Checking out temptation: A natural experiment with purchases at the grocery register

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A Natural Experiment with Purchases at the Grocery Register

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Abstract

A lengthy literature in economics and psychology indicates that prolonged exposure to a tempting stimulus can lead people to "succumb" to that temptation. Here we develop a model of decision under temptation, and test its predictions using a natural experiment. We take advantage of exogenous variations in the amount of time over 2,800 individual consumers spent exposed to tempting items while waiting in grocery store checkout lines. Because we passively observe these consumers' naturally occurring purchase decisions, our approach avoids confounds that can arise in designed experiments on temptation and self-control. Our main finding is that time spent in line economically and statistically significantly increases the probability that a consumer purchases a tempting item. Our results provide novel quantitative content to the rapidly expanding literature on decisions under temptation.

Keywords: Natural Experiment, Temptation, Self-control, Impulse purchasing

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1. Introduction

The iconic study of temptation is the famous "marshmallow test" (Mischel & Ebbesen, 1970; Mischel, Ebbesen, & Raskoff Zeiss, 1972), which investigated the propensity of preschool children to delay gratification. In the experiment, the researchers offered each child the choice between taking a lower reward immediately or waiting fifteen minutes for a higher reward. Some did wait the entire fifteen minutes until the researcher returned without the child's signal, while others opted for the early reward almost immediately. Most interestingly, a third group of children waited significant periods of time before deciding to give up on the reward and taking the lower reward already offered.[1]

This third subset of subjects displayed a systematic deviation from predictions of economic theory. Their time-inconsistent behavior conflicts with standard economic models of maximizing present discounted values of consumption, where a rational agent should either take the immediate but lower reward immediately (given a high discount rate), or else wait the entire period for the delayed but higher reward (given a low discount rate). While they demonstrated an initial preference for delaying gratification to receive the higher reward, they later switched their decision and earned nothing for the time they had spent waiting. On its face this does not appear to be utility-maximizing behavior.

What can we learn about adult decisions in naturally occurring environments from the behavior of young children in a lab? Anecdotally, it seems everyone can recall individuals who initially chose to delay gratification but thereafter failed to carry out their plan, especially when faced with a tempting stimulus. Are there naturally occurring situations where consumers change their behavior in response to exposure to a tempting stimulus in systematically measurable ways, akin to the marshmallow tests with preschool children?

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[1]Another well-known "marshmallow" study (Shoda, Mischel, & Peake, 1990) found a connection between self-control as a child and later life outcomes. This result is not always replicated. For example, Watts, Duncan, & Quan (2018) found an association between children's delay of gratification and later achievements, but much less pronounced than reported in the original study.

This paper explores consumers' behavior in purchasing tempting goods using a large field dataset we created. Our interest is in whether the length of time spent around tempting items affects one's propensity to purchase them in a naturally occurring environment. Supermarkets may present a good source of field data for this purpose. Due to random variation in the number of customers, the number of open aisles, and the number of items in other customers' carts, shoppers exogenously face different amounts of time in line at the checkout aisle, where the shelf is usually stacked with tempting items. This setting thus gives us a natural experiment. Intuitively, if temptation theory has economic relevance in this setting, we should expect that those customers forced to wait in line longer will be more likely to pick up and purchase tempting items.

We develop a model of decision under temptation that generates hypotheses to test with our natural experiment. Our model rests on the idea that spending time around tempting items depletes one's willpower. We model this depletion as disutility and assume that disutility increases with time. We show that under certain circumstances it can be utility-maximizing for an agent to resist the temptation initially, but then succumb to the temptation later. This is similar to predictions of models with time inconsistent behavior (e.g., Gul & Pesendorfer, 2004).

Well-known theories of time-inconsistent preferences include Strotz (1955), Laibson (1997) and O'Donoghue and Rabin (1999). These models attribute time-inconsistent preferences to quasi-hyperbolic discounting, which implies that people are impatient for immediate vs. future rewards, but exhibit much more patience when making tradeoffs among future outcomes. Our approach differs from these, and is more closely related to models on willpower depletion (see Baumeister & Vohs, 2016 for a review). Our model predicts that the probability a person purchases a tempting item increases in the length of time that person is exposed to the tempting item. Consistent with the model, we find that the amount of time a person spends in line is indeed a significant predictor of the decision to purchase a tempting item.[2] Moreover, this effect is larger in magnitude when children are present.

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[2] This contrasts the results in Imas & Kuhn (2018) and Brownback, Imas, & Kuhn (2020), which found that introducing a waiting period leads to more forward-looking decisions (a higher delayed reward or more healthy food choices). It is noteworthy that there are key differences in the waiting time between their studies and ours. First, the waiting period in their study separates information on the choice set from the choices themselves, i.e., people learn

Our results line-up well with the burgeoning multi-disciplinary literature on temptation and self-control. That self-control is a limited resource has been long advocated (see, e.g., Baumeister, Heatherton, & Tice, 1994). Subsequent empirical evidence (mostly experimental) further supports the idea that depletion of self-control or cognitive resources undermines performance in tasks requiring self-control (sometime named as ego-depletion or strength model in the literature, see e.g., (Wang, Rao, & Houser, 2017; or Hagger, Wood, Stiff, & Chatzisarantis, 2010 for a meta-analysis). Willpower depletion seems to impair economic productivity (Bucciol, Houser, & Piovesan, 2011, 2013; Burger, Charness, & Lynham, 2011), render people more susceptible to situational cues (Banker, Ainsworth, Baumeister, Ariely, & Vohs, 2017) and change consumer decision making (Shiv & Fedorikhin, 1999; Vohs & Faber, 2007).[3] The effect on subsequent activities might depend on the extent to which willpower is depleted (Palma, Segovia, Kassas, Ribera, & Hall, 2018).

