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Language and Discounting Behavior

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by

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ABSTRACT

Subjective devaluation of hypothetical outcomes is a widely used metric in the fields of behavioral economics and the experimental analysis of behavior to detect the presence of impulsive behavioral characteristics. While discounting trends are long assumed to be relatively stable patterns of behavior, recent evidence suggests that discounting curves are subject to contextual conditions, either inherent within the experimental task or the surrounding environment. Researchers note that the frame of the task is vitally important to the results obtained from the procedure, but few have examined or manipulated the functional verbal relations present in these tasks. The present dissertation describes a series of investigations on how discounting behavior varies as a function of the language used to describe the task. New measurement methodologies are described, and a program of study is articulated for single-subject analysis of delay discounting.

Keywords: Delay Discounting, Temporal Discounting, Fill-in-the-Blank Discounting.

Dedication

This project is dedicated to my children, Madison and Drake. Thank you for always making me smile. I love you forever.

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INTRODUCTION

Consequences are fundamental for understanding and predicting human behavior (Skinner, 1978). An important factor in regards to the delivery of consequences is the temporal relationship between behavior and the delivery of the consequence. Several fields investigate the delay, subjective devaluation of, and administration of consequences, including economics, neurology, and psychology (see Madden & Bickel, 2010 for a review). Generally, the further a consequence is administered in the future, the less value or control the consequence maintains for the responding organism. This line of research has come to be known as delay discounting.

Delay discounting has been experimentally investigated since the mid-1900s. Specifically, it is defined as, "the process by which future events are subjectively devalued by the decision maker," (Madden & Bickel, 2010, p 3). The origins of discounting theory are debated between disciplines, as early traces of logic and rationale can be applied to the works of Jevons (1871/1911) and Mill (1848/1909), usually resulting in a discussion of maximizing resources from an economic standpoint. Today, discounting is widely theorized and talked about, even in everyday jargon. When making decisions people assess the sacrifice of immediate satisfaction (e.g. buying new shoes) with the benefits of delayed gratification (e.g. having extra money in savings). This is, in essence, a rough calculation of delay discounting.

Discounting research thrives in the Experimental Analysis of Behavior (EAB). EAB is a scientific and objective branch of psychology and the behavioral sciences that involves the manipulation of tightly controlled environments to depict clear functional relationships between environmental stimuli and the behavior of the organism under

investigation (Skinner, 1966). Thoughts, emotions, and motivations are internal processes, and these metrics are not typically used as vital dependent variables to the behavior scientist. Early behaviorists attempted to quantify discounting patterns by using animal laboratories to explore the depreciating value of consequences (Logan, 1965; Skinner, 1950; Snyderman, 1983), and later used to add empirical evidence to economic theory towards irrational devaluation of goods over time (Ainslie, 1974; Rachlin, 1974).

After this preliminary work, EAB and discounting emerged as a top conceptual pillar in the field, eliciting several hundred studies over the past 5 decades (Odum, 2011). The scope of investigation expanded beyond the animal lab and entered the domain of human choice, presenting a new line of complexities for the behavior scientist to address, such as the attempt to operationally define cognitive traits that describe the topics under investigation (e.g. impulsivity and risk-taking). As human processes were investigated further, researchers began elaborating, extrapolating, and making correlations between discounting behavior and other behavioral traits and psychological states (see Madden & Bickel, 2010).

Recent discounting research looks at more socially significant topics outside of financial decision making and choice allocation. Researchers are starting to examine how topics such as environmental stewardship (Hardistry & Weber, 2009), materialistic commodities (Weatherly, Terrell, & Derenne, 2010), workplace safety (Reynolds & Schiffbauer, 2004; Sigurdsson, Taylor, Wirth, 2013) and social policies (Plumm, Bohart, & Weatherly, 2011) fit within the discounting paradigm. Results of these studies show that these methodologies can be used as a sensitive measurement system for complex

social problems. However, more work needs to be done to further develop the paradigm of applying discounting methodologies to novel circumstances.

What follows is a brief review of delayed discounting principles, methodologies, and empirical work. The scope of this preliminary review focuses on the behavior analytic interpretations of discounting. A brief overview of work in the animal lab will be covered, followed by a general discussion of areas of research where discounting methodologies have been applied. A discussion of how delay discounting methodologies have been used in financial decision making, management practices, and behavioral economics will also be reviewed. Innovations that explore discounting related to more complex social issues over the past 10 years will also be reviewed, followed by an appeal to combine discounting methods of investigation with empirical support and metrics from the Relational Frame Theory perspective (Hayes, Barnes-Holmes, & Roche, 2001). This review will provide a foundation to base the logic, methodology, and support for the experimental question.

A Broad Review of Discounting in Behavior Analysis

Methodologies of Discounting. Classical research in delay discounting involves the presentation of at least two opportunities for response, where one of the options results in a small, immediate reward, and the other results in a larger, delayed reward. This scenario is widely used in both human and animal literature as a way to directly quantify the reinforcing consequence from the result. The goal of most studies is to locate the indifference point; the point where the immediate reward is equated with the larger reward. A classical example of a discounting scenario from the human operant lab

consists of presenting a choice between a small financial reward immediately (for example, $5) and a larger reward that will be paid after a certain amount of time has passed (for example, $500 in 6 months). Dollar amounts and the lengths of the delay are systematically varied to illustrate the indifference curve. These curves typically show the quantification of how a reward decreases in value as more time passes.

Early work in the animal laboratory serves as a foundation for the basic methodology used in discounting literature. Most work with nonhumans involves rats and lever presses or pigeons and key pecks, where the delay and magnitude of the consequential reinforcer is contingent upon a particular response (Madden & Johnson, 2010). Mazur (1987) is commonly credited in the delay discounting literature as a pioneer of articulating the experimental procedure to precisely measure the indifference point of nonhuman species. In Mazur's *Adjusting-Delay Procedure*, a pigeon is presented two concurrent stimuli where a response in the presence of one stimulus results in a large delivery of food after an adjusted delay, while a response in the presence of the other results in a small delivery of food after a brief, fixed delay (typically 5-10 seconds. See Mazur 1986; 1987). The adjusted delay is then varied systematically to identify the point at which the organism demonstrates undifferentiated preference for either stimulus.

Results from the *Adjusting-Delay Procedure* yield interesting results. Mazur (1986) demonstrated that pigeon choice behavior was well predicted by a hyperbolic model of discounting (see Equation 1 & Figure 1; Ainslie, 1974; Mazur, 1986). Mazur replicated these earlier results with rats in 2007 to determine the results replicate across species. In this study, rats in an operant chamber were presented a lever. When pressed,

the chamber lights would go off, and two additional levers would automatically appear in the chamber. Responses on the left lever were coded as a standard alternative response, while responses on the right lever were coded as an adjusted alternative response. Responses on the standard alternative resulted in the delivery of two food pellets after a fixed-delay that varied by condition. Responses on the adjusted delay condition resulted in the delivery of one food pellet followed a varying delay. Results support claims of the hyperbolic-decay model.

Similar to the Adjusting-Delay Procedure, the Adjusting Amount Procedure (Richards, et al., 1997) uses a titration system to find a stable indifference point in the response patterns of the organism. In the foundational study of this procedure, Richards et al. (1997) exposed water deprived rats to two concurrent stimuli where responses on the standard alternative resulted in a small delivery of water after a fixed delay, and responses on the adjusting alternative resulted in a delivery of a smaller amount of water immediately. If the organism responded on the standard alternative choice, the quantity of the reinforcement for the adjusting alternative increased by a small percentage. The opposite occurred if responses were allocated to the adjusting alternative. Subjects that showed clear preference for one of the contingencies were put through a force choice condition where responses were required to occur for the alternative contingency. Results show that clear indifference curves develop across subjects. This further validates the adjusting amount procedure as a useful investigative tool to measure discounting rate as a function of delay.

Another common technique used with non-human subjects is the Evenden and Ryan (1996) procedure involving the manipulation of delays systematically over a period of trial blocks. This procedure involves the presentation of two concurrent stimuli where a response on one results in a smaller-sooner consequence and response on the other results in a larger-later reinforcer over a period of 5 blocks, consisting of 8 trials in each block. Over the blocks, the delay to reinforcement in the larger-later condition is systematically increased. The organism is placed under a force choice condition to start every trial to ensure contact with each corresponding contingency.

The study of human discounting has led to its own controversies, innovations, and advancements. The most common discounting scenarios that human subjects are placed in are financial in nature and mostly hypothetical (Madden & Johnson, 2010). Rachlin, Raineri, & Cross (1991) are credited as pioneering classical human discounting scenarios. In this procedure, subjects are presented with a hypothetical choice between $1,000 now or $1,000 after a predetermined delay (typically ranging from 1 month to 50 years). The choice was then altered by decreasing the value of the amount available now until an indifference point where the lower amount available immediately was equivalent to the delayed amount of money in the future.

Procedural factors adopted from Rachlin et al. (1991) varied over the years, evolving with technological advancements. In the original study, an experimenter presented two cards, where one card represented a hypothetical amount to be paid immediately, and the other card showed a delay. The amount on the payment card varied in amount, ranging from $1,000 to $1, and the delays varied from 1 month to 50 years.

Subjects reported their subjective preference for a dollar amount to be received today versus waiting to be paid $1,000 after the delay on the other card. Results from this study are profound, as the data strongly support the behavioral claim that human decision making follows hyperbolic function (Mazur, 1987).

Researchers concerned about the reliance of discounting literature on the use of hypothetical scenarios that might not be representative of actual choice behavior in everyday contexts developed a line of research which resulted in actual payout of the described consequence. Several studies (Johnson & Bickel, 2002; Madden et al. 2003) have replicated Rachlin et al.'s (1991) hypothetical model with real outcomes. Results from these studies do not yield any differences in terms of the rate of discounting of financial outcomes, which adds internal and external validity to the construct of hypothetical outcomes. Of course, more research needs to be done in this area to ensure that trends and recorded behavioral responses of hypothetical situations reflect real-world situations and scenarios. The use of innovative and differing outcomes outside of financial decision making would therefore expand the scope of discounting research.

While groundbreaking, Rachlin's et al. (1991) study did not manipulate the alteration of magnitudes in terms of the consequence description to see if the ratio between smaller-sooner and larger-later reward would show different discounting trends based on the size of the reward. Green, Fristoe, & Myerson (1994) show preference reversals by human participants when delays are added to both the smaller amount and larger amount. In their experiment, the authors used three sets of paired rewards ($20 versus $50, $100 versus $250, $500 versus $1,250) with individual amounts associated

with a time frame in which the hypothetical amount would become available (delays ranging from immediately up to 20 years). As the experiment progressed, the smaller amounts were associated with varying delays. Results of this study show that when the smaller-sooner delays increased, participants began to prefer the larger-later option. These data imply that preference shifts from small rewards over to large rewards as a function of delay, which is not adequately described by a hyperbolic model. Further analyses reveal that these data correspond to an exponential function.

The debate about exponential and hyperbolic function of discounting spans several decades (Lagorio & Madden, 2005; Madden, et al., 1997; Mazur, 1987, Myerson, Green, & Warusawitharana, 2001; Rachlin et al., 1991). Research supporting exponential discounting has been conducted for almost 100 years, as economists hypothesized that outcomes compound with interest over time, and the longer the delay, the greater the risk is perceived of not receiving goods promised once the delay has concluded, whether it be for extenuating circumstance or death of the organism (Madden & Bickel, 2010; Samuelson, 1937). In other words, the longer the delay the more likely the outcome won't be delivered. Therefore, exponential discounting is useful in that it underwrites potential risk that the organism will encounter before receiving the described consequence (Myerson et al., 2001). Hyperbolic discounting differs in that the construct describes the choice situation as one of competing reinforcement rates. Equation 1 and 2 identify the common discounting equations commonly used in decision-based work across the behavioral sciences (see Figure 1 for visual representation of these functions).

$$V_d = Ae^{-}kd \qquad (1)$$

Equation 1 represents the exponential discounting equation, where V_d represents the discounted value of the delayed reward, A is the original reward amount, d is the delay, e is the base of the natural logarithm (2.718), and k is the rate the commodity is discounted (Madden & Johnson, 2010).

$$V_d=(A)/(1+kd) \quad (2)$$

Equation 2 shows the hyperbolic discounting equation, where the variables are the same as Equation 1.

While each equation and approach to discounting holds merit, the nature and logic of utilizing a correct formula from an analytical perspective is questionable. As Madden & Bickel (2010) point out, if the analytical goal of the researcher is to detect sensitivity to delay, then equations set to particular functions should be avoided, as such functions take away from a parsimonious account of the behavior under investigation. Several temporal discounting researchers express support for the Area Under the Curve (AUC) method of investigation (Myerson et al., 2001) to address this issue in a broad and pragmatic way. Using this approach, researchers plot the calculated delayed values of outcomes from their procedure, and calculate the area underneath the data points (see Equation 3).

$$(x_2-x_1)[(y_2+y_1)/2] \quad (3)$$

In the AUC formula, x_2 and x_1 represent the successive delays for the decision, and y_2 and y_1 represent the subjective values observed corresponding to these delays. An AUC value of 1.0 indicates no discounting observed. AUC values close to zero indicate that the commodity under observation is discounted heavily (Myerson et al., 2001). The utility of

this procedure uses actual raw data to calculate values rather than using regression analyses that may introduce faulty mathematical assumptions regarding human behavior (Madden & Bickel, 2010; see Figure 2 for a visual depiction of the logic behind AUC measures).

The utility of these models is explored by examining behavior displayed in choice situations outside the laboratory. Areas of interest are compulsive gamblers and substance abusers, as behavioral characteristics of these populations are frequently labeled as impulsive. Over the next sections, a brief summary of types of discounting work will be reviewed.

Gambling and Substance Abuse. Researchers over the years show strong, positive correlations with compulsive gamblers and steep discounting behavior (see Madden et al., 2011 for a review). They also show that gamblers discount future gains more rapidly when compared to non-gambler control participants (Dixon, Marley, & Jacobs, 2003; Petry, 2001; MacKillop et al., 2006). While research in this area is still developing, it should be noted that results with gamblers and hypothetical discounting rates are difficult to replicate across research laboratories (Holt, Green, & Myerson, 2003; Petry & Madden, 2010). Possible explanations for this difficulty to replicate findings may result from the nature of gambling behavior and the variability of resources to replicate gambling environments, leading to inconsistent environmental control. A majority of the work targeting gamblers comes from states where legal organized gambling facilities are sparse, so participant pools are limited in these areas.

Contextual factors within discounting tasks are important with regards to the rate at which dependent variables are collected. Dixon, Jacobs, & Sanders (2006) compared discounting trends with 20 pathological gamblers in different experimental environments. Participants completed a hypothetical discounting task in a local off-track betting institution (such as a sports book) and a non-gambling environment (such as a laboratory or a coffee shop). Results of this study show a majority of participants alternate in their discounting rate across the different environments, suggesting that contextual cues, like the presence of betting/gambling stimuli, may alter the rate at which individuals discount future gains. Witts, Ghezzi, & Weatherly (2011) show that probability discounting trends vary as a function of win, loss, or break even conditions, which further supports discounting rates being permeable to contingencies of reinforcement.

Several scholars note a correlation between high discounting rates and substance abuse (see Carroll et al., 2010 & Petry & Madden, 2010 for a review). Petry (2001) found that pathological gamblers who also experience problems with substance abuse discount future gains more rapidly when compared to pathological gamblers without substance problems. This study replicates previous findings (Petry & Casarella, 1999), but also offers a theory as to why some researchers (Holt et al., 2003) have been unable to replicate findings concerning gambling populations, since orderly, lawful data are typically collected from individuals suffering with multiple addictions (Petry & Madden, 2010).

Aversive Contingencies. Research on delay discounting studied the preference for a smaller-sooner reward over a larger-later reward extensively over the course of several

decades. An area that received less focus is the description of a hypothetical delay before an aversive stimulus is delivered. As Green & Myerson (2010) point out, "Because most studies of discounting have focused on monetary rewards, another issue on which we have less information than we might like concerns possible differences in the discounting of different kinds of outcomes" (p. 86).

Scholars note that when monetary discounting is shifted from an individual receiving funds to being required to make a payment of funds, the impulsive choice would be to defer payment for as long as possible (Green & Myerson, 2010). In other words, an individual is more likely to request the longest delay option when given the choice, even if there is an increase in the amount they are required to pay. For example, if given the choice between paying $200 in 6 months, or $250 in 12 months, overwhelmingly, participants choose the latter option, despite that option being of a higher monetary value than the sooner option (Holt, Green, Myerson, & Estle, 2008). Still, this preference in behavior is contextually dependent. Holt et al. (2008) found that when both options were far in the future (greater than 120 months), participants opted to pay the lower amount. When delays were closer in temporal relation to the present, participant preference extended to the deferred option. Green & Myerson (2010) note two important distinctions about this finding. First, impulsivity with normally functioning adults is context dependent, meaning the farther removed from the aversive quality of the stimulus as a function of delay, the more likely that individuals are to behave in a more self-controlled way. Second, holding reinforcement rates constant across different scenarios does not impact differentiation between the two competing options (p. 76). The

authors of both studies note that while delay discounting of loss and gains might hold some similarity, it would appear that there are some underlying processes that are unique to each individual task. Replications of this finding are documented, but more empirical support is needed (Mitchell & Wilson, 2010).

In a series of brief experiments on loss, Hardisty, Appelt, & Weber (2013) show that sign (gain/loss) and magnitude (small reward versus large reward) of consequences interact to impact discounting behavior in humans. In their studies, the authors present participants with a scenario where an error on their tax return results in either a sum of money being refunded to the participant or a sum of money that the participant needs to pay to the IRS. Participants in this study showed a preference for the more immediate option, regardless of whether it was a forced payment or cash receipt. Not surprisingly, as the amount the participants had to pay increased the longer participants were likely to put off the payment. In addition, participants reported to be more patient when it came to large disbursements. The authors note the social implications in terms of the relationship this work has with magnitude of outcome, as policymakers looking to achieve buy-in to financial policy might emphasize large gain and small losses.

The notion of aversive contingency differentiation is important as this is critical to choices involving negative consequences of behavior. Severe but delayed consequences are often ineffective in reducing behavior where the immediate reinforcement is sufficient to maintain responding. Little is understood of how humans interact with losses outside of a more theoretically oriented construct. For years authors and scholars used delay discounting methodologies and findings to report on the very nature of human

interaction with immediate, unhealthy, or dangerous stimuli (see Madden & Bickel, 2010), yet there is limited empirical evidence in the behavior analytic community that support these ideas. This is expected for several reasons. First, while topics such as obesity and smoking are easy to explain with constructs developed using discounting principles, it's difficult to operationalize and quantify human decision making in this area because of the over-reliance on subjective values of health. In other words, humans value their own health in different ways, challenging measurement of choice in complex contexts. Second, while research in EAB and traditional behavioral economics literature is starting to produce fruitful endeavors, until recently, little was known about how humans engage in discounting and how these methodologies could combine to produce a new line of integrated, functional and socially valid research.

Behavioral Economics and Prospect Theory. Kahneman & Tversky (1979) classic paper about risk and decisions is perhaps one of the wider known pieces of literature to extend attempts to quantify human decision making. Prospect Theory, the central thesis of their work, states that when a choice is presented to an individual, the individual assigns weights to the probability of the payoff while also converting gains and losses to values. In other words the probabilistic outcome becomes equal to the product of its potential value and weight. Essentially this means that individuals are more concerned about immediate gains and losses rather than the final outcome of a decision. Kahneman & Tversky (1979) showed that individuals devalue probabilistic outcomes more than certain outcomes, and risk-averse individuals may be impacted by small losses more than others.

Of particular interest to the current project and Prospect Theory is the finding of risk aversion as a function of framing effects. In a series of classic studies, Kahneman & Tversky (1979; 1981) showed that the connotation of the frame may exhibit control over preference responses. This is demonstrated by posing a scenario where participants are asked to assume that 600 individuals contract a disease and that there are options on how to treat them. One treatment would ensure that 200 people lived while the other had a small probability that everyone would live and a large probability that everyone would die. Not surprisingly, most participants in this study chose the first option. However, when the frame was altered so that the first option read that 400 people would die, responses for this option dropped dramatically.

Prospect Theory poses that humans are directed by the amount of information present to form immediate values of the immediate gains and losses. In reality, decision making often requires quick analytical reasoning that may not adequately allow for appropriate values to be weighted. In regards to discounting, Prospect Theory offers a large degree of utility towards probability discounting as options in probability discounting often require a degree of assessment and inquiry towards risk. While Prospect Theory is a seminal piece to understand discounting, there are limitations to utilizing this in delay discounting. In particular, when engaging with a delay discounting task, the individual faces a probability of 1.0 that the decision under question is likely to occur, thus skewing a major variable in the conceptualization of prospects. Second, a large portion of this work relies on a cognitive model of decision making, where values placed on particular weights can be dictated and manipulated by the history of the

organism, and thus, are not necessarily reliable in relation to a model of prediction and control.

Social Issues. Discounting literature is expanding into the realm of complex decision making. Early research in the area of delay discounting hypothesized that all individuals discount reinforcers at the same rate. In other words, a similar indifference curve could be observed between different commodities such as money and food items, regardless of the different stimulus classes these two items represent. Within the past several years, many scholars applied the calculation of discounting principles to discuss how individuals make choices about commodities and purchasing goods (Weatherly & Terrell, 2010; Weatherly, Terrell, & Derenne, 2010), choices regarding environmental conditions and air quality (Hardistry & Weber, 2009), legal circumstances (Weatherly, Wise, & Derenne, 2012) and social policies (Hardistry, Johnson, & Weber, 2010; Plumm, Bohart, & Weatherly, 2012). These studies explore the quantification of arbitrary factors of various decisions and mark differences in rates among demographics of participants or different commodities.

Hardistry & Weber (2009) compared discounting rates regarding several different areas involving choice, such as financial decision making, environmental air quality, and health. Their results indicate that while individuals show similar trends in how they discount money and air quality (preference for small gains now over larger gains later), individuals show opposite trends in regards to their health (preference for large gains immediately regardless of outcome in the future). This finding launched a series of

studies aimed at discovering the different discounting rates of more complex stimuli within the same class.

In a series of follow-up studies to Hardistry & Weber (2009), Weatherly, Terrell, & Derenne (2010) attempted to elaborate how individuals discount different commodities for the purposes of comparing the indifference curve for each commodity. Participants were asked to discount within a variety of different circumstances, such as winning money, meeting others via dating websites, choosing medical treatment, and deciding about retirement. The results show that participants discount each factor differently, even when the scale is adjusted to be universal across different circumstances. The authors hypothesize that discounting is not set for each individual. Instead they suggest discounting is mediated by commodity domains where items within particular domains yield similar discounting trends across participants. In a confirmatory analysis, Weatherly & Terrell (2011) replicated this finding with additional stimulus classes. This work supports the hypothesis that discount rates differ as a function of commodity and how the commodity is framed.

As Weatherly and colleagues note, individuals discount different commodities in different ways, but commodities within the same domain yield similar discounting patterns. In terms of treatment utility of delay discounting, these results show great promise for aberrant behaviors in the same response class or domain as other behaviors. For example, it is difficult to intervene on gambling since experimentally replicating all of the factors in a gaming environment is not practical. Theoretically speaking, an individual who values family and gambling could discount these variables in a similar

manner where intervention upon one factor would lead to change in the rate of the other factor. Evidence that humans behave in this manner is scarce. However, these results depict that it may be a useful theory that warrants further investigation.

In conjunction with the previous work cited here, Weatherly, Plumm, & Derenne (2011) investigated the use of a delay discounting procedure to assess outcomes described by a social policy. Participants are given a list of different social policies and told that a governing body is in the process of passing legislation that would result in some change in policy, but doing so would take a predetermined amount of time to gain support. Participants are then instructed that a less-than-perfect version of the policy could be drafted immediately, but would not include some of the provisions that were discussed earlier. Participants are then asked the minimum percentage of "perfect" that they would be willing to accept to have access to the policy immediately. Results of this study show that people discount outcomes described by a social policy more than financial circumstances, but the results are difficult to interpret as extreme political views interfered with the results.

In a follow-up study, Plumm, Bohart, and Weatherly (2011) used a group design to investigate the framing of social policies and discounting rates. The authors hypothesize that features of the policy may elicit skewed reactions on the part of the participant. For example, use of the term *Affirmative Action* may elicit aberrant reactions when posed to the participant, but re-framing the term to *Equal Rights* may elicit more mild responses, as participants have less of a controversial history with this term. Participants were separated into two groups and run through a delay discounting

procedure for five different policies. The first group was asked to rate their support for *Affirmative Action, Gay Marriage, Teaching Creationism, Right to Die, and Abortion*. The second group was given the exact same polices, but identifiers were changed to *Equal Rights, Same-Sex Marriage, Teaching Intelligent Design, Doctor-Assisted Suicide, and Women's Right to Choose*. Results from this study support the authors' hypothesis that the frame of the policy affects the individual discount rate. Group responses differed on three of the five policies.

