CORE
Metadata, citation and similar papers at core.ac.uk
Provided by James Madison University

James Madison University
JMU Scholarly Commons

Senior Honors Projects, 2010-current | Honors College

Spring 2012

Delay discounting in light-social and heavy-social drinkers

Megan Ann Arnold
James Madison University

Follow this and additional works at: https://commons.lib.jmu.edu/honors201019

Recommended Citation
Arnold, Megan Ann, "Delay discounting in light-social and heavy-social drinkers" (2012). *Senior Honors Projects, 2010-current*. 381.
https://commons.lib.jmu.edu/honors201019/381

This Thesis is brought to you for free and open access by the Honors College at JMU Scholarly Commons. It has been accepted for inclusion in Senior Honors Projects, 2010-current by an authorized administrator of JMU Scholarly Commons. For more information, please contact dc_admin@jmu.edu.

Delay Discounting in Light-Social and Heavy-Social Drinkers

A Project Presented to

the Faculty of the Undergraduate

College of Integrated Science and Technology

James Madison University

in Partial Fulfillment of the Requirements

for the Degree of Bachelor of Science

by Megan Ann Arnold

May 2012

Accepted by the faculty of the Department of Psychology, James Madison University, in partial fulfillment of the requirements for the Degree of Bachelor of Science.

FACULTY COMMITTEE:

Project Advisor: Bryan K. Saville, Ph.D.,
Associate Professor, Psychology

Reader: Jessica G. Irons, Ph.D.,
Assistant Professor, Psychology

Reader: Monica J. Reis-Bergan, Ph.D.,
Associate Professor, Psychology

HONORS PROGRAM APPROVAL:

Barry Falk, Ph.D.,
Director, Honors Program

Table of Contents

Acknowledgements

This project could not have been completed without the following invaluable contributions. First, I would like to thank my mentor, Dr. Bryan Saville, for taking on a last-minute honor's student and providing indispensable aid in developing the experimental design, analyzing the data, interpreting the results, and punishing excessive word usage across countless drafts of the research project. Second, I would like to thank my thesis committee: Dr. Jessica Irons, who provided insight regarding screener questionnaire selection and valuable data collection resources; and Dr. Monica Reis-Bergan, who offered guidance regarding the focus of the literature review. Finally, I would like to thank Dr. Dan Holt for helping to facilitate and challenge my understanding of the material and suggesting data collection methods.

Abstract

To examine the relation between alcohol consumption and delay discounting of monetary rewards and alcohol rewards, I gave 164 college students an online screener designed to measure the quantity and frequency of alcohol consumption, and hazardous drinking. I identified 20 light-social drinkers and one heavy-social drinker. I then compared how the heavy-social drinker and the light-social drinker discounted delayed monetary rewards and delayed alcohol rewards. The light-social drinking group and the heavy-social drinker both discounted alcohol rewards more impulsively than monetary rewards; the heavy-social drinker discounted more impulsively than the light-social drinking group on both tasks. I also found that the hyperbola-like function provided a relatively decent fit to much of the data. Together, these findings suggest that a delay-discounting task, along with analysis based on the hyperbola-like function, may be sensitive enough to detect qualitative differences in light-social and heavy-social college drinkers.

Key words: Delay discounting, monetary rewards, alcohol rewards, college students.

Delay Discounting in Light-Social and Heavy-Social Drinkers

Over the past few decades, behavioral researchers have spent a good amount of time and effort studying impulsivity, or the inability to delay gratification (Critchfield & Kollins, 2001). One conceptual framework that has proven useful for understanding impulsivity comes from the operant tradition and entails the choice between smaller, sooner rewards (SSRs) and larger, later rewards (LLRs). For example, a person may choose between eating a piece of cake now (the SSR) and weighing less in 6 months (LLR), or between spending money now (the SSR) and saving and having more money in the future (the LLR). Similarly, a student may choose between going to a party now (the SSR) and staying home to study in hopes of getting a good grade on an upcoming exam (the LLR). According to this framework, impulsivity entails choosing the SSR, whereas self-control (the opposite of impulsivity) entails choosing the LLR (Ainslie, 1975).

Some researchers have suggested that one mechanism that may underlie impulsive decision-making is delay discounting (Ainslie, 1975; Green & Myerson, 2004; Rachlin & Green, 1972). Delay discounting refers to the subjective devaluation of a consequence because the delivery of that consequence is delayed in time. For example, consider a participant who is choosing between $5 available immediately and $5 available in 1 year. In this case, it is likely that the participant will choose the $5 available immediately. Now, consider a participant who is choosing between $5 and $20, both available immediately. In this case, it is likely that the participant will choose the $20 available immediately. Imagine now that the choice is between $5 available now (SSR) and $20 available in 1 year (LLR). In this case, many participants will reverse their preferences and choose the SSR. Although the nominal value of the rewards did not change, the subjective value of $20 decreased as a function of the 1-year delay.

Quantifying delay discounting

Economists first studied the quantitative relation between reward value and delay and described the reward devaluation (i.e., the discounting) using an exponential decay function (Samuelson, 1937). In Equation 1, *V* is the subjective value of the delayed reward, *D* is the delay after which the *A* amount of the reward is delivered, and *k* is a free parameter representing the degree or rate of reward devaluation.

$$V = Ae^{-kD} \quad (1)$$

Theoretically, exponential decay functions assume that there is an inherent risk involved in waiting for delayed rewards, leading always to the smaller-sooner reward preference. However, exponential decay functions fail to account for preference reversals, where at one delay an organism prefers the SSR, but at a longer delay, the same organism will prefer the LLR (Ainsle, 1975).

In order to account for the well-known observation that organisms reverse their preferences, behavioral researchers have proposed a hyperbolic (rather than exponential) function derived from the matching law (Mazur, 1987). The variables in Equation 2 (*V*, *D*, *A*, and *k*) are the same as in Equation 1.

$$V = \frac{A}{1 + kD} \quad (2)$$

Although Equation 2 predicts preference reversals and generally describes the data better than Equation 1 (for a review, see Green & Myerson, 2004), Equation 2 does not take into account individual differences in delay sensitivity, a product of ontogeny (Logue et al., 1987). In order to account for these individual differences, the denominator of Equation 2 is raised to the

exponent *s*. By raising the denominator to a power, the function becomes hyperbola-like (rather than purely hyperbolic).

$$V = \frac{A}{(1+kD)^s} \quad (3)$$

The variables in Equation 3 are the same as in Equation 1 and 2, and *s* is a nonlinear scaling parameter that represents individual differences in sensitivity to delay. Typically, *s* is less than 1.0 (which means that individuals are more sensitive to changes at short delays and less sensitive to changes at long delays); when *s* = 1.0, however, Equation 3 reduces to Equation 2 (Green & Myerson, 2004). It is well known that adding free parameters to an equation will account for more variance in the data; but when compared to Equation 2, Equation 3 provides a superior account for individual and group data than would be expected from simply adding a free parameter. The superiority of the hyperbola-like function has been shown in numerous populations with different types of rewards (e.g., Estle, Green, Myerson, & Holt, 2007; Green & Myerson, 2004; Holt, Green, & Myerson, 2003).