Our work is also related to the theoretical attempts to model self-control as a resource used to resist temptation (Hoch & Loewenstein, 1991; Dholakia, 2000; Fudenberg & Levine, 2006, 2012; Ozdenoren, Salant, & Silverman, 2012). Our setting, however, does not allow for commitment. That is, if one foresees entering a long checkout line is likely to lead one to succumb to temptations, one could commit not to entering a long line by waiting for a short line, or shopping at less busy hours. While the impact of commitment on decisions under temptation has been extensively empirically and theoretically studied (Thaler & Shefrin, 1981; Gul & Pesendorfer, 2001, 2004; Noor, 2007, 2011; Ali, 2011; Kaur, Kremer, & Mullainathan, 2015; Noor & Takeoka,

about the choice sets in advance before the time of decision. This waiting period is meant to introduce deliberation. In contrast, the information on tempting items and the purchase decision are both simultaneously present in our setting. The waiting period is associated with willpower depletion to resist temptation. Second, the magnitudes of waiting periods are substantially different. The waiting period in their study is typically hours or days while it is fractions of minutes to several minutes in ours.

[3] See also studies examining the effect of willpower depletion on risk attitude (Friehe & Schildberg-Hörisch, 2017; Gerhardt, Schildberg-Hörisch, & Willrodt, 2017), framing effects (De Haan & Van Veldhuizen, 2015), intertemporal financial choice (Kuhn, Kuhn, & Villeval, 2017) and asset pricing (Kocher, Lucks, & Schindler, 2018).

2015; Houser, Schunk, Winter, & Xiao, 2018;Toussaert, 2018), we do not have data to enable its study in our setting.

Our paper contributes to the literature in the following ways. First, our methodology is novel. To the best of our knowledge, our paper is the first to provide empirical evidence on decisions under temptation by passively observing decisions made in a naturally occurring environment. Our passive approach sharply contrasts with almost all of the empirical literature on temptation and self-control, including those we review below, all of which draw on data from laboratory experiments.[4] While laboratory studies are valuable and have advanced scientific knowledge of decisions under temptation, the results are often mixed and consistent conclusions seem difficult to reach (Carter, Kofler, Forster, & Mccullough, 2015; Hagger et al., 2016). Some have suggested that this is due to confounds unavoidably introduced by self-control related tasks used in experiments on temptation and self-control (see especially Muraven, 2010) or the questionable validity of willpower depletion manipulations (Carter et al., 2015).

Using passive observation, we produced a dataset on decisions under temptation (over 2,800 observations) substantially larger than that produced by a typical lab experiment. We do not rely on any temptation or willpower depletion manipulations as the time spent in line provides the necessary variation, and serves as an alternative to the willpower depletion tasks used in the literature. Moreover, the naturally occurring decision environment in the field mitigates representativity concerns associated with convenience samples and scalability constraints tied to lab experiments (Harrison & List, 2004; List, 2011; Al-Ubaydli, List, & Suskind, 2017).

Among laboratory studies, Shiv & Fedorikhin (1999) and Vohs & Faber (2007) are of particular relevance to our paper. Shiv & Fedorikhin (1999) study how cognitive resource taxation

[4] A handful of studies employ field experiments to examine the effect of mental resource depletion on judicial decisions (Danziger et al., 2011) and product customization decisions (Levav, Heitmann, Herrmann, & Iyengar, 2010). Though we share a similar data collection approach with those two studies, our study has a different focus: the role of self-control when making binary purchasing decisions under temptation. The one study of which we are aware that investigates self-control using field data (Hofmann, Baumeister, Förster, & Vohs, 2012) asks people to report their experience in resisting temptation as compared to passively observing decisions under temptation, which is the focus of our study.

affects consumers' choice between an affect-laden option (e.g., chocolate cake) and a cognition-laden option (e.g., fruit salad). They find that cognitive resource depletion makes people more likely to choose the affectively desirable alternative (chocolate cake). The finding is replicated in Shiv & Fedorikhin (2002). In addition, Shiv & Fedorikhin (2002) find that the decision time or the exposure to the stimulus also affects the decision. Vohs & Faber (2007) view the self-regulatory resource in a broader sense. They suggest that it is a general reservoir of resources shared by multiple domains and therefore goes beyond a cognitive resource. They find that self-regulatory resource depletion boosts impulse purchases in terms of willingness to pay and actual spending.

Shiv & Fedorikhin (1999) and Vohs & Faber (2007) both provide valuable insights in understanding willpower depletion and consumer decision making. Our findings square with theirs, yet our approach differs in important respects. We already noted the advantages of a much larger dataset and passive observations. In addition, the purchase decision in our study involves subjects using their own money rather than "windfall" money given by experimenters. It is documented in the literature that the so-called "house-money effect" can distort decisions. Such distortions have been found in gambling (Thaler & Johnson, 1990; Cárdenas, De Roux, Jaramillo, & Martinez, 2014), public goods contributions (Harrison, 2007), trust games (Houser & Xiao, 2015), trading in asset markets (Corgnet, Hernán-González, Kujal, & Porter, 2015) and charitable giving (Reinstein & Riener, 2012). Our study rules out any house-money effects and is free from experimenter demand effects. Such effects emerge when participants' decisions are based not on their own preferences, but rather their perception of appropriate or expected behavior (Zizzo, 2010).

In addition, we contribute to the theory of decisions under temptation, particularly in impulse purchase decisions. Impulsive consumption is affected by cognitive evaluation (Shiv & Fedorikhin, 1999; Dholakia, 2000; Vohs & Faber, 2007), the "activation of appetitive goals" (Shiv & Fedorikhin, 2002), the interaction between desire and willpower (Hoch & Loewenstein, 1991) and delays in the consumption decision (DeJarnette, 2018). We complement those findings by proposing a model which captures the utility of consuming a tempting item (the affective dimension) as well as the utility from resisting temptation (the cognitive dimension), and willpower depletion. Our model accommodates individual heterogeneity and predicts cases where consumers succumb to temptation immediately or resist temptations initially, only to succumb later, or to resist temptations entirely. Different from existing theories focusing on whether a certain alternative is chosen (Shiv & Fedorikhin, 1999, 2002) or whether impulsive buying emerges (Vohs & Faber, 2007), our model (like that of Houser et al, 2018) has an element of predicting consumers' delayed but ultimate consumption of tempting goods—the behavior which is our focus. Finally, our model is general enough to accommodate findings on impulse buying in the existing literature (Hoch & Loewenstein, 1991; Shiv & Fedorikhin, 2002; Vohs & Faber, 2007).

