Now or Later:
An Experimental Analysis of the Effects of Distraction on Individual Financial Decisions and Preferences

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Abstract

A number of models in the literature and several experiments show that a high cognitive load will lead to individual decision makers selecting emotionally appealing options over less appealing but, in the long run more advantageous, alternatives. There has been little work examining the effects of cognitive load on intertemporal financial decisions. Researchers used data from an experiment run with 45 college students to test whether filling out a survey under conditions of distraction would elicit higher discounting rates than completing it with no distractions. Additionally, a choice of a small immediate or larger delayed reward was offered at the end of the survey. Researchers found evidence suggesting that ability to defer consumption options that are immediately available is impaired when participants are distracted, but when making decisions about consumption options which are unavailable until a later time, the distraction condition had little effect.

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Conventional analysis of intertemporal choice (choices made between two time periods or over several time periods) takes the view that the effect of delay on the subjective value of future outcomes can be captured by a discount function. It is usually assumed that outcomes should receive less weight the longer they are delayed. An easy way to think about this idea is to put it in terms of your own consumption. Would you be willing to pay as much for, say, a computer that would be delivered in a year as you would a computer that you could start using immediately? What if you were choosing between saving for retirement and getting a new car? There are a number of situations in which ability to exercise self-control is essential to long term well-being, but what affects an individual's ability to delay gratification at any given time? Specifically, does distraction and fatigue lower people's capacity to delay gratification?

The ability to delay gratification has been linked to academic, personal, medical, and financial success (Mischel, Shoda and Rodriguez 1989); therefore, finding ways to improve the capacity to do so may be useful in many areas. For example, helping low-income workers to save more would increase living standards later in their lives. The results of this research suggest that avoiding immediate temptation could potentially be a helpful step toward successful long-term planning. Continuing the example of low-income workers, some strategies to increase savings could include precommitment to a monthly or weekly budget, with a defined contribution to an investment device which cannot be accessed until retirement. Alternately, financial education programs emphasizing the importance of creating lists before entering stores in order to forestall "impulse buys" could aid in the improvement of both financial welfare and public health.

This paper first examines the historical development of discounting theory, beginning

with John Rae's consideration of the psychological factors influencing the desire to delay gratification and then describes the development of various models for intertemporal choice through the 19th and 20th centuries. We then examine research on intertemporal choice from the fields of psychology and behavioral economics. This examination includes a description of psychological and economic concepts such as aversion to risk, the use of heuristics, prospect theory, and previous experimental work. Consideration is also given to recent neurological evidence supporting models which view the process of intertemporal decision making as an internal struggle between competing neural systems. To predict the effects of increasing cognitive load on intertemporal choice a slight extension to Fudenberg and Levine's (2006) dual-self model of intertemporal decision making is made. The paper then describes an experiment run with students recruited from the researchers' institution to test the effects of cognitive load on intertemporal choice. It then explains and discusses statistical analysis of experimental results. Conclusions on the strength and importance of findings then follow.

Our initial findings yielded only one statistically significant result, but there are suggestive trends in the data that may become clearer with a more powerful experiment. Distraction reduced subjects' consideration of future actions. Avoidance of risk seemed to replace achieving goals as a factor in the decision making process. Finally, distracted experimental subjects showed a tendency to have more difficulty deferring rewards when they were immediately available, but had little difficulty when faced asked to consider future plans.

I. A Historical Summary of Discounting Theory

Frederick, Lowenstein, and O'Donoghue argue that John Rae established intertemporal choice as a distinct field 1834 with the publication of his *Sociological Theory of Capital* (2002). The main focus of economics at the time was accounting for the differences in wealth between nations. His work was an extension of Adam Smith's theory regarding the allocation of labor to the production of capital in that it attempted to discern the determinants of this distribution. Rae recognized that long run capital accumulation is the result of investment in future prospects (Rae 1905, 52). In order to stimulate long run growth, some current consumption must be deferred in favor of investment. The more consumption is deferred, the more capital will accumulate in an economy and the more the economy will grow. The longer consumers are willing to invest their income, the more the economy will grow until at some point they will no longer be willing to defer current consumption in favor of the future. He dubbed this willingness to defer present consumption "the effective desire of accumulation," for as Rae put it: "All men may be said to have a desire of this sort, for all men prefer a greater to a less; but to be effective it must prompt to action" (Rae 1905, 54).

The effective desire of accumulation is a psychological factor which determines a country's level of savings and investment. Rae sought to evaluate the determinants of this desire. He rejected personal desire for later consumption as unlikely, as hedonic motives would instead lead one to consume everything immediately. Instead, he believed that "intertemporal choice was the joint product of factors that either promoted or limited the effective desire of accumulation" (Frederick, Lowenstein, and O'Donoghue 2002).

Rae recognized that rational consumers would note the need to provide for themselves in their old age. Thus, the ability to acknowledge this need and restrain consumption in favor of it

was one of his listed motives. Most parents have a desire to pass wealth on to their heirs, and so the bequest motive was another factor in the desire of accumulation. If a society is particularly unstable, then it makes little sense to save, as economic or social upheaval could lead to a loss of savings; therefore, savings and social stability had a positive relationship in Rae's model. The prospect of immediate consumption is the primary argument against deferring consumption. Therefore, in cases where immediate consumption is especially appealing, the probability of deferring gratification will be greatly diminished. Finally, Rae listed utility derived from societal and economic advancement as a factor determining the level of savings, the extent to which individuals would be willing to defer consumption for the good of the economy as a whole (Rae 1905, 56).

The next major developments in the theory of intertemporal choice came in the form of two models based upon the first four of Rae's factors. In 1871, William S. Jevons stated: "It is certain that a very large part of what we experience in life depends not on the actual circumstances of the movement so much as on the anticipation of future events" (Jevons 1957, 33). Further noting that anticipated utility is often much greater than utility actually derived from a consumption option, the utility gained from the prospect of consumption must in some way motivate decision making. He went on to propose that there must be some form of functional relation between anticipal utility, as Frederick, Lowenstein, and O'Donoghue (2002) refer to it, and the temporal proximity of the anticipated consumption:

> Now between the actual amount of feeling anticipated and that which is felt there must be some natural relation… subject to some general laws of variation. The intensity of present anticipated feeling must, to use a mathematical expression, be *some function of the future actual feeling and of the intervening time*, and it must increase as we approach the moment of realization.… a moment which happens a year hence affects us on the average about as much one day as another; but an event of importance, which is to take place three days hence, will probably affect us on each of the intervening days more acutely than the last. (Jevons, 1957, 34)

Jevons proposed an "anticipatory utility" model, where consumption is delayed only if the "anticipal utility" from the prospect of later consumption is greater than the anticipated utility from immediate consumption. Furthermore, the nearer the prospect of consumption gets, the greater the anticipated utility becomes, and so the more difficult it is to delay gratification.

The "abstinence perspective," promoted by Nassau Senior, stands in distinct contrast to that of Jevons. In 1836, Senior (1951, 54) was considering the impact of savings on capital formation, and he noted that the entrepreneurs whose wealth grew the most in the long run were those who were best able to delay gratification. He also recognized that most intertemporal choice is made with some goal in mind (Senior 1951, 55):

> It [abstinence] is recognized instantly in the conduct of a man who allows a tree or domestic animal to attain its full growth; but it is less obvious when he plants the sapling or sows the seed corn. The observer's attention is occupied by the labor, and he omits to consider the additional sacrifice made when labor is undergone for a distant object. (Senior 1951, 59)

Senior never considered that future and immediate consumption could be valued unequally. Instead he accounted for the overvaluation of immediate consumption by suggesting that waiting to consume creates disutility for the agent (Senior 1951, 59-60).

Eugen von Bohm-Bawerk "added a new motive to the list proposed by Rae, Jevons, and Senior" (Frederick, Lowenstein, and O'Donoghue 2002). He modeled intertemporal choice as a "technical" decision about allocating resources, similar to making decisions between different consumption bundles at a given point in time, though people tend to underestimate their future wants. In 1930, Irving Fisher rejected capital as the primary focus of intertemporal choice, stating that "capital wealth is merely the means to the end called income" (Fisher 1965, 61). He further noted that the price ratio between any two goods is based at least in part on their "comparative marginal desirability" (Fisher 1965, 61). Continuing in this train of thought, he then considered the idea of comparing the marginal desirability of the same good at two different

time periods. As many before him had noted, future consumption is always valued less than present consumption, and so there must be a decline in desirability as the prospect of consumption becomes more distant. Furthermore, since price partly represents the comparative attractiveness of consuming a good, Fisher realized that he could model intertemporal preference in terms of willingness to pay for delayed consumption in comparison to willingness to pay for immediate consumption.

Thus, time preference could be evaluated using indifference curves, a tool usually reserved in economics for computing the proportional desirability of two different goods in a consumption bundle; this proportional desirability is known as the marginal rate of substitution. The marginal rate of substitution between two goods is the amount of one good that must be substituted for another if the amount of utility derived from consumption is to remain constant. Using indifference curves, Fisher could calculate the marginal rate of time substitution, or the proportional valuation of consumption in some future time period with consumption immediately (Fisher 1965, 94-99). Fisher's representation showed that intertemporal preference depends on two factors, diminishing marginal utility and time preference. Diminishing marginal utility refers to the fact that the rate of increase in utility lessens as consumption increases. Time preference refers to the devaluation of future consumption simply due to the need to wait; in Fisher's model, it is represented as the marginal rate of substitution between present and future consumption.

Given a method for simplifying a complex issue into a simple proportion or number, it is tempting to think of that issue in terms of that number. Accordingly, after Fisher, "time preference" was thought of as an "amalgamation of various intertemporal motives" (Frederick, Lowenstein, and O'Donoghue 2002). Indeed, Fisher himself referred to Rae's five determinants of accumulation when discussing the determinants of time preference Fisher (1965, 92).

In 1937, Paul Samuelson introduced a generalized model of intertemporal choice which could be applied over multiple time periods as part of a paper constructing a model for the marginal utility of income. As opposed to Fisher's two-period model, Samuelson's model represents the amalgamation as a single discount rate which is consistent between all periods.. Samuelson was careful to stress the hypothetical nature of his model: "This assumption… is in the nature of a hypothesis, subject to refutation by observable facts" (Samuelson 1937).