The implications of this research demonstrate applying discounting methodologies to address some very complex issues. They also depict an important finding; that language of the discounting task greatly impacts how participants interact with the task. While intriguing, Weatherly and colleagues strictly limit their analysis of these findings to a descriptive account of discounting trends and do not fully attribute their results into a functional account of language. Instead, they use large groups in each study to show statistically significant effects of their experimental interventions. While admirable, a deeper, individualized analysis of some of the variables operating in this context is worthwhile. Further, the tasks used in these studies rely on subjective analyses on the part of the participant which may be difficult to interpret from a functional analytic account of psychological events. Metrics such as *percent less than perfect* are unlikely to be interpreted in the same way from participant to participant. This study also fails to show a precise functional relationship; the descriptive methodology only provides a strong, though significant correlation. A more functional analytic interpretation of these data would allow for a more comprehensive understanding of some of the basic human elements involved in studying these events.

Discounting Research Today. Research in temporal and probabilistic discounting today is expanding into several different domains. In 2010, over 65 articles published in PubMed had delay discounting as a keyword (Odum, 2011). Scholars capitalized on the research in substance and begun articulating correlations between impulsivity and other psychological events or traits (Carroll, et al., 2010; Odum, 2011; Odum & Baumann, 2010; Yi, Mitchell, & Bickel, 2010). Others collaborate with neuroscientists to investigate how impulsivity affects brain function at the level of the neuron (Koffarnus et al., 2013; Redish & Kurth-Nelson, 2010; Witstanley, 2010). Theoretical and conceptual analyses are being formulated that explore human health decision making (Tucker, Simpson, & Khodneva, 2010) and managerial behavior in organizations (Foxall, 2014).

Despite several years of empirical support, researchers have only begun investigating the alteration of discounting rate as a function of contingency management. In a recent review of delay discounting work involving alterations of human choice, Koffarnus et al. (2013) cited a series of experiments conducted within the last two decades that document alterations of discounting rates within and between subjects based on experimental manipulations. The review points out that discounting is involved in a wide range of decisions humans make on a daily basis. The stability of how individuals discount has started to be questioned more regularly in the literature (Odum, 2011), starting the debate as to whether discounting is a trait or state type variable in human responding.

A major limitation in the discounting literature is the large portion of studies use correlational methodologies in conjunction with applying discounting methodologies as a way to assess aberrant decision making (Koffarnus et al, 2013). Koffarnus et al. continues

> …little is understood about effective ways to alter discount rate, and the mechanisms by which such treatments and manipulations function. Understanding how discount rate interacts with decision-making in individuals that engage in problematic health behaviors is crucial, especially with respect to the impact of altering discounting rate on the future choices an individual makes (p. 33).

The authors conclude that explicit movements away from descriptive analyses to functional analytic methods of investigation would address these opportunities for elaboration.

Language

The framing of a particular discounting task is an important component in discussing the functional relationship between hypothetical outcome discussed and the indifference curve. While evidence exists that framing of the task is an important feature of discounting, very little research investigated how language interacts with discounting trends, and even fewer studies examined the relational responses corresponding with the indifference curves reported by participants. Dixon & Holton (2009) addressed both of these opportunities. The authors showed that discounting rates of pathological gamblers were malleable via a relational training procedure. The authors first collected baseline data in the presence of neutral stimuli. Then a purple square or pink square backdrop was

presented in the presence of smaller-sooner or larger-later consequences, respectively. Participants then went through a relational training procedure where the function of these neutral stimuli was altered via explicit training of "better than" or "worse than" relations. In other words, the purple square was present when participants were asked to rate if $5 is better than or worse than $20. The pink square was present when participants were asked to rate if $20 is better than or worse than $5. After successive trials, participants completed the same discounting task again. Each participant showed a shift in their discounting behavior, indicating a preference for the larger-later option.

Several studies outside of behavior analysis have been completed in the area of framing and consumer/constituent decision making. In a classic series of experiments, Levin & Gaeth (1988) showed that consumers preferred burgers that were labeled 75% lean as opposed to burgers that were 25% fat. Individuals seeking medical treatment prefer to hear survival rates over mortality rates (Marteau, 1980). In 2010, Hardisty, Johnson, & Weber shifted from a single feature of a product or service to a tradeoff and showed that when a piece of legislation was framed as a "carbon offset," it garnered more consumer support from Republicans versus when the identical policy was labeled a "carbon tax." The experimental analysis of items that are functionally equivalent but that elicit differing levels of support is a needed assessment of the effect of language on decision-making. This is the aim of the present project.

Relational Frame Theory

Interpretations of human language are fruitful avenues for research and scholarship in the behavior analytic paradigm. Skinner's (1957) operant analysis of

verbal behavior is easily one of the most polarizing works in the behavior analytic community. Skinner viewed verbal behavior as behavior that is indirectly reinforced by the mediation of a listener (Skinner, 1957; Torneke, 2010). There are problems with this definition from a strictly functional account. First, the definition of verbal behavior is non-functional, in that it relies completely on the reinforcement history and setting factors of the listener (Stewart & Roche, 2013). According to this notion, Skinner did not consider the act of facilitating the behavior of the speaker (or the behavior of the listener) to be verbal (Skinner, 1957; Torneke, 2010). Another limitation of this approach is that it is too broad to adequately address an operant research framework based on the theoretical assumptions (Stewart & Roche, 2013). By this standard, experimental psychologists taught non-verbal organisms to engage in "verbal" responses based on experimental and technological considerations. For example, a pigeon engaging in a response that results in the presentation of a reinforcer is technically verbal, in that the experimenter mediates the delivery of reinforcement. This issue has inevitably led to the failure to generate much empirical evidence over the last 50 years supporting Skinner's theory outside of teaching language-impaired individuals (Hayes, Barnes-Holmes, & Roche, 1991; Stewart & Roche, 2013; Torneke, 2010) Lastly, Skinner's definition fails to account for difficult human interactions, such as behaving to the presentation of stimuli that have never been previously encountered. For example, if an individual enters a building they have never been in before and are told to wait outside, and they comply, their behavior would not be considered verbal, as they are behaving as a listener. Skinner would argue that such behavior should be treated as a direct contingency of reinforcement. However, from a theoretical standpoint, this is difficult to explain, as if a scenario is truly novel, the

behavior of the listener is not adequately explained by a direct-acting contingency of reinforcement (Torneke, 2010).

These issues have been widely discussed, and while some defense for Skinner's definition and analysis exist (see Gross & Fox, 2009), other theories on human language and cognition developed from behavior analysis. One theory that resulted in a wide range of empirical evidence is Relational Frame Theory (RFT) (Hayes, Barnes-Holmes, & Roche, 2001). RFT provides a functional analytic account of human language that defines verbal behavior as a particular way of relating stimuli or events (Torneke, 2010). Sidman's (1971) groundbreaking work in stimulus equivalence and conditional discriminative responding remains a fundamental component of the central underlying foundation of RFT. In a series of classical studies, Sidman studied reading comprehension with children with developmental disabilities by explicitly training relations between words, pictures, and spoken prompts. In the series of studies, participants were able to identify pictures (A) after prompted by the experimenter speaking a word describing the picture (B), could utter the correct word (B) of the picture when presented with a picture (A), and could point to the correct printed word (C) when prompted by the spoken word (B). After training, participants began to derive responses without explicit training of such relations. For example, individuals began uttering responses (B) after observing the printed word (C), point to correct pictures (B) in the presence of printed words (C), and would point to the printed word (C) after presentation of a picture (B).

These results are not fully explained by Skinner's account of language or by traditional learning theory. In order for this type of responding to occur, the theory would

state the organism should undergo explicit and repetitive training. Sidman went on to describe these phenomena of relating pictures with spoken and written words as stimulus equivalence, as each of these individual stimuli had become functionally substitutable. He would elaborate that in order for stimuli to be equivalent, the stimuli must show reflexivity (A=A), symmetry (if A=C, then C=A), and transitivity (if A=C and B=C, then A=B). Since the publication of these findings, derived conditional discriminative responding has garnered much empirical exploration and evidence to support these preliminary findings (Stewart & Roche, 2013).

Equivalence relations and transitivity among stimuli are unique relationships to humans. Sidman (1992) and others (see Hayes & Hayes, 1992, Torneke, 2010) articulate the anomaly of derived relational responding as an exclusive human trait. It may be that research techniques and technologies are not sophisticated enough to detect if this type of operant occurs as easily with nonhuman species when compared to human responses. RFT explains the link between language and equivalence relations by stating they are exactly the same phenomena under investigation (Hayes et al., 2001; Stewart & Roche, 2013; Torneke, 2010). The theory classifies this type of responding as arbitrarily applicable relational responding (AARR), which is concerned with responding to elements or stimuli within the context that the behavior occurs and is not based solely on the formal properties of the stimulus (Stewart & Roche, 2013).

An example of AARR is as follows: a researcher is training a child in the relational elements of different objects' size. The researcher says the Object A is bigger than Object B, and that Object C is bigger than Object A. Simply by training these two relations to these stimuli, the child would derive that not only is Object C is bigger than

Object A, but that Object B is smaller than Objects A and C. While topography is important in this analysis, what is of particular importance is the manner in which these relations function to the organism, as AARR allows for an analytic and objective detection of acquisition.

Patterns of AARR are referred to as relational frames. Empirical work in RFT investigates several types of relational frames (Hayes et al., 2001). A frame of coordination equates or establishes commonality between two different stimuli (A = B; A is like B). Much of the equivalence literature has targeted frames of coordination in their methodologies (Dymond & Roche, 2013; Hayes et al., 2001; Torneke, 2010). A frame of opposition discusses opposites in relation to a continuum in which at least two sample stimuli are correlated (hot water is different than cold water; A is the opposite of B). A frame of distinction is similar to opposition in that both signal to the listener that response with respect to a particular stimulus may not be reinforced, but unlike opposition, a frame of distinction does not inform the listener to any relation the comparative stimulus provides. For example, the phrase *this room is not warm* does not inform the listener if the room is hot or cold (Hayes et al., 2001). Other relational frames include hierarchical relations (oranges are round; humans are mammals), temporal relations (January is before March), and spatial relations (A is next to B) (Hayes et al., 2001).

One factor explored extensively in RFT is the notion of transformation of function, where stimulus functions are altered based on derived relational training (Hayes et al., 2001; Stewart & Roche, 2013; Torneke, 2010). To date, several researchers thoroughly investigated the role of derived stimulus relations in several basic and applied

settings (see Dymond & Roche, 2013 for a recent review). Several studies show that transformation of stimulus function can either be altered by direct reinforcement (Hayes, Kohlenberg, & Hayes, 1991) or via derived relational responding (Dymond & Rehfeldt, 2000). Further, when relational responding is weak, evidence shows that these relations can be built up in verbal organisms (Barnes-Holmes et al, 2004; Berens & Hayes, 2004; Dymond, May, Munnelly, & Hoon, 2010).

RFT, Discounting, and Behavioral Economics. Given the growing empirical support of derived relational training and responding, several opportunities exist to implement these language interventions within the context of other behavioral methodologies. To date, a review of the literature only found one study that examined the effects of relational training on discounting preference (Dixon & Holton, 2006). These data are worthy of replication in new scenarios and explorations to fully understand and articulate how subjective valuation of future commodity and loss are subject to verbal intervention. Further, a research agenda that seeks to understand, assess, and evaluate the role of psychological and verbal repertoires in relation to discounting would allow for both fields to enter an area of exploration and innovation that opens more opportunities for behavior analysis in topics regarding financial decision making, behavioral economics, and consumer decision making. It should be noted that all of these fields acknowledged the importance of language (see Levin & Gaeth, 1988), but a functional account of human language has not been widely used within these fields as a theoretical construct or an intervention technology. Work that seeks to synthesize these two flourishing areas of research is warranted for these reasons.

Summary

To date, numerous studies adequately show individuals discount the future value of monetary figures, social policies, tangibles, and other commodities. While this literature depicts various degrees of replications, elaborations, and interdisciplinary collaboration, little research explores how discounting might predict how individuals assess and evaluate loss or subjective aversive qualities of stimuli. Further, a limited number of published studies focus exclusively on how an individual is affected by the frame of the discounting prompt. Research to explore these implications could reveal how subjective perception may be altered as a function of human language, given that new evidence on discounting trends suggest discounting curves are subject to experimental and contextual manipulations. Finally, as some work has begun exploring applying discounting trends to socially significant policies, few of these studies methodologically show quantifiably sound results that demonstrate experimental control at the level of the individual.

Experimental Questions

The present dissertation investigates the role of language in a delay discounting task through a series of single-subject analyses. In particular, we ask: Do discounting rates change as a function of how the scenario is framed, and if so, is there a difference in trend between scenarios that describe gains versus scenarios that describe losses? A review of the literature suggests that framing does make an impact, but few have examined this with an adjusting design, similar to those used by Mazur (1987) and Holt

et al. (2008) and no studies have manipulated language using a fill-in-the-blank procedure described by Weatherly, Derenne & Terrell, (2011).

The dissertation is comprised of six studies. The first two studies establish the investigative procedures and can be regarded as pilot work. Specifically, Pilot Study 1 asks how the frame in which a discounting scenario is presented effects the discounting rate across scenarios that are functionally equivalent. Pilot Study 2 asks if other contextual factors within the discounting task itself could potentially impact the discounting rate. The procedure and results from this pilot work are discussed in the Method section of this document and describe the testing of the experimental procedures used in this dissertation.

The next series of studies in this dissertation seek to further investigate the role of language using a Fill-in-the-Blank (FITB) variation of the delay discounting task (Weatherly, Derenne, & Terrell, 2011). Study 3 seeks to establish a modified version of the FITB task to investigate the utility of the procedure. Study 4 attempts to integrate a phase-change design into the FITB model. After methodology refinements, Study 5 initiates an Alternating-Treatment Design (ATD) to conduct a more thorough investigation of discounting and language. Study 6 uses the methods developed in Study 5 to initiate an investigation of how individuals discount losses.

These studies combine to offer progress towards a comprehensive evaluation of the role of language in delay discounting by integrating elements of recent findings that expand the scope of earlier research. Contributions to the literature on delay discounting may be made pending findings in the areas of methodological refinements to current research procedures and a deeper understanding of discounting as a function of how

choices are described. A discussion of future research and implications for application concludes this dissertation

METHOD

A series of studies are described in attempt to answer the experimental questions and provide more understanding of the role of language in delay discounting tasks. Each study in the series is described and the results and discussion follow that inform the next study in the exploration.

Pilot Study 1

Setting, Apparatus, and Participants. Pilot Study 1 took place in a laboratory at the University of Nevada, Reno. The laboratory consisted of individual work stations separated by room dividers. Participants in this study were stationed in one section of the room. The work station consisted of a desk and a 16.5 inch Toshiba Laptop Computer. Participants were seated throughout the entire session. Each session lasted approximately 45 minutes. The experimental program was designed using Visual Basic by an independent computer programmer. The program presented scenarios with choice options presented in two boxes below the instructions. The program recorded participant responses and produced a spreadsheet following the completion of the program. Responses were coded and converted to a master spreadsheet for a more comprehensive analysis.

Participants were recruited via the University of Nevada, Reno's Sona-System, an online scheduling system. Responses for 7 participants were recruited for Study 1. Of the 7 that enrolled, 4 individuals met response criteria to participate (see Johnson & Bickel, 2009).

Informed Consent. All experimental procedures were approved by the University of Nevada's Institutional Review Board (IRB). Prior to beginning the procedure, all participants were read the following statement:

> You are being asked to participate in a study. The study is interested in how people make decisions about money. Specifically, you will be asked how you would choose between either receiving or paying an amount of money. This study is completely hypothetical, but you are encouraged to behave as if the situations described in this study are real. The study will involve you first filling out some short demographic forms, and then you will be instructed to answer some questions on a computer. You can stop participating at any time, and none of the information you share with me will contain any personal information related to you. If you have any questions, please ask them at this time. Thank you.

Participants were given an opportunity to ask questions and then were provided instructions on how to provide consent.

Procedure. After providing consent, participants were instructed by the experimenter to fill out a basic demographic form and the Acceptance and Action Questionnaire (AAQ-II; see Appendix D & E for templates of both forms). Once these paper forms were completed, participants gave the documents to the experimenter. The experimenter then launched the computer program to begin the actual experiment and remained in the room for the duration of the procedure (the experimenter sat at a different workstation and was out of the direct view of the participant). The computer program was composed of two phases and all instructions were provided via the program. In Phase 1 (Baseline), participants completed a basic discounting task that presented a choice between an immediate and delayed amount of either a gain or a loss. Participants were randomly presented choices between receiving and paying amounts of money with altering delays.

A screenshot from Phase 1 is illustrated in Appendix G. The display shows a series of instructions at the top of the screen (i.e. which option would you prefer?) and two boxes at the bottom of the screen. The box on the left shows an immediate amount to receive or pay and the box to the right shows a delayed amount to receive or pay. Phase 1 investigated gains (money to be received) and losses (money to be paid). In this phase, no other information was provided outside of the initial presentation of the choice with the instructions above. In the gains scenario, participants were presented with a choice between an amount of money to receive today versus receiving an amount in the future. If the amount available today was selected, then the next presentation of the choice was modified to display the same delayed amount, but the amount available today was reduced by 25%. If the amount available in the future was selected, then the next presentation of the immediate choice was increased by 25%. Once participants changed their preference, an indifference point was collected, and a new choice condition was displayed.

Procedures regarding loss were very similar to the gains condition in that two choices were presented. However, the direction of the change was reversed for losses. In other words, if a participant indicated that they would prefer to pay an amount today, the amount to pay today would be increased by 25% on the next trial. If participants selected the delayed amount, the amount to pay today would decrease by 25%.

Phase 1 investigated participant's decisions of three amounts (i.e. $100, $1000, and $6000) and eight delays (i.e. 1 month, 3 months, 6 months, 1 year, 3 year, 5 year, 7 year, 10 years). Each presentation was randomly presented to record indifference points for each amount with each delay.

When Phase 1 was completed, participants were instructed to notify the experimenter that the program was complete. Participants were given an opportunity to take a brief break, and then Phase 2 began. Phase 2 was similar to the structure of Phase 1 in terms of the alternating amounts (Mazur, 1986), but the top of the screen displayed a scenario describing a gain or a loss. For gains, participants were assessed in regards to their preference for winnings, refunds, money owed to them, and inheritances. For losses, participants were assessed for taxes, offsets, penalties, and money they owed (See Appendix F for a list of scenarios used in Study 1). The same amounts and delays assessed in Phase 1 were assessed for each scenario in Phase 2. Each scenario was randomly presented with each delay and amount.

Data for this procedure were excluded if the participant completed the experiment in under 20 minutes or if discounting rates fluctuated excessively. This was defined by analyzing the data outputs of participants, and then notating if an indifference point was higher than a previously indicated point for a preceding delay. If this happened twice in a data series, it was assumed that the participant was randomly providing responses and not attending to the experiment.

Dependent Variable. The primary dependent variable in this procedure is the indifference point, as measured by the change in preference observed across all trials. If participants went through six presentations with no change in preference, the amount available today was recorded as the indifference point. These indifference points were then used to calculate the area under the discounting curve for all participants, a standardized method of reviewing discounting data.

Study 1 Results and Discussion

Figure 3 shows an aggregate of responses collected from the 4 individuals whose data met the response criteria. Higher AUC values correspond to little discounting behavior while lower values (close to zero) indicate high amounts of discounting. Visual inspection of the data establish a small difference between the control measures and the remaining options, indicating that different rates of discounting can be observed via discussing the financial decision different ways. For each scenario in each magnitude class, participants made decisions about identical forms of financial outcomes. This pilot work confirms other studies (Koffarnus et al, 2013; Plumm, Bohart, & Weatherly, 2011; Weatherly, Terrell, & Derenne, 2010; Weatherly & Terrell, 2011) that suggest the frame of the financial task can influence the observed discounting rate of the individual. The experimental procedure yields orderly data.

Individual data in Figure 4 shows how individual indifference points were collected for each participant. The control condition is fit with a trend line while the other conditions do not to better observe differentiation between the control and other conditions. Variation in these data are evident, however this method of display can be unclear as some points can be lost in the illustration. Therefore, Figure 5 illustrates AUC values for each of the 4 participants across the different stimuli used in this procedure. Visual inspection of these data show that different scenarios elicit different forms of responses across different participants.

Figure 6 illustrates AUC values for the loss condition. Like the gain condition, these values are the aggregate of four participants, and variation can be observed across the different conditions. Of special interest is the 100 magnitude condition, particularly in

the Control and Inheritance trials. Notice the AUC value is high, indicating little discounting. However, when observing individual data, participants in these two trials in particular indicate that a strong preference was observed for paying items off immediately rather than delaying the payment of debt, even when the debt to pay today was higher than the debt in the future. This presents an interesting question as to how losses are approached by these individuals.

Figure 7 shows the aggregate data from the $100 condition. The indifference points were observed higher than the amount in question, indicating that participants indicated preferred paying amounts off immediately rather than delaying the cost for a short delay. It is also interesting to note that when the magnitude increased or when the delay exceeded 3 months, this finding vanished. Figure 8 shows the individual AUC data collected. These data again depict the variation of responding observed in this procedure.

Several limitations should be considered when examining these data. First, collecting indifference points over the course of several scenarios potentially leads to a practice effect that may account for variation in the data observed. Discounting rates collected in the beginning of the trial may influence rates observed at the end of the trial. The program was randomized to attempt to control for this, but caution should still be exercised when interpreting these data.

Second, the rate of decay may be too drastic in this procedure. Several studies indicate that human discounting resembles a hyperbolic function, which would predict a much more decelerated rate of value depreciation than what was presented to our participants. This may have caused participants to make much more conservative decisions to avoid rapidly losing the value of the outcome described.

The amount of money discounted may have been too high for the present audience of college students. This study measured discounting rates for three amounts ($100; $1000; $6000). It can be argued of those three amounts, only the $100 dollar magnitude is a realistic number for college students. It also should be noted that inspection of the data did not reveal drastic discounting differences from 5 years to 10 years, rendering long delays as being too removed from the present financial circumstance of our population pool. This is not difficult to conceptualize, as college students can be individuals with limited exposure to financial matters and under the control of unique financial contingencies atypical of employed adults.

Lastly, the task itself may be too labor intensive. Much collected data had to be discarded (just under 50%) because some participant's behavior were either random (frequent clicks to end the program) or depicted inconsistent rates across trials. This problem is frequently discussed in discounting literature, which is a potential reason that some discounting experts do not report individual data or conduct within-subject replications. Despite these drawbacks, this preliminary study created a template for further examination.

Upon inspection of these data, several questions emerged regarding what potentially alters the discounting rate other than the wording of the scenarios. For the next modification of this study, the program was redesigned to combine types of responses to particular types of decisions (small gains; large losses) to measure if exposure to some conditions might alter responses on others.

Pilot Study 2

After reviewing the results from Study 1, several contextual questions about the procedure were developed, particularly about how the order of decisions potentially impacts the observed discounting rate. Study 2 examines how these rates could be altered by a succession of decisions that alternated between gains and losses and high and low value decisions. All of the materials and procedures for recruiting participants were identical to Study 1.

Procedure. Like Study 1, participants were instructed to take a computer assessment that evaluated discounting preferences, however, some subtle changes were made to the program to account for some potential limitations. Participants completed the demographic form and the AAQ-II, but instead of doing a standard control condition first, participants completed an abbreviated control procedure that only measured decisions about small gains ($10; $50; $100; $200) that had a much slower depreciation scale as compared to Study 1 (7%). In addition, the delay scale was changed to attempt to capture some subtle changes in discounting trends inside the three year mark, as many of the participants from Study 1 appeared to reach the maximum amount the program would discount prior to 5 years, with little to no differentiation observed after. Therefore, the delays were altered to support a more sensitive time scale (1 week, 1 month, 2 months 3 months, 6 months, 9 months, 1 year, 3 years). Eight subjects participated in this study.

After this abbreviated control session, participants began a loss condition, where decision were made in regards to high, complex losses. The losses are labeled as complex as the nature in which the decisions occurred had more context explaining them than the gains condition. Participants made decisions about late fees, taxes, offsets, and penalties

and values ranged from $1,000-$10,000. After this part of the experiment was complete, participants took the abbreviated control condition again, and differentiation was notated.

Dependent Variable. For Study 2, the primary dependent variable was the differentiation between pre- and post-test AUC values after completing a high loss series of questions. Indifference points were collected and then converted to an AUC value for each participant.

Pilot Study 2 Results and Discussion.

Figure 9 illustrates the aggregate values obtained in Study 2. When the aggregate is calculated, little differentiation is observed across pre- and post- test differentiation. Visual inspection of these data suggest these contextual effects may not exist. Interesting trends emerged, however, from a close inspection of the individual data revealing that with psychologically flexible individuals their AUC values increased in post-test measures, while with psychologically rigid individuals their AUC values decreased in post-test measures. Tables 1 and 2 outline the AUC values for these individuals. This finding offers a glimpse into some potential differences between flexible and rigid individuals in regards to measuring discounting rates.