The remainder of the paper is organized as follows. Section 2 introduces our model of decision under temptation. Section 3 details the design and data collection procedure of the natural experiment. Section 4 discusses the results and Section 5 concludes.

2. A Model of Decision Under Temptation

There has been substantial recent theoretical progress in the theory of temptation and self-control. Our focus is temptation within the context of individual decision problems (e.g., Gul & Pesendorfer, 2001), as compared to temptation that might arise in strategic interactions (e.g., the temptation to free ride in a public good game: Ledyard, 1995; Chaudhuri, 2011). Of particular theoretical relevance to our paper is a contribution by Ozdenoren et al. (2012), which develops a model of will-power management that could in principle account for decision-switching behaviors such as observed in the marshmallow task.[5] In particular, in the presence of competing demands for limited willpower, Ozdenoren et al. (2012) model how an agent optimally allocates willpower across time and domains. Their insightful model could be applied in various contexts. We build on the work of Ozdenoren et al. (2012) in order to develop a simple model that provides insights into decisions under temptation in our specific context. Our model shares the spirit of Ozdenoren et al. (2012) in the sense that resisting tempting goods depletes willpower. Our model differs from theirs, however, in two important ways. First, Ozdenoren et al. (2012)'s model focuses on the endogenous allocation of willpower, that is, the agent takes into account the rate at which willpower depletes along different consumption paths; in this sense, willpower depletion is endogenous in their model. In contrast, our model assumes willpower depletion to be exogenous

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[5] Their model draws on arguments and experiment results detailed in a lengthy literature in economics, marketing and psychology (e.g., Hoch & Loewenstein, 1991; Muraven, Tice, & Baumeister, 1998; Shiv & Fedorikhin, 1999; Fudenberg & Levine, 2006; Vohs & Faber, 2007; Baumeister & Vohs, 2016).

and that the depletion depends on the duration of the exposure to tempting goods. Our focus is not on willpower management per se but rather on how exogenous willpower depletion impacts consumption. Second, their model allows agents to save willpower for subsequent activities that require self-control, and they assume that the agent foresees such needs. Our model focuses on only the current consumption decision. Subsequent activities and future needs for self-control are beyond the scope of our data and thus our analysis.

Our model is also closely related to the work of Houser et al. (2018). They report evidence that people generally give in or incur a cost to eliminate a tempting choice (a form of commitment) at the first chance when faced with continuous temptations. They employ a linear dual-self model to formulate predictions. Our model specification shares the spirit of Houser et al. (2018) in the sense that we also assume additive separability and adopt the simple linear framework. Just like a certain self-control cost specification justifies the delay in commitments in their setting, our approach to defining willpower depletion helps to explain the switching behavior in our setting.

Our model is as follows. An agent either consumes ($d = 1$) or does not consume ($d = 0$) a "tempting" item. For simplicity, we assume that all utility associated with consuming or not consuming the item occurs at the point when the item is no longer a target for consumption, either because the agent consumed it or because it is no longer immediately available to the agent (e.g., the customer reaches the front of the line and is ready to check out). Let $U(1)$ and $U(0)$ be the utility of consuming and not consuming the tempting goods, respectively. No-consumption generates utility as the agent might find himself/herself better off in the long term without consuming the tempting goods. We define the cost of willpower $W(t)$ as a function of the exposure duration to tempting items. There have been some attempts in the literature trying to quantify the cost of self-control. For instance, the cost could depend on the relative magnitude of one's commitment ranking and temptation ranking of lotteries (Gul & Pesendorfer, 2001). The cost could be linear or convex (Fudenberg & Levine, 2006, 2012). Note that we do not specify the function form of $W(t)$ to keep the model simple and general but we assume $W(t)$ is increasing in t. The monotonically increasing feature echoes the message in the literature that willpower is a limited resource and that exercising willpower is costly.

An item is "tempting" to a consumer if his/her preferences for the item satisfy the following. First, the "no-consumption" ($d = 0$) utility depends on the exposure duration according to $U(0) - W(t)$, where $U(0)$ is a real scalar and $W(t)$ (cost of depleted willpower) is real-valued and monotonically increasing in t. Second, utility derived from consumption is a scalar $U(1)$ that does not vary with exposure duration and that satisfies $U(1) < U(0)$. This model captures the simple intuition that the longer an agent is exposed to a tempting item the less satisfaction they feel in the ultimate decision not to consume it, while consuming it gives them the same pleasure regardless. Thus, when exposed to a tempting item for duration t, consumer j's preferences are:

$$V(d = 0, t) = U(0) - W(t) \quad (1)$$

$$V(d = 1, t) = U(1) \quad (2)$$

The consumption decision d^* is $d^* = 0$ if $V(0, t) > V(1, t)$, and $d^* = 1$ otherwise.

Now, suppose there are two possible exposure durations, S(short) and L(long), so that $W(S) < W(L)$. Suppose also that a consumer knows whether he/she will be exposed to the tempting good for duration S or L. Three cases arise.

Case 1. $U(1) > [U(0) - W(S)] > [U(0) - W(L)]$. (3)

In case 1 the agent consumes the tempting good immediately and obtains utility $U(1)$.[6] It could be because the agent values the consumption of such goods highly and/or the cost of any self-control is large.