Discounting and addiction

In recent years, behavioral researchers have extended a delay-discounting framework to the study of addiction, with the assumption that addicts often focus on short-term rewards over long-term rewards (e.g., consuming a drug now vs. long-term health). This research has reliably demonstrated that addicted individuals discount delayed monetary rewards faster than nonaddicts and that monetary rewards are discounted more slowly than consumables (Green & Myerson, 2004; Holt, Green, & Myerson, 2003; Madden, Petry, Badger, & Bickel, 1997; Mitchell, 1999; Odum, Madden, Badger, & Bickel, 2000; Vuchinich & Tucker, 1988).

Addiction and monetary rewards. In an early study on delay discounting and addiction, Madden et al. (1997) found that opioid dependent participants discounted hypothetical monetary rewards more steeply than non-opioid-users. Odum, Madden, Badger, and Bickel (2000) subsequently compared opioid users willing to share needles with non-needle-sharing opioid users on a delay-discounting task with hypothetical monetary rewards. The needle-sharing participants discounted the rewards more steeply than the non-needle-sharing participants. In another study, Bickel, Odum, and Madden (1999) compared how current cigarette smokers, ex-smokers, and never smokers discounted delayed hypothetical monetary rewards (see also Mitchell, 1999). Current smokers discounted more steeply than never smokers and ex-smokers. Also, ex-smokers discounted delayed rewards no differently than never smokers, suggesting that impulsivity may be related to current addiction and not past addiction. Similar discounting of hypothetical monetary rewards has been observed in gamblers (Holt, Green, & Myerson, 2003) and in Internet addicts (Saville, Gisbert, Kopp, & Telesco, 2010).

In a study relevant to the present study, Vuchinich and Simpson (1998) compared how heavy-social drinkers, heavy-problem drinkers, and light-social drinkers discounted delayed monetary rewards. Heavy-problem drinkers and heavy-social drinkers discounted hypothetical monetary rewards more steeply than light-social drinkers. The difference in discounting between the groups was also less pronounced for the light-social and heavy-social drinkers than for the light-social and heavy-problem drinkers.

Addiction and consumable rewards. Researchers have also examined how addicts discount the rewards they consume. For example, Bickel, Odum, and Madden (1999) compared how current smokers discounted hypothetical cigarette rewards and hypothetical alcohol rewards. They found that current smokers discounted the addiction-relevant drug (cigarettes)

more steeply than consumable drugs that were not relevant to the current addiction (alcohol). Madden et al., (1997) also found that opioid-dependent participants discounted hypothetical heroin rewards more steeply than hypothetical monetary rewards, and Odum et al., (2000) found that both needle-sharing and non-needle-sharing opioid users discounted heroin rewards more steeply than monetary rewards.

In another study on consumable rewards, Petry (2001) asked participants to state their most preferred food and alcoholic beverage, as well as the price of each. Participants then chose between a hypothetical unit of consumable reward worth a monetary value of $100 and a hypothetical delayed monetary reward. Petry (2001) found that nonclinical participants discounted alcohol rewards more steeply than monetary rewards. Odum and Rainaud (2003) further investigated Petry's (2001) findings by comparing how participants discounted food rewards, alcohol rewards, and monetary rewards (all matched for unit price). Odum and Rainaud found that participants discounted the hypothetical consumable rewards (food and alcohol) more steeply than hypothetical monetary rewards. Participants also discounted hypothetical alcohol rewards more steeply than hypothetical food rewards.

Finally, Estle, Green, Myerson, and Holt (2007) compared magnitude effects (i.e., whether large and small rewards are discounted at different rates) in delay and probability discounting of hypothetical monetary rewards, alcohol rewards, and non-abuse consumable rewards (e.g., candy, soda) using nonclinical participants. Participants discounted alcohol and non-drug consumable rewards similarly; they also discounted consumable rewards more steeply than monetary rewards. Furthermore, Estle et al. (2007) found that magnitude effects on delay discounting and probability discounting tasks generalized to consumable rewards (i.e., participants discounted large rewards more slowly than small rewards).

The present study

As noted above, there has been a good amount of research examining how both addicts and nonaddicts discount delayed consumable and delayed monetary rewards, and several of these studies have examined discounting in drinkers. To date, however, there have been no studies examining whether there are differences in how social drinkers discount delayed monetary rewards and delayed alcohol rewards. Although Vuchinich and Simpson (1998) examined differences in discounting between heavy-problem, heavy-social, and light-social drinkers, they did not examine whether these groups discounted alcohol rewards differently. Such a study might provide further information on delay discounting as well as information on the impulsive characteristics of alcohol consumers. Thus, the purpose of the present study was to extend the findings of Vuchinich and Simpson (1998) by comparing how heavy-social drinkers and light-social drinkers (all without alcohol-related problems) discounted delayed hypothetical monetary rewards and delayed hypothetical alcohol rewards.

Method

Participants

One hundred sixty-four undergraduate students attending James Madison University completed an online screener for a study on drinking patterns and decision-making through the Department of Psychology participation pool or through an announcement in class. Students were enrolled in introductory psychology courses and/or a psychology research methods course. Participation resulted in partial fulfillment of course requirements or in extra credit. Of the 164 students who took the screener, 22 qualified as abstinent, 29 qualified as light-social drinkers and four qualified as heavy-social drinkers. Of the 55 who qualified for the second part of the study, 31 completed the delay discounting tasks (see below). Ten of these participants (nine women and one man) comprised the abstinent group, 20 participants (12 women and eight men) comprised the light-social drinking group and one male participant met the criteria for heavy-social drinking.

Measures

Screener. Participants first filled out an online screener, which took 5-10 min to complete. The screener included an informed consent form (see Appendix A), the Daily Drinking Questionnaire – Revised, and the Alcohol Use Disorders Identification Test. Some participants (see below) also completed two delay-discounting tasks.