Inspection of Tables 1 and 2 also reveals that flexible individuals tend to have higher AUC values when compared to rigid individuals. While the sample size is not sufficient to establish this finding, it may be that different AAQ-II scores may predict impulsivity. More replications of this finding need to be demonstrated in order to confirm this, but the results from this study are intriguing.

Similar limitations to this work are noteworthy of discussion. Several participants in the middle of the flexibility scale did not show much differentiation between their

results, and if a large group study were designed, it is unlikely that any major differentiation would be detected between pre- and post- tests as the effect would be obscured in the averaged data. The small effect observed in those considered flexible versus rigid is peculiar, and a deeper analysis of this finding is beyond the scope of this current project, but future studies that are privy to vast populations of flexible versus rigid individuals should explore the differences in discounting rates to postulate a theoretical explanation of this finding. It could be that flexible individuals are more sensitive to the presentation of the loss scenarios, and the mitigating effect of these presentations carry over to the post test. Rigid individuals could experience the opposite, where presentation of the loss conditions results in verbal behavior that are less frugal than earlier indicated. It could also be that these data are spurious, as the sample size was small.

Pilot Study 2 presented logistical challenges in assessing how individuals engaged with the program. Like Pilot Study 1, this investigation involved the presence of a researcher who collected demographics, explained the program, and provided consent, all of which might create expectancy effects. In addition, the same programmatic restriction existed where results could potentially be explained by practice effects on the behalf of the participant. Shifting the study materials to an online platform and removing physical contact with the experimenter, in addition to some other programmatic changes, might address some of these shortcomings.

A potential solution to the problems of collecting data in a titration model is the use of the Fil-in-the-Blank (FITB) procedure (Weatherly, Derenne, & Terrell, 2011). In the FITB procedure, participants are prompted to indicate their own indifference point

rather than coming to it by presenting fixed options. This form of data collection is more efficient, but less studied, than other discounting methodologies. Therefore, an investigation using this procedure with a similar task as the ones described thus far might lend to a more comprehensive understanding of the role of language in discounting. The next iteration of this project describes a method of investigation seeking to understand a modified version of the FITB procedure.

Study 3

Results from Pilot Studies 1 and 2 yield provocative results for future research and established confidence in the experimental procedures. The fixed titration option underlying both studies remains a major limitation in regards to a comprehensive analysis of language and discounting. In addition, the presence of an investigator may result in variation in the AAQ measures. Therefore, design elements were extensively revised to investigate additional manipulations, both with the current measurement system and modification of the experimental environment.

Setting, Apparatus, and Participants

Study 3 seeks to investigate the utility of a modified version of the fill-in-the-blank (FITB) method on a delay discounting task. The discounting task was designed using a third-party survey website (surveygizmo.com). The primary student investigator designed all experimental materials and then programmed a template to investigate discounting rates. Unlike the preliminary studies, all materials were delivered over an online medium, thus eliminating the presence of an investigator during the task. All participants in Study 3 were recruited, provided consent, and given experimental materials over the Internet. No data were collected in the laboratory.

The online setting provides an interesting alternative to data collection that could not be replicated easily in the laboratory. First, the online environment lacks an experimenter supervising study procedures. While this potentially impacts internal validity, the virtual setting establishes a degree of external validity lacking in Pilot Studies 1 and 2. It is possible that subject responses in the laboratory may have been under the control of environmental stimuli present in the lab. This is especially relevant in a discussion about the collection of AAQ data from participants. In Pilot Study 1, AAQ scores lack diversity, and it is possible that participants altered their response on this questionnaire due to the experimental setting. Second, many studies on the Sona-Systems at UNR are also delivered online. Converting to an online study opens participation opportunities up to individuals who possess scheduling restrictions and are unable to participate in lab based studies. Lastly, most discounting studies published today use an online delivery system. For these reasons, Study 3 was designed to investigate the feasibility and efficacy of posting experimental procedures online.

Recruitment materials and changes to the study protocol were submitted and approved by the UNR Research Integrity Office. Like Pilot Studies 1 and 2, participants were recruited via the UNR Sona Systems. Once participants signed up for this study, they received an automated email that contained a personalized link and instructions to provide consent. All participants were instructed that they could terminate their participation at any time by closing the program on their computer. Once their participation was complete, participants were given 1 PEC credit for their participation. Average completion time for Study 3 was 21 minutes. Six individuals participated in

Study 3. Of the six, two individuals were excluded because of fast completion times (below 6 minutes), indicating inadequate engagement with the procedure.

The primary purpose of Study 3 is to investigate whether or not the revision of experimental programs is a substantial alternative to the binary-laboratory scheme described in Pilot Studies 1 and 2. Specifically, the question asked in Study 3 is how do discounting rates differ across individuals using a modified FITB task compared to the more conventional fixed scale?

Procedure

After initial recruitment, prospective participants enrolled in the study via the UNR Sona-Systems. Immediately following their enrollment, participants received a personalized link to the study materials. Each participant was assigned a five digit code in the URL which corresponded to their responses on data output sheets. After clicking on the link, a consent form appeared that described the experiment and instructions for both engaging with and terminating the program. Participants were required to indicate consent by providing their initials on the bottom of the form. The experimental program then launched a modified version of the demographic form used in Pilot Studies1 and 2, followed by an electronic version of the AAQ. Once these forms were submitted, the experiment began.

The layout of the experimental stimuli is posted in Appendix H of this document. Participants first read a description of a scenario. In this study, all scenarios read:

> "Suppose you can receive $(x amount of money) in (x amount of time). What is the lowest amount you'd accept today rather than wait the (x amount of time)?"

Underneath the scenario, a digital scale was presented with a slide bar starting at the zero mark. The value of the scale varied according to the amount of money in question, meaning the maximum amount on the scale depended on the amount displayed on the scenario description. Once the participant clicked on the slide bar, the value underneath the scale lit up and provided feedback as to the location of the bar in relation to the entire scale. Once the bar was slid to the indifference point, participants clicked on a button labeled *Submit*, and the next trial began. This study investigated four monetary amounts ($50, $100, $150, $200) over eight delays (1 week, 1 month, 2 months, 3 months, 6 months, 9 months, 1 year, and 3 years).

For this study, the presentation of values and delays was randomized in order to seek higher efficacy standards of this method. In other words, no two participants received the same order of presentation of the experimental prompts, and the presentation of all materials was not done with regard to sequential order of the decisions. The FITB procedure is emerging in discounting literature, and no known studies have used a modified version like the one described in this procedure. Therefore, a design that uses a randomized presentation is preferred in order to assess if data produced by this procedure are orderly.

Study 3 Results and Discussion

Figure 10 displays AUC measures for all four participants across the different magnitudes investigated in this procedure. Data across the different magnitudes indicate subtle differences across magnitude, indicating that discounting rates were fairly consistent across the different magnitude presentations. This effect would likely be more profound if the n-size was increased, but for the purposes of this current investigation, the

rates of discounting were stable, providing an indication that this modified version of the FITB procedure may be a viable option for data collection.

Figures 9-12 display individual indifference points across all of the magnitudes. Data streams across magnitude manipulations are on a stable decline across time (within subject) for 3 out of 4 subjects. Most participants show orderly discounting data as a function of delay. This is exciting for several reasons. First and foremost, the individual responses were orderly and did not deviate tremendously across trials. Second, these data indicate that each individual maintained a stable discounting rate across the different magnitudes that varied slightly, but not profoundly across trials. The displayed data also nicely lend themselves to investigations using time-series methodology, as most participants depicted stable rates of decline. Using this variation of the FITB method to analyze how changes in scenarios impact the rate of decay with different magnitudes may yield interesting and revealing results in studies examining how discounting behavior is affected by language used to frame scenarios.

This study depicts stable trends in data and further confirms that this version of the FITB method is a viable alternative to the titration scheme described in the preliminary studies. Visual inspection of these data support suspicions that the decay rate in the first Pilot Study was generally too high. When given the option of indicating their own indifference point, participants generally were more conservative with their discounting, particularly when the delays were short. These important considerations are vital to AUC measures, as small changes in preference can alter internal validity of the AUC quotient. Lastly, this study also describes a new and innovative way to measure discounting rates that has yet to be investigated in the literature. This preliminary study

appears to suggest that the slide bar is a valid way to measure discounting rates across participants.

Some notable limitations are present in this study. First, the number of participants in this study is small, and each participant displayed a unique discounting rate. This would not be troubling if the rates were somewhat similar across trials, but many of the data series were distinct. This trend is typically lost in discounting research because most studies analyze large aggregates and notate individual peculiarities. For instance, in the four participants reported in this study, one individual (P23933) never engaged in any discounting behavior while another individual (P25353) engaged in steep discounting. While this could open some argument about the validity of the procedure, the important component within these data is the stability of the trends across different delays and magnitudes.

The online setting did not seem to threaten the validity of the data. Most participants who started the program finished the program within 20 minutes. However, data collected from two individuals were not included in the final analysis because of rapid response time. The data collected from these individuals appeared random in nature (rates increased and decreased randomly throughout the procedure). This unfortunately appears to be a risk with online studies, as some of the social components of laboratory research (the presence of the investigator, verbal prompts, consent process, etc.) are absent in the online environment. Still it is important to consider that in Pilot Study 1, portions of the collected data were discarded for similar issues with participant responses. It is evident that discounting is difficult to study via multiple extended trials, and

participants quickly try to escape from such tasks. Still, the orderliness of the data provides justification for future iterations of this study to be delivered online.

Given that this project investigates individual discounting responses, manipulations to the order of presentation, design factors, and other elements of single-subject methodology need to be systematically replicated in future work to achieve a comprehensive understanding. Single-subject analyses that investigate individual discounting curves and AUC values present an intriguing opportunity currently lost in discounting work using large group designs. Single-subject investigation holds merit for the following reasons. Primarily, discounting studies that utilize large n-sizes to detect statistically significant trends in responses fails to account for individual anomalies in individual responding. The central hypothesis formed based off our pilot work suggests that different statements elicit different responses in peculiar ways. Recent studies call for further analysis in the discounting of individual data (Green, Myerson, Oliveria, & Chang, 2014). The next studies in this dissertation seek to answer this call.

The role of single-subject analysis to the research process is fundamental to a broader analysis of empirical knowledge. In their discussion of the Scientist-Practitioner Model, Hayes, Barlow, & Nelson-Gray (1999) depict how research elements are incorporated into an empirically driven culture. They argue that prior to investigating large n-size statistically driven results, an emphasis should be placed on single-subject investigation and program tinkering to achieve replicable data and arrange refinement in methodology (Azrin, 1977; Hayes, Barlow, & Nelson-Gray, 1999; Sidman, 1960; Skinner, 1966). An intimate analysis of individual data could allow for a more comprehensive depiction of human decision making while also allowing opportunities for

future research to replicate results on a larger scale. Therefore, future research might use some of the elements of single-subject methodology to investigate effects of language manipulations on the role of discounting.

Study 3 revealed a steady decline in responses across time. Given this, a simple phase-change component is an investigative strategy that would yield a comprehensive analysis of the role of language in discounting (Hayes, Barlow, Nelson-Grey, 1999; Johnston & Pennypacker, 2008; Sidman, 1960). In steady-state methodology, a stable trend is established via observation and a systematic change is implemented while maintaining measurement procedures to detect any change in trend. According to the logic of this procedure, an effect is observed when a change in trend is observed in the data series as a function of the experimental manipulation. As the functional relation is replicated, confidence increases that the change in the dependent variable is a function of the independent variable (Hayes, Barlow, & Nelson-Gray, 1999; Sidman, 1960; Skinner, 1966).

The most common and powerful form of a within-subject phase-change design is the ABA design (Hayes, Barlow, & Nelson-Grey, 1999; Johnston & Pennypacker, 2008; Kazdin, 2010; Sidman, 1960). In the ABA design, the researcher collects a series of baseline data (A) and then systematically changes to an intervention phase (B) and measures the change in response. After a series of stable intervention data is collected, the researcher then implements a reversal back to baseline (A) and records the responses corresponding to the phase change. If patterns alter during the intervention phase and return to baseline trends following the reversal, then it can be assumed that the observed behavior change is a function of the experimental variables. Further experimental control

can be demonstrated by introducing other elements of the independent variable sequentially through the experimental procedure and measuring the effects of the variation (ABCABC). Given the stability of responses by participants in Study 3, a revised design that incorporates single-subject methodology allows for systematic replication of the role of language in a discounting procedure.

Study 4

Up to this point, the dissertation has attempted to produce orderly data with respect to individual levels of responding. Study 4 attempted to replicate initial findings from Study 3 and investigate the role of language on the delay discounting. Upon the initial launch of Study 4, the data series generated by the first two participants did not replicate findings from Study 3 and suggested changes in the presentation of trials was influencing discounting. Program modifications were made and eventually produced data comparable to Study 3. Thus Study 4 has two parts. In Part 1, a description of the program and order of presentation is provided, and the data from two participants are analyzed. Part 2 discusses the program modification that followed, and analyzes the data from eight other subjects. A brief discussion follows that hypothesizes why Part 1 failed to replicate results from Study 3.

Part 1

Setting, Apparatus, and Participants. All experimental materials, recruitment procedures were identical to Study 3. All participants were recruited by the UNR Sona-Systems for this online study. Program modifications were made to accommodate the simple-phase change design (Hayes, Barlow, & Nelson-Grey, 1999; Johston & Pennypacker, 2008; Kazdin, 2010, Sidman, 1960; Skinner 1966). Participants provided

informed consent via an online form. All participants that completed the study received 1 Psychology Experience Credit (PEC). Part 1 of this study reports results from two participants.

Procedures. After consent, participants completed a short demographic form and the AAQ. After submitting these forms, the experiment began. With respect to format, this study was similar to the procedure in Study 3. Participants read a brief description that involved a dollar amount and a corresponding delay, and indicated the smallest amount they would accept today rather than wait. The major difference in Study 4 is that participants made decisions about other types of gains.

Participants were assessed across four different magnitudes ($50; $100; $500; $1000) and fifteen delays (ranging from 1 week to 3 years). Unlike Study 3, the order in which the presentation of experimental materials in study 4 was controlled by the experimenter (Study 3 order was randomized). Part 1 of this study assessed the A-B-A design, summarized in Table 3. Participants were first assessed in the baseline procedure corresponding to the shortest delays (1 week to 6 months). After the participants provided these data points, they then were assessed in the Inheritance condition for the next five corresponding delays (9 months to 1 year and 9 months). The last five responses were a return to the baseline condition, where the baseline language was used to assess indifference in the last five delay points (2 years to 3 years). This same assessment was used across all magnitudes. A completed experiment showed sixty responses from one participant (4 magnitudes multiplied by 15 delays).

Part 1 of Study 4 Results and Discussion.

Figure 15 through 18 displays the data collected from Part 1. These data represent assessments from 2 participants across the different magnitude comparisons. Participant 2550-17, represented by the red line, presents an interesting comparison across all scenarios. In this individual's data stream, when approached with the small delay at the start of the trial, the indifference point is observed at a low amount (for most trials, the first indifference point reflects between 20-25% of the value under question). This participant then saw a gradual gain in the intervention phase, (B-Inheritance), followed by a gradual increase in discounting after the baseline wording was introduced. Participant 25516-27 never diminished the amount under question, but did adjust the indifference point as a function of the language used in the task.

Upon inspection of these data, Part 1 of Study 4 was terminated to evaluate the constructs and contingencies necessary to replicate the steady decay rates observed in Study 3. One of the primary differences between Study 3 and Part 1 of Study 4 is the randomization component. A hypothesis was then formed by the experimenter that in this version of the FITB, orderly data emerge as a function of random presentation. Part 2, which is described in the following section, examined the discounting trends of individuals that had similar exposure to participants in Part 1, but with the order of the experimental program randomized.

Part 2

Procedure. Part 2 of Study 4 was identical to Part 1 in regards to the design, recruitment, and consent procedures employed in the initial study. The major difference for this component of the experiment was the order and presentation of the experimental variables of interest. While Part 1 presented questions in order of corresponding delay,

the nature of the rates recorded were problematic in regards to comparing data recorded from Study 3. Therefore, the presentation in which participants received experimental variables was randomized to replicate the experimental conditions in Study 3.

In an effort to maintain the inherent logic and produce the appropriate number of replications in Table 3, an alternating-treatments design (ATD) was initiated for this project that produced one indifference point across the delay spectrum for each magnitude under investigation. This was done to study more magnitudes while also keeping the time to complete the study manageable. For this study, the indifference points of participants were assessed in a baseline scenario (A), an inheritance scenario (B), and a money-owed (C) scenario (See Appendix H for exact wording of scenarios).

For this study, four different types of replications were examined. The ABA condition evaluated the baseline phrasing in the initial 5 delays (1 week to 6 months) and the culminating 5 delays (2 years-3 years), while evaluating the inheritance language in between the two baseline phases (9 months to 1 year and 9 months). Indifference points were then plotted and evaluated to detect changes in correspondence to the assessed delays. Similar assessment strategies were utilized in the ACA, ABC, and ACB conditions. Nine subjects participated in this part of the experiment. One participant's data did not meet eligibility requirements due to speedy completion. This dissertation reports data from two individuals per each condition (8 participants total).

Part 2 of Study 4 Results and Discussion.

Figure 19 through 22 display the indifference points for the two participants that responded to the ABA phase change design. Figure 19 displays the indifference curves for the $50 condition, Figure 20 displays the $100 condition, Figure 21 displays the $500

condition, and Figure 22 displays the $1000 condition. As the amount of money increased, more differentiation in regards to trend and shape of the discounting curve is observed.

Figures 23 through 26 report data from the ACA phase change condition for two other participants. The ACA phase compared the discounting rate of money owed to the participant versus a baseline phase. These two participants responded differently in the presence of the *money owed* scenario in comparison to the ABA dyad. In observing these graphs, it appears that the intervention affected the discounting rate of the two participants in different ways. After examining Participant 29875-11's results, it appears that when the money-owed scenario was presented, the discounting curve became more steep, indicating a drop in subjective valuation. Participant 25480-22 had the opposite effect, showing that in the presence of the intervention, the curve had a lesser slope and the indifference points were higher in comparison to the baseline phases. This is an interesting effect, showing that changes in language may disrupt discounting rate, but not in a uniform manner.

Figures 27 through 30 displays data from the ABC condition. Results from this condition display peculiar results. Rates from each phase are altered by the introduction of the language throughout but generally regress to initial levels. The stability of these lines appear to be the most peculiar notion of this condition, as two individuals that reported data for this portion of the study seemed to not alter much within phases but showed differentiation upon the introduction of different scenarios.

Finally, Figures 31 through 34 display data from the ACB condition. Results from this condition also display an experimental effect across different phase changes. Like the

previous replications, the changes in rate do not seem to be done in a predictable manner, but what is clear after visually inspecting these data is that the way the discounting scenario is framed clearly alters the location of the indifference point and disrupts the discounting rate.

All conditions display a degree of experimental control that the language of the task places over the observed discounting rate. Like Study 3, there were individuals in this procedure that did not engage in discounting. However, it is interesting to note that those particular individuals were ones that had a high AAQ-II score (Psychologically Rigid individuals- AAQ scores are coded in the participant ID's). While this is noteworthy, this interpretation is cautioned, as other individuals in this dissertation have undergone similar discounting practices, but have failed to show the same psychological assessment. Still, further replication is warranted on this topic.

A major limitation to this study is the assessment points of the independent variables (the inheritance and money owed scenarios). At no point did the experimental program assess the discounting rate of these two scenarios in the short delays (1 week to 6 months). In some ways the current design resembles a hybrid of a phase change design with an ATD. This was done in an attempt to keep the proposed methodology, but a major issue with the replication option adopted in Part 2 was the inherent logic of the phase-change design disappears. Replication that addresses the same experimental questions from a true ATD assessment is warranted to provide a clear picture of the process occurring in this experiment.

In addressing this shortcoming, Study 5 was designed to measure the indifference curves of individuals across the delay spectrum for all three scenarios. This design would

allow for a better assessment of how the discounting rates differ as a function of the language used to describe the discounting task. Study 5 also lends itself to more uniform measures of discounting, such as the AUC. AUC measures in Study 4 did not fully capture the experimental effects because of the parameters and logic used to compute this quotient.

Study 5

The Alternating Treatment Design (ATD) examines the rapid alternation between experimental conditions and examines if emergent trends develop as a function of the different discriminative stimuli associated with each independent variable (Barlow and Hayes, 1979; Hayes, Barlow, & Nelson-Gray, 2001; Johnston & Pennypacker, 2008; Kazdin, 2011). Study 4 showed differentiation with a randomized phase-change design. To approach a comprehensive analysis of the effects of language and discounting, the study of discounting in a thorough ATD is warranted.

Setting, Apparatus, and Participants. Experimental conditions in Study 5 are identical to Study 3 and 4. Participants were recruited, provided consent, and participated in an online environment. Five participants were recruited for this study. Of the five, two of these individuals did not meet inclusion criteria due to speedy completion (average time to complete Study 5 was 27 minutes).

Procedure. The procedure for Study 5 was identical to Study 4. Participants provided discounting rates across different scenarios for varying magnitude rates. The major difference between Study 4 and Study 5 is each scenario was measured across the delay spectrum. In other words, each scenario was presented with each delay assessment in this procedure.

In an effort to reduce the time to completion, small changes were made to the experimental program. For the present investigation, only three magnitudes were assessed ($100; $500; $1000). The $50 condition was removed from Study 5 because the other three magnitudes tended to elicit more interesting and provocative results. Another variable changed for the current investigation was the number of delays that were analyzed. This number dropped from 15 delay assessments to 11. The current investigation reports delays from 1 week, 1 month, 2 months, 3 months, 6 months, 9 months, 1 year, 1 year and 6 months, 2 years, 2 years and 6 months, and 3 years. Despite the cut in delay assessments, the range of time investigated is still equivalent with Study 3 and Study 4. Both changes resulted in fewer questions posed to the participant and thus decreased the time to completion. Like Study 4, Study 5 only investigated the gains scenarios for the current subjects. This was done to ensure the methodology would produce orderly data.

The dependent variables for this study were the indifference points for each participant across the assessed delays for each presented scenario, the AUC value for each assessment, and the hyperbolic k-value for each assessment. The independent variable for this investigation was the different types of scenarios presented to the participant. For this study, participants discounting rates were assessed for a control condition, an inheritance condition, and a money-owed condition. Each scenario was presented randomly to the participant and the data are reported as a function of the indifference point with the respective scenario.

Study 5 Results and Discussion.

Figure 35 displays results for the $100 magnitude across the three participants and the corresponding scenarios. Visual inspection of these data suggests an experimental effect on discounting rate as a function of the language describing the scenarios. In each graph, the blue line represents the observed discounting rate across the control condition (no context provided with respect to the nature of the gain), the red line represents the indifference curve for the decisions about money to be inherited, and the green line displays information about money owed to the participant. It is interesting to note that the experiment elicited different levels of reaction from each participant in the $100 condition. For example, Participant 24726-16 shows similar discounting trends for the control and inheritance condition, but displays steep discounting across the money-owed condition. The effects are much more subtle in Participant 22406-12's results. While the curves are not identical, each stream tends to regress around the same point.

Figure 36 displays the results of the $500 magnitude across the different experimental scenarios. The assessment once again shows that an experimental effect in regards to the effect of language on discounting rate. It is also interesting to note the similarities of the within-subject behavior across magnitudes. For instance, the results for Participant 24726-16 still show similar rates of discounting across the control and inheritance conditions and steep discounting in the money-owed condition. This stability across different conditions and amounts has been shown several times in this dissertation, and it is exciting to see it replicated once again in this study.

Figure 37 displays the indifference curves for the $1000 magnitude across the different experimental scenarios. Similar behavior patterns are observed in this condition,

where the language of the task appears to alter the rate of discounting across different scenarios. The within-subject comparisons across magnitudes also resemble similar trends with respect to scenarios.

Figure 38 show the corresponding AUC values computed for the data represented in Figures 35, 36 and 37. This quantification confirms visual inspection conclusions in regards to differentiation between various scenarios and participants. *K*-Values for each data stream are represented in Table 4. Larger *k*-values are indicative of steep discounting. The diversity of the rates reported on this table confirms that different commodities elicit different rates of discounting.

The methodology in Study 5 has produced orderly and replicable data across the scenarios. In regards to the overarching goal of the dissertation, Study 5 provided the most powerful data to support the hypothesis that language impacts delay discounting. There are still issues to consider when interpreting these data. First, the illustrated curves across the delay spectrums contain variation that is not perfectly fit with a hyperbolic analysis. This is not surprising, given that most studies that report group hyperbolic results rely on a large number of subject to achieve that result. Still, more refinement could be done to approach the orderly production of single-subject discounting assessments.

Second, how realistic some of these scenarios are in relation to the subject pool is worthy of consideration. Like most discounting studies, this study relied on self-reported subjective devaluation. When interpreting these data, it is impossible to validate the likelihood that if posed with a situation like the one described in the task, the individual

would actually behave in similar ways. This is especially interesting to consider when the curves for various types of decisions are so different.