Case 2. $[U(0) - W(S)] > [U(0) - W(L)] > U(1)$. (4)

In case 2 the agent does not consume the tempting good and obtains utility $U(0) - W(S)$ if the duration exposed to tempting items is short, and $U(0) - W(L)$ if the duration is long. This is the case where the agent values no-consumption highly and/or the cost of self-control is relatively small.

Case 3. $[U(0) - W(S)] > U(1) > [U(0) - W(L)]$ (5)

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[6] This does not necessarily imply that the actual consumption happens right away. Since exposure time does not affect the utility derived from consumption, the point of consumption is irrelevant to our model. Consuming the tempting item "immediately" in this context means the agent decides to purchase the tempting item without exercising self-control.

In case 3 the agent consumes the tempting good immediately and obtains utility $U(1)$ if the known duration is L, but does not consume the good and earns utility $U(0) - W(S)$ if the duration is short. In other words, the consumption decision is dependent on the duration of the exposure to tempting goods.

Assuming individuals' heterogenous preferences are characterized by different cases, this simple model is sufficient to predict (i) the frequency of tempting purchases increases as exposure duration increases, and (ii) some people will not purchase tempting goods even with long exposure; (iii) some people will purchase tempting goods even with short exposure.

Moreover, if there is uncertainty regarding exposure duration then the model can also account for delay in consumption of tempting items. In particular, because the value of consumption is time-invariant, a person with Case 3 preferences will always wait to resolve whether the duration will be short prior to making their consumption (or no-consumption) decision. Consequently, an additional prediction of this model is that consumption decisions will not necessarily cluster near the end of total wait period but will occur at any point after the "short" length of time has passed.[7]

Our model takes the willpower depletion approach to explain time-inconsistent preferences. It views self-control as a costly exercise. This approach is shared by a number of theoretical contributions (e.g., Gul & Pesendorfer, 2001; Fudenberg & Levine, 2006; Ozdenoren et al., 2012). Besides willpower depletion being time-dependent, it is not impossible that the utility of consumption and no-consumption might be time-dependent as well. Being in proximity to tempting goods may increase one's desire to consume such goods, and longer exposure might enhance that desire. These ideas have been modeled by Hoch & Loewenstein (1991). They propose that exposure to a good not only makes people feel attached to the consumption of the good but also activates the feeling of deprivation from no-consumption. Such exposure shifts the reference

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[7] The model is rich enough to make a large variety of predictions. For example, looking forward to our empirical analysis, we would expect children to experience more difficulty with self-control (Bucciol, et al, 2011), suggesting a larger $W(S)$ and $W(L)$ in shopping groups that include children. Consequently, we would expect groups with children to be more likely to succumb to temptation (in our case, purchase a tempting item).

point with regard to how people value consumption and non-consumption of a product, which results in time-inconsistent preferences. Since only the relative terms of utility and willpower depletion are of interest in our model, relaxing the assumption that utility is time-invariant does not change the model's prediction.

3. A Natural Experiment

To test the predictions of our simple model of decision under temptation, we turned to the checkout aisles of local supermarkets. At the checkout aisle, "tempting items" such as magazines, candy bars, and gum have become an everyday part of our grocery experience.[8]

The data for this project were collected by undergraduate research assistants, who directly observed checkout aisles at three grocery stores.[9] First, 886 observations were made at an Albertsons, which is part of a national chain. This particular store is in a middle-income area. Later, we collected data from a Wild Oats, a more upscale chain store in a wealthier part of town, and from Grant-Stone Market, a local, independent grocery in a lower-income neighborhood.

Initially, a set of 1671 data points included: (1) the time that a customer entered a checkout line, (2) the time at which the customer reached the cashier, (3) whether the customer purchased a tempting item from the checkout aisle, (4) the customer's gender, and (5) whether the customer

[8] Because these tempting items are easily available, it is reasonable to assume that consumers generally have familiarity with those products and therefore do not need much time to investigate the product. One may argue people sometimes spend time to investigate the content of magazines before purchasing them. This is possible but it is unclear how this might impact the temptation to purchase.

[9] We tried to record as many observations as possible in the observation period. This does not imply that every customer in each observation period was recorded. Numbers of observations collected depended on the number of research assistants in the field, the number and location of the opening aisles at store and the number of customers in line. In situations where it was not possible to cover all opening aisles, research assistants were told to choose aisles randomly. The research assistants were located near the checkout line but they were far away enough so they could not be observed by the customers. They observed customers independently. Research assistants were told to record key information first (time in and out of the line, purchasing behavior, kid presence, gender, sometimes pick-up time of the tempting items, race and age guess) and then record other information (such as the things customers purchased, aisle number, etc.) to the greatest extent possible.

had children with him or her. Later, 1156 additional observations were made, adding three more variables: (6) the approximate age of the customer, and (7) the elapsed time (if any) until the customer actually picked up a tempting item that he or she eventually purchased. We also made an effort to collect information on race. Our sample is overwhelmingly white (about 86%), with Hispanics, Asians and Blacks representing 7%, 4% and 3% of our sample, respectively. We have too few observations for reasonable inference regarding race effects on temptation, so we do not pursue a race analysis.

We gathered a total of 2827 independent observations concentrated mainly at an Albertson's store (72.2 percent), and more modest proportions from Wild Oats (15.0 percent) and Grant-Stone (12.8 percent). Observations were made on different days of the week (weekdays and weekends) and various times of the day (roughly in the 9am to 8pm range).[10]

Finally, note that the store determines which aisles will be open or closed. If the store chooses open aisles randomly, or if there are no systematic differences between open aisles and closed aisles in terms of tempting goods, then this poses no problem for our analysis. However, one might argue that stores make a systematic effort to keep aisles with tempting products open at all times, while aisles with less-tempting items might be open only in the busiest times. If so, this works against our ability to find relationships between amount of time spent in line and the purchase of tempting items. The reason is that busy times, perhaps with longer waits on average, would include more observations from aisles with fewer temptations. We unfortunately do not have the data necessary to determine how our stores managed aisle availability.