Samuelson's model is called *discounted utility theory* (DU), the utility obtained from a series of future consumption occasions occurring at regular intervals by an agent with a given discount function. He gave his hypothesized function in as mathematically vague terms as possible.

$$U_t = \sum_0^t e^{-\pi t} U(x) \qquad \text{(Equation 1a)}$$

$$where\ \pi = \log e(x + p)$$

U(x) refers to the agent's utility function, and p is the discounting rate (Samuelson 1937). This functional form is known as the exponential discounting model and it has dominated discounting literature since soon after its inception. A more modern functional form for this model is the following:

$$U_t = \sum_t^{t+d} F(d) U\big(c(t + d)\big) \qquad \text{(Equation 1b)}$$

$$where\ F(d) = \left(\frac{1}{1+k}\right)^t$$

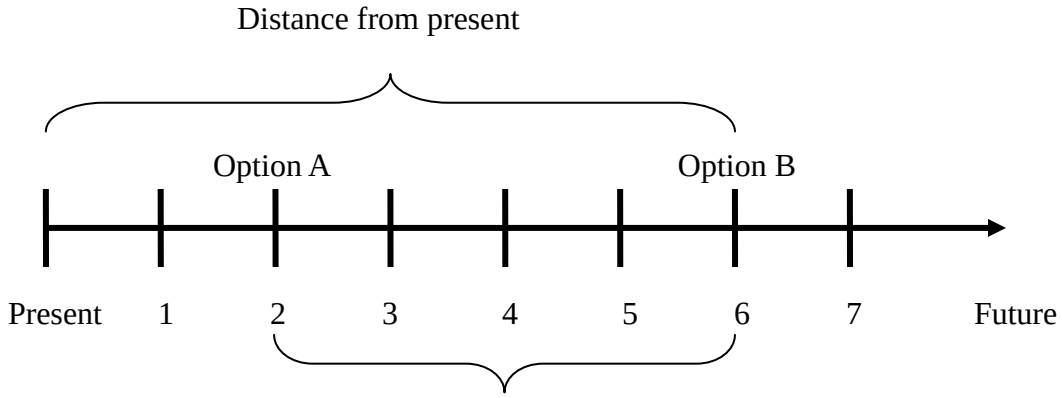
c(t+d) refers to the resources consumed at time *t+d*, *U(c(t+d))* refers to the instantaneous utility derived from that consumption at the time it is consumed, and *F(d)* is the discount function (how much consumption at time d is devalued in relation to the present time), and k is some constant. k is the discount rate. In other words, in order to make decisions about how to behave in the future, people will try to maximize the sum of the utility they expect to have in each period, but

the further into the future that utility is obtained, the less they will value it. The term exponential discounting is derived from the fact, future consumption in any given time period is valued at a constant percentage of consumption in the previous period.

The exponential discount function predicts that devaluation between two consumption options is dependent only on the time between those choices and is independent of the temporal distance of those options from the present. A choice between $10 today and $11 tomorrow will be evaluated in the same way as $10 in a year and $11 in a year and a day. The total valuation will differ, since $11 tomorrow is obviously more appealing than $10 in a year.

For the purposes of demonstration, suppose the discount rate is 0.99 per day, then $10 today will have a value of $10 and $11 in one day will be valued at $(0.99)11 = \$10.89$. $10 in one year will be valued at $(0.95)^{365}10 = \$0.2551$, and $11 in one year will have the value $(0.95)^{366}11 = \$0.2778$. But notice that $\frac{10.89}{10} = 1.089$ and $\frac{0.2778}{0.2551} = 1.089$. From this example we see that the proportional difference in how the consumption options are valued is independent of how far into the future the consumption options are. This is demonstrated more generally in figure 1. The agent's relative valuation of consumption options A and B is dependent on the distance four time periods between them, and is independent of their temporal distance from the present.

Fig. 1 illustration of relative valuation in exponential discounting



Strotz (1955) questioned the assumption that individuals would be constant in their preferences, theorizing that as consumption options were reevaluated closer to the time of consumption, previous plans would be abandoned in favor of more myopic ones. Strotz created a model which assumed that consumers periodically reevaluated their consumption plans and found that instead of the rational intertemporal decision making predicted by the DU model, consumers would exhibit disturbingly high levels of short-sightedness, suggesting that time preference is inconsistent with regards to temporal proximity to the present. Strotz therefore theorized that a new functional form was needed to account for this inconsistency.

Strotz's inconsistent discount idea has held up well in experimental settings. Herrnstein (1961) noticed that pigeons tended to follow a hyperbolic discount function when responding to delays in grain rewards. Subsequent experimental evidence has shown that a functional form that better fits the way people actually behave tends to be a hyperbolic discount function (Laibson 1997). That is, for consumption near the present, the discount rate is quite high, but as decisions go further into the future, the discount rate decreases. For example, $11 in a year and a day is preferred to $10 in a year, but $10 today is preferable to $11 tomorrow. The continuous hyperbolic discount function d periods from now has the form

$$F(d) = \frac{1}{1+kd} \qquad \text{(Equation 2)}$$

Laibson (1997) has proposed a discrete version of this idea derived from previous work by Phelps and Pollak (1968) on intergenerational altruism. Laibson's functional form is known as quasi-hyperbolic discounting. The quasi-hyperbolic function is similar to the exponential function except that for the time period immediately following the current one, the discount rate is different from all other time periods. The quasi-hyperbolic function has the form

$$F(0) = 1 \qquad \text{(Equation 3)}$$

$$F(t) = \beta * (\delta^t)$$

where β and δ are constants between 0 and 1.

Note that the discount rate for period 1 (the immediate future) is $\beta * \delta$, whereas each subsequent period will have a discount rate of $\frac{\beta*(\delta^{t+1})}{\beta\delta^t} = \delta$. From this, we see that the important aspect of the hyperbolic function (an initially steep, but diminishing discount rate) has been maintained with a much more analytically tractable model. This situational discount rate fits well with dual-self intertemporal choice models (Thaler and Shefrin 1981) and recent neurological evidence (McClure et al. 2004), discussed below, in that they have differing discount rates for various situations.

Fig.2. A comparison of the various discount functions

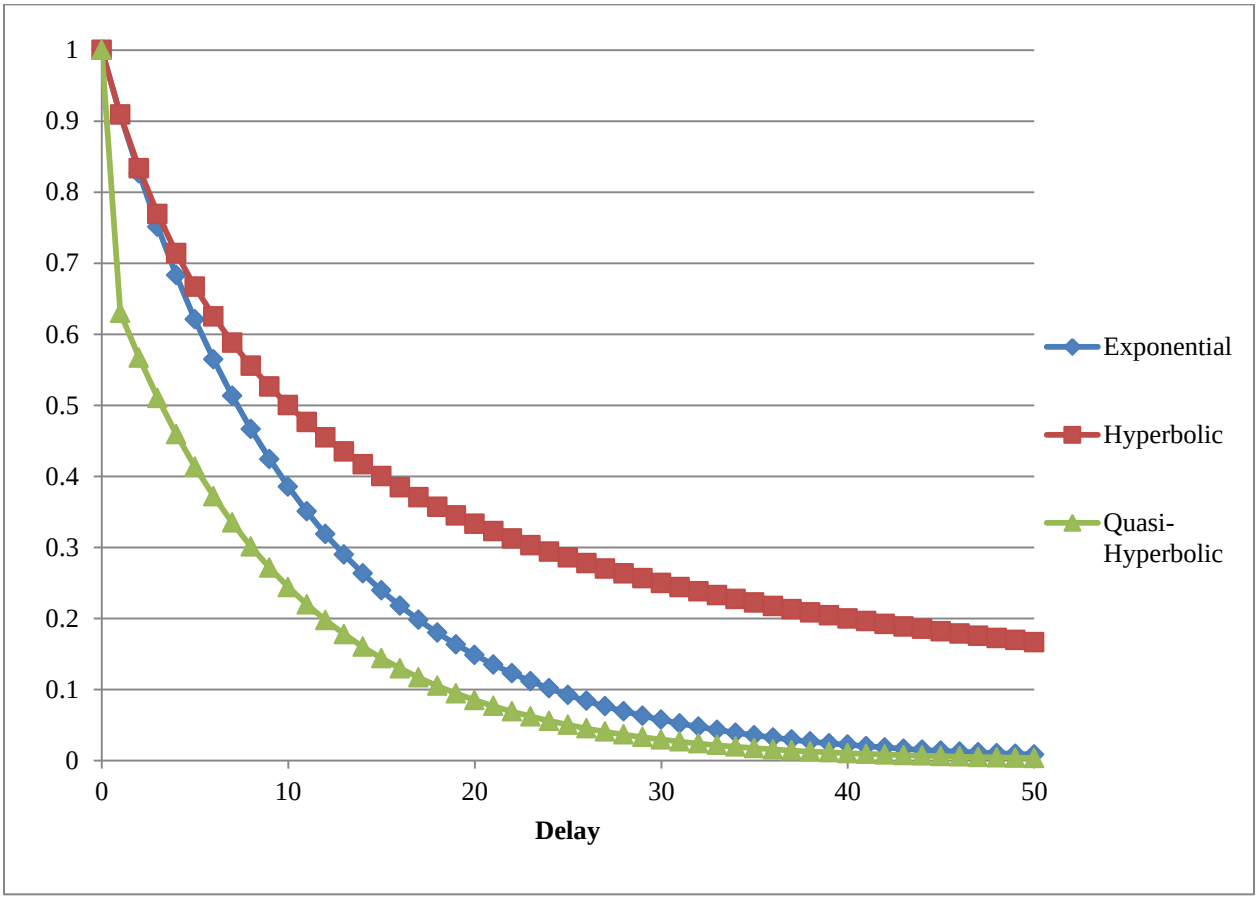


Figure 2 illustrates the behavior of the various discount functions in terms of how they reflect devaluation over time. The hyperbolic discount function is initially steep but as consumption options get further from the present the amount by which they are devalued per time period decreases. This form better represents the way people actually tend to think, but it may overvalue distant consumption options. The quasi-hyperbolic discount function has a steep discount rate after the first period, but then follows the exponential discounting form. This behavior captures the essential part of the hyperbolic discount function in that immediate consumption is discounted faster than distant consumption.

II. Problems with the DU model

Even Paul Samuelson, the creator of the Discounted Utility model, had doubts about its descriptive power. The DU model assumes that all of the complex psychological factors influencing intertemporal choices can be condensed into a single "discount rate" (Frederick, Lowenstein, and O'Donoghue 2002), and given the results discussed, it is not surprising that experimenters have found a number of deviations in actual behavior from DU predictions. Some examples include the following: larger rewards and costs tend to be discounted less than small amounts even when the proportional difference is the same (for example, $150 in a month is preferred to $100 today, but the same does not hold for $15 and $10); and people seem to prefer increasing utility profiles rather than decreasing ones (that is, saving the best for last).

The focus of our work is the effect of limited cognitive resources on decision making. Situations where a decision maker has met or is close to the limits of his or her cognitive resources leads to the use of rules of thumb and instinctive decision making (Baumeister 2003). In psychology, these rules of thumb are known as heuristics. Heuristics are mental shortcuts which people use to make decisions with a minimum of time and mental resources (Fiske and Taylor 2007). Choices made using heuristics tend to be polarized and biased in favor of emotionally appealing options (Shiv and Fedorikhin 1999). In general, heuristics are preferable when a decision is needed quickly and/or when thinking deeply about a matter would cloud judgment instead of aiding it (Fiske and Taylor 2007). Combat situations are a good example in that they require fast, almost instinctive decision making; part of the reason that military training emphasizes drills is so that soldiers will know what do when combat begins without having to deliberate about actions. However, in situations where the emotionally appealing option will be less optimal, heuristics can lead to self-defeating behavior (Baumeister 2003).

Some examples of heuristics include: the representativeness heuristic, which is comparison of a specific event to a general category (that is fitting an event to a mental story); availability, the estimation of the likelihood of an event based on personal experience with similar events (for example, people with friends who are divorced estimate that the divorce rate is higher than for those who do not); simulation, where an event or explanation is deemed more likely if it can easily be imagined; and anchoring, where estimated amounts are compared to an initial value from a similar situation (Fiske and Taylor 2007). Ariely (2008) provides a good example of anchoring in his discussion of homebuyers moving to significantly different markets. Homebuyers moving from a market where housing is relatively cheap may end up renting an apartment because they cannot find a house for sale within their expected price range. When moving in the other direction, buyers may end up with extravagant housing for the same reason. In both cases, adjustment of expectations can take several months.