The final component to consider in regards to studying this method of collecting discounting data is the study of losses. In this dissertation, the study of losses only was done in Pilot Study 1. The reason for this is that losses are a much more complex process, and prior to measuring how individuals approach losses, it was important to refine the methodology. Given that Study 5 showed stable, powerful effects of the experimental variable, a justification to study losses using the FITB method emerged.

Study 6

The final study of this dissertation seeks to investigate if the FITB method can serve as an assessment tool for the measurement of delay discounting of losses. Study 5 showed promising progress for an effective way to measure single-subject discounting rates. The current study replicated the procedure of the previous study to investigate the role of the language on delay discounting of losses.

Setting, Apparatus, and Participants. Experimental conditions and recruitments were identical to Study 5. For this procedure, four subjects were recruited. One of these subjects did not qualify due to speedy completion. Average completion time for this procedure was 35 minutes.

Procedure. The ATD was used in the modified version of the FITB to investigate losses. The general procedure was identical to Study 5, with the major difference being the type of question posed to each participant. For the current investigation, participants were asked to make decisions about money to be paid rather than money gained. Losses

assessed were a control condition, a carbon tax, and money owed by the participant. The exact wording of the procedure is listed in Appendix H.

Program design of Study 6 involved a careful examination of the experimental variables on the part of the lead researcher. Given that the loss condition involved a more complex process and difficulty hypothesizing how individuals would respond to the current investigation, only two magnitudes were examined ($100; $1000). It is interesting to note that the average completion time for the current study was longer than Study 5, which investigated more magnitudes. This further supports that discounting of losses is a different and more difficult process than discounting future gains.

Study 6 Results and Discussion.

Figure 39 displays the discounting results for the $100 condition for all three participants in Study 6. Note that two participants indicated that they would always pay the maximum amount, despite the option of deferring the amount until a later date. This is in accordance with earlier pilot work, as some participants in Pilot Study 1 showed similar responding. The other participant discounted the loss only on the money-owed condition.

Figure 40 displays the discounting results for the $1000 condition. Here more differentiation is observed across the different scenarios, indicating an experimental effect. The loss language did not seem to alter the behavior in any predictable manner, but rather, seemed to elicit different responses by different individuals. Quantitative differentiation is confirmed by examining the calculated AUC and *k*-values located in Table 5. Little to no differentiation is observed in the $100 condition across participants.

The $1000 condition contains more diversity across subjects, indicating an experimental effect.

Green and Myerson (2010) note the complexity of losses with discounting methodologies. It is possible that a sophisticated measurement system used to detect losses has not been yet developed by researchers. The current methodology detected some differences with how individuals discount large losses, but the methodology failed to detect any differentiation with small losses. It could be that all participants in this study were debt averse. In examining the AAQ scores of the participants, all participants had commonality in flexibility scores (see Table 5). Still, the similarities in AAQ scores do not fully explain the differences observed in the larger magnitude. These findings present opportunities for future research to explore the role of psychological flexibility and aversive decision making.

The methodology employed here may not have been well-suited to make an informed decision about losses. The scenarios in the loss condition may have been perceived as unusual, which in turn may have elicited in unique responding on the part of the participant. Regardless, a level of experimental control was still observed, indicating that this form of investigation should be replicated. Provided these data, the measurement system employed here may exercise utility only in gains scenarios. The use of the FITB with losses may need further refinement.

GENERAL DISCUSSION

The collection of six studies included in this dissertation highlight several points of discussion. The primary aim of this project was to approach a comprehensive understanding of the role of language in delay discounting tasks. After completing these series of experiments, we conclude the frame of the discounting task can alter the observed discounting rate and the effects vary across individuals.

The nature of delay discounting involves the participant allocating a subjective devaluation to reduce the current value of a particular commodity. As observed in these procedures, the devaluation demonstrated by participants occurred at different decay rates as a function of how the task was framed to the participant. This is an interesting finding with respect to delay discounting, as few studies have examined the role of language manipulations with commodities that have the same functional outcome.

The fill-in-the-blank (FITB) task used in this study presented a potential useful technique to study individual discounting rates. This is promising for several reasons. Traditionally, discounting research relied on large group sizes to detect changes in behavior. As this project shows, analyzing individual discounting data is difficult, as slight variations in procedural elements of the discounting task can alter the observed rates. Individuals are also variable in the rates that they report, which can be problematic when designing new measurement techniques. The FITB task designed to study discounting rates yielded orderly data across different scenarios which mimic results shown in the binary choice condition done in this study (Pilot Study 1).

To account for the variation observed across different variations of scenarios, several postulates are worthwhile of discussion. From a radical behaviorism perspective (Skinner, 1978), the differentiation observed across the different variations of the task could potentially be explained by stimulus control, whereas components of the decision, or the words describing the decision, exert some control over the individual's discounting behavior, and further influence the rate at which the commodity is devalued. This notion is intriguing, but problematic when considering the reinforcement history of the subject pool. The subjects in this study may not have had direct contingency experience with various scenarios described in this task, and may be behaving in regards to probable behavior.

Skinner (1957) discusses the autoclitic as a verbal operant that modifies other components of verbal behavior. For example, if someone was reading a newspaper and says to a listener, "I see it will snow today," the modifier at the beginning of the sentence (I see) informs the listener of the strength of the context described in the sentence. Skinner (1957) also notes that autoclitics may serve as a mand ("verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the control of relevant conditions of deprivation or aversive stimulation" (pp. 35-36)). In a business proposition, a speaker may ask an individual to *assume* a particular context or scenario. Skinner (1957) notes that "(a)n autoclitic affects the listener by indicating either a property of the speaker's behavior or the circumstances responsible for that property" (p. 329). The utility of the autoclicitic in a functional analysis of verbal behavior is that the operant in itself has the ability to alter the strength or properties of the other forms of verbal behavior emitted by a speaker.

Appeal to autoclitics can account for the modifications made to discounting behavior as a function of the different scenarios posed in the current investigation. In several of the studies included in this dissertation, clear differentiation is observed across discounting rates as a function of the language. It may be the components of the scenarios describe a context that modifies the behavior of the listener. The data in this study suggest if such modifications do occur, they do not do so in a uniform, predictable manner or direction. This would support a Skinnerian account as history of individual reinforcement is likely an important factor to consider in the prediction of discounting. It is difficult to identify the modifying component of the statements used in this study as the independent variables were not subjected to that level of deconstruction. Future research should investigate more simple verbal labels and investigate the modifying role that less complex verbal labels may elicit over discounting responses.

Another explanation of the differentiation observed in these experiments across scenarios could be explained by Relational Frame Theory (Hayes, Barnes-Holmes, & Roche, 2001). RFT explains verbal behavior as complex relational responding whereas the strength of the response is indicative of the strength of the relationship. In the current circumstance, RFT would predict that different types of decisions involve different types of relational frames (coordination, opposition, spatial, etc). For instance, decisions about taxes may elicit different types of relations in regards to taxes, which may influence the discounting rate of the individual. An RFT approach suggests if a researcher could manipulate the functional verbal relationships evident in an individual's verbal repertoire, it may be possible to indirectly manipulate other items in the relational frame. For example, if an individual displays steep discounting in the money-owed condition, and

more stable decay rates in other scenarios, equating stimuli associated with the money-owed frame (establishing or strengthening a frame of coordination with respect to this condition) to the other scenarios might directly impact the discounting rate of the participant (see Dymond & Rehfeldt, 2000 and Hayes, Kohlberg, and Hayes, 1991). Future research should continue to investigate equivalence relationships and discounting as potential interventions to alter discounting.

With respect to RFT and discounting, targeting impulsive behavior through modification of verbal relations would yield clinically significant outcomes with verbal populations. Researchers targeting impulsivity may find clinical utility in manipulating verbal relations and establishing frames of comparison and coordination with impulsive behaviors. For example, training *more money tomorrow* is greater than *less money today* and *saving is good* might have the potential to limit impulsive behavior. This is similar to some of the theories Weatherly and Terrell (2010) postulate in regards to domains. In this theory, individuals discount domain specific items in similar ways. Intervening on one item in the domain might influence the discounting rate of other items in the domain. Utilizing RFT methods to confirm domain arguments and manipulate discounting behavior under particular domains is an exciting opportunity for future research.

The AAQ failed to reveal any formal relationship in regards to predicting the likelihood or tendency of discounting behavior. There are some noteworthy results from this investigation involving the AAQ. Pilot Study 2 showed a small relationship between flexibility score and sensitivity to the intervention. Study 4 displayed individuals that did not respond to the language intervention. Visual inspection of these data confirms that most of these individuals had a higher AAQ score, but the data are inconsistent.

Opportunities exist to investigate how psychological flexibility may or may not be predictive of discounting behavior.

While the FITB procedure designed in this experiment yielded orderly responding, caution should be exercised with respect to replication. Each study had at least 1 participant that did not meet inclusion requirements and their data were discarded. Inattentive participants or their insufficient understanding of experimental protocols explain the failure to replicate, but regardless, the failure to produce a procedure that had high inclusion rates is a limitation worth considering while reviewing these data. Discounting research is difficult, and most studies investigating discounting rely on large participant pools to detect order. Moving forward, screening tools that detect suitable candidates for discounting research would be worthwhile to consider. Appeal to RFT and assessment of relational responding at the start of studies may be a solution.

A surprising finding was how small manipulations resulted in the drastic changes in observed discounting rates. In Study 4, the original design called for a controlled presentation of experimental scenarios. When presented so the shorter delays were presented first, participants engaged in steep discounting. Upon the phase change, the rate of discounting accelerated upwards. This finding can be explained by low setpoints established on the part of these participants. Still, when designing discounting studies, many details are important to consider. For the purposes of this study, randomization of the experimental materials resulted in more orderly responding. However, investigators measuring other forms of discounting behavior not involving money may not find similar results. Future research should focus on individual responding and variations of the discounting task.

A strong advantage of single-subject methodology over the more typical large group designs used to investigate discounting is more intimate analysis of participant responding. The data from this project confirm unique patterns of responding across different individuals obscured in the large group designs. Some of the more interesting statements generated from this study result from observing individual peculiarities and the different rates correlated with the verbal stimuli. These findings would have been lost if the data were aggregated in a large n-size study and the group averages mask the interesting variations in individual's behavior. However, given the variety and diversity of responding, an argument can be made that larger replications are warranted in order to achieve a level of statistical significance. This was not a priority for the current investigation as an exploration of techniques and recommendations for single-subject comparisons were the primary analytical goals. Large n-size replications may reveal more powerful effects or reveal subtle correlations not detected in the current study regarding demographic information and discounting behavior.

Individual responding on the delay discounting task present a diversity of quandaries and potential research opportunities. The advantage of studying the role of language on discounting behavior is that the issue is primarily human and findings have broad implications for many important social phenomena. Replicating these findings across species would be difficult to establish, especially when considering functional verbal histories of human participants. Still, techniques that remove complexity and create more controlled environments to increase the confidence of the responses would be justified and inform refinements to human operant research.

Delay discounting is difficult to study and the investigations conducted in this dissertation explore methodological refinements that advance the contributions of previous work. Programmatic considerations like the experimental setting, characteristics of participants, frame of scenarios, order of trials and more determine the success of producing orderly data. The current dissertation attempted to establish replicable and functional measurement systems and evaluations that could potentially assist future researchers in exploring single-subject analyses of discounting. While more work is to be done, this project provides systematic and replicable groundwork necessary to progress the study of delay discounting. Through replication and further study, these methods may potentially produce other studies that target clinical utility and assessment. Further study in delay discounting is warranted.

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Figures

Figure 1

Hyperbolic vs Exponential Discounting

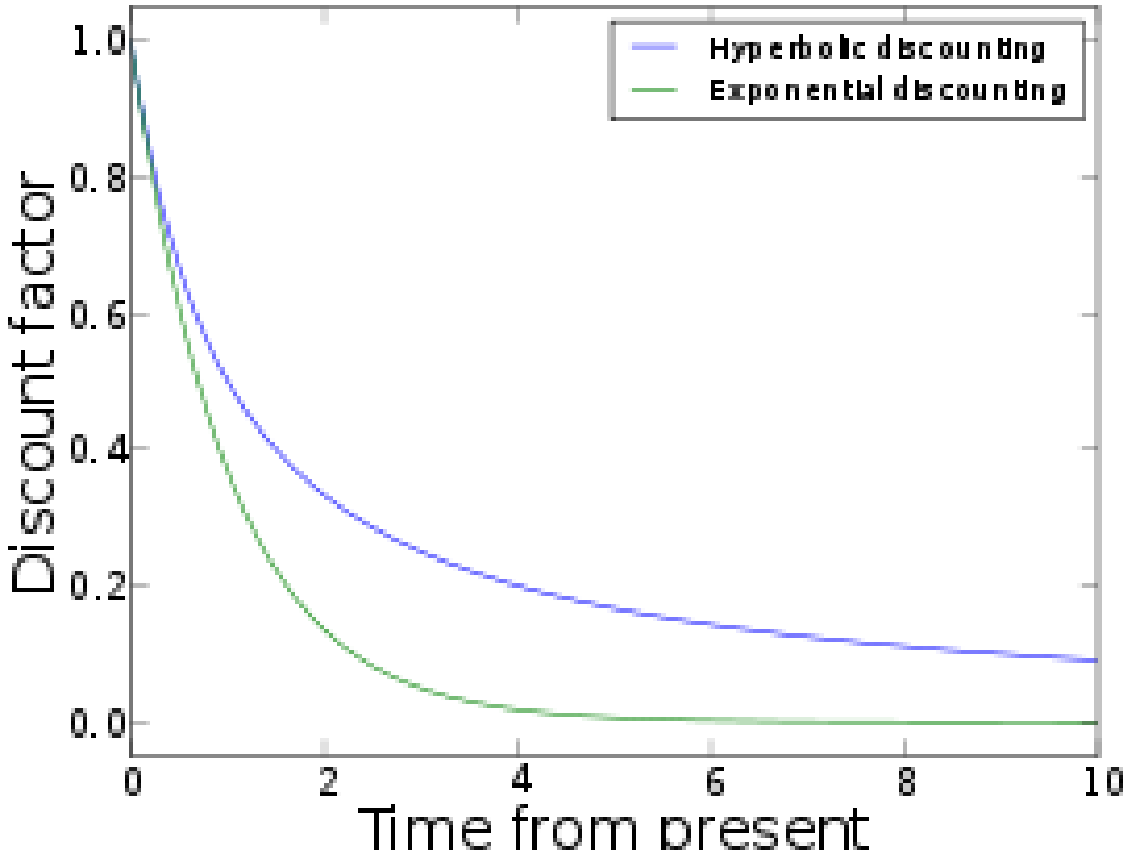

Figure 1: Hyperbolic versus exponential discounting functions across time. Figure taken from Myerson, Green, and Warusawitharana (2001).

Figure 2

Trapezoid Areas Calculated during AUC Measurement

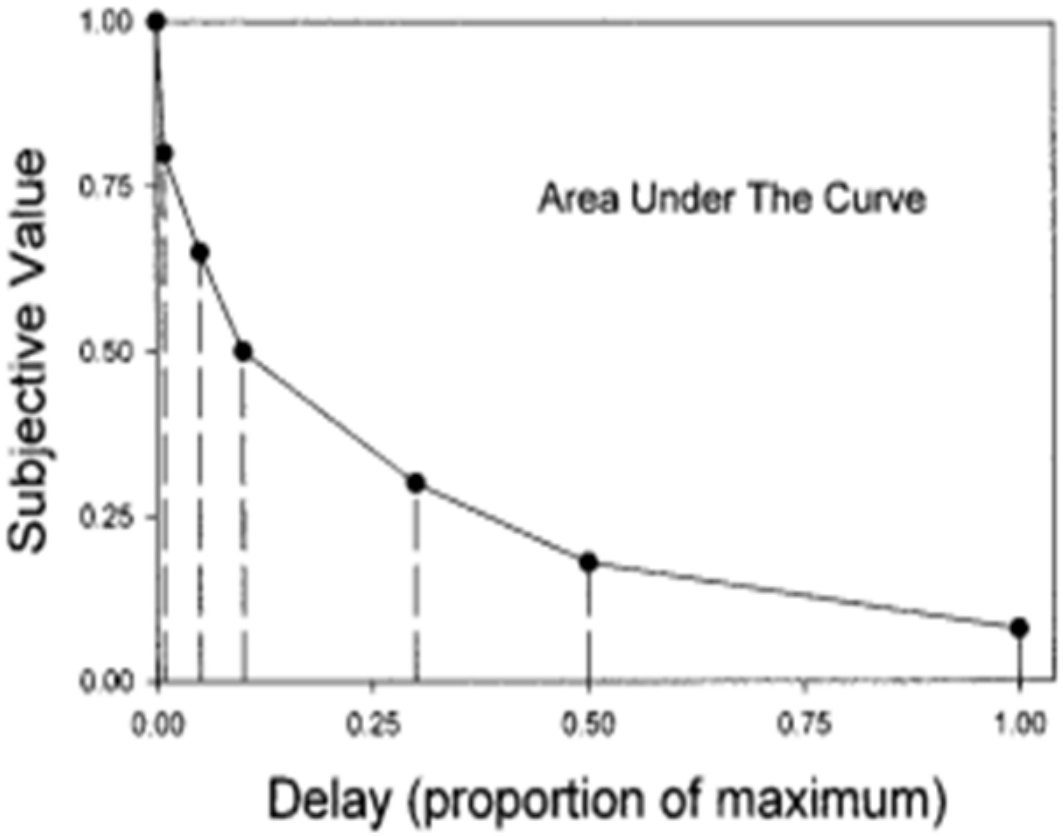

Figure 2. Procedure used during AUC calculation. A straight line is drawn done for each indifference point, and the area between each point is calculated. Then the sum for each trapezoid is calculated. Notice that both axes are standardized. Figure taken from Myerson, Green, and Warusawitharana (2001).

Figure 3

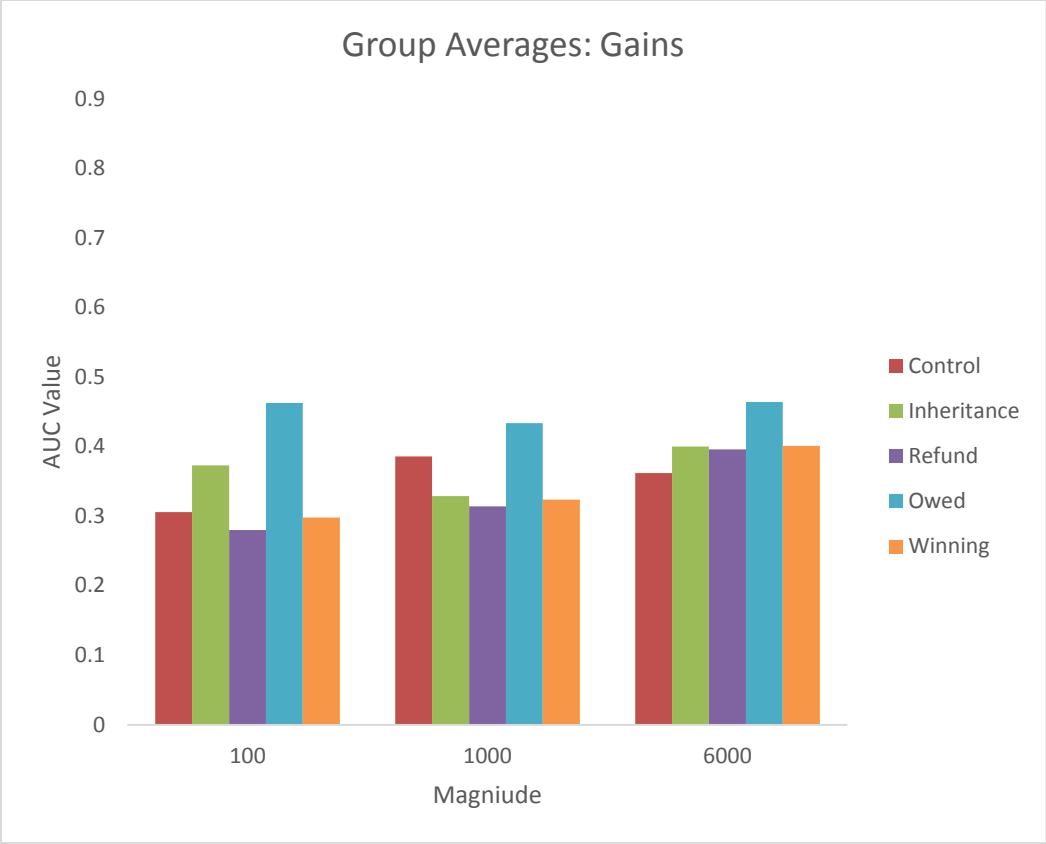

Figure 3. AUC Averages for 4 participants in Gain condition.

Figure 4
Individual Data for 2719

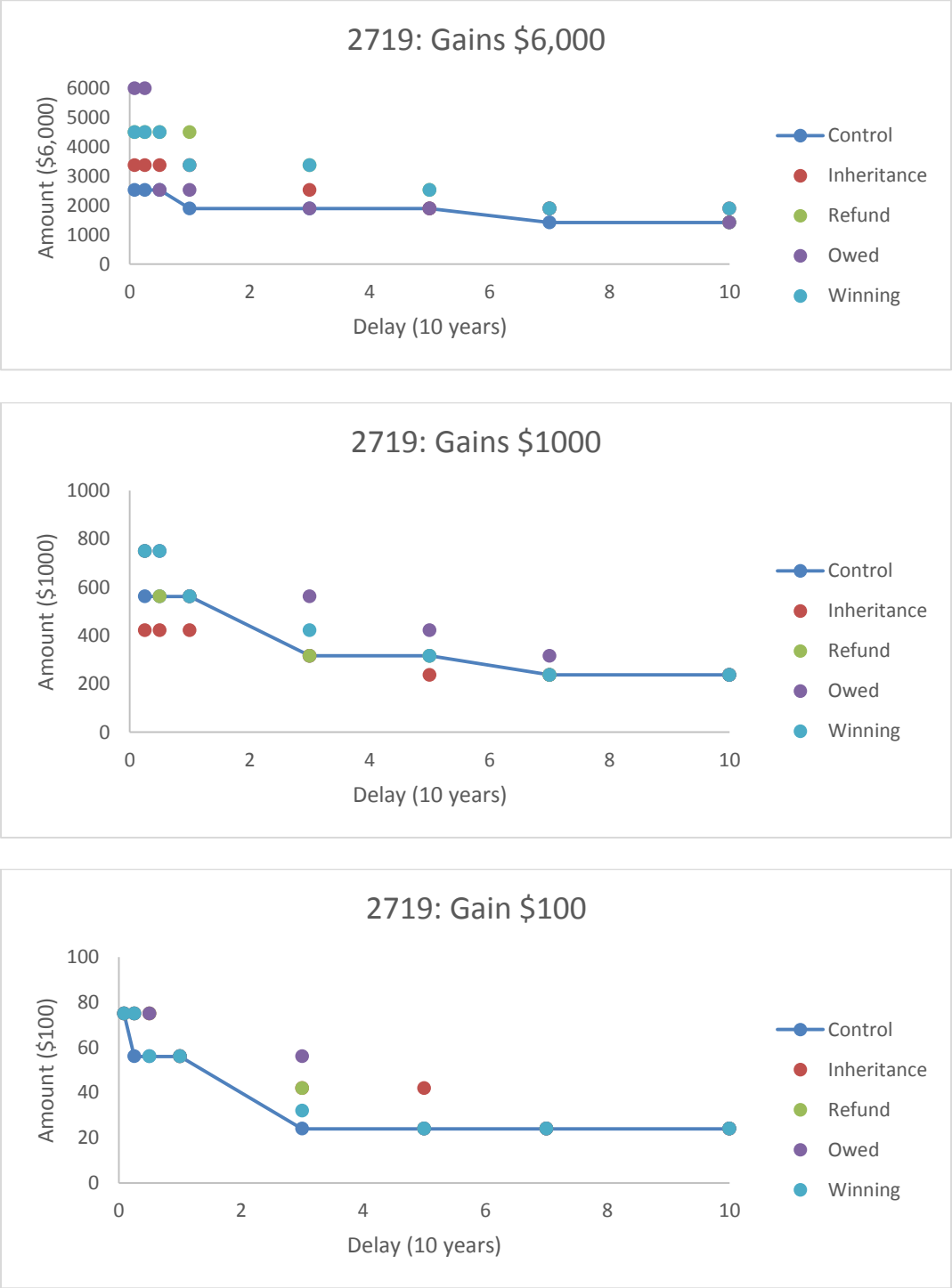

Figure 4. Individual data for Gain condition (Participant 2719).

Figure 5

Individual AUC Values for Gains Condition.