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[10] One may argue that shoppers may self-select into busy or less busy times, which could leave waiting time endogenous. Though it is possible shopping at busy hours may result in longer waiting time, it is also true that stores tend to have more aisles open at busy times. The waiting time could still be random. We did not record the precise time of each observation, so we are unable to know how the waiting time varied by hours of the day. We do however, for a small subsample (N=886) at Albertson's, have coarse information on time of observation, including whether the observation was collected on the weekend or whether the observation was collected in late morning (9am-12pm)/early evening (5pm-8pm). We have conducted regressions adding those variables and their interactions with waiting time as controls, we did do not discover any significant effect. Adding these controls does not change our result that waiting time remains highly significant. These regression results are reported in the appendix.

4. Results

4.1. Descriptive Statistics

Overall, slightly more than half of the observed customers (56.0 percent) were female (see Table 1). (Note that when a mixed-gender group checked out together in a single transaction, we recorded an appropriate fraction for the gender variable, e.g., 0.5 for one man and one woman. This occurred in 262 of the 2827 observations.) We observed a higher proportion of females at Wild Oats (63.4 percent) and a lower proportion of females at Grant-Stone (40.1 percent), with Albertson's close to the group average (57.3 percent). We also observed that at each store the proportion of females purchasing tempting items was greater (9.4 percent overall) than the proportion of males who did so (6.4 percent overall).

[Insert Table 1 here]

We observed children with 8.8 percent of the customers, and this ratio was reasonably consistent across the three stores (see Table 2). Children led to a much higher probability of a tempting purchase (46 out of 250, 18.4 percent) than the aggregate average (229 out of 2827, 8.1 percent). Nearly three quarters (74.8 percent) of the observations with children present occurred with a female customer. So we see already that the male/female difference in purchases of tempting items is likely attributable at least in part to the increased presence of children.

[Insert Table 2 here]

For our purposes, the most interesting descriptive statistics concerns time in line, which are detailed in Table 3. Aggregating our data from all stores, time spent in line before reaching the cashier ranged from a mere 3 seconds to a whopping 18.5 minutes, with a mean of 3 minutes 56 seconds. Interestingly, no customer who spent less than 20 seconds in line purchased a tempting item. The average time in line among those who did purchase a tempting item is 4 minutes 57 seconds, a full minute longer than the group who did not purchase, and this difference is statistically significant ($p < 0.01$). Table 3 also shows that this pattern holds true separately for each store, although statistical significance is lost at Wild Oats where we have relatively few purchase observations. Overall, Table 3 provides first evidence that customers who wait longer in line are more likely to purchase a tempting item, providing empirical support that temptation affects consumer decisions.

[Insert Table 3 here]

A subset of the Albertson's data (N = 1156) included observations on age and elapsed time until tempting item pickup. We assigned customers to one of three approximate age categories: younger than 25 (14.53 percent), between 25 and 60 (69.20 percent), and older than 60 (16.26 percent). The younger and older groups exhibited somewhat higher proportions of purchases (6.0 percent and 4.3 percent respectively) than the middle group (3.8 percent). However, these differences are economically small, and statistically insignificant in pair-wise comparisons (two-tailed t test, younger vs middle, p =0.19; younger vs older, p = 0.47; middle vs older, p = 0.75).

Lastly, for this latter subset of Albertsons data we measured the time elapsed from arrival in the checkout line until the pickup of a tempting item. This set contains only 48 purchases. Figure 1 shows the distribution of the elapsed time to pick up of tempting items and that of the total time in line. The elapsed times ranged from a minimum of 2 seconds to a maximum of 5 minutes 21 seconds, with a mean of 1 minute 34 seconds. An interesting feature of this chart is that it seems to suggest decision switching. People resisted temptations for some time before succumbing to them. It is consistent with the view that, like the children in the lab, people do not initially choose to purchase a tempting item, but eventually succumb to temptation and do so.

[Insert Figure 1 here]

4.2. Analysis

When applied to our grocery store data, the main predictions of our simple model are that (i) frequencies of purchases of tempting items will increase with time in line and (ii) assuming there is uncertainty regarding time to be spent in line, the decision to purchase a tempting item will not be made upon entering the line, but with some delay.

The goal of our analysis is to investigate the validity of these predictions. To do this we conducted logit regressions that shed light on the impact of exposure duration on purchase decisions. Using probit or OLS regressions yields qualitatively similar results.

Result 1: *Total time spent in the checkout line is a significant predictor of a shopper's decision to purchase a tempting item.*

Support for this derives from an analysis of our 2827 observations. The dependent variable is whether a tempting item was purchased, and the independent variables available to us are the duration of time in line (*Time*, in minutes), the sex of the consumer (*Female*, taking value 1 if female) and whether children were present (*Kids*, taking value 1 with children present). We also add interactions between *Female*, *Time* and *Kids*. Our findings are reported in Table 4, and strongly suggest that, after controlling for these factors, time spent in the checkout line is significantly positively related to purchases. The logit coefficient on time is 0.179, which implies one additional minute in line increases the ratio of the probability of a purchase over that of a no-purchase by roughly 19.6%.

[Insert Table 4 here]

We explored the robustness of Result 1 in a variety of ways. First, Table 4 reports a logit analysis adding store dummies for Wild Oats and Grant-Stone Market. The dummy for the former is insignificant while that for the latter indicates positive significance. Importantly, time in line remains a significant predictor.

We also analyzed the subset of data (N=1156 at Albertson) that contained observations on age. We conducted regressions with dummies for age and their interactions terms for each with time, as well as without those dummies. In all cases total time in line is highly significant.