An important factor in determining how people make inter-temporal decisions which is closely related to the anchor heuristic is framing. Framing refers to the manner in which a consumption option is presented (Kahneman and Tversky 1979). Imagine a lottery where each ticket costs $5, and there is a 1% probability of winning $500. If this lottery is presented as described, it is going to sound much more appealing to the average consumer than if we describe it as a 99% probability of losing $5 and a 1% probability of gaining $495, even though we are describing the same lottery. This example shows that the amount of emphasis placed on risk is an important factor in framing. Prospect theory predicts that people tend to be risk averse when considering gains and risk seeking when considering losses. People will choose a certain gain over an uncertain one with a higher expected value and an uncertain loss over a certain one with a lower expected value (Kahneman and Tversky 1979). Gains tend to be discounted more than

losses, meaning that decisions about future gains will tend to be undervalued more than future losses will be underestimated (Fiske and Taylor 2007). If we view delayed receipt of a reward or penalty as a form of risk (for example, you might die before you receive it), then it is consistent with prospect theory that people would prefer smaller immediate rewards over larger delayed ones. The preference for immediate elimination of potential penalties suggests that there are other forces at work. Experimental evidence suggests that the prospect of loss imposes dis-utility, and so people would prefer to avoid having the impending penalty "hanging over their head" (Nyhus and Webley 2006).

A further implication of framing has to do with how consumers change their plans to accommodate new consumption options. One of the assumptions in the DU model is that intertemporal decision makers integrate new consumption options with existing plans. Thus, when offered a new option, a DU decision maker will compare the expected utilities over the relevant time period of the old plan and the new option, and choose whichever is greater. It seems somewhat nonsensical to assume that individuals will perform this sort of calculation every time a new option presents itself (Frederick, Lowenstein, and O'Donoghue 2002). Individuals make decisions using their current state as a reference point. From this tendency, we can see that framing is closely related to the anchoring heuristic. The present state is the anchor value from which other situations are compared and estimated (Fiske and Taylor 2007).

People also generally prefer an increasing utility profile if they can arrange it (Frederick, Lowenstein, and O'Donoghue 2002). This too can be explained by the anchoring heuristic. If we assume that individuals are at least somewhat sophisticated about their preferences, then they know that they will frame their thoughts about their current state in terms of the previous states. Thus, a decreasing utility profile will be less satisfactory than a level one since disutility is

incurred from being less well-off than one was previously. Similarly, given an increasing utility profile, comparisons to previous states will be positive, meaning that an increasing profile is preferable to a level one (Frederick, Lowenstein, and O'Donoghue 2002).

Individuals react quite differently to delays than they do to accelerations of rewards. Generally, they will require much more to accept a delay than they will be willing to pay in order to accelerate receipt (Weber et al. 2007). This bias is another form of the anchoring heuristic where acceleration is viewed as a gain (from the present perspective), and delay is viewed as a loss. Given the lower discount rate for losses, it follows that individuals would demand more for a delay than they would be willing to pay for an acceleration (Nyhus and Webley 2006).

Heuristics are used with greater frequency in situations of high memory load, stress, or other distractions. Leith and Baumeister (1996) showed that a perturbed mood causes individuals to make decisions without fully thinking through their options in a choice of an unlikely high payoff versus a likely low payoff. They ran a series of studies examining choices made by subjects in a variety of emotional states. One notable experiment involved offering subjects a choice between two lotteries. The first gave 70% probability of receiving $2, and the other a 4% of receiving $25.

In both cases, losing the lottery caused the subject to be subjected to "noise stress." The expected payoff from the "long shot" was set intentionally lower than that of the "safe bet" in order to ensure that rational agents would predominantly choose the safer option. Subjects were then split into three categories and subjected to different conditioning methods designed to induce good, neutral, or bad moods depending on which group the subject was in. Those in good moods chose the long shot 40% of the time, while those in bad moods chose it nearly 87% of the time, with those with neutral inducement falling roughly in the middle.

In another experiment, subjects were given a similar choice after being induced to either a neutral or angry mood. In addition to a simple aversive mood condition, some of the angered participants were told to either complete the decision quickly or to consider their decision carefully before choosing. The angered subjects once again chose the long shot significantly more often than neutral subjects, but the responses of the angered subjects told to carefully consider their decision were nearly identical to those of the neutral group. A decision process questionnaire afterward showed that angered subjects considered only the money; while the neutral and thoughtful subjects considered both the payoffs and the odds of receiving them. These results suggest that subjects with limited cognitive resources, whether due to mood or distraction, tend to consider only the desirability of payoffs in a given choice set, and not the likelihood of receiving them.

Similarly, Shiv and Fedorikhin (1999) showed that subjects trying to remember a seven digit number were significantly more likely than subjects trying to remember a two digit number to choose the more initially appealing but less healthy option when given a choice between fruit salad and chocolate cake. This effect is due to the fact that restraint from eating chocolate cake requires active cognition ("I should not eat the cake, it is worse for me in the long run) which is unavailable due to a high mental load (Shiv and Fedorikhin 1999).

From these experiments, we can see that straining cognitive resources can lead to two forms of self-defeating behavior (as defined by Baumeister 2003). The first is unfavorable tradeoffs, defined as making a choice, often between present and future consumption, which is initially appealing but reduces welfare in the long run. The second form consists of counterproductive strategies. Counterproductive strategies occur when the agent chooses an option which they think will improve their welfare but actually decreases it. These strategies are

usually the result of failure to carefully consider the implications of a decision, and obtaining the information that the decision in question is unfavorable involves a cognitive cost (Baumeister 2003). In unfavorable tradeoffs, information is usually readily at hand, but the unfavorable option is chosen because no mental resources are available to exercise self-restraint. The fact that self-restraint must be exercised suggests that there are at least two opposing forces at work in the decision making process (Thaler and Shefrin 1981).

Decision making can be divided into two distinct processes. The first is an initial, more instinctive appraisal of the alternatives presented where heuristics are used to evaluate options. The second process is deliberative and requires time and mental resources; therefore, it will not be initiated in situations of high cognitive load (Shiv, Fedorikhin 1999). "Affect [emotion] based or 'hot' outcomes undergo steeper time discounting than cognition based or 'cool' outcomes" (Fiske and Taylor 2007). In other words, the further away an event is, either temporally or spatially, the more cognitively significant aspects of decisions regarding it are considered, and the less weight is given to emotionally important aspects. A corollary of this effect is that events that are distant from an individual tend to be thought of in abstract terms regarding personal goals (for example, that vacation in Spain will be extremely relaxing, the savings I will have built up for retirement will allow a comfortable lifestyle) whereas events that are closer to the individual will be thought of in terms of the details and logistics of the decision (did I pack everything I needed?, how am I going to pay for groceries and save for retirement?). Thus, decisions that are distant from the individual may be made in one way, but when the event gets nearer, they may be reversed as logistical concerns become more pressing (Fiske and Taylor 2007).

McClure et al. (2004) found that the hot-cool effect may be due to separate parts of the brain making decisions in different ways. In functional Magnetic Resonance Imaging scans, they found that certain areas of the brain (right and left intraparietal cortex, right dorsolateral prefrontal cortex, right ventrolateral prefrontal cortex, and right lateral orbitofrontal cortex) are activated for all decision making. These areas are designated δ (delta) areas after the quasi-hyperbolic model. The ventral striatum, medial orbitofrontal cortex, medial prefrontal cortex, and left posterior hippocampus are also activated for situations where the reward from a decision is immediately available. These areas are designated β (beta) areas. The δ and β areas correspond to the cool and hot systems, respectively. Interestingly, in situations where there is a choice between known and ambiguous risk, the β areas are activated more by the known risk, suggesting an aversion to ambiguity as well as risk aversion. Hsu et al (2005) show that individuals with damage to the medial orbitofrontal cortex are both risk and ambiguity neutral, suggesting that risk aversion lies in the β areas. The hot and cool systems are activated by different external stimuli, thus individuals will express differing attitudes toward intertemporal choice in differing situations. Access to the cool system is reduced by stress, distraction, and, in certain situations, mood (Hsu et al 2005). The growing evidence for multiple forces at work in decision making suggests a need for models which incorporate the idea of multiple agents in the individual decision making process.

III. Dual-self Models

In their influential paper on self-constraint, Thaler and Shefrin (1981) quote Donald McIntosh: “The idea of self-control is paradoxical unless it is assumed that the psyche contains more than one energy system, and that these energy systems have some degree of independence

from one another." This idea is the basis of dual-self models, where the psyche is modeled as having two or more parts, usually in opposition to each other. Thaler and Shefrin (1981) view the consumer as an organization making decisions over many time periods, with many "doers" who only gain utility from one time period, and a planner who gains utility from the doer's collective utility. It is therefore the planner's job to control the myopic doers so that utility over the lifespan of the consumer is maximized. There are two options for doing this, exerting control over the doer's preferences and incentives (at some cognitive cost) or setting behavioral rules limiting the doer's actions (Thaler and Shefrin 1981; Strotz 1955). The advantage of using rules for self-control is that they require little active effort on the part of the planner, but unfortunately, they are not fully appropriate for every situation.

Placing this model in terms of the hot-cool systems, we can view the resources required to control the actions of the doer as efforts on the part of the cool system to restrain the hot system. The lack of access to the hot system in stressful or other cognitively intense situations can be modeled as an immediate need for cognitive resources in areas other than self-control (Nyhus and Webley 2006).

The behavioral rules can be separated into two general categories: precommitment and prohibitions/requirements. A precommitment rule is one that invokes social rules or some other form of enforcement in order to force the individual to behave in a certain way or face negative repercussions. Some examples of precommitments include: promises between individuals, deadlines for homework and papers, and the purchase of illiquid assets in order to prevent one from dipping into savings impulsively. A prohibition or requirement is a self-imposed rule that the individual follows in relevant situations in order to prevent suboptimal long-term behavior. Examples include regulating oneself to a healthy daily routine such as exercising every morning,

or putting a certain percentage of one's income into a retirement account with every paycheck (Brocas, Dewatripont, and Carrillo 2004).

Prohibitions are more flexible than precommitments due to the fact that they do not require an external enforcement source. However, they are much more costly to begin and maintain. When they are initially self-imposed, there is a training period where the rule is not a habit. Brocas, Dewatripont, and Carrillo (2004) describe the process of habit formation as a form of self-reputation. If there is a previous trend of behavior following the rule, then it is reasonably easy to continue following the rule. Without this base to work from, each instance is akin to exercising non-rule based self-control and requires mental effort to maintain until the rule has been established (Nyhus and Webley 2006). Thus, in the situations where they are feasible, a precommitment strategy is often optimal unless flexibility is a concern. Precommitment is most likely to be seen among individuals who are sufficiently sophisticated about their preferences to know that they will make non-optimal decisions in the future unless prevented from doing so (Frederick, Lowenstein, and O'Donoghue 2002).