Daily Drinking Questionnaire – Revised (DDQ-R). The DDQ-R (Appendix B) is a measure of the average and maximum quantity and frequency of alcohol consumption for a typical day and week; it is sensitive to general patterns of alcohol consumption as well as heavy episodes of alcohol consumption. Based on their DDQ-R scores, participants in the present

study were assigned to the abstinent group, the light-social drinking group, or the heavy-social drinking group. Abstinent drinkers are those who do not consume alcohol. Light-social drinkers are those who consume an average of one to four drinks per drinking occasion on no more than four separate occasions during the past month (Monti, Tevyaw, & Borsari, 2004/2005). Heavy-social drinkers consume five or more alcoholic drinks per drinking occasion on at least five separate days during the past month (Monti et al., 2004/2005).

Alcohol Use Disorders Identification Test (AUDIT). The AUDIT (Appendix C) consists of 10 items. Items 1-3 assess the quantity and frequency of alcohol consumption, Items 4-6 assess symptoms of alcohol dependence, and Items 7-10 assess harm related to alcohol consumption (Bohn, Babor, & Kranzler, 1995). AUDIT scores not only take into account the presence or absence of consumption, dependence symptoms, and harm, but also the magnitude of consumption. Questions 1-8 on the AUDIT are scored as 0, 1, 2, 3, or 4 and Questions 9 and 10 are scored as 0, 2, or 4 (Saunders, AAsland, Babor, De La Fuente, & Grant, 1993). The minimum score for the AUDIT is zero and the maximum score is 40; a score of eight or greater indicates a strong possibility that the participant engages in hazardous or harmful alcohol consumption (Saunders et al., 1993**)**. By taking into account the magnitude of scores on each item, the AUDIT allows for superior discriminability between hazardous and non-hazardous drinkers (Bohn, Babor, & Kranzler, 1995). Therefore, participants who scored an eight or greater were excluded from participating in the study.

Delay-discounting tasks. Participants who came into the laboratory (see below) completed two delay-discounting tasks: a hypothetical-monetary-rewards task and a hypothetical-alcohol-rewards task (only for the drinkers). Both tasks required participants to choose between a SSR and a LLR (e.g. $5 now or $10 in 1 month; 5 drinks now or 10 drinks in 1

month). For the two discounting tasks, the LLR remained constant while the SSR changed according to a titration schedule (Mazur, 1987; for a description see below). Each task consisted of five choices at each of the five delays (1 day, 1 week, 2 weeks, 1 month, and 3 months) for a total of 25 trials.

Procedure

Participants first completed the online screener (informed consent, the DDQ-R, and the AUDIT). Based on their screener responses, I emailed participants an invitation to come into the lab, individually, and complete the delay-discounting tasks for credit. Only participants who met inclusion criteria on the DDQ-R (either abstinent, light-social, or heavy-social drinkers) and AUDIT (non-problematic drinkers) received an invitation.

Participants reported to the laboratory and first read a consent form. Then they completed two computer-based, delay-discounting tasks, one consisting of hypothetical monetary rewards and one consisting of hypothetical alcohol rewards. The instructions for the delayed hypothetical monetary rewards task were as follows:

> In this portion of the study, you will answer questions concerning hypothetical amounts of money. You will be asked to choose between two amounts of money, and you will indicate your choice by clicking the bubble next to the choice you prefer to RECEIVE. For example, you might be asked to choose between:
>
> $50 NOW or $200 in 6 MONTHS
>
> To record your answer and advance to the next question, you must press the arrow button at the bottom-right corner of the screen. You will not actually receive any money in this

task. All of the monetary amounts are hypothetical, but please choose as if the outcomes were real. You should choose the option that is most appealing to you. Please do not choose randomly. Make your choices as quickly and accurately as possible.

Upon completing the delay discounting of hypothetical monetary rewards task, participants completed the hypothetical alcohol rewards task, the instructions for which read:

> In this portion of the study, you will answer questions concerning hypothetical amounts of alcohol. You will be asked to choose between two amounts of alcohol, and you will indicate your choice by clicking the bubble directly below whichever choice you prefer to RECEIVE. In this task, ONE drink is equal to one standard drink: 12 ounces of beer, 5 ounces of wine, or 1.5 ounces of 80-proof liquor. You will not actually receive any alcohol in this task. For example, you might be asked to choose between:
>
> 1 drink NOW or 10 drinks in 6 MONTHS
>
> To record your answer and advance to the next question, you must press the arrow button at the bottom-right corner of the screen. All the drink amounts are hypothetical, but you should choose as if the outcomes were real. Please do not choose randomly. Make your choices as quickly and accurately as possible.

Each trial included the prompt "Which of the following do you prefer to RECEIVE?" The SSRs and LLRs, as well as the respective delays, were located below the prompt (e.g. $5 NOW or $10 in 1 DAY; 5 DRINKS NOW or 10 DRINKS in 1 DAY).

At each delay, choices followed a titrating pattern. On the first trial, the nominal amount of the SSR was half the nominal amount of the LLR (i.e., $5 for monetary rewards or 5 standard

drinks for alcohol rewards). Depending upon the participant's response on the first trial, the amount of the SSR adjusted up or down by half the value of the SSR. For example, if the participant chose the SSR on Trial 1, then on Trial 2, the participant chose between $2.50 (or 2.5 standard drinks) available immediately and $10 (or 10 standard drinks) available after a delay. If the participant again chose the SSR ($2.50) on Trial 2, the choice on Trial 3 would be between $1.25 immediately and $10 after the delay. If, however, the participant chose the LLR on Trial 1, then on Trial 2 the participant chose between $7.50 (or 7.5 standard drinks) available immediately and $10 (or 10 standard drinks) available after a delay. If the participant again chose the LLR on Trial 2, the choice on Trial 3 would be between $8.75 (or 8.75 standard drinks) immediately and $10 (or 10 standard drinks) after the delay. On all subsequent trials, the amount that the SSR adjusted up or down was half of the previous adjustment, rounded to the nearest hundredth after the decimal. This adjusting process continued until the participant had made all five choices at a delay. After the participant made the fifth choice, a new delay began and the value of the SSR reset to $5 or 5 standard drinks.

After participants completed the tasks, the researcher debriefed them (Appendix E) on the purpose of the study. Specifically, participants were told that the purpose of the study was to investigate factors that influence decision-making in college students.