Thus, this result provides empirical support for models of willpower depletion such as those mentioned in Section 2.[11]

[11] In addition to including time linearly in the regression, we have also explored potential non-linearity between time and the dependent variable. We thank an anonymous reviewer for this suggestion. We conducted the same regressions with the added time squared term. Time remains highly significant. The time squared term is marginally negatively significant, suggesting a potential concave relationship. This finding echoes prior work on the non-linearity of self-control costs (Gul & Pesendorfer, 2001; Fudenberg & Levine, 2006, 2012; Houser et al., 2018). A promising direction for future research is to explore the shape of the time effect on willpower depletion and on tempting item purchase decisions.

Result 2: *The presence of children significantly increases the likelihood of purchasing a tempting item.*

Table 4 shows that the presence of children is also a significant predictor of purchase decisions. An explanation for this is that children are more impatient than adults, as well as capable in the art of persuasion. Alternatively, keeping children in line may deplete adults' willpower more quickly, leading one to succumb to temptation more easily. Moreover, the different rates of purchases between men and women detailed in the descriptive statistics seem entirely attributable to the fact that women were more likely than men to shop with children. In particular, after controlling for the presence of children the gender dummy becomes statistically insignificant. Finally, note that this result is robust to the various alternative specifications described in the discussion of Result 1.

It is noteworthy that time remains highly significant after kids' presence is controlled. This suggests that Result 1 is not just driven by kids' presence. Waiting time in line is a strong and robust driver of tempting purchases.

Result 3: *The decision to purchase a tempting item is generally made with delay.*

We support this result using observations in our Albertsons data that include elapsed time until item pick up. As shown in Figure 1, the majority of purchases happen after some waiting time in line. The modal waiting time before pickup of tempting items is between 40 seconds and 1 minute. Switching behavior on average occurs after 41.7% of total time in line elapses. Thus, purchases are frequently made with delay. This is consistent with the willpower depletion model reported in section 2 above.

5. Conclusion

Drawing from a long multi-disciplinary literature, we developed a simple model of decision under temptation. The key implication of our model, like other models in this area, is that one is more likely to purchase a tempting item if one is exposed to it for a longer period of time. We took advantage of a natural experiment to test this prediction. Our approach involved building a dataset based on passive observation of consumer decisions under temptation. Inferences based on passive observation avoid experimenter demand effects and other confounds that some have suggested are responsible for inconclusive findings in the empirical literature on temptation and self-control (Muraven, 2010).

We created a dataset including over 2,800 observations on purchase decisions at grocery store checkout aisles, and found that time in line significantly increases the probability of purchasing a tempting item. This effect is both statistically and economically significant. For example, we found that waiting in line 25 percent longer, five instead of four minutes, increases the probability of purchase over that of no-purchase by roughly 19.6%. Moreover, we found that, for any fixed duration of time in line, the presence of children increases the chance of purchasing a tempting item. This is consistent with the view that children "succumb" to temptation more quickly than adults (and are experts at persuading adults to buy the tempting product they want!). Alternatively, it could be that the presence of children depletes accompanying adults' willpower more quickly and thus makes them more susceptible to temptations.

Our finding that exposure duration matters is both intuitive and consistent with theory. We were surprised, however, by the magnitude of this effect. Even small changes in duration can have a substantial impact on purchase probabilities, and this finding seems to have important practical implications for the design of many markets. The importance of small increases in exposure duration provides an explanation for the perceived value of repeating the same advertisement to the same people over short periods of time.

Moreover, our field study benefits from large variation in exposure time (from 3 seconds to 18.5 minutes) and our findings in this regard may provide useful information for the design of lab experiments involving self-control manipulation tasks. In particular, our results show that no customer who spent less than 20 seconds in line purchased a tempting item, which suggests a short exposure to the tempting stimulus might have only limited impact on the depletion of self-control resources. It is possible that different exposure times used in laboratory manipulations might contribute to the mixed results found in the existing experimental literature on ego-depletion.[12]

The dataset we developed offers novel empirical content to the notion that "willpower" is depleted when a person is in the presence of a tempting opportunity. It is this intuition that

[12] We thank an anonymous reviewer for pointing this out.

underlies a psychology literature dating to Abelson (1963), as well as more recent sophisticated theory on this topic (e.g., Fudenberg & Levine, 2006, 2012; Noor 2007, 2011; Ozdenoren et al., 2012). Future research might profitably address commitment strategies people use to avoid willpower depletion in tempting situations, especially those that, like standing in checkout lines, are largely unavoidable and yet entail substantial economic significance.

Our conclusions were limited by our data. For instance, we do not have information on individual characteristics such as patience, employment status or working hours conditions due to the nature of our data collection process. We cannot speak to whether those characteristics vary across different times of the day and days of the week. We also only have limited information on the timing of the collection for a subsample from a single store location. Lacking precise collection time and aisle numbers for each observation also prevents us from exploring some potential avenues to explain our results, which we elaborate next as directions for future research.

First, it would be interesting to control for a shopper's expected waiting time in line. One could calculate this as the average waiting time in the hour before and after his/her shopping time, excluding his/her immediate shopping time window, say 20 mins. Another way to capture the effect of exogenous waiting time is to study purchase decisions with unexpected waiting time. A clear separation of the endogenous selection effect and the exogenous waiting time may lead to important findings and stimulate additional theory on this topic.[13]

Second, one could investigate whether waiting time has heterogenous effects on purchase decisions across different hours of the day. People might be more susceptible to temptation when they are hungry (before meals) and when they are tired (at the end of the day). Using passively observed field data, Danziger, Levav, & Avnaim-Pesso (2011) find that the fraction of favorable court rulings gradually decreases from around 65% to almost zero between food breaks but restores back to 65% after the food break. They attribute their findings to mental depletion. It would be

[13] we thank an anonymous reviewer for this suggestion.

intriguing to explore whether shopping at hours when one is likely to have less willpower naturally affects one's tempting item purchase decisions.[14]

Third, social preferences may play a role in purchase decisions. Longer waiting times may also mean there is a higher probability that customers see other people in front of them purchasing tempting items, which could affect their own purchasing behavior. Our data indicate that no customer who spent less than 20 seconds in line purchased a tempting item. Perhaps when waiting time is short one is less likely to observe other people purchase tempting items.[15]

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[14] we thank an anonymous reviewer for this suggestion.