We saw from Rae that intertemporal choice is the result of interplay between numerous, often conflicting psychological factors. Evidence presented here suggests that individuals tend to be risk averse in the face of uncertainty, use rules of thumb when trying to be parsimonious with their cognitive resources, and that they fail to consider their actions carefully when distracted or perturbed. The implication of these findings is that decisions made under mental strain tend to differ from those made with all mental faculties fully available. One of the most notable differences is that emotionally appealing consumption becomes more difficult to defer when cognitive resources are strained, which increases the effective discount rate.

Standard economic models for intertemporal choice condense these factors influencing

choice of consumption into a single discount rate. Assuming one knows the consumer's discount rate, it is then possible to compare the value that consumer places on consumption at some point in the future with consumption at any other time. The first model to adopt this method was Samuelson's concept of exponential discounting, but even Samuelson had doubts about this model's validity. Experimental and theoretical evidence refuting exponential discounting led to the development of alternative models. Some examples include the hyperbolic discount function, which takes into account the diminishing discount rate as the delay of consumption increases, or the quasi-hyperbolic function, which has one discount rate for comparing two future prospects, and one for delaying immediate prospects.

The problem with trying to condense discounting into a single rate is that this fails to take into account all of the psychological factors mentioned previously, which can lead to divergence between the predictions of the model and actual behavior. Some models try to account for this, Thaler and Shefrin's dual-self model accounts for rules of thumb, many myopic decisions, and differences in behavior under stressful conditions. There is even neurological evidence supporting the dual-self model of the psyche, and linking the dual-self model to that of the quasi-hyperbolic function. The downside to Thaler and Shefrin's model is that it is quite general, so it is difficult to use in order to make specific predictions. We attempt to resolve this dilemma in the next section.

IV. Modeling Distraction and Intertemporal Choice

For the purposes of our research, we use Fudenberg and Levine's extension of Thaler and Shefrin's model, paying particular attention to their "Simple Savings Model" (2006). The advantage of this model is that it makes more specific predictions than the Thaler and Shefrin

model, while retaining its explanatory power regarding psychological factors key to understanding intertemporal choice, particularly when it comes to discussion the effect of cognitive load on intertemporal decisions.

The consumer being modeled is making decisions over infinite time periods. In the initial time period (t_0), the consumer has a wealth endowment of y_0 and no income aside from interest earned on saved wealth. Letting R be the interest rate and *a* be the percentage of income saved, this means that wealth in time t is given by

$$y_t = Ra_{t-1}y_{t-1} \qquad \text{(Equation 4)}$$

The doer for time t only cares about consumption in time t, and we assume diminishing marginal utility, therefore we assign a logarithmic utility function to the doer based on the percentage of wealth consumed during the relevant time period. Since the percentage of wealth consumed is (1-a), the doer's utility from consumption is given by:

$$u(y,a) = \ln[(1-a)y_t] \qquad \text{(Equation 5)}$$

$$\text{where we define } \ln(0) = -\infty$$

We define the cost of self-control as the difference between the utility if no restraint is exercised ($\ln(y)$) and the utility if restraint is exercised ($\ln\big((1-a)y\big)$). The doer wants to consume all wealth in time t, so the cost function is defined as:

$$C(y,a) = \gamma[\ln(y) - \ln\big((1-a)y\big)] \qquad \text{(Equation 6)}$$

$$= \gamma[\ln(y) - \ln\big((1-a)\big) - \ln(y)]$$

$$= -\gamma \ln(1-a)$$

$$Where\ \gamma > 0\ represents\ the\ difficulty\ of\ self\ control$$

γ is where we take factors such as distraction, mood, or other forms of high cognitive load into account.

Since an increase in self-restraint means an increase in a, we can take the partial derivative with regard to a:

$$\frac{\partial(-\gamma \ln(1-a))}{\partial a} = -\gamma \left(-\frac{1}{1-a}\right) = \frac{\gamma}{1-a} \qquad \text{(Equation 7)}$$

Which will increase as a increases, and will always be positive since a is a proportion less than 1, thus the cost of self-control will always be positive.

The planner's utility is the sum of the present values of the doer's utilities for all *n* time periods being considered. Thus we will have a discount rate θ representing the time preference of the planner. The doer's utility in each time period will be the utility derived from consumption ($\ln[(1-a)y_t]$ from equation 5) minus the cost of self-control [$(-\gamma \ln(1-a)$ from equation (6)]. Using basic properties of logarithms we see that this gives us

$$u_c = \ln\big((1-a)y_t\big) - (-\gamma \ln(1-a)) \qquad \text{(Equation 8)}$$

Eliminating the double negative

$$= [(\ln(1-a)\, y_t) + \gamma \ln(1-a)]$$

We then use properties of logarithms to separate out $\ln(y_t)$

$$= \ln(1-a) + \ln(y_t) + \gamma \ln(1-a)$$

And so the planner's utility will be given by

$$u_p = \textstyle\sum_{t=0}^{\infty} \theta^t [\ln(1-a) + \ln(y_t) + \gamma \ln(1-a)] \qquad \text{(Equation 9)}$$

Consolidating the ln(1-*a*)'s, we get

$$= \sum_{t=0}^{\infty} \theta^t [(1+\gamma)\ln(1-a) + \ln(y_t)]$$

We can then add and subtract $\gamma \ln(y_t)$

$$= \sum_{t=0}^{\infty} \theta^t[(1+\gamma)\ln(1-a) + \ln(y_t) + \gamma\ln(y_t) - \gamma\ln(y_t)]$$

Note that $\ln(y_t) + \gamma\ln(y_t) = (1+\gamma)\ln(y_t)$ and so we can consolidate terms

$$= \sum_{t=0}^{\infty} \theta^t\left[(1+\gamma)\ln\left((1-a)y_t\right) - \gamma\ln(y_t)\right] \qquad \text{(Equation 10)}$$

But the planner must maximize this equation according to our wealth function in (4). Additionally, Fudenberg and Levine show that planner utility is maximized with a constant savings rate. If the savings rate is constant in each period, then we have that $y_t = (Ra)^t y_1$, and so making the substitution into the planners utility function

$$= \sum_{t=0}^{\infty} \theta^t[(1+\gamma)(\ln(1-a) + \ln((Ra)^t\, y_1)) - \gamma\ln((Ra)^t\, y_1)]$$

We can separate this out using basic logarithm properties into a new equation.

$$= \sum_{t=0}^{\infty} \theta^t[(1+\gamma)\ln(1-a) + t * \ln(Ra)\ + \ln(y_1) - \gamma(t * \ln(Ra)\ + \ln(y_1))]$$

Using the formula for convergence of a geometric series and the fact that $\theta < 1$ we can simplify this to

$$\frac{(1+\gamma)\ln(1-a)+\ln(y_1)}{1-\theta} + \frac{\theta\ln(Ra)}{(1-\theta)^2} \qquad \text{(Equation 11)}$$

Applying the first order conditions for maximization and solving for a we get

$$a = \frac{\theta}{1+\gamma-\theta\gamma}$$

See Appendix 2 for details.

Since γ is our stand in for difficulty in self control, we can set distraction as one of its determinants, making $\gamma = f(\varepsilon,\mu)$. Here we substitute $\gamma = \mu + \varepsilon$ here μ is the distraction element and

ϵ represents all other impediments to self-control. This substitution is arbitrary and we could just as easily substitute the product $\gamma = \mu * \varepsilon$ should we desire to do so.

Thus our optimal savings rate becomes

$$a = \frac{\theta}{1 + \mu + \varepsilon - \theta(\mu + \varepsilon)}$$

We distribute θ, and then consolidate the μ and ε terms

$$= \frac{\theta}{1 + \mu + \varepsilon - \theta\mu + \theta\varepsilon}$$

$$= \frac{\theta}{1 + (1 - \theta)\mu + (1 - \theta)\varepsilon}$$

Consolidating the (1-θ) terms

$$a = \frac{\theta}{1+(1-\theta)(\mu+\varepsilon)} \qquad \text{(Equation 12)}$$

Since θ is always less than one, an increase in distraction will decrease the optimal savings rate from the viewpoint of utility. Thus, we would expect that in cases where the agent's attention is divided, the cost of delaying gratification to the planner will be increased, and so the level of income saved will decrease.

Predictions based on a model are interesting, but they require empirical evidence to back them up. Thus, we sought to design an experiment to test the effects of divided attention on financial decision making. Since this model has factors such as distraction levels which are difficult to measure at best, we based our experiment on previous work, and then decided to see how we use that work to test the explicit predictions of our model. With the exception of its reward structure, Shiv and Fedorhikin's experiment was almost exactly focused on the effects of cognitive load on ability to delay gratification. Therefore we decided to use their work as a rigorous basis for some of the empirical predictions made.

V. Experimental Design

Since the experimental method follows that of Shiv and Fedorhikin's experiment (1999), it is necessary to offer a brief summary of their method. The following description is a condensed version of that in Shiv and Fedorhikin (1999):

Recruits for the experiment were informed that the experiment was testing the effects of a change in environment on consumers' memories for information and that they would be asked to go to another room as part of the experiment. They would be given either a two or seven digit number to memorize depending on whether they were in the low cognition or high cognition group. After instructions had been read to participants, they were asked to leave the room one at a time. Each one was given a number to memorize as they left the room and a sheet of paper with instructions on how to get to the next room. Participants were then instructed to walk over to a cart that was visible from the first room. They were informed that there would be two snacks on display on this cart. They were told to select a ticket for the snack they wished to have, and then proceed to the second room. As discussed above, the choice of snack was between emotionally appealing, but unhealthy chocolate cake, or less appealing but healthier fruit salad. Participants who memorized the seven digit number were much more likely to choose the chocolate cake than those memorizing the two digit number.

The purpose of our experiment was to test the effects of distraction on intertemporal preferences as an extension of the work done by Shiv and Fedorhikin (1999). As predicted by our model, the general hypothesis was that the treatment group would exhibit an increased tendency to discount future consumption. The design of the experiment was primarily derived from those of Shiv and Fedorhikin and Weber et al (2007). The goal was to offer a binary choice similar to that of Shiv & Fedorhikin, but offering a choice of financial incentives comparing ability to defer

gratification with differing cognitive loads rather than a choice of dietary options. The deceptive format used by Shiv and Fedorhikin was deemed both impractical and unnecessary, as offering a financial choice without making its experimental nature obvious would have been excessively difficult. Additionally, the role of intertemporal choice is often obvious in real-life financial situations, and so deceiving subjects as to the nature of the experiment could have decreased the resemblance of the decision to those encountered outside of experimental settings rather than increasing it. Since much of the experimental literature uses survey based experiments (e.g. Leith and Baumeister 1996, Weber et al 2007), a computer based questionnaire format was used for the experiment. Given that the format was changed from Shiv and Fedorhikin, a new form of distraction was needed as well. The researchers decided that subjects would be interrupted intermittently during the survey to solve one to two digit addition or subtraction problems. The cue to solve these problems would be signaled by a beep delivered through earbuds. Once given, participants had 20 seconds to solve each problem. Failure to complete the problem correctly within the time limit led to a $0.25 deduction from subjects' participation payments (see participants below).

The purpose of the beep was twofold. First, since there was a financial consequence for failure to correctly answer a question, a clear indication that it was necessary to do so was needed. Second, the beep interrupted subject's thought processes and so increased the distraction under treatment conditions. The beep and arithmetic questions were a part of the survey program (see the materials section below). The volume of the beep was calibrated to be as disruptive as possible without being painful for the participants.

