types, although the effect size is comparable to the one of the full sample; there is also no differential impact of exposure to $\{0, 1\}$ for SSB_{-0} types relative to the other types (regression results in subsamples available upon request). At the same time, attention levels during the task appear to have been differentially impacted only for SSB_{-0} types, who report higher levels of distraction when exposed to $\{0, 1\}$ rather than $\{0\}$; see OA-B.2.

psychology, which proposes that willpower is a limited resource and shows that prior acts of self-restraint such as resisting tempting food may lead to a subsequent breakdown of self-control on cognitively challenging tasks (Baumeister et al. [1998], Vohs and Heatherton [2000], Baumeister and Vohs [2003]).

5. Conclusion

In this paper, I propose a new experimental method designed to identify and document costly self-control. This method is grounded in the theory of Gul and Pesendorfer (2001), which captures the notions of temptation and self-control through the decision maker's preferences over a set of menus. Contrary to the more popular model of present bias, which can only rationalize overwhelming temptation, GP 2001 suggests that there may be hidden costs to resisting tempting alternatives, even if those alternatives are resisted eventually.

To measure the prevalence of self-control types, I conduct a laboratory experiment in which subjects faced the temptation to forfeit money in order to learn a sensational story while performing a mundane task. The identification strategy relies on a two-step procedure. First, I elicit subjects' preferences over a set of menus, which either did or did not allow access to the story during the task. Second, I implement subjects' menu preferences using a probabilistic implementation rule. This mechanism allows me to observe the behavior of subjects who faced the flexibility of choice, yet preferred commitment and to contrast *perceived* self-control with *actual* self-control. With this rich dataset containing menu preferences, beliefs about ex post choice and realized ex post choice, I can assess the explanatory power of the GP model relative to other temptation models. To my knowledge, this is the first experimental design allowing to disentangle various theories of temptation.

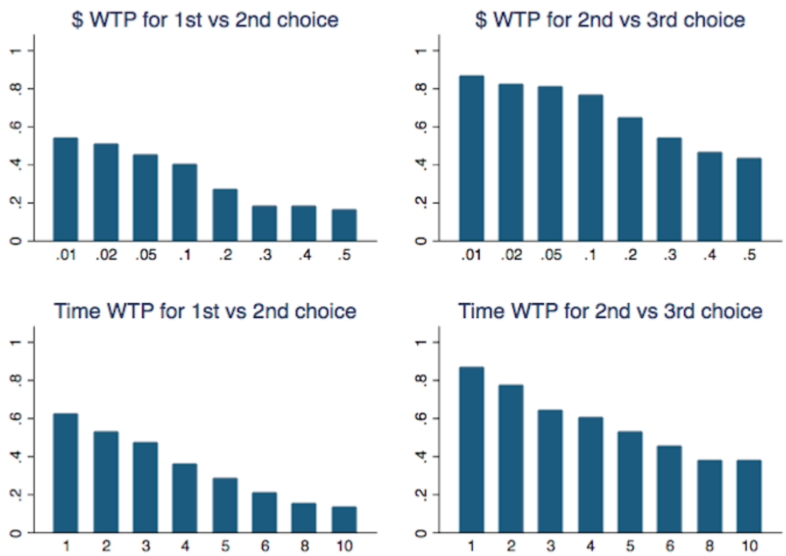
In this specific setting, between a quarter and a third of subjects can be classified as self-control types according to their menu preferences, a proportion which is 3 to 4 times higher than what would be observed if subjects had picked a rank ordering at random. Consistent with their menu preferences, almost all self-control types predicted that they would resist the temptation to learn the story in the absence of commitment. Furthermore, perceived self-control, as measured by subjects' menu preferences and anticipated choices, almost entirely coincides with actual self-control when facing the choice: while 18% of subjects read the story when offered the choice, all but one subject with self-control preferences succumbed to the temptation. Finally, although relatively few subjects chose to learn the story, the mere presence of learning opportunities seems to have negatively impacted productivity in the whole sample.

These results are obviously specific to the particular environment considered in this paper and may not extend to different settings. In this specific environment, subjects faced relatively little uncertainty since the attention task was straightforward and all decisions (Period 1 & 2) occurred within a single session. These features of the experiment could explain why demand for flexibility was relatively low and subjects correctly anticipated that they would resist temptation. An important area of future work is therefore to understand how the prevalence of self-control types may vary across decision environments.

Yet, if they generalized to other settings, these findings would have important implications for the design of policies aiming to reduce the welfare costs of temptation. Although not every customer ends up purchasing the unhealthy snacks readily available at cashier counters, the above results suggest that there are hidden costs to resisting those environmental cues, with potential collateral damages such as a reduced focus on some other tasks. As a consequence, customers' welfare could greatly increase if those tempting options were removed from immediate sight.

Appendix

Figure 4: Distribution of WTP by condition and comparison of ranks



Notes: Each histogram shows the proportion of subjects who are willing to pay to replace one menu with the menu ranked just above for each payment value, ranging from \$0.01 to \$0.50 in the dollar WTP condition and from 1 to 10 minutes in the time WTP condition. The distributions are shown separately for top versus second choice and second versus last choice.