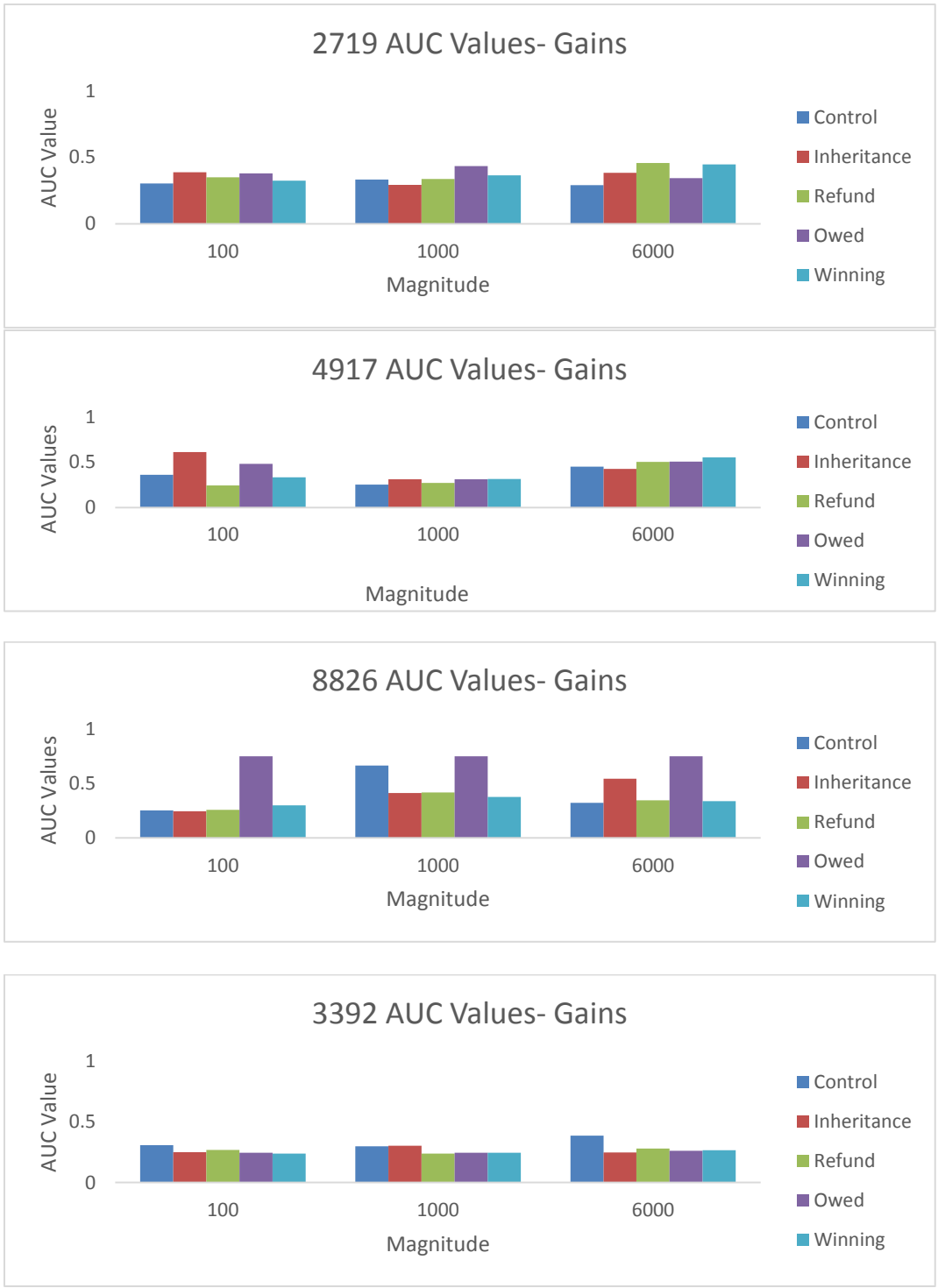

Figure 5. AUC values for the gains condition for each participant in Pilot Study 1.

Figure 6

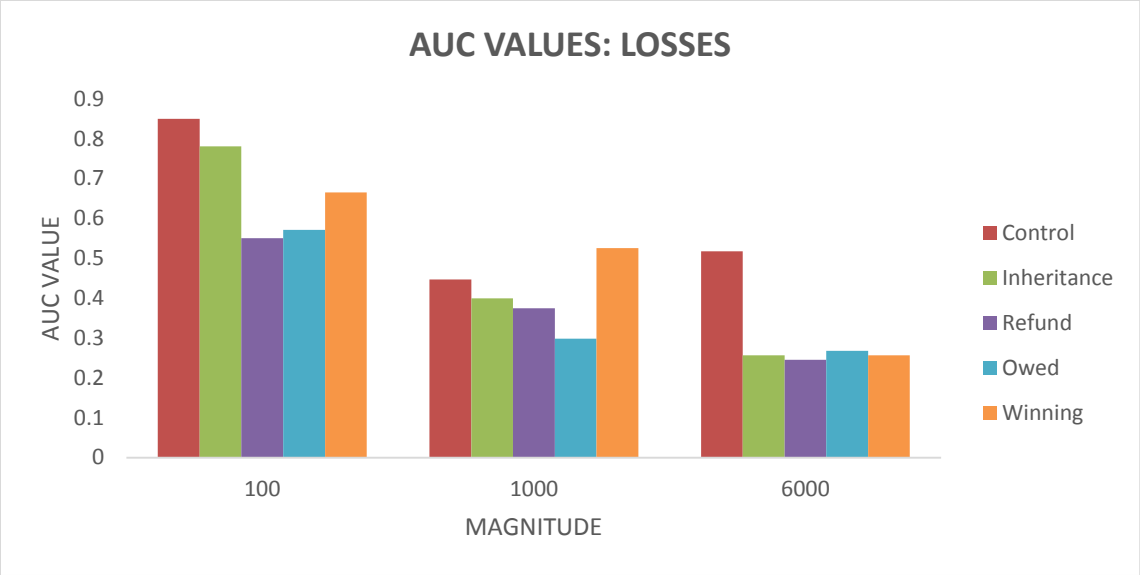

Figure 6. AUC Values for Loss Conditions.

Figure 7

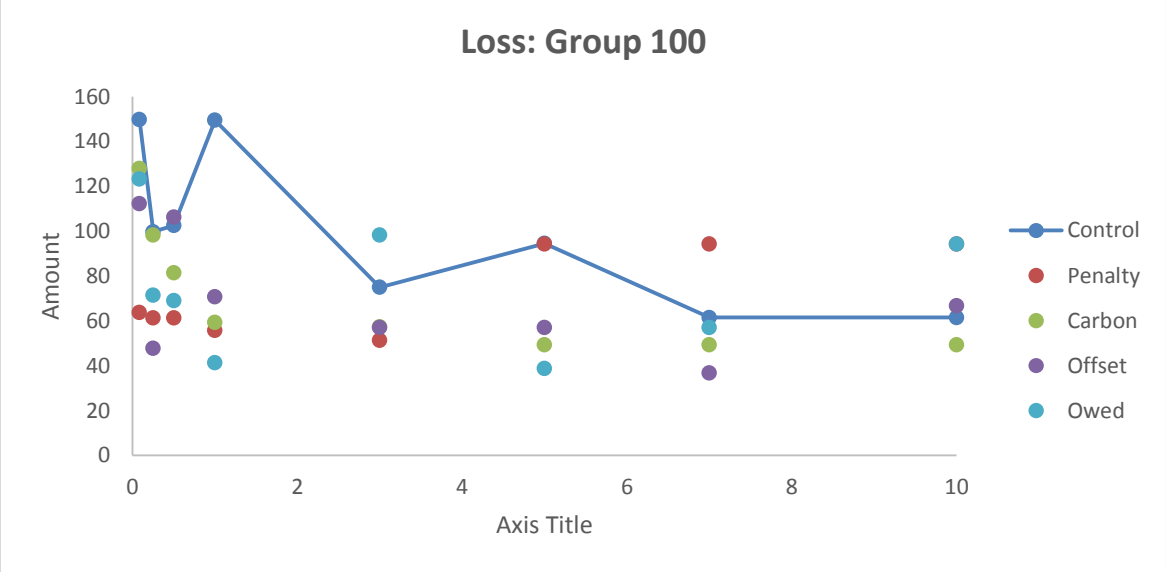

Figure 7. Aggregate Data for Loss ($100 Delay)

Figure 8. Individual AUC Values for Loss Condition.

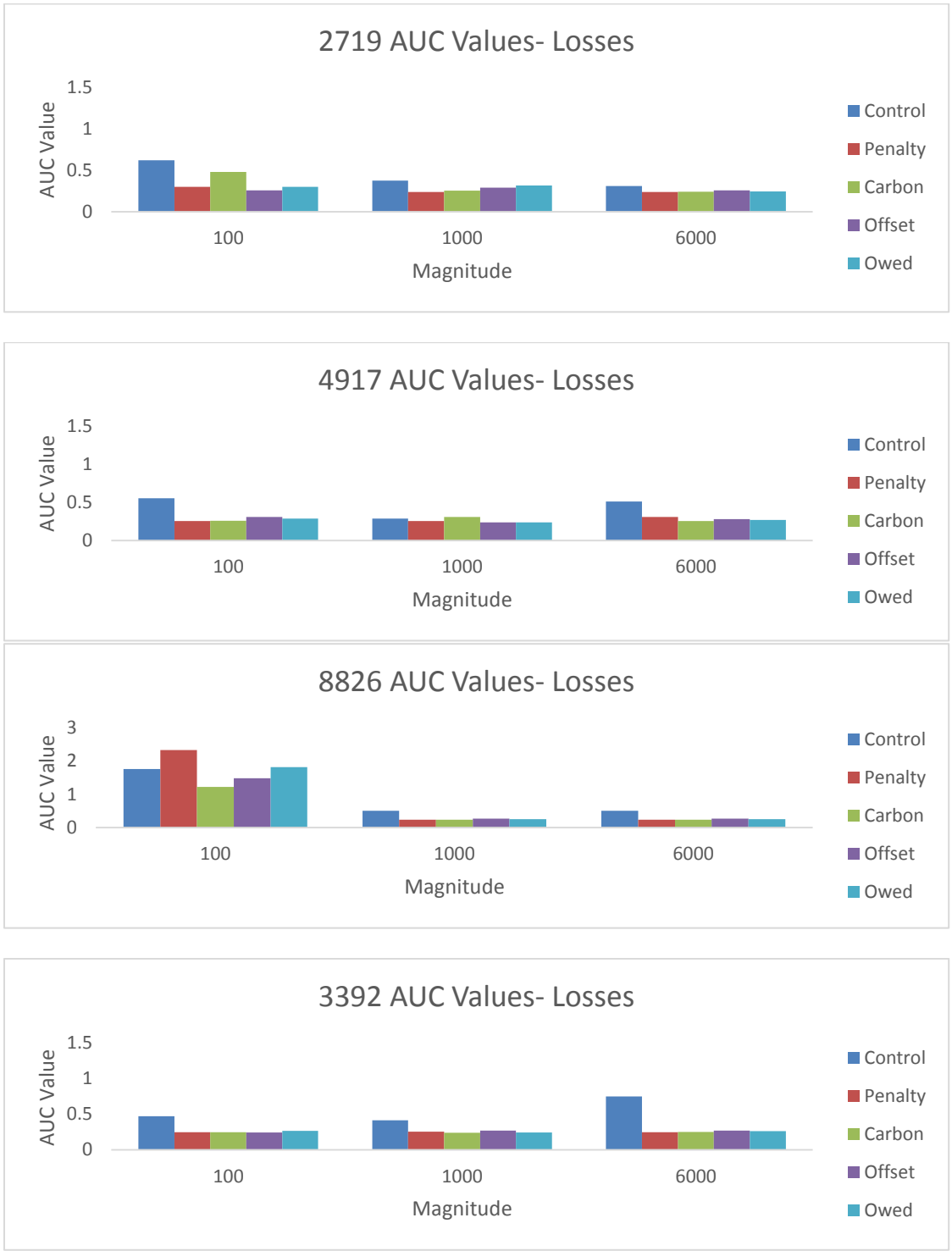

Figure 8. AUC Values for individual participants for the Loss Condition in Pilot Study 1.

Figure 9

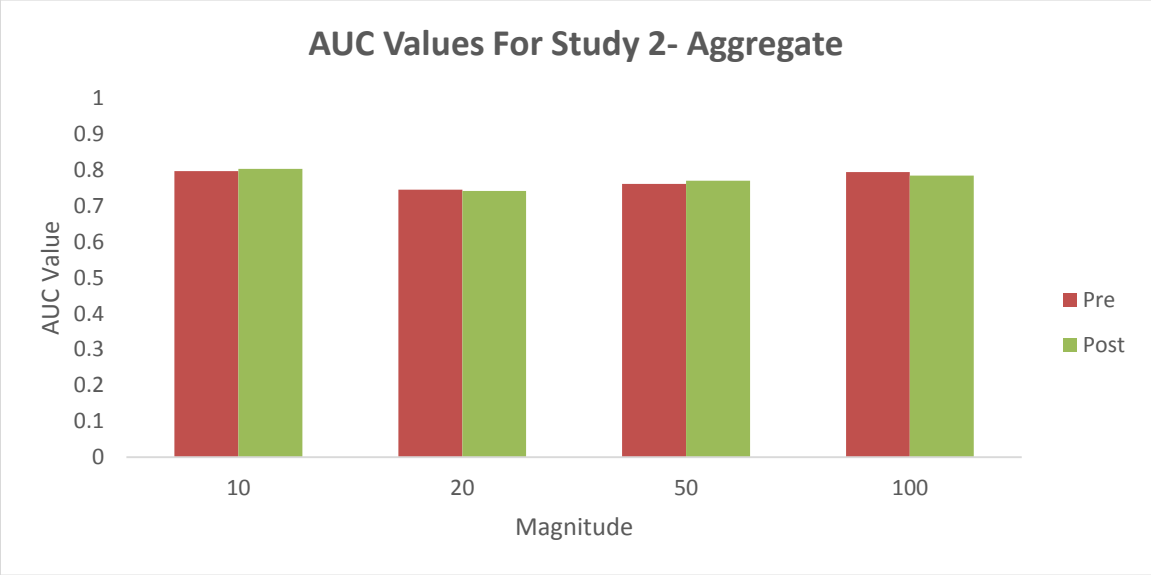

Figure 9. AUC Aggregate Values for Participants in Study 2.

Figure 10

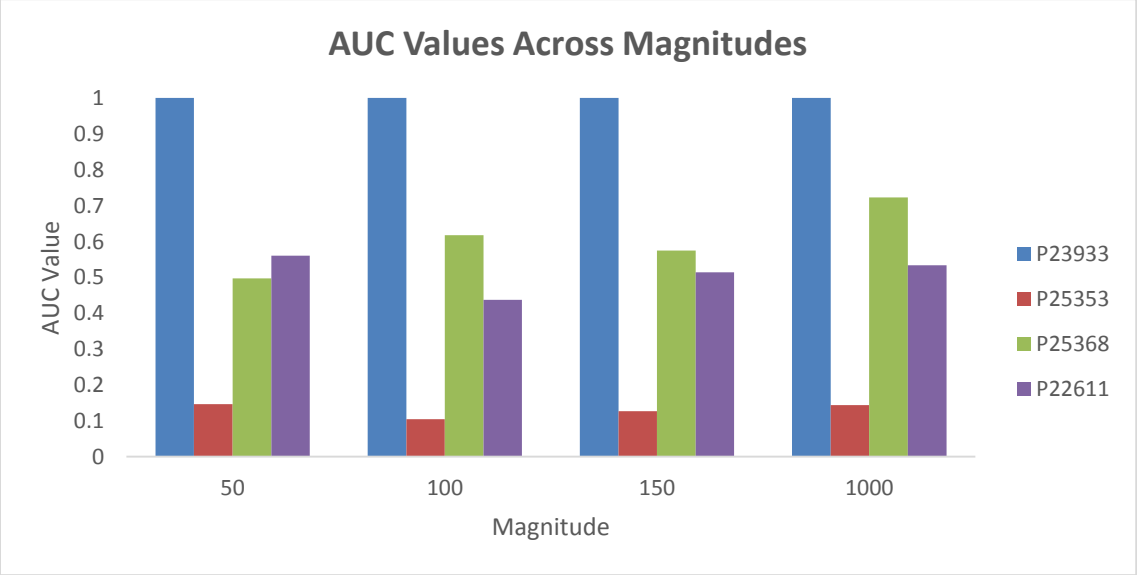

Figure 10. AUC Values across magnitude for 4 individuals in Study 3.

Figure 11

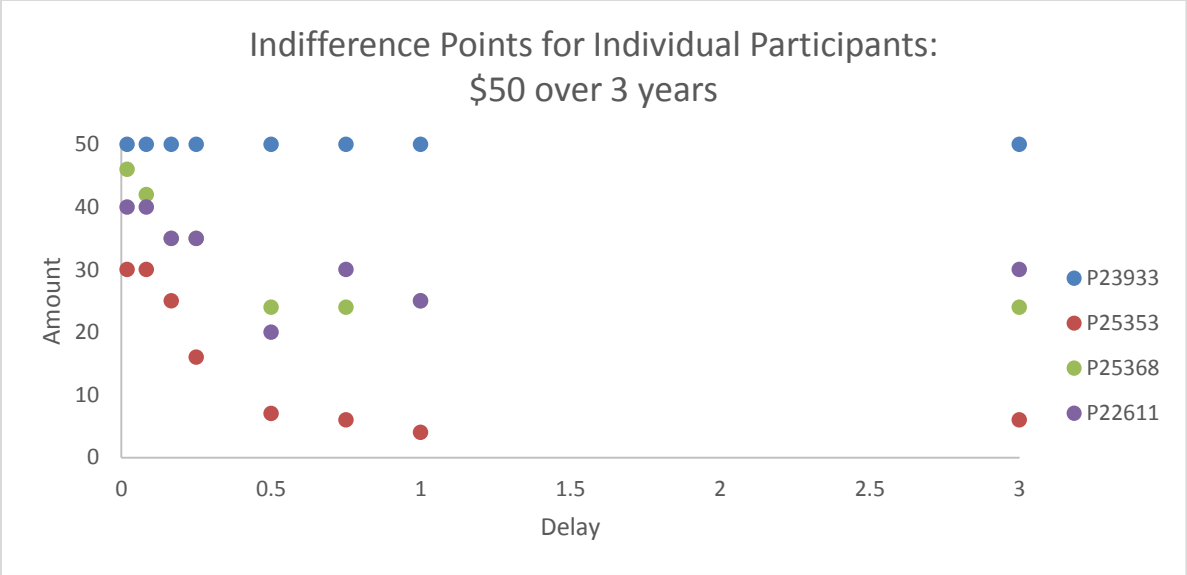

Figure 11. Indifference points for $50 across all participants in Study 3.

Figure 12

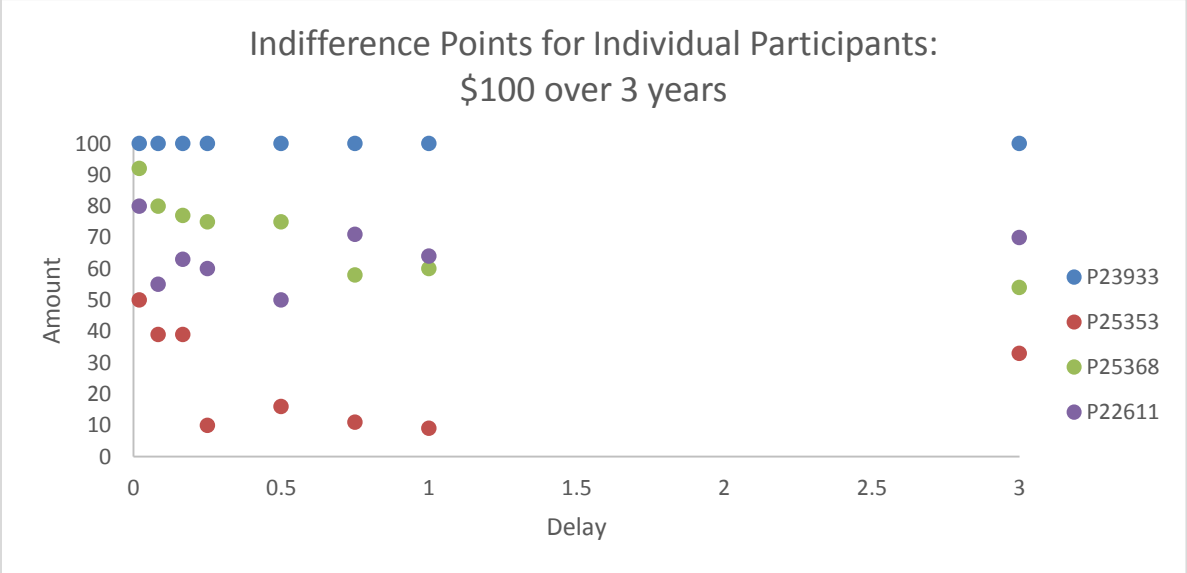

Figure 12. Indifference points for $100 across all participants in Study 3.

Figure 13

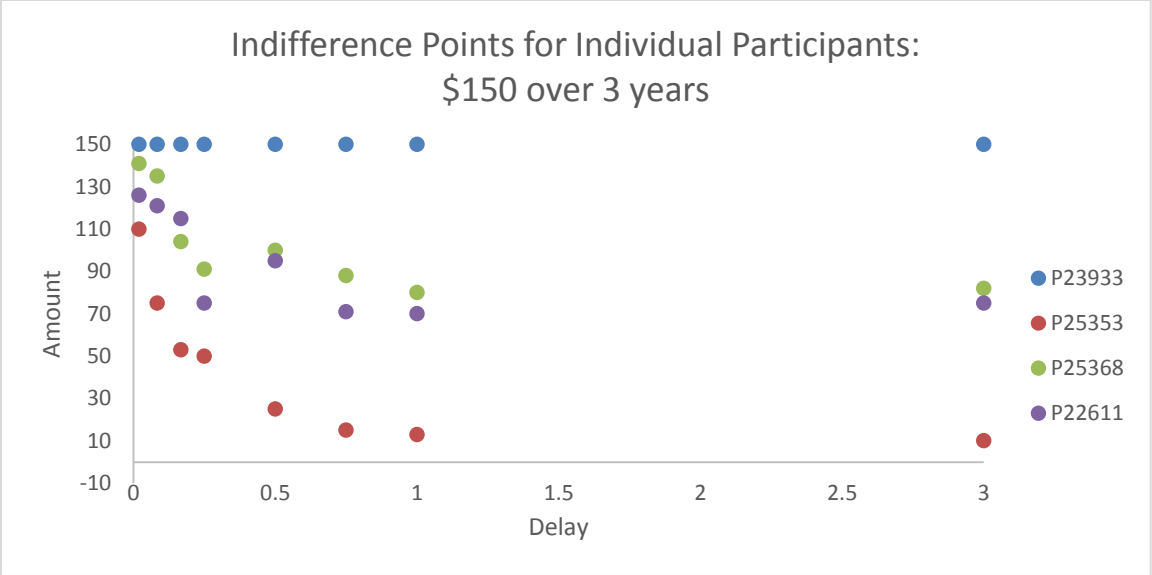

Figure 13. Indifference points for $150 across all participants in Study 3.

Figure 14

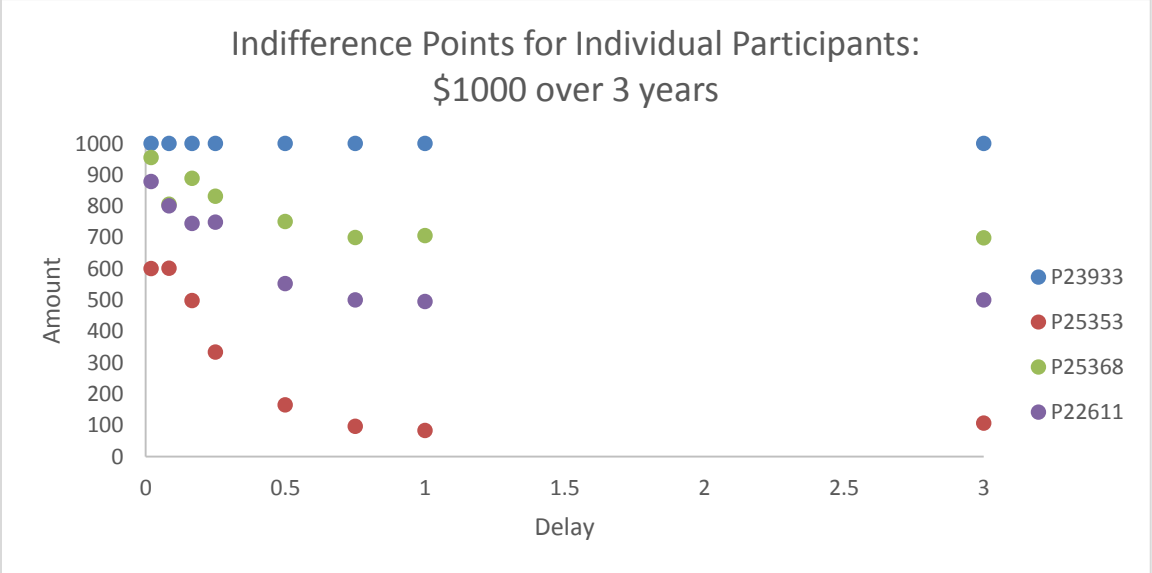

Figure 14. Indifference points for $1000 across all participants in Study 3.