[15] we thank an anonymous reviewer for this suggestion.

Tables and Figures

Table 1. Distribution of Sex and Purchases by Store (N = 2827)

	Albertson's		Wild Oats		Grant-Stone		Aggregate	
	Total	Purchases	Total	Purchases	Total	Purchases	Total	Purchases
Males	872.67	53	155	6.5	216.83	20	1244.5	79.5
Females	1169.33	114	268	14.5	145.17	21	1582.5	149.5
Total	2042	167	423	21	362	41	2827	229

Notes: Purchases refer to tempting purchases. Groups of customers of mixed gender were treated as an appropriately proportioned fractional sex observation.

Table 2. Distribution of Kid Observations and Purchases by Store (N = 2827)

	Albertson's		Wild Oats		Grant-Stone		Aggregate	
	Total	Purchases	Total	Purchases	Total	Purchases	Total	Purchases
With Males	52	6	4	0	7	2.5	63	8.5
With Females	141	27	24	4	22	6.5	187	37.5
Overall	193	33	28	4	29	9	250	46

Notes: Purchases refer to tempting purchases. Groups of customers of mixed gender were treated as an appropriately proportioned fractional sex observation.

Table 3. Descriptive Statistics of Time in Line (mm:ss) (N = 2827)

	Albertson's		Wild Oats		Grant-Stone		Aggregate	
	Given Purchase	Given No Purchase	Given Purchase	Given No Purchase	Given Purchase	Given No Purchase	Given Purchase	Given No Purchase
Min Time	0:29	0:03	0:26	0:30	0:21	0:09	0:21	0:03
Max Time	14:03	18:35	7:20	16:24	6:45	12:42	14:03	18:35
Mean Time	5:40	4:22	2:44	2:28	3:10	2:33	4:57	3:51
Std Dev	2:32	2:20	1:40	1:27	1:31	1:48	2:36	2:19
Difference‡	1:18	(6.81***)	0:16	(0.83)	0:37	(2.09**)	1:06	(6.81***)

Notes: Purchases refer to tempting purchases.

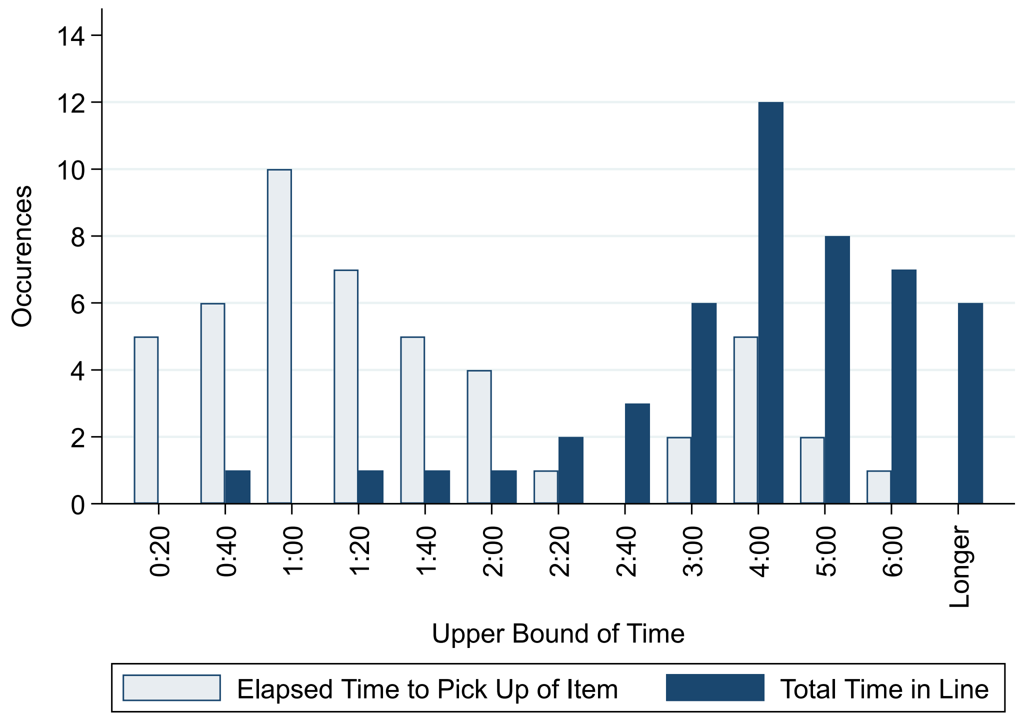
‡ Difference in mean of time in line given purchase and mean of time in line given no purchase (t-statistics for the test of equality of means appear in parentheses).
** significant at the 5% level
*** significant at the 1% level

Table 4. Determinants of a Tempting Item Purchase: Logit Regressions

Dependent variable: purchase decision					
	(1)	(2)	(3)	(4)	(5)
Time	0.171***	0.179***	0.210***	0.249**	0.296**
	(0.0258)	(0.0486)	(0.0496)	(0.113)	(0.123)
Female		0.330	0.473	0.979	0.886
		(0.317)	(0.317)	(0.682)	(0.703)
Kids		1.158***	1.166***	1.209*	1.459*
		(0.373)	(0.374)	(0.733)	(0.768)
Female × Time		-0.0219	-0.0378	-0.242	-0.228
		(0.0608)	(0.0604)	(0.152)	(0.160)
Kids × Time		-0.0864	-0.0866	-0.149	-0.175
		(0.107)	(0.107)	(0.202)	(0.203)
Kids × Female × Time		0.0581	0.0522	0.233	0.228
		(0.0946)	(0.0954)	(0.191)	(0.191)
Wild Oats			-0.124		
			(0.252)		
Grant-Stone			0.809***		
			(0.200)		
below 25					0.895
					(0.834)
above 60					0.967
					(0.846)
Below25 × Time					-0.0358
					(0.196)
Above60 × Time					-0.170
					(0.197)
Constant	-3.174***	-3.475***	-3.758***	-4.306***	-4.680***
	(0.142)	(0.245)	(0.267)	(0.537)	(0.600)
Observations	2827	2827	2827	1156	1156
Log. Likelihood	-774.4	-759.6	-751.4	-191.7	-189.6
Chi-squared	41.12	70.73	87.16	16.01	20.25