The survey questions were a mix between qualitative and quantitative choices. The quantitative questions consisted of a choice titration similar to that performed by Weber et al.

(2007) and a binary reward choice. A choice titration asks subjects how much they would demand to be compensated in order to accept delay of an otherwise immediate reward, or how much they would be willing to pay to accelerate receiving an otherwise delayed reward. The purpose of this exercise is to elicit discount rates. Given the neurological evidence presented by McClure at al, as well as its close relation with the dual-self model, the quasi-hyperbolic discounting $\beta\delta^t$ functional form was used when modeling the discount rates. For our choice titration, participants were asked two series of questions. The first asked them to state the amount they would demand to delay receipt of a reward of $100 for various time periods. These questions are referred to as delay questions. The second asked for the amount they would be willing to pay to immediately receive $100 if it would otherwise be received some period of time later. These are referred to as acceleration questions. As theorized by Nyhus and Webley (2006) and noted by Weber et al (2007), the expectation is that the discount rate for the questions about hypothetical delays will be significantly greater (lower β in our quasi-hyperbolic discounting form) than the questions regarding acceleration of rewards. From this we build our first quantitative hypothesis:

H_1: The delay questions will elicit a higher discount rate than the acceleration questions

From our model, we expect future consumption to be devalued more under situations of high cognitive load, so the treatment group should exhibit greater discounting tendencies than the control group. However, Shiv and Fedorhikin (1999) and McClure et al (2004) both showed that the mechanism by which distraction interferes with emotional choice is based on inability to resist the emotional appeal of immediate consumption. This concept fits with our model; given that the doer cares only about current consumption, reduced ability to control the doer should not affect ability to plan delays in the future. However, since the planner's ability to control is

diminished, the agent will seek out immediate gratification which is appealing to the doer. In other words, the δ values should be roughly equal between groups, but β values should be lower in the treatment group. From this we derive two more hypotheses

H_2: The β values in the treatment group will be lower than those in the control group

H_3: The δ values between the two groups will be roughly equal.

In order to justify offering a financial incentive for the binary choice, the delayed option needed to be sufficiently large to be considered significant despite being received some time in the future. Bolle (1988) argued that a large uncertain reward can be substituted for a smaller certain one in experimental cases where there are no decision costs. Thus, a relatively large value of $50 was chosen for the delayed option, but only one randomly selected participant from each group would actually receive the reward.

Participants were split into four groups. For the first two groups, the lottery consisted of a choice between a large reward of $50 delayed by one month, and a smaller reward of $25 delayed by one week. For the second two, the lottery consisted of a choice between a large reward of $50 delayed by one month, and a smaller reward of $25 immediately. This division tested the hyperbolic prediction that immediate consumption is more difficult to defer than consumption which is already delayed. With each pair of groups, one took the survey under the treatment condition, and the other was a control group which only had the survey questions. The only question which differed between the long-delay/short-delay and delay/immediate groups was the lottery choice, and so the two control groups and two treatment groups shall be referred to as the "control" group and the "treatment" group unless we are discussing the lottery results.

The probabilities given (1/15 versus 14/15) are the probabilities of an individual

participant receiving the reward had the researcher's recruitment goals been reached. The goal was to have 15 participants per session. The actual number of recruits per session was somewhat less, and so the actual probabilities of winning varied between 1/9 and 1/14. The larger potential reward given to each group was $50 with a one month delay. The long-delay/short-delay group had the option of choosing $25 to be received in one week instead. The delay/immediate group had the option of choosing $25 immediately. However their choice of relatively immediate versus delayed reward had to be made before they knew whether or not they had won.

The value of $25 for the immediate reward was made through comparison to other work done in the literature. The aim was to provide participants options which would yield equivalent utility when they were choosing delayed or immediate gratification. The majority of experimental papers read did not assume any particular discount function, instead they compared present to future valuation by calculating a ratio of present to future valuation (see Weber et al (2007) for an example). The papers considered actual rather than hypothetical rewards whose values lay between $40 and $75. The discount factors tended to range from 0.4 to 0.6 with a slight tendency to be closer to 0.6. The time frames varied from one to three months. From this evidence, it was anticipated that papers in the literature payoffs which assumed a particular discounting function would yield discounting rates giving a present value between 0.4*50 = $20 and 0.6*50= $30 for $50 to be received in one month.

We compared the results of three papers that used the quasi-hyperbolic format: Laibson, Repetto, and Tobacman (2004); Benhabib, Bisin, and Schotter (2007); and Chabris et al (2008). Laibson led a study which inferred β and δ from field behavior. This gave $\beta = 0.70$ and $\delta = 0.95$. The other two papers which each gave multiple examples whose β values were close to 0.7, had δ values ranging from 0.58 to 0.91. The difference in the immediate reward which

results from these varying δ's is minimal, with calculated present values for $50 in one month ranging from $15-$16 (using a logarithmic utility function). This value seemed low to the researchers, especially compared to the values derived from present to future valuation ratios. Since the ratios did not assume a particular discounting function, more credence was given to their results, and so $25 was chosen as it lies roughly midway between the ranges the values of $20-$30, and it seemed appropriate to the researchers.

The hypotheses for the binary choice are as follows:

H_4: Subjects in the long delay/short delay groups will choose the immediate and delayed gratification options in roughly the same proportions whether they are filling out the survey under the control or treatment conditions.

H_5: Subjects in the treatment section of the immediate/delay group will choose the immediate gratification option more often than those in the control section

The primary purpose of the qualitative questions was to provide a more difficult task for subjects to complete during the survey in order to allow the treatment group more time to be affected by the distraction condition, however, it was expected that they would yield some useful information as well. The qualitative questions were split into two series. The first section asked participants what decisions they would make in a hypothetical situation, and to then state the reasoning for that decision. The purpose of these questions was to see if subjects would use different reasoning under the distraction condition. The second asked them to list five behavioral rules they follow to aid self-control. Given that the experiments run by Leith and Baumeister (1996) showed that variation in decision making under different mental states was due at least in part to subjects using different decision making processes, we expect that any differences in responses to qualitative questions regarding decision processes will show a similar difference in

reasoning. This leads to our first qualitative hypothesis:

H_6: The reasoning used in the first set of qualitative questions will vary distinctly between the control and treatment groups

The reasoning for the questions regarding rules is to see whether different rules come to mind under cognitively taxing situations than in relatively free ones. If there is a difference, this suggests that only certain types of prohibitions or requirements as described by Thaler and Shefrin (1981) will be effective without an external enforcement mechanism, thus further narrowing the scope for internally enforced rules over and above restrictions already noted by Nyhus and Webley (2006).

Leith and Baumeister (1996) and Fiske and Taylor (2007) both emphasize the importance of salience when it comes to decision making. Thus, a difference in the types of rules listed would suggest that cognitive load increases the salience of certain situations, and thus rules governing behavior in those situations. Thus those rules would pertain more to the activities restricted by prohibitions or requirements which are salient under high cognitive load. This leads to our second qualitative hypothesis:

H_7: The rules given by the treatment group will restrict or prohibit different activities than those given by the control group.

The context dependent nature of rules means that conclusions from this section will not be strong indicators differences in non-experimental situations, and so results this section should be viewed as suggesting further avenues of research rather than demonstrative evidence of any effect.

VI. Participants

The effectiveness of students in demonstrating market principles has been shown in a variety of contexts (Davis and Holt 1992). Random selection of students from the student population at the researchers' institution was deemed difficult at best. Therefore, once approval was granted by the Institutional Review Board, at the institution in question (The College of Saint Benedict and Saint John's University), recruitment was done through a series of emails sent to the student body. The experiment was split into four sessions, one for each group. The emails listed the times when each session would be held and asked recruits to state which session they could attend, after which the researcher would assign them to a session. There were not enough recruits to assign sessions randomly without risking disproportionate sample sizes for the various groups. Therefore the primary concern was to keep the number of participants in each session as close to equal as possible within the limitations of recruits' stated availability. A participation payment in the form of a small gift card of up to $5 (depending on how many arithmetic questions were answered incorrectly) was offered to encourage participants to show up on time, and to take the experiment seriously (Davis and Holt 1992). Additionally, the lottery at the end of the experiment offered the potential for a larger reward. Out of 56 recruits, a total of 45 participated and 11 failed to come to the experiment. The control group comprised 20 control subjects with a distribution of 9 and 13 in the long delay/short delay and delay/immediate groups There were 25 treatment subjects, with a respective distribution of 11 and 12 for the long delay/short delay and delay/immediate groups. The gender distribution was 27 female and 18 male. There were 10 first-year students, 10 sophomores, 12 juniors, and 13 seniors.

Materials

The experiment was held in an academic computer lab in one of the classroom buildings at the researchers' institution. Instructions, a consent form, and, in the treatment sessions, earbuds were placed by various computers in the lab so as to seat subjects with as much distance between computers as the experimental space would allow. Earbuds were not present in the control sessions. A survey program was created specifically for this experiment. The program was placed on a section of an Introductory Economics course at the researchers' institutional Moodle site. Participants were added to this course, but could only see the sections relevant to their session during the experiment. This method of delivering the survey kept all data from the research subjects to ensure confidentiality of the data within the control of the faculty member advising this research. The classroom contained a data projector, which the researchers used to demonstrate each step of the experiment as they read through the instructions with participants.

VII. Procedure

Participants signed in upon arrival in the room and were then seated at one of the prepared computers. As the experiment began, one of the researchers would read through the consent form with participants who were then asked to sign the form, after which the researcher would collect the forms and then read through the experimental instructions. Once they had finished reading through the instructions, participants were invited to begin the experiment. In the control groups, all subjects were asked to wear their earbuds at this point. No specific explanation was offered for the math problems or the earbuds, although the distraction element was clearly present in the title of the consent form. Participants downloaded the survey program to their accounts on the school's network. They were given as much time as needed to complete

the survey, and the researchers would come by to answer any questions participants had during the experiment. Once they finished the survey, participants uploaded the results to the Moodle course from which they downloaded the survey program. After all participants finished the survey, the winner of the lottery was selected using a random number generator. Following the selection of the winner, there would be a short debriefing explaining the purpose of the research and allowing for any final questions. Participants were allowed to leave after the debriefing was completed.

VIII. Results

Choice Titration

For each subject, the titration responses were ordered from smallest hypothetical delay to the largest. Delays were then all renamed in terms of the number of days (e.g. 1 year became 365 days). We then divided the future value of each data point by the present value in order to conform to our regression equation and then ran Ordinary Least Squares (OLS) regressions on each subject's delay and acceleration responses in order to estimate β and δ values for each subject. For the acceleration questions participants were given a future value of $100 and asked how much they would be willing to pay to accelerate receipt of the reward. The present value was calculated by subtracting the stated amount that subjects said they would be willing to pay from $100. For the delay questions participants were asked to give future values such that the present value would be equivalent to $100. Dividing 100 by these values should give the proportion of future to present valuation, and so the calculations of future values for the delay questions used the formula

$$FV = (100) * \left(\frac{100}{100 + stated\ amount}\right)$$

An OLS regression uses statistical techniques to estimate the coefficients and fit of a theorized relationship between two or more variables; note that the variables themselves need not be linear, only the coefficients. Fit is estimated using a statistic known as the Pearson's R^2. R^2 values range between 0 and 1, with 1 indicating a perfect correlation between the estimates and the data. The lowest R^2 among our regressions was 0.71, and the average was 0.86, indicating a reasonably good fit between the theorized relationship and actual data.