Figure 15

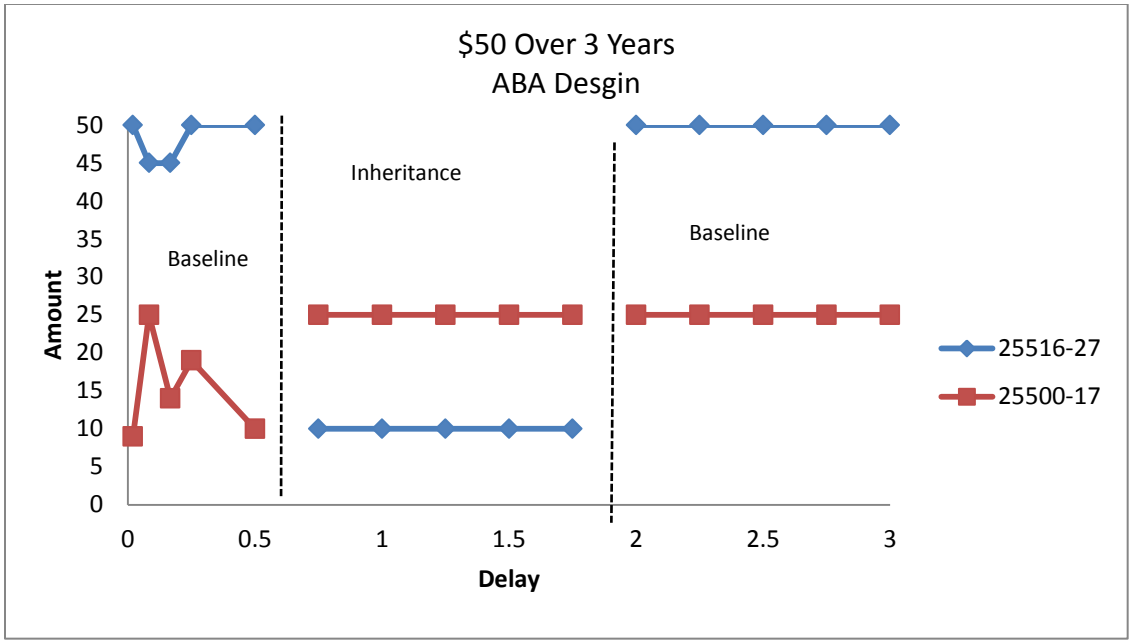

Figure 15. Discounting of $50 over three years for two participants in Part 1 of Study 4 (ABA).

Figure 16

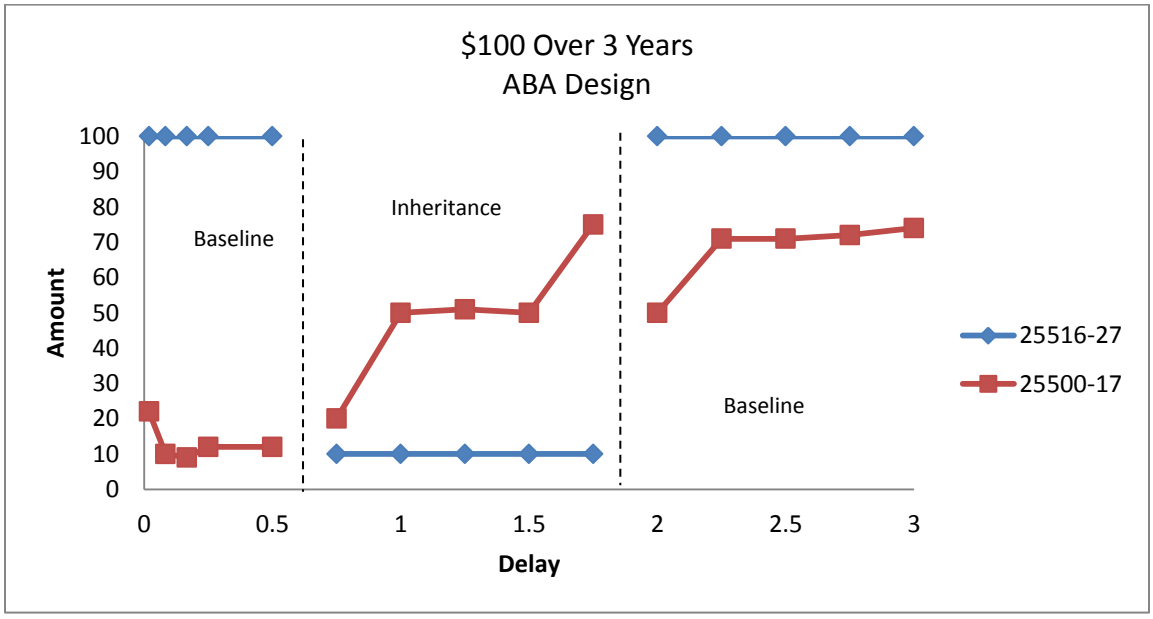

Figure 16. Discounting of $100 over three years for two participants in Part 1 of Study 4 (ABA).

Figure 17

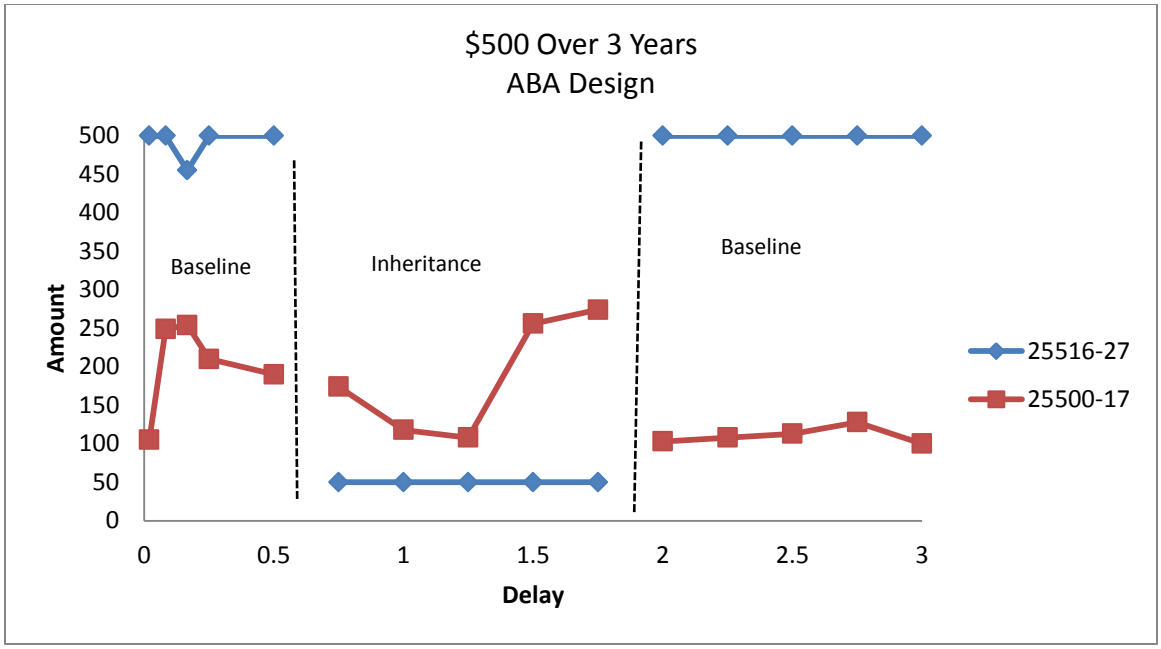

Figure 17. Discounting$500 over three years for two participants in Part 1 of Study 4 (ABA).

Figure 18

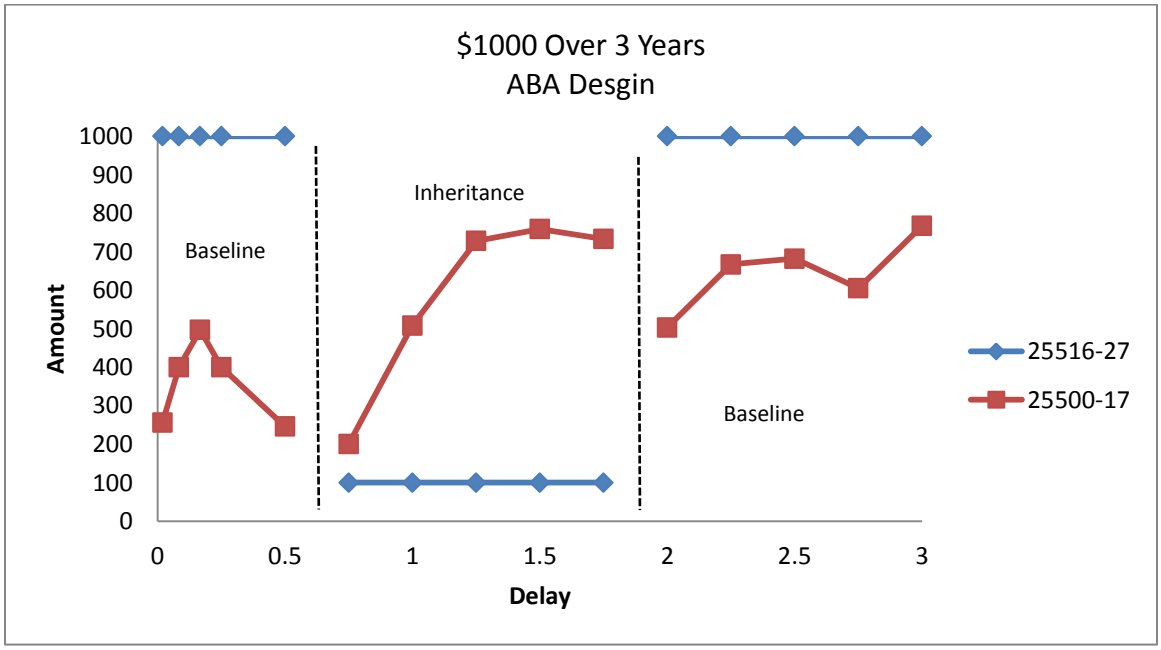

Figure 18. Discounting of $1000 over 3 years for two participants in Part 1 of Study 4 (ABA).

Figure 19

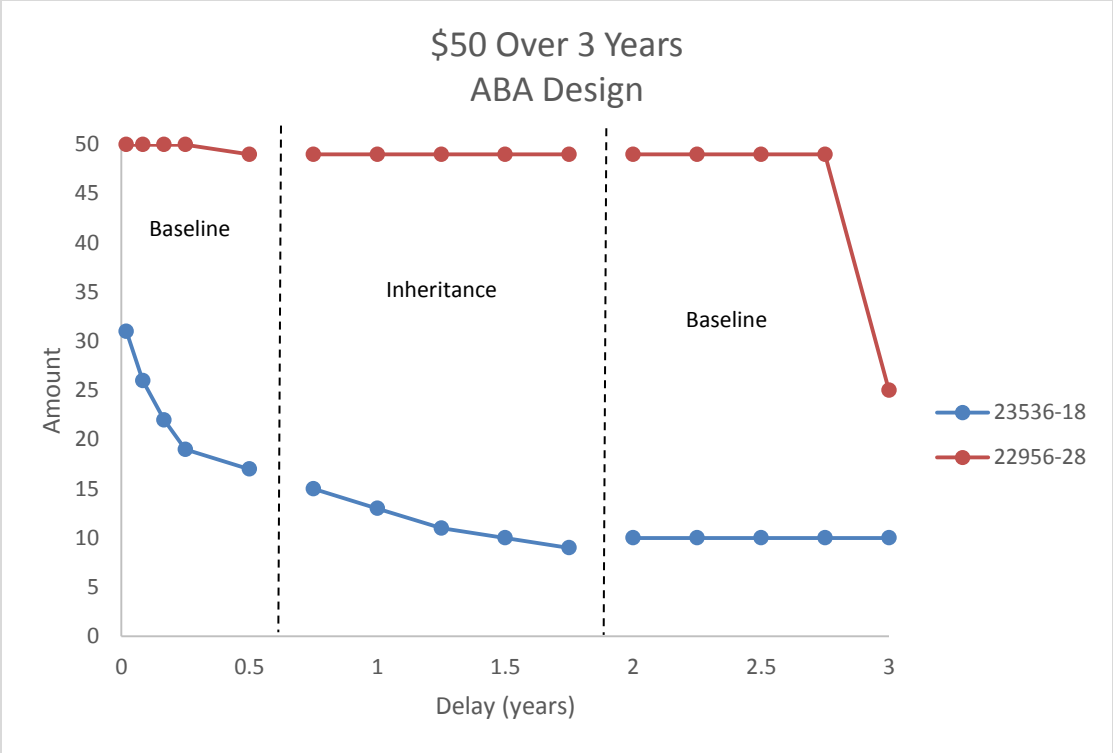

Figure 19. Discounting $50 over three years for two participants in Study 4 (ABA).

Figure 20

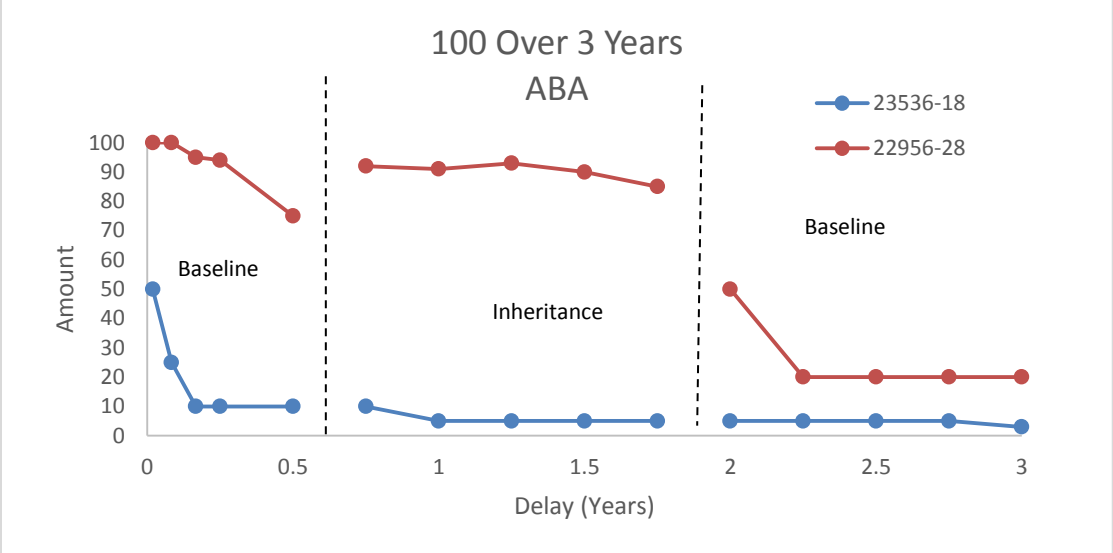

Figure 20. Discounting $100 over 3 years for two participants in Study 4 (ABA).

Figure 21

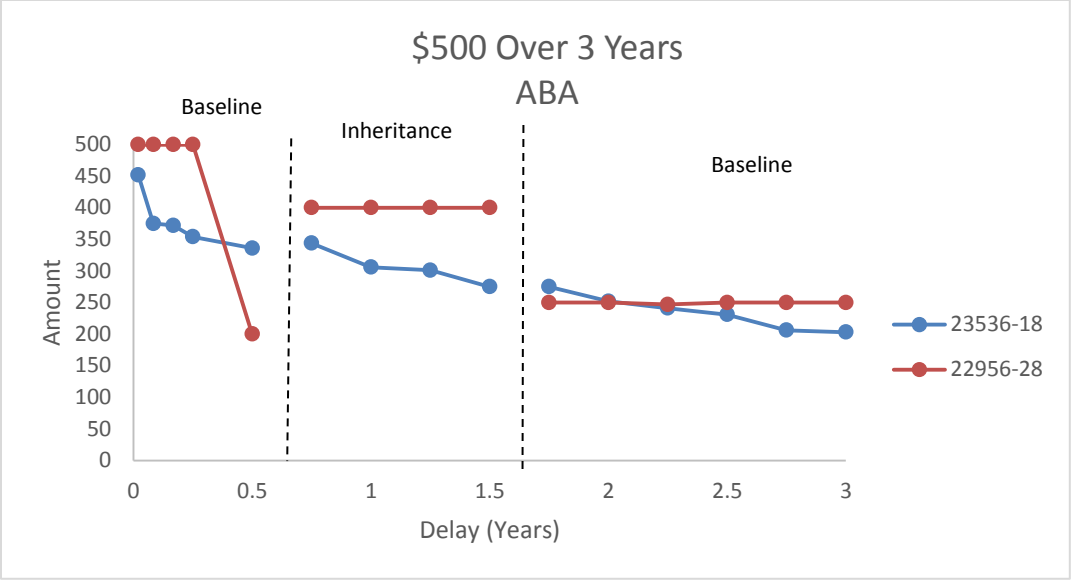

Figure 21. Discounting $500 over 3 years for 2 participants in Study 4 (ABA).

Figure 22

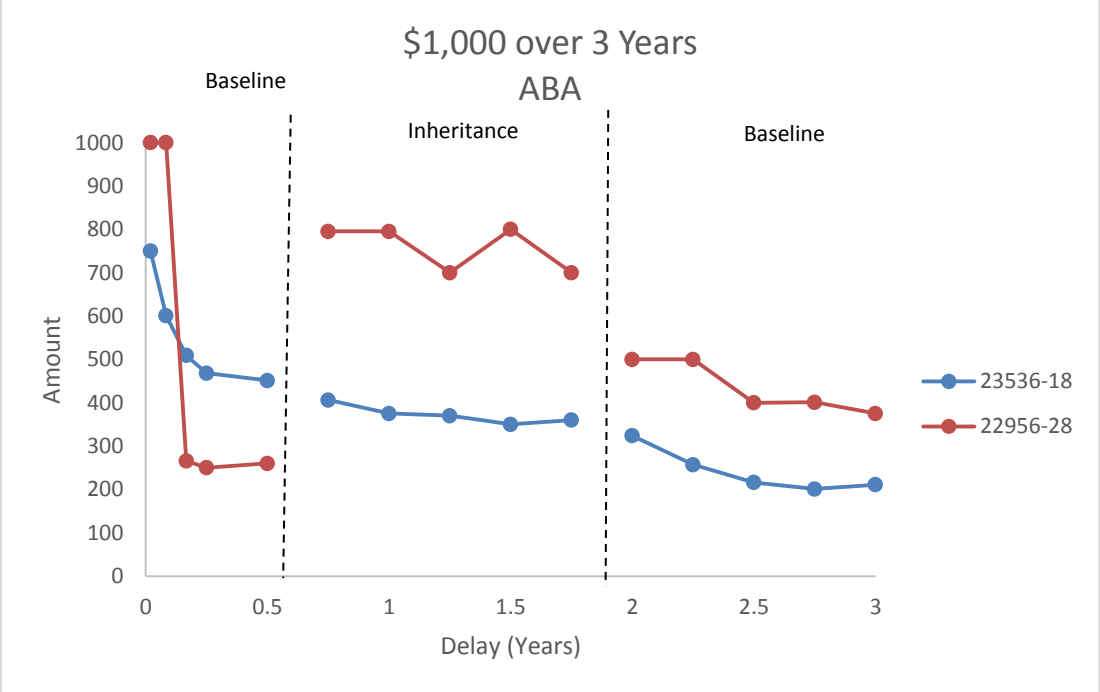

Figure 22. Discounting $1,000 over 3 years for 2 participants in Study 4 (ABA).

Figure 23

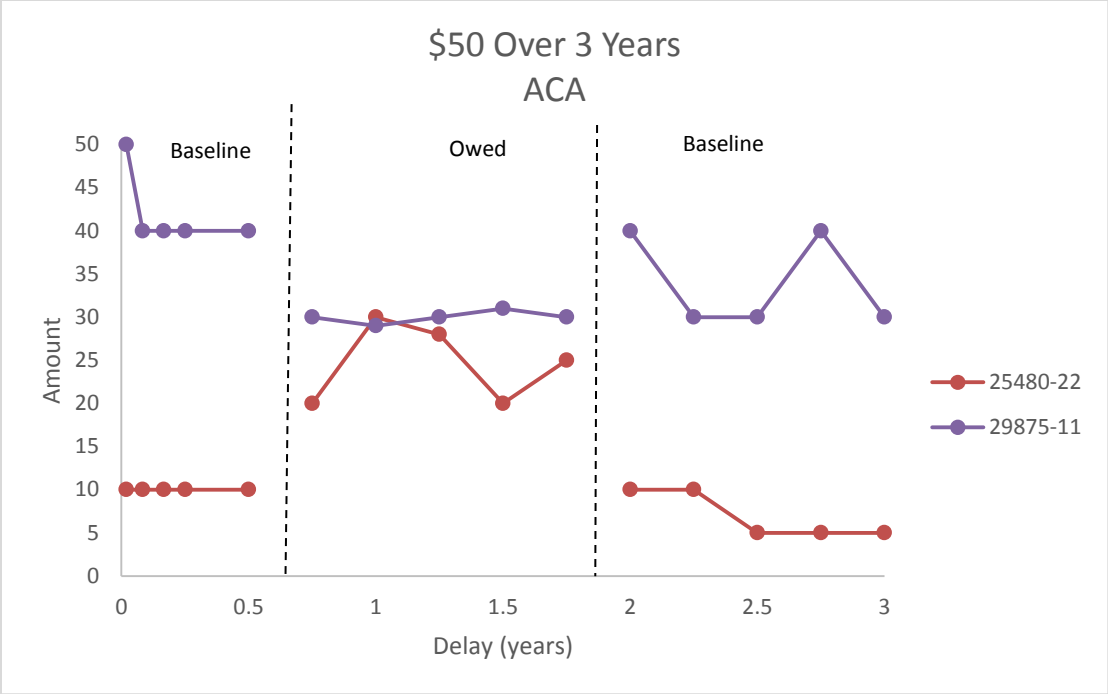

Figure 23. Discounting $50 over 3 years for 2 subjects in Study 4 (ACA).

Figure 24

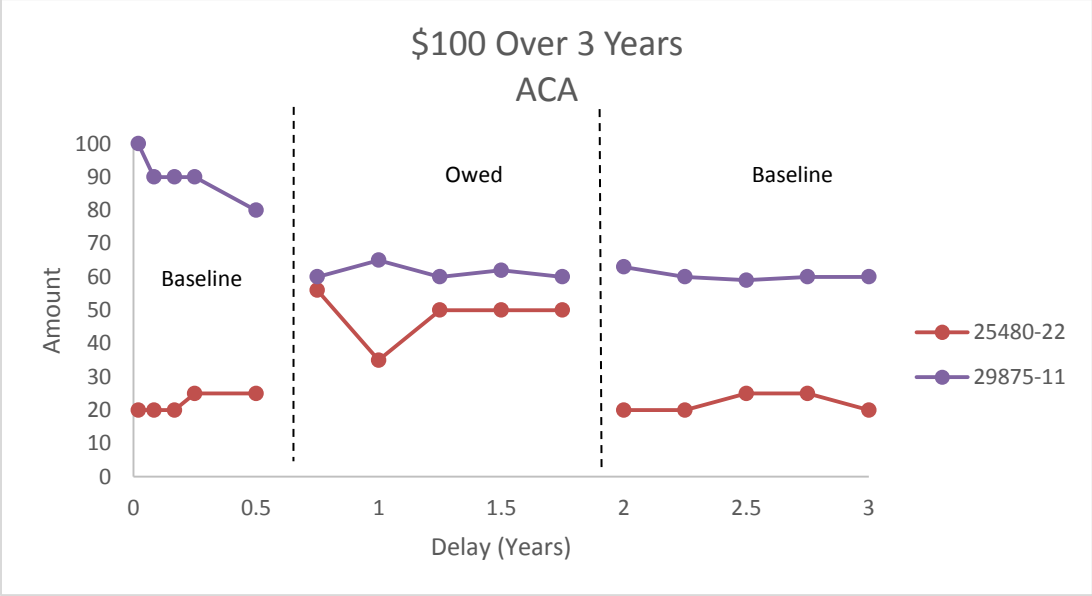

Figure 24. $100 over 3 years for 2 participants in Study 4 (ACA).