Data Analysis

Indifference points for each individual participant at each of the five delays on the two tasks were calculated as the value of the SSR on what would have been the sixth trial for each delay. All delays were converted to a uniform scale (days).

Using Johnson and Bickel's (2008) two-step algorithm, I then examined whether there were any nonsystematic discounters. Only two of the 10 abstinent participants discounted systematically. Given the small number of remaining abstinent drinkers, I chose to exclude them from further analysis and focused instead on the participants who consumed alcohol. Nine of the 20 light-social drinkers discounted systematically on both the monetary rewards and alcohol rewards task. The 11 light-social drinkers who discounted nonsystematically on one of the tasks were included in the analyses, in order to increase group size. The one heavy-social drinker discounted systematically on both tasks.

Because of the small number of participants in both groups (which limited my ability to conduct valid statistical analyses), I limited my analyses to the visual inspection of graphs and descriptions of the data. Using SigmaPlot 10.0, I determined how well Equation 3 fit the data by conducting a regression analysis on each data set (using the indifference points). I analyzed both the individual and group data for the light-social drinkers and the individual data for the one heavy-social drinker who participated. In all cases, the regression analyses resulted in k (rate of discounting) and s (sensitivity to delay) values.

Results

Screener. For the light-social drinking group, all participants reported consuming between one and four standard alcoholic drinks per drinking occasion on no more than four drinking occasions during the last 28 days (median number of drinks per occasion = 2, median number of drinking occasions = 4). AUDIT scores for the light-social drinking group fell into the range of 2 to 7 (median AUDIT score = 5). The heavy social drinker reported consuming five or more drinks per drinking occasion on more than five drinking occasions during the last 28 days (number of drinks per occasion = 5.3, number of drinking occasions = 8). The one heavy-social drinker scored a 7 on the AUDIT.

Delay Discounting. Figure 1 shows the median indifference points as a function of reward delay for the light-social drinking group and the heavy-social drinker on both discounting tasks. Equation 3 fit the data for the light-social group on the monetary rewards task moderately well (R^2 = .79) and the alcohol rewards task quite well (R^2 = .94). Equation 3 fit the heavy-social drinker data quite well on both tasks (monetary rewards task, R^2 = .97, alcohol rewards task, R^2 = .91). Equation 3 was also fit to the individual data for participants in the light-social drinking group. Equation 3 provided a good fit for only a minority of the individuals on both tasks (see Table 1). Specifically, of the 20 light-social drinkers, only three participants had R^2 values above .90 on the monetary rewards task, and none had R^2 values above .90 on the alcohol rewards task. On the monetary rewards task and the alcohol rewards task, the median R^2 values were .73 and .71, respectively. Within the light-social drinking group, men and women did not systematically differ in how they discounted delayed rewards.

Visual analysis of Figure 1 suggests that there were differences in how the light-social drinkers and the heavy-social drinker discounted both monetary and alcohol rewards. Generally, the light-social drinkers discounted monetary rewards the slowest, and the heavy-social drinker discounted alcohol rewards the fastest. In addition, the discounting of alcohol rewards by the light-social drinkers and the discounting of monetary rewards by the heavy-social drinker were similar and fell in the middle. The heavy-social drinker discounted monetary rewards and alcohol rewards more rapidly than the light-social drinking group. The *k* values for each group confirm these observations. For monetary rewards, the heavy-social drinker had a *k* value of .29, whereas the group *k* value for the light-social drinkers was .20. For alcohol rewards, the heavy-social drinker had a *k* value of .01, whereas the group *k* value for the light-social drinkers was .06. Finally, the *s* values, which represent sensitivity to reward delay, were less than 1.0 for heavy-social and light-social drinkers on the monetary rewards task (heavy-social, $s = .57$; light-social, $s = .30$). The smaller *s* values suggest that individuals were more sensitive to changes at small delay values on the monetary rewards task. Both the heavy-social drinker and the light-social drinkers had *s* values greater than 1.0 on the alcohol rewards task (heavy-social, $s = 12.23$; light-social, 1.26), which suggests that drinkers are more sensitive to changes at larger delays (as shown by the fact that alcohol rewards retained more subjective value than predicted at the two longest delays).

Discussion

The purpose of the present study was to assess delay discounting of hypothetical monetary and alcohol rewards in both light-social and heavy-social drinkers. College students filled out an online screener that consisted of the DDQ-R and the AUDIT. Participants who met inclusion criteria subsequently completed two computer-based delay-discounting tasks. My results can be summarized as follows. First, the heavy-social drinker discounted delayed monetary rewards and delayed alcohol rewards faster than participants in the light-social drinking group. Second, both the light-social drinking group and the heavy-social drinker discounted the alcohol rewards faster than the monetary rewards. Finally, I found that the hyperbola-like equation (Eq. 3) fit the data relatively well, although it generally described the group data better than the individual data.

Conclusions based on my findings should be considered preliminary for several reasons. First, the abstinent group was eliminated from analyses because a majority of participants discounted nonsystematically on the monetary rewards task. It is possible that the instructions for the present study were ambiguous and participants did not understand how to properly perform the task. It is also possible that for a small percentage of organisms, the subjective value of a reward does not systematically decrease as a function of delay. A thorough discussion of nonsystematic discounting is beyond the scope of this study; however, future research should attempt to elucidate nonsystematic data. Finally, I collected data for 20 light-social drinkers and one heavy-social drinker. Because sample sizes for both groups are so small, it is unclear whether my findings are generalizable to light-social drinkers and heavy-social drinkers in general.

Monetary vs. alcohol rewards

The results of this study are consistent with the extant literature on the delay discounting of monetary and consumable rewards. More specifically, these findings are in line with previous research on the discounting of money and alcohol. Petry (2001), for instance, compared how currently using alcoholics, abstinent alcoholics, and control drinkers discounted food and alcoholic beverages. The two alcoholic groups discounted monetary rewards more rapidly than controls and all groups discounted alcohol more rapidly than money. Odum and Rainaud (2003) subsequently compared how non-addicted participants discounted delayed alcohol, food, and monetary rewards. They found that their participants discounted consumable rewards, including alcohol, more steeply than monetary rewards. Together with these studies, my results provide further support for the idea that consumables, including alcohol, are discounted (i.e., lose their subjective value) more quickly than non-consumables such as money. Put differently, people seem to make more impulsive choices with consumable rewards than they do with non-consumables.