Using the responses from the choice titration questions, we ran a log-log OLS regression on the results to estimate quasi-hyperbolic discount rates for each participant using the following equation:

$$\ln\left(\frac{future\ value}{present\ value}\right) = \ln\left(\frac{(\beta\delta^t)PV}{PV}\right) = \ln(\beta\delta^t) = \ln(\beta) + \ln(\delta) * t \quad \text{(Equation 13)}$$

These are the β and δ values from the quasi-hyperbolic discounting function, which assumes that future value is equal to present value times the discount function, we can made the appropriate substitution, cancelled out present value, and the rest of the derivation followed from properties of logarithms.

Log-log regressions are used when the coefficients in the equation to be estimated are related through a product rather than a sum (Studenmund 2010). Using the quasi-hyperbolic discount function as an example, note that the form $\beta\delta^t$ is a product of the two coefficients we wish to estimate. However if we take the log of this function, then note that

$$\ln(\beta\delta^t) = \ln(\beta) + \ln(\delta^t) = \ln(\beta) + t * \ln(\delta) \quad \text{(Equation 14)}$$

This then yields a regressable linear equation. Our reasoning for the left hand side of the equation is that the future value of any consumption option is the present value of that option

multiplied by a discount function, and thus dividing the future value by the present value for each data point will yield the value of the discount function for that data point as in Equation 13. However in order to maintain the validity of the OLS regression, we had to take the log of each quotient before regressing the data points for each subject, which gave us an estimated discount function for each subject.

To test for differences between the control and treatment groups, we ran two sample t-tests using the Minitab 16.1 statistical package on the β and δ values. A two sample t-test uses an important finding from statistics that the average of sufficiently large sample taken from a given population will vary according to a specific mathematical function. Thus we can estimate the probability that two samples come from the same distribution given the difference between their averages. In the case of our test, this means that we are computing the probability of obtaining the results we had from our experiment if distraction had no effect on responses to the questions.

The results are given in Tables 1 and 2. The p-value in each test indicates the probability that the samples come from the same distribution. The lower the p-value, the less likely it is that the distraction condition had no effect. A result is said to be statistically significant at the X level if the p-value is less than or equal to X. There is room for interpretation as to what significance level represents a conclusive difference, but a p-value of less than 0.1 is usually considered relatively strong, although 0.05 is more standard. For the purposes of our test we will be using the 0.1 level. Thus, if the p-value is less than 0.1 we will say that the result is statistically significant.

Table 1: Choice titration t-tests (β values)

	Delay		Acceleration	
	Control	Treatment	Control	Treatment
β	0.9232	0.9026	0.9885	0.9775
Std. Dev	0.0519	0.0597	0.0222	0.0145
Pooled Std. Dev	0.0557423		0.01817212	
t-value	-1.24		-1.9	
p-value	0.222		0.066	
Cohen's d	.37		.61	

Table 2: Choice titration t-tests (δ values)

	Delay		Acceleration	
	Control	Treatment	Control	Treatment
δ	0.998444	0.99845	0.99962	0.999561
Std. Dev	0.000793	0.00156	0.000434	0.000561
Pooled Std. Dev	0.0012645		0.00050156	
t-value	-0.02		0.39	
p-value	0.981		0.697	
Cohen's d	.00		-.12	

The mean for the control group delay βs was 0.9232, and the test group had 0.9026, the t – value was -1.24. The p-value for the delay β levels was 0.22. While this value is not statistically significant, it is fairly low. More significantly, the effect size for the β levels as measured by Cohen's d was 0.37. The effect size for the δ levels was essentially 0. Cohen's d is a method of

comparing statistically insignificant results. It is defined as the difference of the two sample means divided by their pooled standard deviation. The higher the d value, the more likely it is that there is a difference between groups which the statistical test failed to catch. It is useful here because it allows us to find trends in the data which may not be immediately apparent or significant due to small sample sizes. d values are dependent upon sample size as well as strength of effect, and so all of the d values discussed here will be relatively low. Small d's are those less than 0.3, and large d's are those greater than 0.8. This puts 0.37 at the low end of a medium effect, suggestive of a trend, but not conclusive. The δ values showed little to no difference.

The mean for the control group acceleration β's was 0.9885, and the test group had 0.9775, the t –value was -1.9. The p-value for the delay β levels was 0.066, as statistically significant result. As expected, delays were discounted significantly more than accelerations. None of the δ values were different to a statistically significant degree; however, the difference in acceleration β levels was statistically significant. With a p value of 0.066 and a d value of 0.61, this is fairly strong evidence that the experimental condition affected responses to the acceleration questions. Statistical significance is our metric for concluding whether or not the experiment had an effect, however a it is entirely plausible that we could have gotten a result with a p-value of 0.066 by chance, and so further work must be done before this result is considered a strong one.

These results suggest that distraction has an effect on discount rates, but not after the initial period. In other words, this evidence suggests that distraction levels do not affect agent's ability to delay gratification when considering future consumption, but are more easily tempted to behave myopically when trying to defer a reward that is immediately available. These trends

fit well with both the literature and our hypotheses. We did not use a decision process survey like that of Leith and Baumeister (1996) but the findings of both Shiv and Fedorhikin and McClure et al suggest trends like those seen in the data. Not only that, but we also had much more discounting in the delay questions than the acceleration questions, which fits with the predictions of Nyhus and Webley (2006) Weber et al (2007).

Binary Choice of Lottery

Two sample binomial tests were used to compare the choices between groups. Two sample binomials are similar to t-tests in that they calculate the probability of obtaining the results given in the data if the two samples come from the same distribution. They differ in that they are calculating the probability of a "success" in a given distribution, rather than comparing sample means. Here, a "success" means choosing the delayed reward. The binary nature of the data in the lottery makes the binomial test an ideal fit. We chose this test because it was the one employed by Shiv and Fedorhikin while analyzing their data (1999).

In this test, the relatively small sample sizes, and the fact that only four subjects chose the more immediate reward, indicate that conclusions drawn from statistical inference may not be particularly strong. The disproportionate choice of the delayed reward suggests that the immediate reward was set too low, and so a value closer to $30 may have been more appropriate. The test for the short-delay/long-delay group had a p value of 0.768, whereas the delay/immediate group had a p value of 0.296

While neither difference was statistically significant, the difference between the immediate/delay groups had a narrower confidence interval than that of the long-delay/short-delay groups. This correlates well with the fact that the β levels differed between the control and

treatment groups in the choice titration, while the δ levels were roughly equivalent, however given the overwhelming choice of the delayed lottery, the difference in result cannot be viewed as anything besides the weakest of trends.

There are a number of possible reasons for the disproportionate preference for the delayed reward. Given that all of the qualitative questions at the beginning of the survey had an intertemporal component, there might have been a framing effect causing subjects to choose the delayed option. Alternately, the immediate reward may have been too small, this would mean that $50 in a month gives more utility than $25 immediately or in a week, which could have overwhelmed the experimental effect.

Qualitative Questions

Among the qualitative questions, the only quality which showed a strong tendency to appear in only one group was for the members of the control group to list rules requiring them to consider situations carefully before acting. There were a number of slight differences between groups, but no other disparities that were prevalent enough to be considered convincing evidence of distraction affecting the subjects' responses. Among these differences: the control group exhibited a slightly greater tendency to cite long term goals such as weight loss, career goals, or retirement than the treatment group. For example, a typical control group response was "I eat small meals spread throughout the day in order to keep myself from eating a lot at one time." Whereas a more typical response from the treatment group would be "Don't spend money that you haven't yet earned, you don't want to one day end up in severe debt." In addition to having more misspellings and grammatical errors, the treatment group's reasoning and behavioral rules had a greater tendency to be aimed at avoiding risks than did that of the control group. A more detailed analysis of the reasoning and hypothetical choice questions can be found in Appendix 1,

but for now we will focus on the behavioral rules question set.

This series of questions asked participants to list five rules that they use to regulate their behavior. The rules in this section were almost universally prohibitions or requirements, although a few subjects listed what we could call self-imposed external enforcement where they would force themselves to forgo some pleasurable activity, or to undertake a necessary but unpleasurable one such as exercise whenever they broke a prohibition or requirement they had placed upon themselves. Most subjects mentioned completing their homework, limiting alcohol consumption, and enforcing exercise regimens.

The most common types of rules cited by the control group can be divided into two categories: daily regimens e.g. “I make myself do my daily work immediately after my classes are done for the day so I do not put it off.”, or pledges to consider actions carefully before undertaking them e.g. “I evaluate how these actions are following my mode of conduct, and evaluate the authenticity of my actions”. Prohibitions tended to be of a limiting nature rather than completely precluding activities, e.g. “During the week if I choose to have a drink, I can only have one.”

In contrast, the treatment group’s rules tended to proscribe rather than limit behavior. Variations on “I do not drink alcohol” were especially common. There were few rules which mentioned careful consideration of situations before action. This response is reminiscent of the work done by Leith and Baumeister (1996) suggesting that many of the differences in self-control between individuals at differing levels of cognitive load stem from failure to consider actions carefully when distracted. Note that aside from the lack of requirements to think before acting in the treatment group, all of these tendencies are noted from slight predominance in one group over the other. There were many in the treatment group who listed limitations on behavior

and daily regimens. It is therefore highly probable that the only real difference is level of consideration. This conclusion is further supported by the fact that there is little evidence in the literature to suggest that high cognitive load would lead to increased tendency to proscribe, rather than limit, behavior.

The similarity of choices made in both groups may have been an effect of the experiment whereby participation in a survey gives an implicit, though perhaps not consciously perceived, suggestion to the subject as to which answer to give. This experimental effect may also have been the reason that subjects primarily chose the delayed reward in the lottery results.

It is also worth noting that all of the situations in the qualitative questions were hypothetical, and so there would have been no emotional response to engage McClure et al's β regions in the brain. Other evidence from this survey and the literature suggests that the δ regions' ability to make decisions is not impaired by cognitive load

IX. Discussion and Future Research

We have seen strong support in the literature for the idea that high cognitive load impairs ability to exercise self-control. From the psychological standpoint, we see increased use of heuristics and undue emphasis on the total, as opposed to expected, reward when deciding between consumption options. From the fields of economics and neuroeconomics, we have several models supporting this hypothesis, as well as experimental evidence, and neurological evidence suggesting that how available consumption prospects are changes which areas of the brain are used in decision making. We had 7 hypotheses for our experiment based on results from the literature. Of these, we found little support for two, trends favoring three, and moderate support for two.

H_1:
The delay questions will elicit a higher discount rate than the acceleration questions

A two sample t-test run on the beta and delta values yields differences with p-values that are essentially 0 (t= -5.94 and t = -6.87 respectively). This fits with the predictions of Nyhus and Webley (2006) and the results of Weber et al (2007).

H_2:
The β values in the treatment group will be lower than those in the control group

The acceleration questions showed a statistically significant difference, ($P<0.1$) and there was an effect size suggestive of a trend in the delay questions (d = .37). While a d value of .37 is at the low end of medium effect sizes are also dependent on sample size, and given the relatively small size of our sample, it is not surprising that we did not see a large d value here. These results are not strong enough to be conclusive, but they do provide justification for further research, especially given that the titration questions were largely hypothetical.