Figure 25

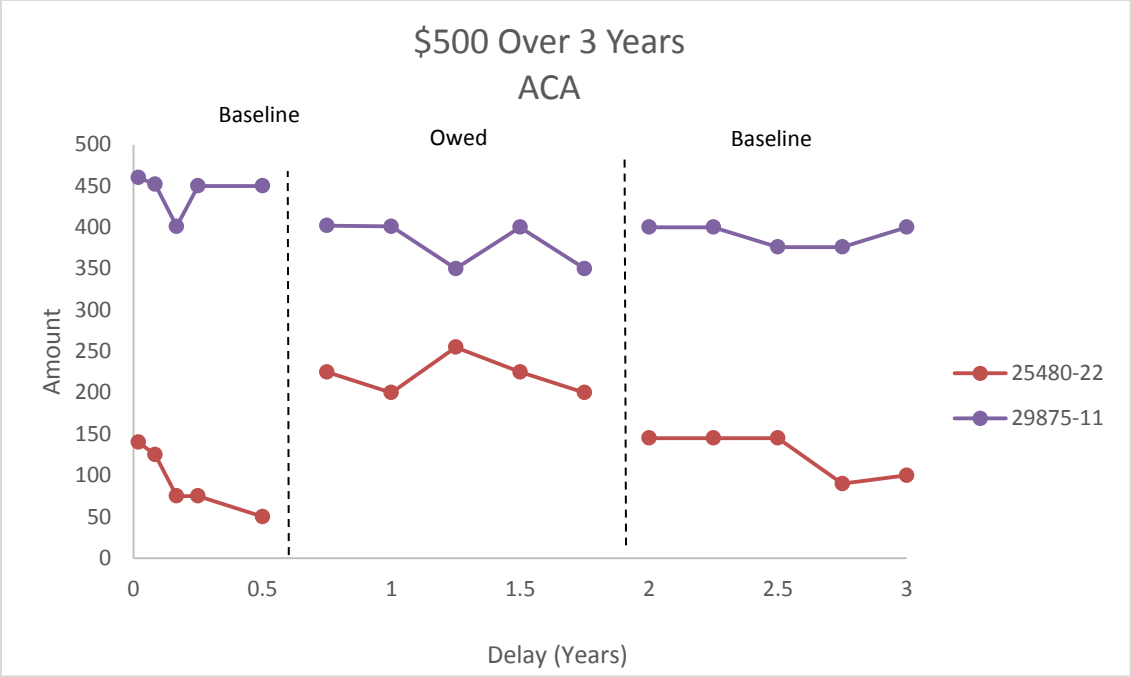

Figure 25. $500 Over 3 years for 2 participants in Study 4 (ACA).

Figure 26

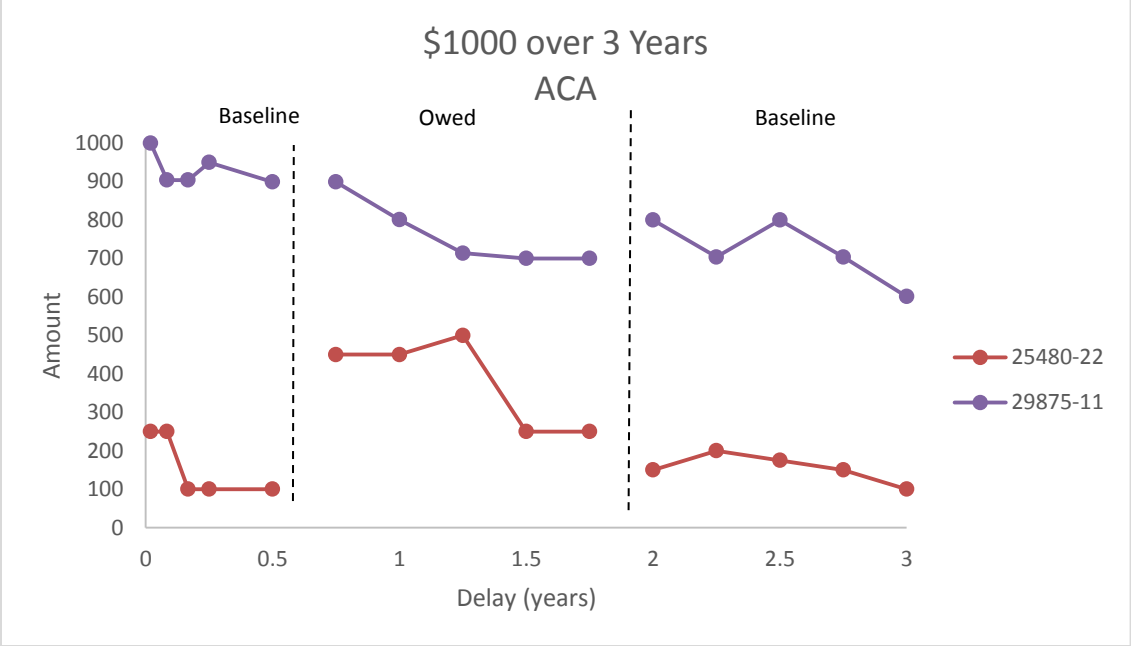

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Figure 27

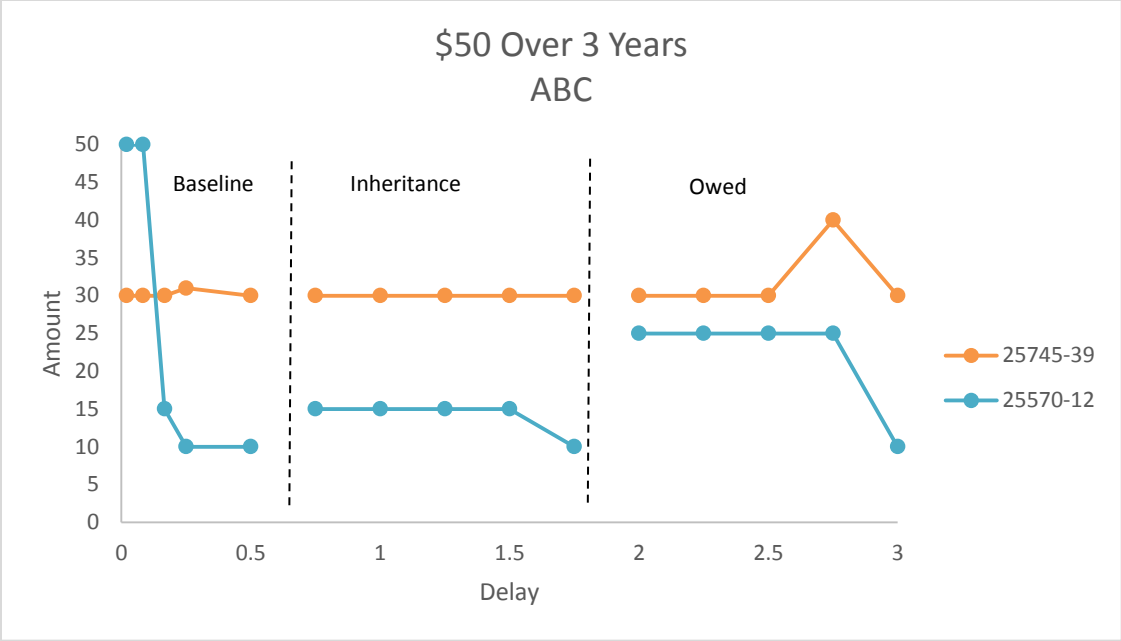


Figure 27. Discounting of $50 over 3 years for 2 participants in Study 4 (ABC).

Figure 28

Figure 28. Discounting of $100 over 3 years for 2 participants in Study 4 (ABC).

Figure 29

Figure 29. Discounting of $500 over 3 years for 2 participants in Study 4 (ABC).

Figure 30

Figure 30. Discounting of $1000 over 3 years for 2 participants in Study 4 (ABC).

Figure 31

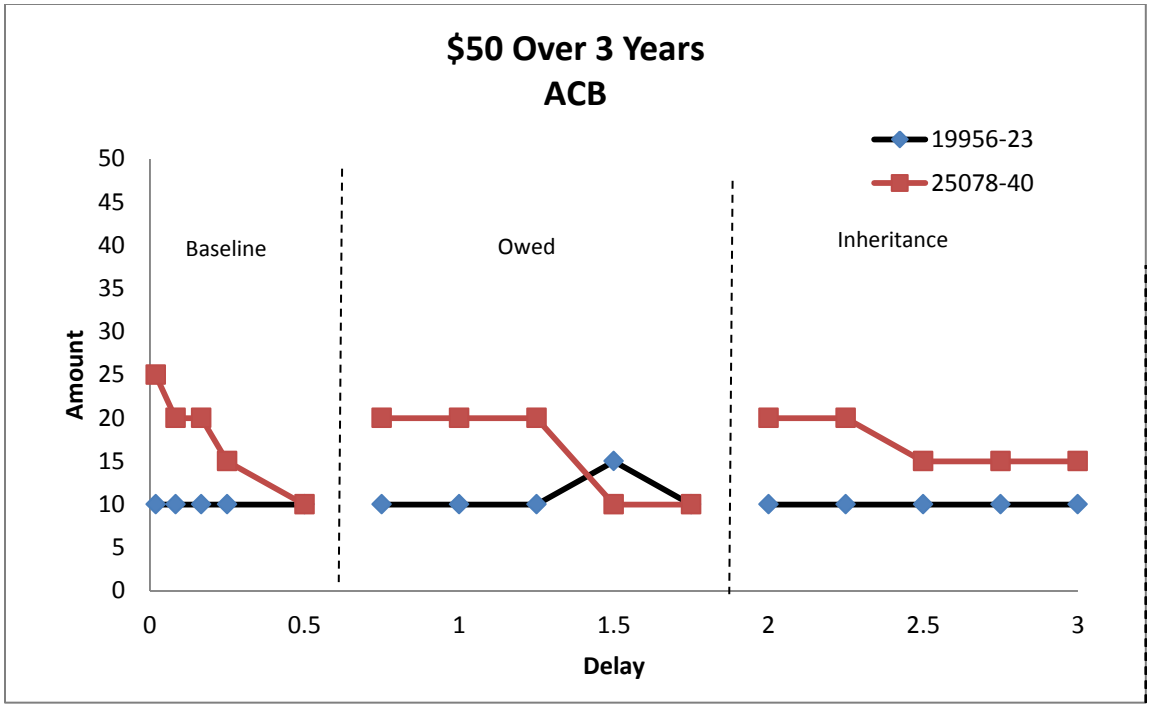


Figure 31. Discounting of $50 over 3 years for 2 participants in Study 4 (ACB).

Figure 32

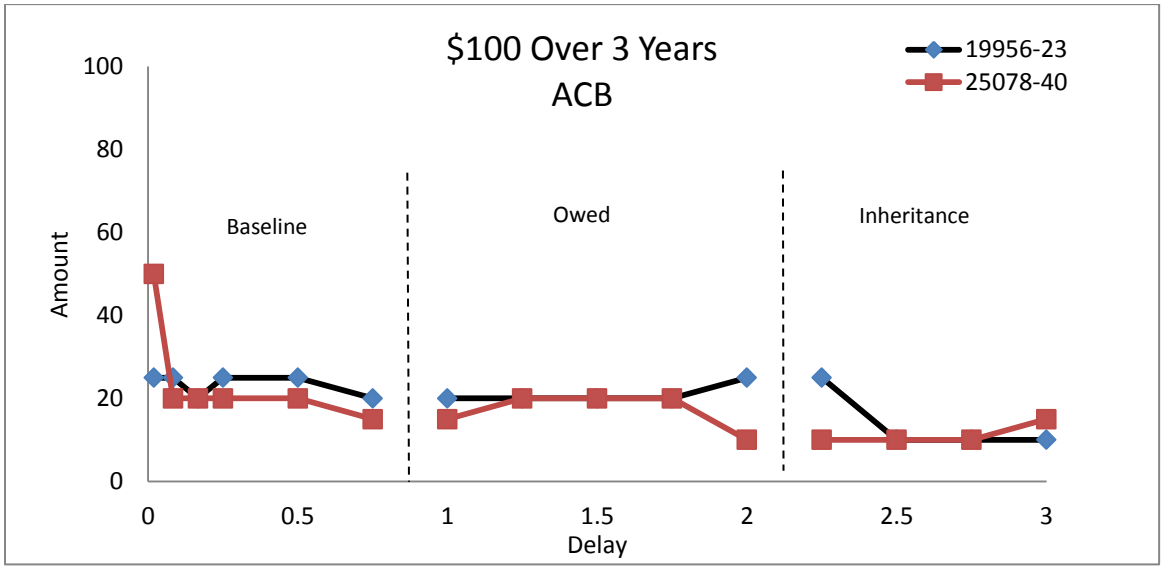


Figure 32. Discounting of $100 over 3 years for 2 participants in Study 4 (ACB).

Figure 33

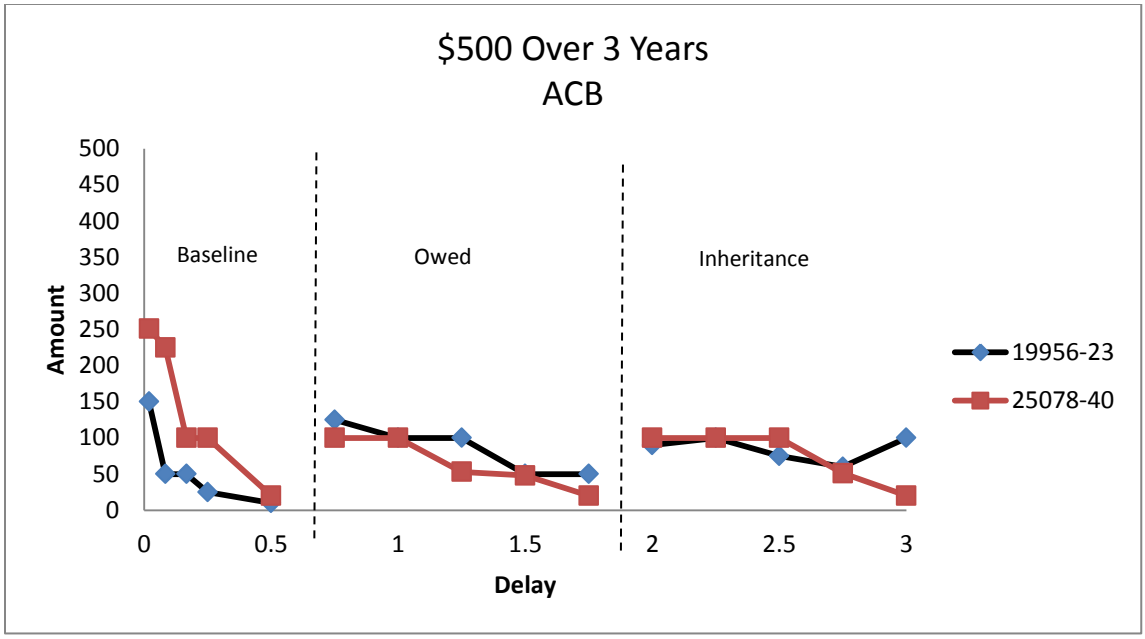


Figure 33. Discounting of $500 over 3 years for 2 participants in Study 4 (ACB).

Figure 34

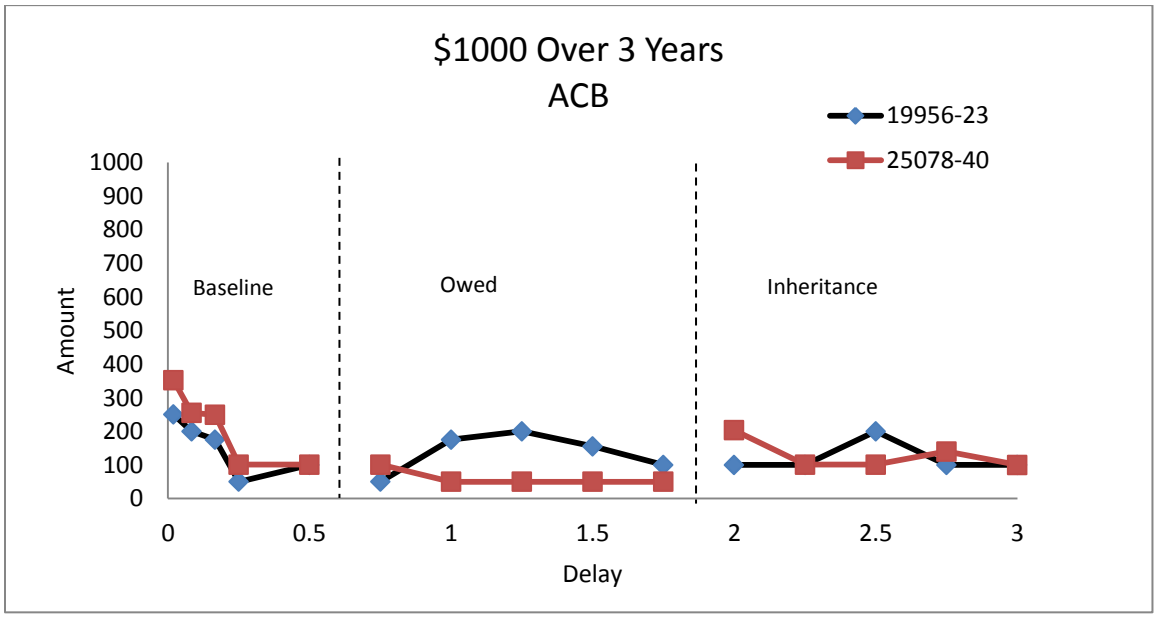


Figure 34. Discounting of $1000 over 3 years for 2 participants in Study 4 (ACB).

Figure 35
$100 Condition in Alternating Treatment Design for 3 Participants.

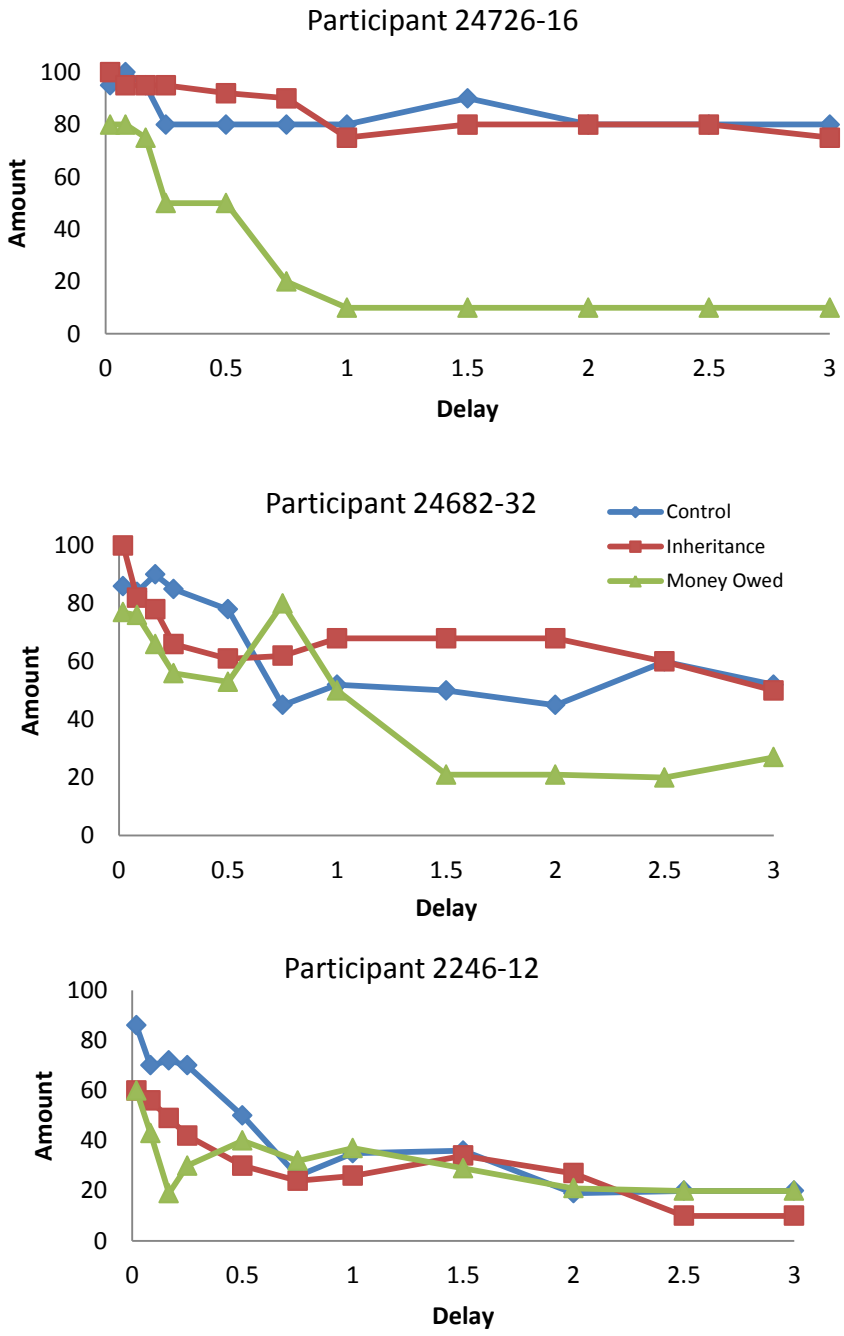


Figure 35. Results from ATD experiment in Study 5 for 3 participants for gaining $100 over 3 years.

Figure 36

$500 Condition in Alternating Treatment Design for 3 Participants.

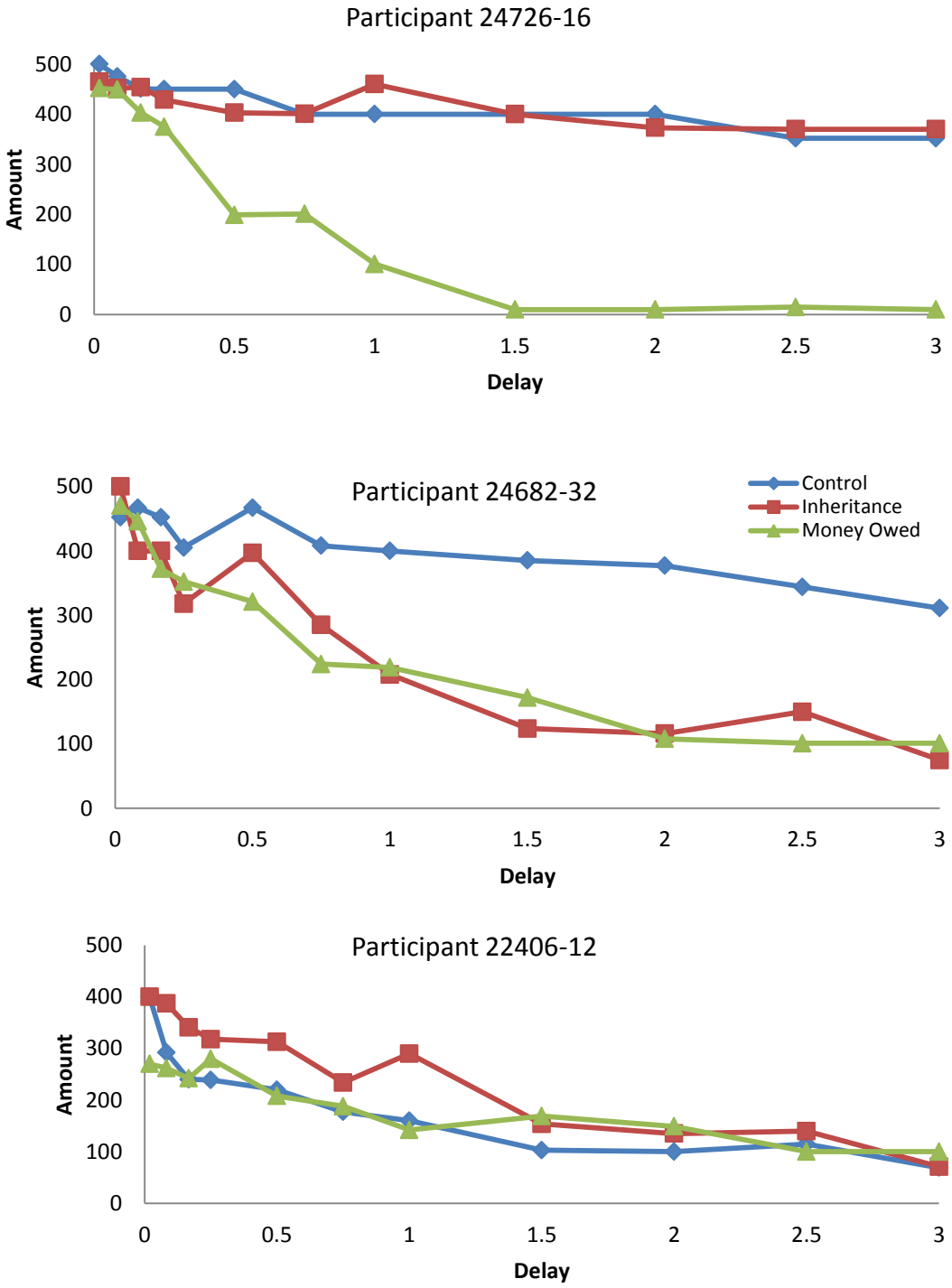


Figure 36. . Results from ATD experiment in Study 5 for 3 participants for gaining $500 over 3 years.

Figure 37
$1000 Condition in Alternating Treatment Design for 3 Participants.