One reason why participants typically discount alcohol more steeply than money is that alcohol is a primary, consumable reinforce, whereas money is a conditioned reinforcer (Odum & Rainaud, 2003). Another reason why participants may discount money slower than consumables is that money (a generalized conditioned reinforcer) is exchangeable for many primary (i.e. alcohol, food) and secondary (i.e. housing, transportation) reinforcers (Estle et al., 2007). Raineri and Rachlin (1993) suggested that discounting is related to the rate and duration of consuming the reward. Consumable rewards (e.g., food and alcohol) are biologically relevant, and their value depends upon that rate that the organism can consume it; generally, rewards that degrade faster (and thus need to be consumed more quickly) are discounted faster. On the other

hand, monetary rewards are exchangeable for many types of consumable rewards. Because the participant can exchange money for whichever consumable reward is most biologically relevant at that time, delay may devalue monetary rewards less quickly than consumable rewards (Raineri & Rachlin, 1993).

Alcohol consumption and discounting

The present results also align with previous research on addiction and discounting, or more specifically, on alcohol consumption and delay discounting. A number of studies have shown that addicts tend to discount delayed rewards more steeply than non-addicts (Baker et al., 2003; Bickel et al., 1999; Holt et al., 2003; Johnson et al., 2007; Madden et al., 1997; Mitchell, 1999; Odum et al., 2000; Petry, 2001; Saville et al., 2010; Vuchinich & Simpson, 1998). In one relevant study, Vuchinich and Simpson (1998) found that heavy-social-drinkers and heavy-problem-drinkers discounted delayed monetary rewards more steeply than light-social drinkers did. Similarly, I observed that the heavy-social drinker discounted both monetary and alcohol rewards more quickly than light-social drinkers. Although I only had one heavy-social drinker in my study, the pattern of results is consistent with previous research on discounting. Therefore, these results tentatively provide support for the notion that heavier drinkers may be more impulsive than light drinkers. They also suggest that impulsivity (and delay discounting) may underlie numerous types of addictions.

Nevertheless, if alcohol use and impulsivity are causally related, the present study does not help determine the direction of causation. A few studies provide some insight on the potential direction of causation between drug use and impulsivity. Bickel et al. (1999) compared how current smokers, ex-smokers, and never smokers discounted monetary rewards. They found

that current smokers showed the steepest discounting of monetary rewards, whereas ex-smokers and never smokers did not differ in how they discounted monetary rewards. Thus, it appears that steeper discounting is related to current addiction and not past addiction, which suggests that drug use may result in impulsivity. In another study, Yi et al. (2008) compared how current smokers discounted monetary and cigarette rewards before and after a contingency management (CM) intervention for smoking reduction. The CM group discounted monetary and cigarette rewards significantly less after a 5 day CM intervention. The control group did not show any significant changes across sessions in how they discounted monetary rewards and cigarette rewards. Based on these findings, it seems possible that addiction may cause changes in impulsive behavior.

Hyperbola-like discounting

Generally, a hyperbola-like function (Equation 3) accounts for more variance in the data than other functions (e.g., Equations 1 and 2; Green & Myerson, 2004). In the present study, Equation 3 provided a relatively poor fit for much of the individual data but fit the light-social group data rather well. This difference in R^2 values at individual and group level may not be surprising, though, given that individual differences in sensitivity to delay and amount tend to average out at the group level. Over 50 years ago, Sidman (1952) noted that grouped data are typically of the same form as individual data (e.g., a negatively accelerated hyperbola-like function) but only under certain conditions. Therefore, grouped data may be useful for investigating functional relations at the group level, but conclusions regarding functional relations for individuals cannot necessarily be determined based on averaged data alone. Sidman's (1952) observations apply to the present study, in particular that Equation 3 provided a better fit for the light-social drinking group's median indifference points than it fit individual

data. Nevertheless, because the heavy-social drinker in the present study discounted delayed monetary rewards and alcohol rewards faster than the light-social drinkers, and because Equation 3 provided a relatively decent fit to much of the data, suggests that a delay-discounting task, along with an analysis based on Equation 3, may be sensitive enough to detect qualitative differences in light-social and heavy-social college drinkers.

Appendix A

Consent to Participate in Research - Screener

You are invited to participate in a research study being conducted by Megan Arnold and Dr. Bryan K. Saville at James Madison University. The purpose of this study is to examine factors that contribute to decision-making in college students. We will use the information from the questionnaire to determine if you are a good fit (based on your responses) for this study. If you are interested in being contacted about further study participation, we may contact you and invite you to join this study. You are being invited to participate in this study because you are an undergraduate at James Madison University and enrolled in an introductory psychology course and you are between the ages of 18-30.

Participation in this study is completely voluntary. If you decide to participate, your consent will be implied by completion and submission of your responses on this website. In this screener you will complete several questionnaires related to alcohol-related behaviors you may or may not emit. If you indicated that you are interested in being invited to the second part of this study, should you be eligible, you may be notified (via your JMU email) about the opportunity to participate and earn credit for Psychology Participant Pool (Sona-Systems) credit as indicated on your course syllabus or course extra credit (e.g. Psyc 211).

Your participation in this study is confidential, although I will ask you to provide several pieces of demographic data (e.g. year in school, gender) and your email address, which the researcher may use to invite you to participate in the second part of this study. If you qualify to participate in the second portion of the study, the researcher will contact you via your JMU email and provide you with a password so that you may sign up to complete the study in the lab (Miller Hall, Room 1208, 1225, or 1227).

The risks of participating in this study are minimal. Breaches of confidentiality are highly unlikely because your identifying information will be limited to your email address which will be deleted upon determination of eligibility for the second portion of this study. All data will be kept electronically in a secure location accessible only to the researcher and the research advisor. You have the option to withdraw your consent to participate at any time – you may withdraw consent by simply not submitting your responses should you choose to begin the surveys and then decide not to complete them. If you decide to withdraw from the study you will not be penalized. If you report or endorse illegal activity in the screener, we will keep that information confidential; however, in the event of a court subpoena we may be required to submit your data. This is an unlikely occurrence, especially because we delete identifying information from the database (within one month of completion of the surveys, regardless of eligibility for future studies).

Potential benefits from participation in this study include a greater understanding of the factors that influence decision-making in college students. The results of this research may be published in a professional journal, and/or presented at a professional meeting. Your name and any other identifying information will not be associated with the data collected – all data will be presented in aggregate form (averages or generalizations about the data set). Thus, you will retain anonymity. Final aggregate results will be made available to participants upon request.