H_3: The δ values between the two groups will be roughly equal.

We found strong support for this hypothesis in both the acceleration and delay questions (p = .697 and p = .981 respectively). This supports the quasi-hyperbolic model, and provides some evidence for the dual-self models, as one of the predictions was that consideration of future decisions would be unaffected by distraction.

H_4:
Subjects in the long delay/short delay groups will choose the immediate and delayed gratification options in roughly the same proportions whether they are filling out the survey under the control or treatment conditions.

We had strong statistical evidence supporting this hypothesis (p = .768). However, the small sample size, combined with an unexpectedly high proportion of subjects choosing the delayed lottery means that there were probably other factors influencing decisions in this exercise. Future work will probably need a larger sample size, as well as a larger immediate reward. We may even cut out the long-delay/short-delay distinction altogether.

H_5: Subjects in the treatment section of the immediate/delay group will choose the immediate gratification option more often than those in the control section

We found no support for this hypothesis. While the p value (.296) was lower than that for the long-delay/short-delay group, the actual difference in choices was sufficiently small (only four subjects out of the whole sample chose the delayed reward) that we need to redesign and rerun the experiment before we can come to any conclusions about our binary choice questions.

H_6:
The reasoning used in the first set of qualitative questions will vary distinctly between the control and treatment groups

The members of the control group showed a tendency to remind themselves to consider actions carefully before undertaking them. This fits well with the findings of Leith and Baumeister (2006) where experimental subjects who were told to consider decisions carefully made roughly the same choices across groups. It is worth noting that there was a slight propensity in the treatment group for risk avoidance, but it was sufficiently weak that it could easily be due to random variation.

H_7:
The rules given by the treatment group will restrict or prohibit different activities than those given by the control group.

The members of the control group once again showed a tendency to think of long term goals, and to remind themselves to consider actions before undertaking them. This actually supports the effectiveness of internally enforced rules While the treatment group showed a small propensity to give risk avoidance as the reasoning behind their rules, it was not strong enough to be considered evidence of a difference.

Conclusions, Limitations, and Future Research

Given the limitations of sample size, it is not surprising that only one test showed a statistically significant difference between the control and treatment groups. On the other hand, the effect sizes were relatively high considering the size of sample, and while statistically insignificant, the p-values in the tests comparing computed choice titration β values were relatively low. This evidence suggests that distraction had some effect on the "β" conditions in the subject's discounting behaviors. Put in terms of the model, the evidence suggests that distraction limits the ability of the planner to restrain the doer. This is further supported by the fact that the one notable difference in the qualitative data fit quite well with the results of Leith and Baumeister (1996) whose results also showed evidence for a connection between high cognitive load and inability to delay gratification.

Limited recruitment capabilities meant that it was not possible to select or assign participants randomly. The experiment was held on a weekend in order to have as wide a variety of students available as possible, but the design of the experiment means that self-selection into various sessions also meant self-selection into various groups. The order of the treatment and control sessions was reversed on the second day in an attempt to minimize the effect of this

constraint. The fact remains that subjects were not randomly assigned, which means that participants in each group may have traits in common that participants in another group do not have. If this is the case, then the results of this experiment may be biased, though it is impossible to tell by how much. Non-random assignment means that any one of the conclusions may be due to some exogenous factor caused by self-selection into a particular experimental session. It may be that people with a tendency to consider actions carefully, and whose discount rates are slightly lower than average, would tend to pick the times during which the control sessions were run. Thus all conclusions from this experiment must be viewed with a modicum of skepticism.

Additionally, the sample sizes from this experiment are relatively small leaving the statistical tests underpowered. This problem is exacerbated in the binary choice question by the fact that the groups were split further, and so the largest sample size is 13. Smaller sample sizes allow for more statistical "noise" where differences between groups may be concealed in chance variation. The small size also increases the size of difference required for variation between groups to be considered statistically significant.

The various time delays in the choice titration exercise were presented to participants in a list which was placed in a mixed order with regards to the amount of time being considered in order to try and avoid anchoring effects from the first question asked. However, the questions were presented to subjects all at once in a list format (see appendix) which meant that subjects were able to see all of the questions in either the delay or acceleration conditions at once. One of the researchers noticed that many of the subjects would answer the choice titration questions in order of temporal distance from the present rather than in the order presented.

The evidence from this experiment suggests that high cognitive load impedes the ability to delay gratification in the face of immediate temptation but does not impede ability to delay

future gratification. These conclusions are not very strong given that the largest effect size was in the upper medium range, but they do provide justification for future research as well as suggesting that the choice titration may be a more interesting area of focus than the binary choice.

Future experiments with choice titration should consider presenting the questions sequentially rather than concurrently in order to avoid this effect. Possible future experiments to further explore this concept include an auction format choice titration exercise which would force subjects to make decisions based on actual preferences, or running a survey similar to the one discussed here but using a higher value for the immediate reward in the lottery.

The process underlying decision making is complex, involving both conscious and unconscious elements. Research such as that presented here seeks to uncover the determinants and mechanisms behind good and bad decisions in order to learn how to make better ones in the future.

> We my safely call happy that man who, however lowly his position and limited his possessions, can always hope for more than he has, and can feel that every moment of exertion tends to realize his aspirations.
>
> -William Stanley Jevons (1957, 34)

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Appendix 1: Detailed Analysis of the Hypothetical Choice Questions

The following is a detailed summary of the responses for each of the qualitative questions. For each question, we give two examples of a typical response. One from the control group, and one from the treatment group. We will then summarize the general responses in each group and note any differences in response.

Choice and reasoning

This series of questions asked subjects to consider their actions and/or preferences in a hypothetical situation, and to state both their choice, and the reasoning for their decision.

Question 1:

> "Given a choice between purchasing durable, but expensive goods at specialty stores or cheaper but lower quality items at Target/Walmart/Thrift Stores, which would you choose?"

Control Group:

> "If the item is something disposable (food, toilet paper, etc.) I would choose the lower quality store to purchase it from. If the item is something that should last a long time (furniture, electronics, appliances) I would choose the more expensive, high quality store."

Treatment Group:

> "Durable, but expensive goods. I prefer the quality to cost ratio. I would pay for something I like and have it last longer."

A slight majority (about two thirds) of each group chose the durable option over the cheap option. Those that chose the cheaper option almost exclusively cited low income as the reason, and several participants from each group stated conditional decisions similar to the quoted response from the control group. Overall there was little variation in the response to this question between groups.

Question 2:

"In general, is it better to use credit or debit cards to make purchases?"

Control Group:

"Debit. When possible, I believe it is better to use one's own money instead of borrowing credit from a company in order to purchase something."

Treatment Group:

"Debit cards because I can keep track of my spending easier and I dont have to worry about messing up my credit scores."

The majority of each group chose debit cards as the superior option. Control group members usually cited an aversion to debt as an ethical concept, whereas the treatment group cited aversion to the risks that come with debt. The treatment group had a slightly higher tendency to list credit cards as the superior option than the control group, but all subjects in each group who chose credit cards as the superior option cited the opportunity to improve credit as the reason for their choice.

Question 3:

"Assuming similar food quality, would you prefer to make most of your meals yourself, or to buy prepackaged meals/eat at a dining hall/restaurant. Which do you usually do?"

Control Group:

"I prefer to make meals myself. I have found this to be cheaper and generally healthier, and I also enjoy cooking."

Treatment Group:

"Make my own meals. I currently have a meal plan, so I have to eat at the dining hall, but I know that in most cases, individual ingredients (like flour, etc.,) are cheaper and last much longer than one prepackaged meal."

There was little variation in this question between groups. The majority of participants stated a preference for cooking their own meals. Their reasons were almost universally cost and quality. Those who chose prepackaged meals cited convenience and ease in time constraints without exception.

Question 4:

"Do you usually prefer to finish your studying/homework and then have leisure time or vice versa?"

Control Group:

"I prefer to finish homework first and then have leisure time because once the work is done I can completely relax."

Treatment Group

> "I prefer to study first and reward my studies with leisure time."

The majority of both groups chose studying first, citing the desire to be able to relax completely without having any sort of homework to worry them. Again, there was little variation between groups.

Question 5:

> "Suppose you are faced with an emergency need for cash. Would it be better to withdraw money from a long term savings account, or to live on the bare necessities for a while and leave your savings intact?"

Control Group:

> "I would probably choose to live simpler for a while instead of withdrawing money from the savings account if I could because I don't want to use the money I am saving for specific purposes and it is useful to have in case of true emergencies when living simply isn't enough."

Treatment Group:

> "I would rather live off the bare necessities for a while because in case of another emergency I would like to know I had back up funds available."

The majority of both groups chose living simply over withdrawing money. Participants in the

control group usually cited long term goals for the funds they were saving, whereas the treatment group members were more often concerned with the possibility of a larger emergency at some point in the future. These results are slightly suggestive of a higher level of risk aversion among the treatment group.

Appendix 2: Solving the cost equation in Fudenberg and Levine

We start by separating the first quotient by the two parts of the sum in the numerator. We then note that $\ln(Ra) = \ln(R) + \ln(a)$ and so we can separate the second quotient as well.

$$\frac{(1+\gamma)\ln(1-a) + \ln(y_1)}{1-\theta} + \frac{\theta \ln(Ra)}{(1-\theta)^2}$$

$$= \frac{(1+\gamma)\ln(1-a)}{1-\theta} + \frac{\ln(y_1)}{1-\theta} + \frac{\theta \ln(R)}{(1-\theta)^2} + \frac{\theta \ln(a)}{(1-\theta)^2}$$

We then take the partial derivative with respect to a. All terms with no a in them will drop out of the equation. Since we are maximizing we set this equal to 0

$$\frac{(1+\gamma)}{1-\theta}\left(-\frac{1}{1-a}\right) + \frac{\theta}{(1-\theta)^2}\left(\frac{1}{a}\right) = 0$$

Since the left most term is negative, we can move it over to the other side of the equation

$$\Rightarrow \frac{\theta}{(1-\theta)^2}\left(\frac{1}{a}\right) = \frac{(1+\gamma)}{1-\theta}\left(\frac{1}{1-a}\right)$$

Eliminating the quotients:

$$\Rightarrow \theta\left(\frac{1}{a}\right) = \big((1+\gamma)\big)(1-\theta)\left(\frac{1}{1-a}\right)$$

$$\Rightarrow \theta(1-a) = (a)\big((1+\gamma)\big)(1-\theta)$$

Distributing the left hand product and moving all a terms to the right hand side, then solving for a.

$$\Rightarrow \theta = (a)\big((1+\gamma)\big)(1-\theta) + \theta a$$

$$\Rightarrow \theta = a[\big((1+\gamma)\big)(1-\theta) + \theta]$$

$$\Rightarrow \frac{\theta}{(1+\gamma)(1-\theta)+\theta} = a$$

Simplifying the polynomial in the denominator we get

$$a = \frac{\theta}{1 + \gamma - \theta\gamma}$$

Appendix 3: Recruitment emails, consent form, and instructions

Recruitment Email

The following email was sent out to the student body:

Dear Fellow Students,

You are invited to participate in a study and experiment on the nature of students' consumption and saving habits as part of my senior thesis in economics. Participants will be asked to fill in a computer based survey under controlled conditions. This survey is expected to take about 60 minutes. Participants will receive a base compensation* of up to $5 for participation (depending on performance) and can choose to enter a drawing for either $25 or $50. Below are the planned dates and times for this activity.