Figure 5: Relationship between belief about other and belief about oneself

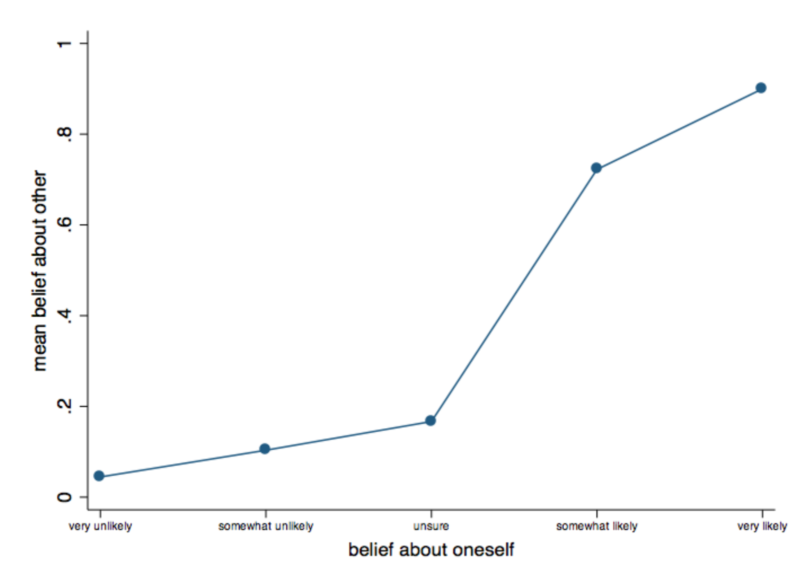


Table 6: Relationship between belief about other and belief about oneself

	said unlikely to learn **[Oneself]**	said likely to learn	Total
	69	6	75
expected No Learning	**92.0%**	8.0%	100%
	93.2%	21.4%	73.5%
[Other]			
	5	22	27
expected Learning	18.5%	**81.5%**	100%
	6.8%	**78.6%**	26.5%
	74	28	102
Total	72.6%	27.4%	100%
	100.0%	100.0%	100.0%

Notes: The categories "expected No Learning" and "expected Learning" refer to the incentivized guess of a subject regarding the choice from $\{0, 1\}$ made in Period 2 by someone with the same rank ordering as them. The category "said unlikely to learn" ("said likely to learn") includes subjects who reported being somewhat or very unlikely (likely) to learn the story if offered {0,1} in Period 2; subjects who reported being "unsure" (18/120) are excluded.

Table 7: Relationship between preference ordering based on WTP and beliefs

Preference ordering $\succeq_1$ on $\mathcal{M}$	menu type	dist. of Period 2 choices under S and NPR	% (N) with belief $1 \in c(\{0,1\}, \succeq_2)$ incentivized	unincentivized
$\{0\} \succ_1 \{0,1\} \succ_1 \{1\}$	SSB_{-0}	$\lambda_0 > \lambda_1 \geq 0$	0.0% (0/28)	0.0% (0/28)
$\{1\} \succ_1 \{0,1\} \succ_1 \{0\}$	SSB_{-1}	$\lambda_1 > \lambda_0 \geq 0$	100.0% (5/5)	100.0% (5/5)
$\{0,1\} \succ_1 \{0\} \succ_1 \{1\}$	$FLEX_{-0}$	$\lambda_0 > \lambda_1 > 0$	38.5% (5/13)	30.8% (4/13)
$\{0,1\} \succ_1 \{1\} \succ_1 \{0\}$	$FLEX_{-1}$	$\lambda_1 > \lambda_0 > 0$	57.1% (4/7)	71.4% (5/7)
$\{0,1\} \sim_1 \{0\} \succ_1 \{1\}$	STD_{-0}	$\lambda_1 = 0$	8.3% (3/36)	5.6% (2/36)
$\{0\} \succ_1 \{1\} \succ_1 \{0,1\}$	$GUILT$	$\lambda_0 > \lambda_1 \geq 0$	30.0% (3/10)	20.0% (2/10)
$\{0\} \sim_1 \{1\} \sim_1 \{0,1\}$	IND	$\lambda_0, \lambda_1 \geq 0$	36.4% (4/11)	45.5% (5/11)

Notes: *Incentivized* measures a subject's belief that someone with the same rank ordering will choose to learn the story if offered {0,1} in Period 2 (i.e. $1 \in c(\{0,1\}, \succeq_2)$). *Unincentivized* takes value $= 1$ ($= 0$) if a subject reported being somewhat or very likely (unlikely) to learn the story if offered {0,1} in Period 2; for subjects reporting being "unsure", answers to the *Incentivized* question are used as a tie breaker. The distribution of Period 2 choices inferred from $\succeq_1$ relies on the assumptions of *Sophistication* (S) and *No Preference Reversals* (NPR).

Table 8: Effect of flexible menu on productivity

	Received perfect score		Number of correct answers	
	(1)	(2)	(3)	(4)
assigned {0,1}	-0.22**	-0.19*	-0.43*	-0.39*
	(0.10)	(0.11)	(0.23)	(0.23)
assigned {1}	-0.34	-0.26	-0.70	-0.54
	(0.26)	(0.26)	(0.57)	(0.57)
odds of {0}		1.30**		2.09*
		(0.55)		(1.20)
odds of {0,1}		1.06*		2.12
		(0.61)		(1.34)
Observations	120	120	120	120
Mean dependent variable	0.37	0.37	3.93	3.93

Notes: Columns (1) & (2) are linear probability models where the dependent variable *Received perfect score* is equal to 1 if the subject correctly answered all 5 prompts; probit models give almost identical results. Session fixed effects included in all regressions. * and ** refer to $p < 0.1$ and < 0.05.

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