If you have any other questions or concerns regarding your participation in this project, or after its completion you would like to receive a copy of the final aggregate results of this study, please feel free to contact

Dr. Bryan K. Saville
Department of Psychology
James Madison University
(540) 568-2277
savillbk@jmu.edu

For questions about your rights as a research subject, you may contact:
Dr. David Cockley
Chair, Institutional Review Board
James Madison University
(540) 568-2834
cocklede@jmu.edu

Thank you for your participation in this research.

Appendix B

The Daily Drinking Questionnaire – Revised (DDQ-R)

Please use the charts below to describe your recent drinking patterns. Please report your drinking in standard drinks, where 1 standard drink equals 12 ounces of beer, 4 ounces of wine, and or a 1 ounce shot of hard liquor.

For the **past month** fill in for each calendar day the number of standard drinks you **usually drink** on that day.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

Now fill in for the **past month** the **maximum number** of standard drinks you had on each calendar day.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

1) During the last 28 days, on how many days did you drink alcohol? _____

2) During the last 28 days, on how many days did you drink beer? _____

3) During the last 28 days, on how many days did you drink wine? _____

4) During the last 28 days, on how many days did you drink a shot of hard liquor? _____

5). During the last 28 days, on how many days did you drink a mixed-drink? _____

6) During the last 28 days, on how many days have you been drunk? _____

7) MALE ONLY: During the last 28 days, on how many days did you have 5 or more standard drinks? _____

FEMALES ONLY: During the last 28 days, on how many days did you have 4 or more standard drinks? _____

8) During the last 28 days, what is the largest number of standard drinks you consumed in one night? _____

9) Approximately how many hours did it take you to finish the largest number of drinks mentioned in #7? _____

10) How much do you weigh? _____

Appendix C

Alcohol Use Disorders Identification Test (AUDIT) and Scoring

1. How often do you have a drink containing alcohol?
    a. Never
    b. Monthly or less
    c. Two to four times a month
    d. Two to three times a week
    e. Four or more times a week
2. How many drinks containing alcohol do you have on a typical day when you are drinking?
    a. 1 or 2
    b. 3 or 4
    c. 5 or 6
    d. 7 to 9
    e. 10 or more
3. How often do you have six or more drinks on one occasion?
    a. Never
    b. Less than Monthly
    c. Monthly
    d. Weekly
    e. Daily or almost daily
4. How often during the last year have you found that you were not able to stop drinking once you had started?
    a. Never
    b. Less than monthly
    c. Monthly
    d. Weekly
    e. Daily or almost daily
5. How often during the last year have you failed to do what was normally expected from you because of drinking?
    a. Never
    b. Less than monthly
    c. Monthly
    d. Weekly
    e. Daily or almost daily
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?
    a. Never
    b. Less than monthly
    c. Monthly

    d. Weekly
    e. Daily or almost daily
7. How often during the last year have you had a feeling of guilt or remorse after drinking?
    a. Never
    b. Less than monthly
    c. Monthly
    d. Weekly
    e. Daily or almost daily
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking?
    a. Never
    b. Less than monthly
    c. Monthly
    d. Weekly
    e. Daily or almost daily
9. Have you or someone else been injured as a result of your drinking?
    a. No
    b. Yes, but not in the last year
    c. Yes, during the last year
10. Has a relative or friend, or a doctor or other health worker been concerned about your drinking or suggested you cut down?
    a. No
    b. Yes, but not in the last year
    c. Yes, during the last year

Appendix D

Informed Consent – Delay Discounting Tasks

You are invited to participate in the second portion of a research study being conducted by Megan Arnold and Dr. Bryan K. Saville at James Madison University. The purpose of this study is to examine factors that contribute to decision-making in college students. To do so, I will ask you to answer some questions and indicate your preference for various outcomes. You are being invited to participate in this study because you are considered a good fit for this study and you indicated on our screener that you wished to be contacted for participation.

Participation in this study is completely voluntary. By signing and dating this form you are giving your consent to participate in the study and potentially earn credit for the Psychology Participant Pool (Sona-Systems) as indicated on your course syllabus.

Your participation in this study is confidential, although you provided your email address that was used to invite you to participate in this portion of the study, any link between any identifying information and data will be destroyed upon completion of participation.

The risks of participating in this study are minimal. Breaches of confidentiality are highly unlikely because once Psychology Participant Pool credit is assigned all identifying information will be stored separately from any data and your email address will be deleted from our database. All data will be kept electronically in a secure location accessible only to the researcher and the research advisor. Forms (e.g. informed consent, debriefing) will be stored in a secure location in our lab. You have the option to withdraw your consent to participate at any time – you may withdraw consent by simply not submitting your responses should you choose to begin the surveys and then decide not to complete them. If you decide to withdraw from the study you will not be penalized.

Potential benefits from participation in this study include a greater understanding of the factors that influence decision-making in college students. The results of this research may be published in a professional journal, and/or presented at a professional meeting. Your name and any other identifying information will not be associated with the data collected – all data will be presented in aggregate form (averages or generalizations about the data set). Thus, you will retain anonymity. Final aggregate results will be made available to participants upon request.

If you have any other questions or concerns regarding your participation in this project, or after its completion you would like to receive a copy of the final aggregate results of this study, please feel free to contact

Giving of Consent

I have read this consent form and I understand what is being requested of me as a participant in this study. I also certify that I am at least 18 years of age.
If you agree to give consent and wish to participate in this part of the study, please sign below.

_____

Name of Participant (Printed)

_____ _____

Name of Participant (Signed) Date

_____ _____

Name of Researcher (Signed) Date

Appendix E

Debriefing Form

Title of Project: Drinking Patterns and Decision-Making in College Students

Investigator: Dr. Bryan K. Saville (email: savillbk@jmu.edu; phone 540-568-2277)

Considerable research has examined the way in which different human populations make choices. To date, however, no studies have examined how choice is related to subclinical alcohol consuming and alcohol abstinent college students. In this study, we measured your decision-making by requiring you to choose between several smaller, immediately available rewards/costs and several larger, delayed rewards/costs (e.g. $5 now or $10 in 1 month; 5 drinks now or 10 drinks in 1 month). People tend to choose a smaller reward that is available immediately rather than a larger reward that requires the person wait for a period of time. People also tend to choose a larger, delayed payment rather than a smaller, immediate payment. We wanted to see how college students who do not consume alcohol, who consume alcohol sparingly, and who consume large amounts of alcohol make choices between different types of rewards and different types of costs, or payments.

Your participation is now complete. Thank you for your participation. We ask that you do not share any of the details of this experiment with anyone else because we are still collecting data. If you have any additional questions regarding your participation in the study, please feel free to contact the investigator listed above.