Notes: "Purchase decision" and "Kids" are binary variables. Standard errors in parentheses
* p<0.10 ** p<0.05 *** p<0.01

Figure 1 Elapsed Time to Pick Up of a Tempting Item and Total Time in Line



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Appendix

Additional analyses

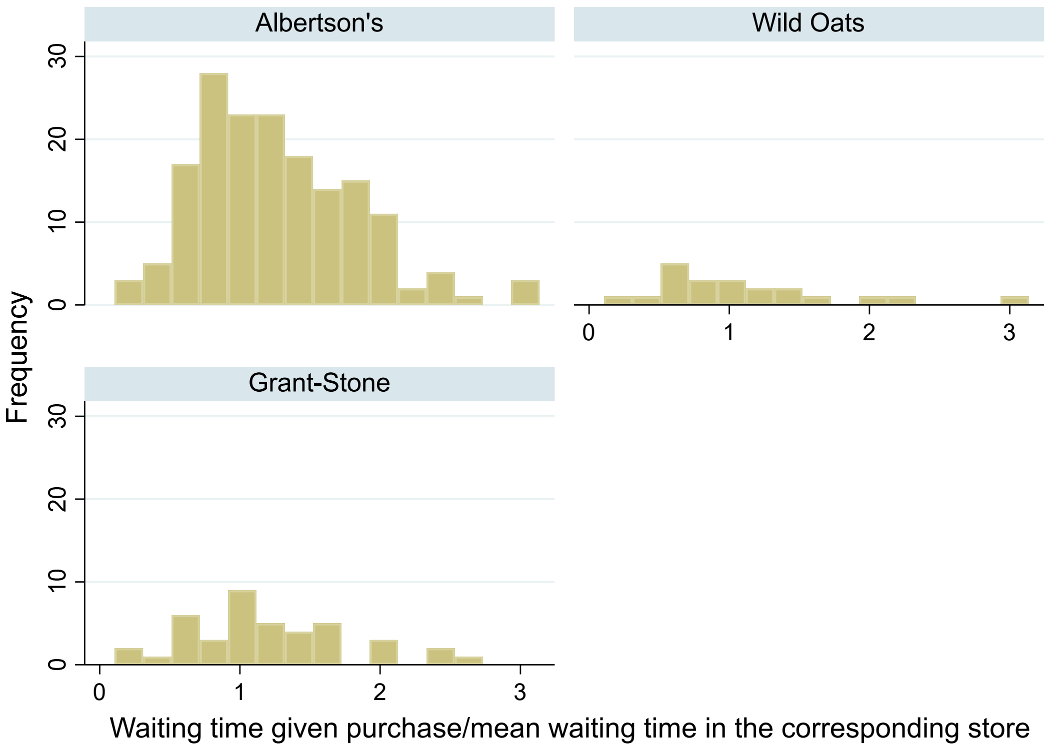

Figure A1. Histogram of waiting time given purchase and mean waiting time by store

Table A1. Determinants of a Tempting Item Purchase: Logit Regressions

Dependent variable: purchase decision		
	(1)	(2)
Female	0.363	0.373
	(0.233)	(0.233)
Kids	0.634**	0.636**
	(0.272)	(0.273)
Time	0.135***	0.148***
	(0.0418)	(0.0439)
Weekend	0.236	0.978
	(0.282)	(0.826)
Weekend × Time		-0.134
		(0.144)
Constant	-3.025***	-3.111***
	(0.317)	(0.333)
Observations	886	886
Log. Likelihood	-338.8	-338.4
Chi-squared	21.38	22.27

Notes: Standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

Table A2. Determinants of a Tempting Item Purchase: Logit Regressions

Dependent variable: purchase decision

	(1)	(2)	(3)	(4)	(5)	(6)
Female	0.358	0.367	0.359	0.363	0.359	0.367
	(0.233)	(0.233)	(0.233)	(0.233)	(0.233)	(0.234)
Kids	0.632**	0.627**	0.632**	0.626**	0.632**	0.627**
	(0.272)	(0.273)	(0.272)	(0.273)	(0.272)	(0.273)
Time	0.132***	0.160***	0.129***	0.113**	0.129***	0.159**
	(0.0415)	(0.0472)	(0.0426)	(0.0532)	(0.0428)	(0.0677)
Late Morning	-0.0238	0.722			0.00206	0.725
	(0.227)	(0.643)			(0.250)	(0.694)
Late Morning × Time		-0.123				-0.122
		(0.101)				(0.112)
Early Evening			0.0595	-0.236	0.0603	0.0216
			(0.220)	(0.628)	(0.242)	(0.676)
Early Evening × Time				0.0449		-0.000354
				(0.0892)		(0.0985)
Constant	-2.963***	-3.139***	-2.973***	-2.882***	-2.974***	-3.142***
	(0.313)	(0.349)	(0.309)	(0.356)	(0.316)	(0.436)
Observations	886	886	886	886	886	886
Log. Likelihood	-339.2	-338.4	-339.1	-339.0	-339.1	-338.4
Chi-squared	20.72	22.23	20.78	21.03	20.78	22.24

Notes: Standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01