Saturday, March 5th
1:00 PM
3:00 PM
Sunday March 6th
1:00 PM
3:00 PM

If you are interested, please contact me (Ben Casner) at bscasner@csbsju.edu with your preferred session time. Please reply by March 2nd if you are interested in participating. You will be contacted within 48 hours with details on the location, your assigned session time, and to confirm your participation in the study.

Your participation will help in better understanding consumer behavior, and I thank you for considering this opportunity.

Sincerely,
Ben Casner
Senior Economics Major

*Please note that while I hope to make these payments in the form of credits to your student account, it may be necessary to make this payment in the form of a bookstore gift card due to CSB|SJU policies. However, the prizes will be made in the form of a check.

Response to recruits

Once participants responded to the recruitment email, the following email would be sent to them indicating what time, and for what session they should arrive.

> Dear (student name),
>
> Thank you for your interest in helping me with my research project. I have put you down for the (time) session on (day) March (date). The experiment will be taking place in the Simons computer lab (Simons G60).
>
> Please note that it is standard practice to over-recruit for experiments of this nature, so there is a small chance that I will need to send one or two people home without participating in the experiment. In the unlikely event that you are one of these people, you will still receive your participation payment. To help with timing and such organization matters, please arrive 10-15 minutes before the start of the experiment.
>
> Also, since it is imperative that I have a complete group of students at each session, please let me know if you find yourself unable to attend the session I have assigned you to so I can try to place you in a different session and look for a replacement.
>
> Thank you again for your willingness to participate.
>
> Sincerely,
> Ben Casner.

Consent Form

The following is the consent form which participants were asked to sign.

COLLEGE OF ST. BENEDICT/ST. JOHN'S UNIVERSITY
The Effects of Distraction on Future Discounting Tendencies

INTRODUCTION

You are invited to be in a research study of the nature of student's spending and saving habits. You were selected as a possible participant because you responded to one of the recruitment emails. We ask that you read this form and ask any questions you may have before agreeing to be in the study. This study is being conducted by Benjamin Casner, an SJU senior, and is being supervised by Parker Wheatley, Ph.D. The survey asks questions about your financial and savings habits and ideas.

OVERVIEW

If you agree to be in this study, we would ask you to do the following things.

1. The experiment consists of a computer survey. You will be expected to answer the questions in the survey to the best of your ability. The questions in the survey will be asking you to make a series of hypothetical choices, and to give the reasoning for them when prompted.
2. There will also be a short section asking you to state some rules you set for yourself in your everyday life.
3. For the last question of the survey, you will be asked to choose between two possible rewards (see risks/benefits below). Your response to this question is part of this experimental activity.
4. Depending on which session you are participating in, you may be asked to solve some arithmetic problems during the survey. Failure to solve these problems correctly, or within 10 seconds will result in a $0.25 deduction from your participation payment
5. Once the experiment is complete you will be asked not to discuss the contents of the experiments for a period of two weeks. The reason for this non-disclosure clause is that foreknowledge of the experiment could affect the answers of participants in subsequent experimental sessions.

This survey is expected to take no longer than an hour and a half, but you will be given as much time as you need to complete the questions.

RISKS/BENEFITS

This study has no known risks; however, you may be subjected to mild auditory cue ("a

buzz") from an earbud from time to time during the experiment.

The benefits will consist of a participation payment of up to $5 and a drawing for a larger cash reward of $15 or $50, depending on your choice.

CONFIDENTIALITY

The records of this study will be kept private. In any sort of report I/we might publish, I/we will not include any information that will make it possible to identify a participant.

Research records will be kept in a locked file; only the researchers will have access to the records, and personal identification data will be destroyed once compensation for participation has been distributed

VOLUNTARY NATURE OF THE STUDY

Your decision whether or not to participate will not affect your current or future relations with the College of Saint Benedict or Saint John's University or the researchers. While we would appreciate it if you would remain for the duration of the activity, you may withdraw from this activity at any time.

CONTACTS AND QUESTIONS

The researcher conducting this study is Benjamin Casner. You may ask any questions you have now. At conclusion of the survey activity, there will be an opportunity to debrief and discuss your responses to the survey and to address any concerns or questions you might have about the activity if you have questions after the survey is complete, you may contact any of the following at

Benjamin Casner: (920)-202-4852
Parker Wheatley (research advisor): 320-363-5917
Rachelle Larsen (IRB Chair): 320- 363-5192

You will be given a copy of this form to keep for your records.

STATEMENT OF CONSENT

I have read the above information. I have asked questions and have received answers. I consent to participate in the research.

Signature _____ Date _____

Printed name _____

Control group instructions

The following were the instructions given to the control group:

You will be asked to answer a series of questions, most of which will be asking you to choose between a set of two or more alternatives. Some of the questions will ask for the reasoning for your choice or ask you to give examples of methods you use to make decisions. Please read each question carefully and answer to the best of your ability, you will have as much time as you need to answer each question, but you will not be able to modify your answers once you have proceeded to the next page. At the end of this test you will be entered into a drawing for a small cash reward. You can choose either a small, immediate reward or a larger but delayed reward. Please note that your choice will not influence your chances of actually receiving the reward. Once you have answered this final question you will be done with the experiment.

- Create a folder on your desktop called survey
- Open up Internet explorer and go to Moodle on the CSBSJU website
- Log in

- You will see ECON 111: Introduction to Economics (Wheatley) added to your list of classes, go there.
- Scroll down to Casner Research
- Download "Group C" to the folder you just created
- Open the file
- Please DO NOT click "Begin" until we have finished with the instructions

There are two types of question in the survey that may be unclear at first glance. Here are some examples to ensure your understanding.

The first type of asks you to imagine that you are about to receive $100. It then asks you to state the minimum amount that you would demand in order to delay receiving the $100 by the amount of time given in the question.

Example: one week. And then you state $10

This response would mean that in order to delay the dividend of $100 by one week, you would demand an additional $10, thus increasing the total payment to $110.

The second type of question asks you to imagine that you will receive $100 at some point in the future (given in the question). For this type of question you should state the maximum amount that you would be willing to pay in order to receive the $100 immediately instead of waiting.

Example: one week, and you state $10

In this case, responding with $10 means that if you do nothing you will receive $100 in one week, but you would be willing to pay $10 in order to receive it now, thus reducing the total payoff to $90.

Once you've finished taking the survey there should be a text file inside the folder with the survey program.

- Please go back to the moodle site you visited earlier (you may need to log back in)
- Click on "Results file"
- There should be a new file with your name in it either in the folder you created earlier, or on your desktop
- Upload this file to the "results file" section in moodle.
- Once everyone is done I will use a random number generator to determine the winner of the drawing.

If you have any questions or need clarification regarding some aspect of the survey at any point please feel free to ask. Raise your hand and I'll come by to see what you need. However, questions regarding the research itself will not be answered until after the experiment is over. Does anyone have any questions before we begin?

Treatment group instructions

The following instructions were given to the treatment group:

You will be asked to answer a series of questions, most of which will be asking you to choose between a set of two or more alternatives. Some of the questions will ask for the reasoning for your choice or ask you to give examples of methods you use to make decisions. Please read each question carefully and answer to the best of your ability, you will have as much time as you need to answer each question, however you will be interrupted intermittently to solve an arithmetic problem before continuing the survey. You will notice a pair of earbuds in front of you. Please wear them from the beginning of the test until the end. You will hear a tone to notify you that it is time to complete one of these arithmetic problems. Failure to complete a problem within 20 seconds, or an incorrect answer, will result in a $0.25 penalty to your participation reward as well as a harsh tone. At the end of this test you will be entered into a drawing for a small cash reward. You can choose either a small, immediate reward or a larger but delayed reward. Please note that your choice will not influence your chances of actually receiving the reward. Once you have answered this final question you will be done with the experiment.

- Set the volume on your computer to 35
- Please open up Internet explorer and go to Moodle on the CSBSJU website
- Log in
- You will see an introductory economics class added to your list of classes, go there.
- Create a folder on your desktop called survey
- Open up Internet explorer and go to Moodle on the CSBSJU website
- Log in
- You will see ECON 111: Introduction to Economics (Wheatley) added to your list of classes, go there.
- Scroll down to Casner Research
- Download “Group T” and “Other” to the folder you just created
- Open the file
- Please DO NOT click “Begin” until we have finished with the instructions

There are two types of question in the survey that may be unclear at first glance. Here are some examples to ensure your understanding.

The first type of asks you to imagine that you are about to receive $100. It then asks you to state the minimum amount that you would demand in order to delay receiving the $100 by the amount of time given in the question.

Example: one week. And then you state $10

This response would mean that in order to delay the dividend of $100 by one week, you would demand an additional $10, thus increasing the total payment to $110.

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Once you've finished taking the survey there should be a text file inside the folder with the survey program.

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If you have any questions or need clarification regarding some aspect of the survey please feel free to ask. Raise your hand and I'll come by to see what you need. However, questions regarding the research itself will not be answered until after the experiment is over. Does anyone have any questions before we begin?

Appendix 4. Survey Questions

The following is the complete list of survey questions.

First section:

Name
ID#
Gender
Year
Age
Major

Second section (Instructions, followed by questions with text box for each question)

For the following questions, please state what choice you would make in the situation presented, and then give the reasoning for each choice.

1. Given a choice between purchasing durable, but expensive goods at specialty stores or cheaper but lower quality items at Target/Walmart/Thrift Stores, which would you choose? `
2. In general, is it better to use credit or debit cards to make purchases?
3. Assuming similar food quality, would you prefer to make most of your meals yourself, or to buy prepackaged meals/eat at a dining hall/restaurant. Which do you usually do?
4. Do you usually prefer to finish your studying/homework and then have leisure time or vice versa?
5. Suppose you are faced with an emergency need for cash. Would it be better to withdraw money from a long term savings account, or to live on the bare necessities for a while and leave your savings intact?

Third Section

Instructions followed by one page for each question

For the following questions please state the minimum amount that you would be willing to accept in order to *delay the reward $100* by the given period of time.

1. two weeks
2. one week
3. one month
4. one year
5. two months
6. three days
7. one year
8. Eight months
9. two weeks
10. Five Days

For the following questions please state the maximum amount that you would be willing to pay in order to *receive a reward of $100 immediately*.

1. One week

2. One month
3. One year
4. Tomorrow
5. Three days
6. Five days
7. Two weeks
8. Two Months
9. Eight months
10. Five months

Fourth Section
Instructions, then text 5 text boxes

Please list a 5 rules that you use in your everyday life to keep yourself from engaging in unwise behaviors. (e.g. “As an ex smoker, I refuse to smoke even one cigarette because I do not wish to fall back into the habit.”)

Final Section
Instructions, followed by a radio button for each option.

Long-Delay/Short-Delay
As a thank you for participating in this study you will be entered into a drawing for a cash prize. If you win, you will have the option of receiving either $25 in one week, or $50 a month from now. Which would you prefer?

Delay/Immediate
As a thank you for participating in this study you will be entered into a drawing for a cash prize. If you win, you will have the option of receiving either $25 in immediately, or $50 a month from now. Which would you prefer?