Figure 1

Subjective Value as a Function of Reward Delay

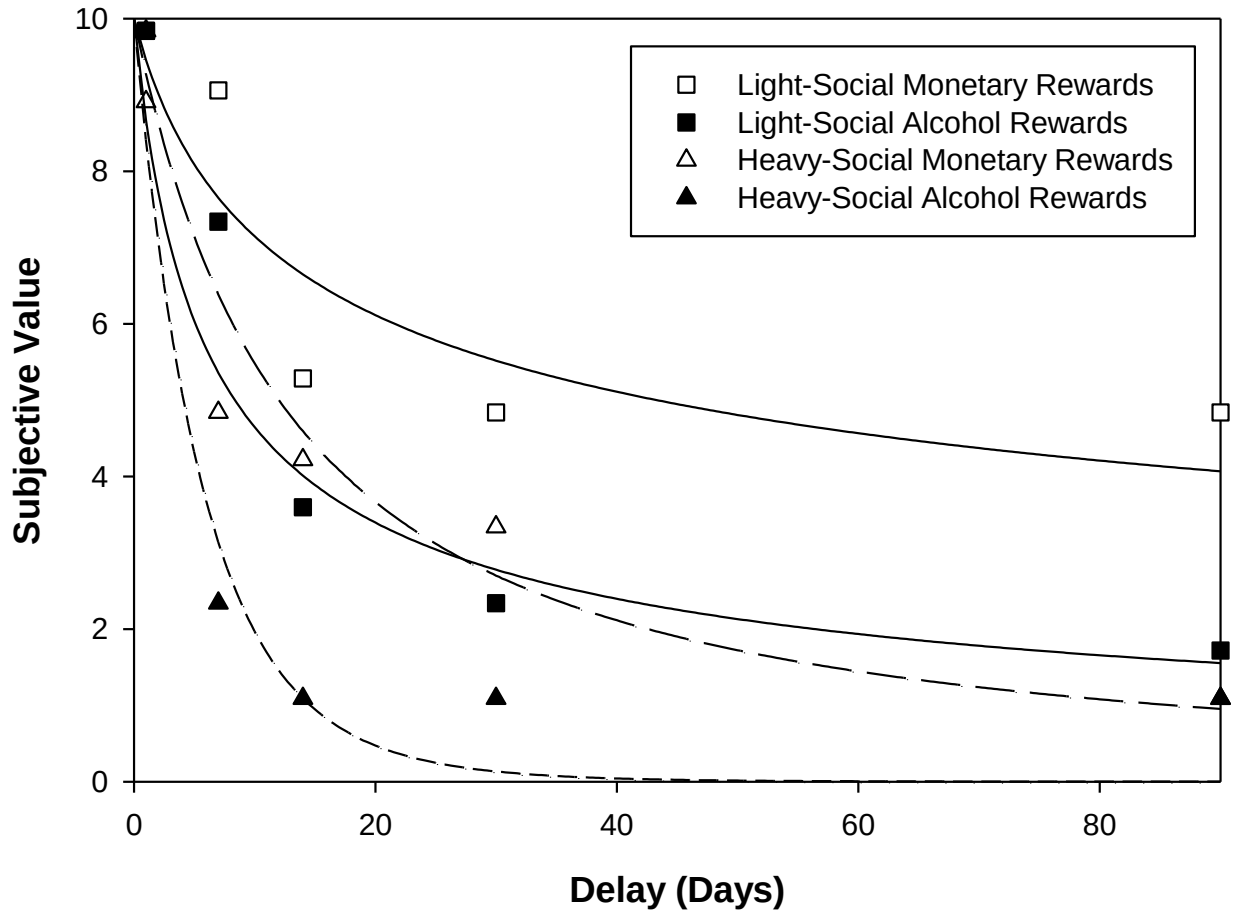

Figure 1. The subjective monetary (empty) and alcohol (filled) reward value as a function of delay for the light-social group (squares) and the heavy-social drinker (triangles). The data points for the light-social drinking group represent the median indifference points. The data points for the heavy-social drinker represent his individual indifference points. The curves represent the best-fitting hyperbola-like functions.

Table 1

The Derived k *Value, the Derived* s *Value, and Variance Accounted for by Equation 3 (R^2) for the Light-Social Drinking Group (GB) and the Heavy-Social Drinker (GC) on the Monetary Rewards Task and the Alcohol Rewards Task. The Light-Social drinking group is separated by gender and rank ordered according to* k *values on the monetary rewards task.*

	Monetary Rewards			**Alcohol Rewards**		
	k	***s***	***R²***	***k***	***s***	***R²***
Light-Social Males						
GB13	53293674.28	0.03	0.00	184.41	0.12	0.65
GB01	830123.76	0.17	0.06	17.00	0.30	0.64
GB05	32.63	0.26	0.71	0.00	14.61	0.71
GB03	6.30	0.02	0.68	0.20	1.17	0.86
GB10	4.84	0.06	0.08	53186237.81	0.00	0.00
GB06	4.53	0.43	0.84	0.30	0.85	0.78
GB21	1.46	0.03	0.94	0.62	0.47	0.73
GB09	0.56	0.23	0.83	0.00	91.98	0.83
GB14	0.02	1.66	0.86	3.42	0.29	0.86
Male Group	**0.56**	**0.23**	**0.84**	**0.05**	**0.49**	**0.86**
Light-Social Females						
GB04	7888559.58	0.00	0.00	30216416.79	0.22	0.00
GB27	55.99	0.06	0.43	0.00	14.61	0.71
GB07	0.64	0.03	0.68	35.35	0.19	0.66
GB19	0.25	0.29	0.76	7888559.58	0.00	0.00
GB02	0.19	0.30	0.66	0.00	49.58	0.72
GB25	0.18	1.16	0.88	0.00	59.20	0.74
GB08	0.09	0.67	0.73	7888559.58	0.00	0.00
GB18	0.07	0.32	0.83	41193837.49	0.13	0.00
GB22	0.02	0.87	0.74	0.02	0.87	0.74
GB26	0.01	0.62	0.98	7888559.58	0.00	0.00
GB12	0.00	96.12	0.93	3.02	0.38	0.82
Female Group	**0.25**	**0.72**	**0.91**	**0.00**	**46.74**	**0.73**
Light-Social Group	**0.20**	**0.30**	**0.79**	**0.06**	**1.26**	**0.94**
Heavy-Social Male						
GC03	0.29	0.57	0.97	0.01	12.23	0.91

References

Ainslie, G. (1975). Specious reward: A behavioral theory of impulsiveness and impulse control. *Psychological Bulletin, 82*(4), 463 – 496. doi: 10.1037/h0076860

Baker, F., Johnson, M. W., & Bickel, W. K. (2003). Delay discounting in current and never-before cigarette smokers: Similarities and differences across commodity, sign, and magnitude. *Journal of Abnormal Psychology, 112*(3), 382-392. doi: 10.1037/0021-843X.112.3.382

Bickel, W. K., Odum, A. L., & Madden, G. J. (1999). Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology, (146),* 447-454. doi: 10.1007/PL00005490

Bohn, M. J., Babor, T. F., & Kranzler, H. R. (1995). The alcohol use disorders identification test (AUDIT): Validation of a screening instrument for use in medical settings. *Journal of Studies on Alcohol, 56*(4), 423-432. Retrieved from http://www.jsad.com/jsad/article/The_Alcohol_Use_Disorders_Identification_Test_AUDIT_Validation_of_a_Scre/238.html

Critchfield, T. S., & Kollins, S. H. (2001). Temporal discounting: Basic research and the analysis of socially important behavior. *Journal of Applied Behavior Analysis, 34*(1), 101-122. doi: 10.1901/jaba.2001.34-101

Estle, S. J., Green, L., Myerson, J., & Holt, D. D. (2007). Discounting of monetary and directly consumable rewards. *Psychological Science, 18*(1), 58-63. doi: 10.1111/j.1467-9280.2007.01849.x

Green, L., & Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological Bulletin, 130*(5), 769 – 792. doi: 10.1037/0033-2909.130.5.769

Holt, D. D., Green, L., & Myerson, J. (2003). Is discounting impulsive? Evidence from temporal and probability discounting in gambling and non-gambling college students. *Behavioral Processes, 64,* 355-367. doi: 10.1016/S0376-6357(03)00141-4

Johnson, M. W., Bickel, W. K., Baker, F. (2007). Moderate drug use and delay discounting: A comparison of heavy, light, and never smokers. *Experimental and Clinical Psychopharmacology, 15*(2), 187-194. doi: 10.1037/1064-1297.15.2.187

Johnson, M. W., Bickel, W. K. (2008). An algorithm for identifying nonsystematic delay-discounting data. *Exp Clin Psychopharmacol, 16*(3), 264-274. doi: 10.1037/1064-1297.16.3.264

Logue, A. W., Rodriguez, M. L., Peña-Correal, T. E., & Mauro, B. C. (1987). Quantification of individual differences in self-control. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *Quantitative analyses of behavior: Vol. 5, The effect of delay and intervening events on reinforcement value* (pp. 245-265) Hillsdale, NJ: Erlbaum

Madden, G. J., Petry, N. M., Badger, G. J., & Bickel, W. K. (1997). Impulsive and self-control choices in opioid-dependent patients and non-drug-using control participants: Drug and monetary rewards. *Experimental and Clinical Psychopharmacology, 5*(3), 256 – 262. doi: 10.1037/1064-1297.5.3.256

Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *Quantitative analyses of*

behavior: Vol. 5, The effect of delay and intervening events on reinforcement value (pp. 55 – 73). Hillsdale, NJ: Erlbaum

Mitchell, S. H. (1999). Measures of impulsivity in cigarette smokers and non-smokers. *Psychopharmacology, 146*(4), 455-464. doi: 10.1007/PL00005491

Monti, P. M., Tevyaw, T. O., & Borsari, B. (2004/2005). Drinking among young adults: Screening, brief interventions, and outcome. *Focus On Young Adult Drinking, 28*(4), 236-244. Retrieved from http://pubs.niaaa.nih.gov/publications/arh284/236-244.pdf

Odum, A. L., Madden, G. J., Badger, G. J., & Bickel, W. K. (2000). Needle sharing in opioid-dependent outpatients: Psychological processes underlying risk. *Drug and Alcohol Dependence, 60,* 259-266. doi: 10.1016/S0376-8716(00)00111-3

Odum, A. L., & Rainaud, C. P. (2003). Discounting of delayed hypothetical money, alcohol, and food. *Behavioral Processes, 64,* 305 – 313. doi: 10.1016/S0376-6357(03)00145-1.

Petry, N. M. (2001). Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. *Psychopharmacology, 154*(3), 243-250. doi: 10.1007/s002130000638

Rachlin, H., & Green, L. (1972). Commitment, choice, and self-control. *Journal of the Experimental Analysis of Behavior, 17*(1), 15-22. doi: 10.1901/jeab.1972.17-15

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior, 55*(2), 233-244. doi: 10.1901/jeab.1991.55-233

Raineri, A., & Rachlin, H. (1993). The effect of temporal constraints on the value of money and other commodities. *Journal of Behavioral Decision Making, 6,* 77 – 94.

Samuelson, P. A. (1937). A note on measurement of utility. *The Review of Economic Studies, 4*(2), 155-161. Retrieved from http://www.jstor.org/stable/10.2307/2967612

Saunders, J. B., AAsland, O. G., Babor, T. F., De La Fuente, J. R., & Grant, M. (1993). Development of the alcohol use disorders identification test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption – II. *Addiction, 88*(6), 791-804. doi: 10.1111/j.1360-0443.1993.tb02093.x

Saville, B. K., Gisbert, A., Kopp, J., & Telesco, C. (2010). Internet addiction and delay discounting in college students. *The Psychological Record, 60,* 273-286.

Sidman, M. (1952). A note on functional relations obtained from group data. *Psychological Bulletin, 49*(3), 263 – 269. doi: 10.1037/h0063643

Vuchinich, R. E., & Simpson, C. A. (1998). Hyperbolic temporal discounting in social and problem drinkers. *Experimental and Clinical Psychopharmacology, 6*(3), 292 – 305. doi: 10.1037/1064-1297.6.3.292

Vuchinich, R. E., & Tucker, J. A. (1988). Contributions from behavioral theories of choice to an analysis of alcohol abuse. *Journal of Abnormal Psychology, 97*(2), 181-195. doi: 10.1037/0021-843X.97.2.181

Yi, R., Johnson, M. W., Giordano, L. A., Landes, R. D., Badger, G. J., & Bickel, W. K. (2008). The effects of reduced cigarette smoking on discounting future rewards: An initial evaluation. *The Psychological Record, 58,* 163 – 174.