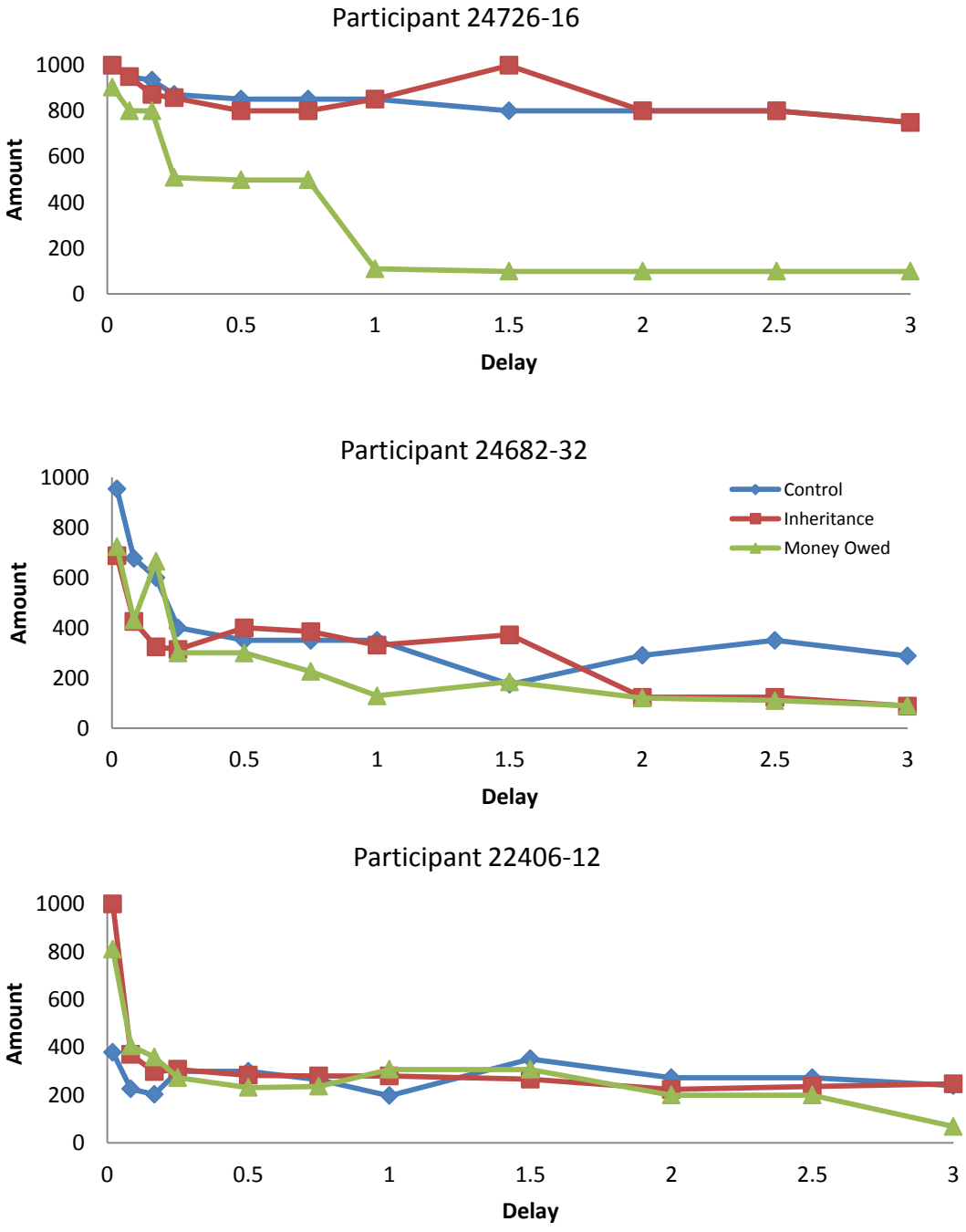


Figure 37. Results from ATD experiment in Study 5 for 3 participants for gaining $1000 over 3 years.

Figure 38
Individual AUC Values across Magnitudes for Participants in Study 5.

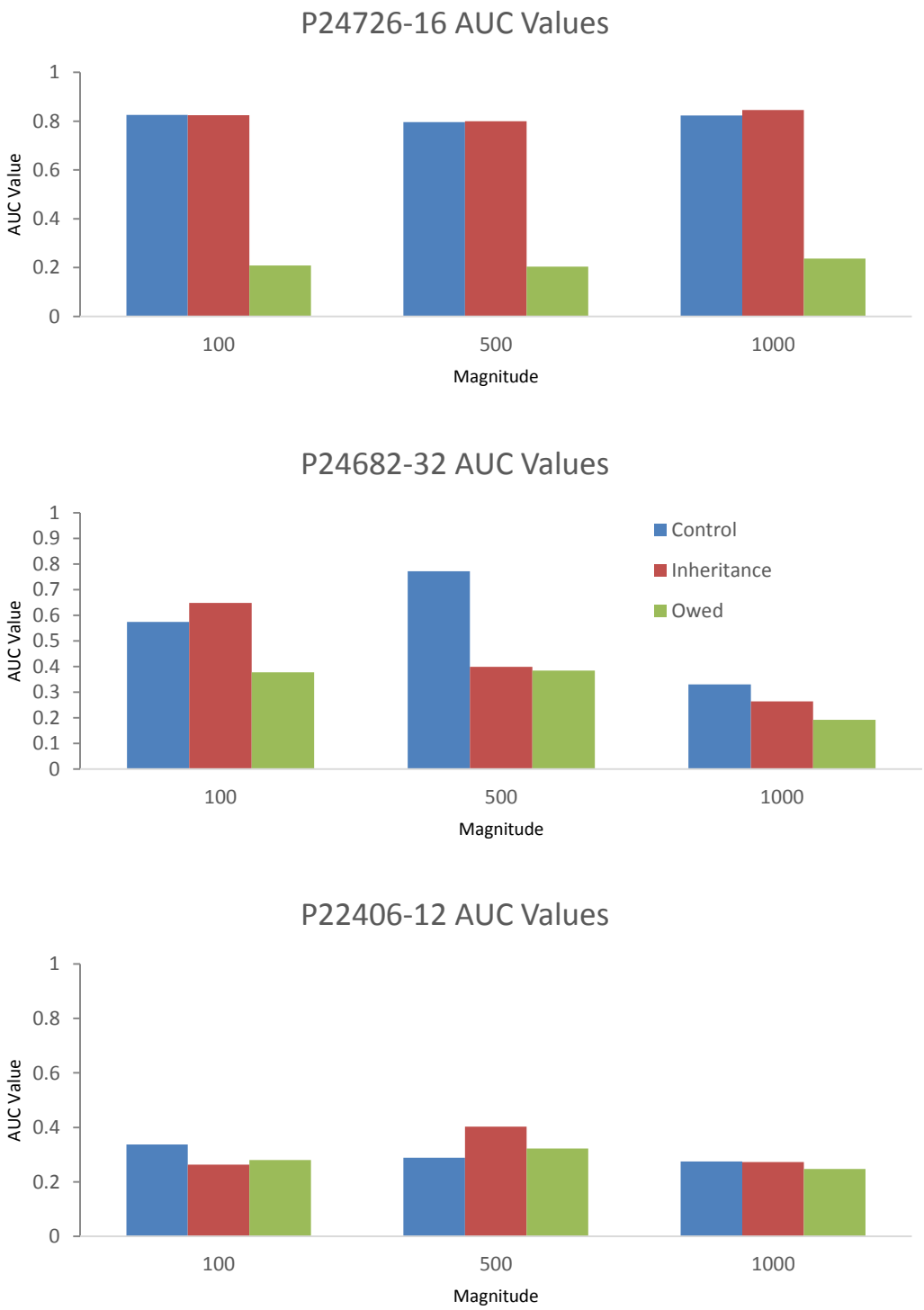


Figure 38. Individual AUC values for three participants across magnitudes in Study 5.

Figure 39
Indifference Curves for Loss of $100 Over 3 Years

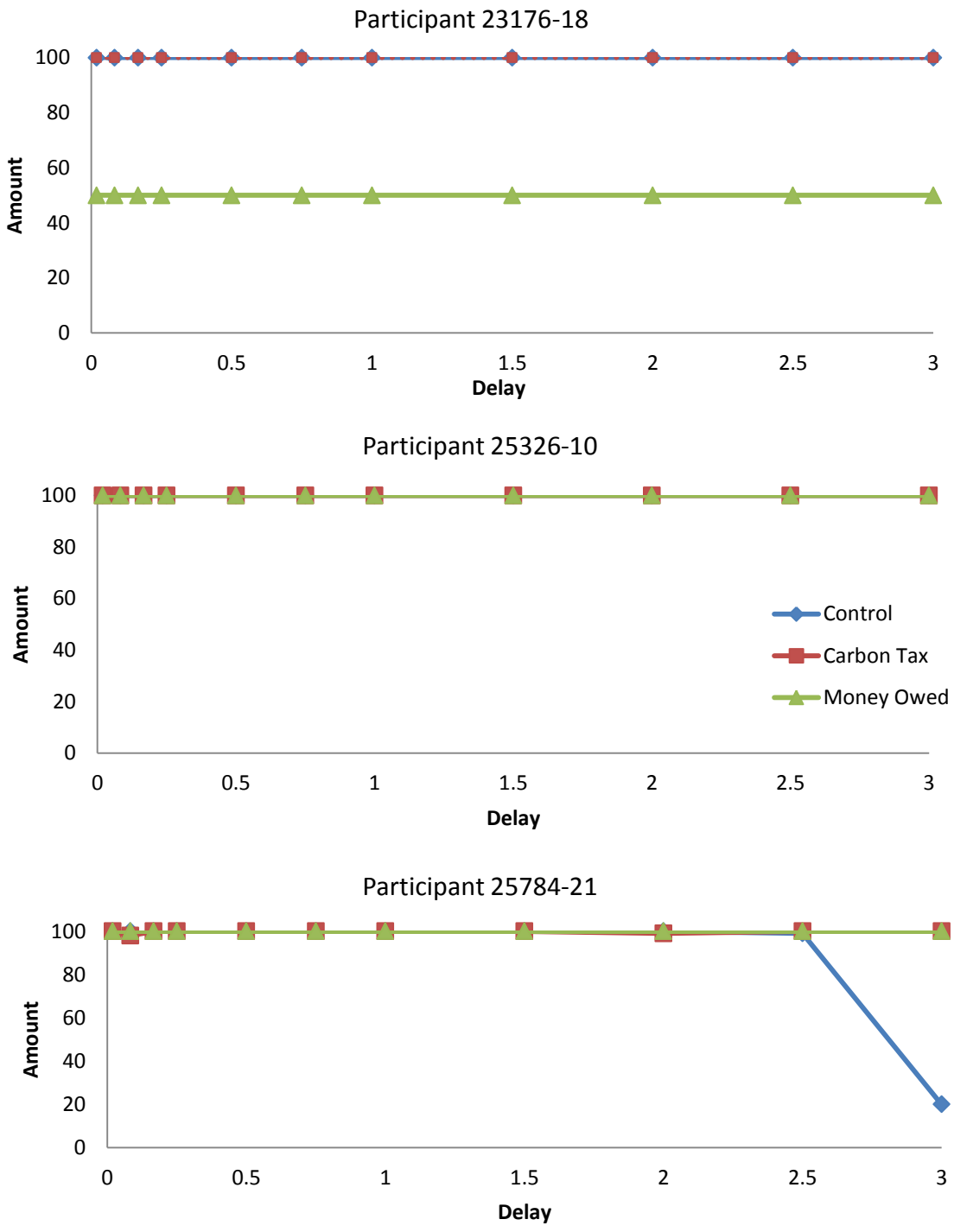


Figure 39. Indifference curves for Participants in Study 6 for the $100 scenarios.

Figure 40
Indifference Curves for Loss of $1000 over 3 Years

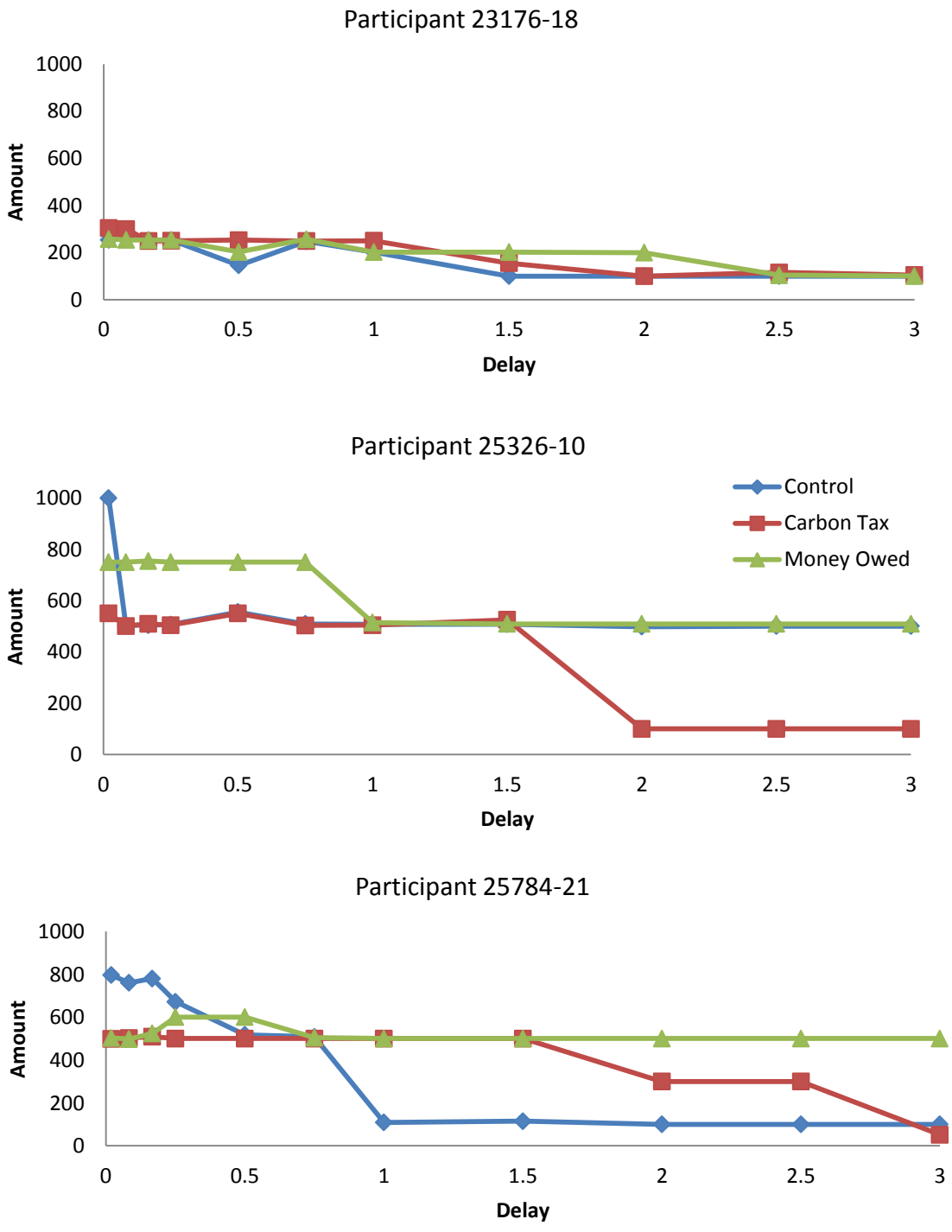


Figure 40. Indifference curves for participants in Study 6 in the $1000 loss scenarios.

TABLES

Table 1

AUC Values for Rigid Participants

	20		50		100		200	
Participant ID	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
7770	0.7528	0.7497	0.7362	0.7006	0.7912	0.6997	0.7238	0.7238
9984	0.7476	0.7476	0.6787	0.6778	0.6951	0.6901	0.7634	0.6779
2469	0.7497	0.7476	0.6849	0.6809	0.6900	0.6900	0.7079	0.7040

Table 1. Psychologically rigid individuals from Pilot Study 2. Notice that for all participants the posttest never increases, indicating that posttest results were more impulsive when compared to pretest measures.

Table 2

AUC Values for Flexible Participants

	20		50		100		200	
Participant ID	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
5017	0.8282	0.8678	0.8320	0.8571	0.9270	0.9270	0.9270	0.9270
4544	0.8575	0.8608	0.7512	0.821	0.7061	0.8458	0.8610	0.8097
0193	0.7476	0.7804	0.6857	0.7346	0.6893	0.6972	0.7401	0.7634

Table 2. Psychologically flexible individuals from Pilot Study 2. Notice that for all participants the posttest never decreases, indicating that posttest results were more self-controlled when compared to pretest measures.

Table 3

Phase Change Design for Study 4

			Number of Phase Change Replications					
Condition	**Participant Number**	**Phase**	**A-B**	**B-A**	**A-C**	**C-A**	**B-C**	**C-B**
Gains	1 2	ABA ABA	2	2				
	3 4	ACA ACA			2	2		
	5 6	ABC ABC	2				2	
	7 8	ACB ACB			2			2

Table 3. Phase-Change Design Plans for Study 4. Part 1 examined the first two changes in sequential order. Part 2 kept the phase change logic, but randomized the presentation of the conditions, effectively transitioning the design of the study into an Alternating Treatments Design (ATD). See Discussion section from Study 4 for more information.

Table 4

AUC and *k*-Values for Participants in Study 5

		AUC			K		
Participant-AAQ	**Magnitude**	**Control**	**Inheritance**	**Money Owed**	**Control**	**Inheritance**	**Money Owed**
24726-16	100	0.8252	0.8243	0.2085	0.127	0.1368	3.49
24726-16	500	0.7966	0.7997	0.2039	0.1712	0.1606	2.692
24726-16	1000	0.8232	0.8453	0.2374	0.1361	0.1187	2.745
24682-32	100	0.5739	0.6482	0.3779	0.6104	0.4275	1.4771
24682-32	500	0.7719	0.3993	0.3842	0.2057	1.3138	1.4625
24682-32	1000	0.3307	0.2636	0.1924	3.0264	6.9458	6.6286
22406-12	100	0.3368	0.2632	0.2804	2.126	5.3153	9.445
22406-12	500	0.289	0.4029	0.3224	3.652	1.447	3.354
22406-12	1000	0.2746	0.2722	0.2477	31.099	7.6252	8.705

Table 4. AUC and *k*- (rate of decay) values for all participants in Study 5.

Table 5

AUC and *k*-Values for Study 6

		AUC			K		
Participant-AAQ	**Magnitude**	**Control**	**Carbon Tax**	**Money Owed**	**Control**	**Carbon Tax**	**Money Owed**
23176-18	100	1	1	0.5	0	0	1.16
23176-18	1000	0.1474	0.1761	0.1873	60.7974	39.0891	55.9842
25326-10	100	1	1	1	0	0	0
25326-10	1000	0.5132	0.342	0.5776	1.0191	2.3835	0.5729
25784-21	100	0.928	0.9946	1	0.1154	0.0009	0
25784-21	1000	0.2487	0.3947	0.5133	2.5056	2.0982	0.0971

Table 5. AUC and *k* (rate of decay) values for each participant in Study 6. Note the lack of differentiation in the 100 condition compared to the diversity exhibited in the 1000 condition.

APPENDIX

Attachment A. Recruitment Script

Hello.

I'm here today to see if any of you would be interested in participating in a study about money. Specifically, you will be asked how you would choose between either receiving or paying an amount of money. This study is completely hypothetical, but you are encouraged to act as if the situations described in this study are real. The study will involve you first filling out some short demographic forms, and then you will be instructed to answer some questions on a computer. If you are interested in participating, please either email Wade Brown or find our study on the SONA page. At this time, are there any questions about participating in this study?

Thank you for your time today.

B. Sona Post (Pilot Study 1)

Study Name: Discounting of Equivalent Stimuli

Description: The purpose of this study is to investigate how different people make decisions about money. Specifically, participants in this study will be asked to make choices about either receiving or paying amounts of money under different situations. The study is completely hypothetical, but participants are encouraged to act as if these situations were real. Participants will be required to come into our lab and provide informed consent. Participants will then fill out a series of short demographics, and then start the study. Participation in this study should not exceed one hour, and students will receive 2 Psychology Experience Credits for their participation.

Eligibility Requirements: To be eligible for this study, participants must be over the age of 18, UNR students, and fluent English speakers.

Duration: 1 Hour

Credits: 2

Contact:

T Wade Brown
Wadebrown60@yahoo.com
75-830-1138

Mark Alavosius
marka@unr.edu
775-682-8688

C. Consent Form

UNIVERSITY OF NEVADA, RENO SOCIAL BEHAVIORAL INSTITUTIONAL REVIEW BOARD
CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: Discounting of Equivalent Stimuli

INVESTIGATOR(S): Mark P. Alavosius, Ph.D. 682-8688 &

T. Wade Brown, M.A. 775-830-1138

PROTOCOL #: 2014S078

SPONSOR:

PURPOSE

You are being asked to participate in a study. The study is interested in how people make decisions about money. Specifically, you will be asked how you would choose between either receiving or paying an amount of money. This study is completely hypothetical, but you are encouraged to behave as if the situations described in this study are real. The study will involve you first filling out some short demographic forms, and then you will be instructed to answer some questions on a computer. You can stop participating at any time, and none of the information you share with me will contain any personal information related to you. If you have any questions, please ask them at this time. Thank you.

PARTICIPANTS

You are being asked to participate because you are over the age of 18, a fluent English speaker, and a student at the University of Nevada, Reno. This experiment will record responses from 30 individuals like yourself.

PROCEDURES

The general procedure of this experiment after the consent process will be as follows:

1. You will be asked to fill out two forms that outline information about yourself. You are not required to list anything personal, and we will only look at these forms after we have collected data from all of our other participants.
2. After you provide us with these forms, we will begin the experimental program. You will begin working on a computer program. The program will ask you a series of questions about hypothetical money. **The scenarios included in this program are not real, but we encourage you to answer like they are.** The questions ask about spending and receiving money, so make sure you read each scenario carefully.
3. Once you have finished answering all of the questions, the experiment is complete. Please keep a copy of the consent form in case you have any follow-up questions about this procedure.

DISCOMFORTS, INCONVENIENCES, AND/OR RISKS

There are no known risks to participating in this study. A variation of this study has been done several times at other universities, and the researchers there have not reported any discomfort. Still, if at any point you wish to stop participating in this study, you can do so without any negative consequence.

Most experimental materials are on the computer, and you will be seated the duration of the time.

If any discomfort is experienced due to the procedure, participants are encouraged to call the University of Nevada, Reno Counseling Services Office at 775-784-4648.

BENEFITS

There may be no direct benefits to you as a participant in this study. However, your participation will allow for our research team to understand interesting aspects of how people come to financial decisions. We plan on presenting the results of this study at conferences and conventions across the country. Your participation is essential for us to complete this work.

Students in the Psychology Curriculum at the University of Nevada, Reno will earn 2 PEC credits for participating in this study, which in some cases may serve as a requirement or extra credit for courses in the psychology department.

Your identity will be protected to the extent allowed by law. You will not be personally identified in any reports or publications that may result from this study.
The Department of Health and Human Service (HHS), other federal agencies as necessary, the University of Nevada, Reno Social Behavioral Institutional Review Board may inspect your study records.

We will not collect any personal identifiers in the duration of this procedure. Response data will be stored electronically and everyone who participates will be assigned a participant number. We will not keep any record linking participant names with participant numbers.

COSTS/COMPENSATION
There will be no cost to you nor will you be compensated for participating in this research study.

In the event that this research activity results in an injury, treatment will be available, including first aid, emergency treatment, and follow-up care as needed. Care for such injuries will be billed in the ordinary manner to you or your insurance company.

If you think you have suffered a research related injury, you should immediately contact the Principle-Investigator, Mark P. Alavosius, Ph.D. at 775-682-8688 or Co-Investigator, T. Wade Brown at 775-830-1138.

DISCLOSURE OF FINANCIAL INTERESTS

We do not have any financial interest in the results of this study.

RIGHT TO REFUSE OR WITHDRAW

You may refuse to participate or withdraw from the study at any time and still receive the care you would normally receive if you were not in the study. If you choose withdraw from the study or to not participate, you still will receive the 1 PEC credit for research participation. If the study design or use of the data is to be changed, you will be so informed and your consent re-obtained. You will be told of any significant new findings developed during the course of this study, which may relate to your willingness to continue participation.

QUESTIONS

If you have questions about this study or wish to report a research-related injury, please contact Mark P. Alavosius, Ph.D. at 775-682-8688 or T. Wade Brown at 775-830-1138 at any time.

You may ask about your rights as a research subject or you may report (anonymously if you so choose) any comments, concern, or complaints to the University of Nevada, Reno Social Behavioral Institutional Review Board, telephone number (775) 327-2368, or by addressing a letter to the Chair of the Board, c/o UNR Office of Human Research Protection, 205 Ross Hall / 331, University of Nevada, Reno, Reno, Nevada, 89557.

CLOSING STATEMENT

I have read ( ) this consent form or have had it read to me ( ). [Check one.]

_____has explained the study to me and all of my questions have been answered. I have been told of the risks or discomforts and possible benefits of the study

If I do not take part in this study, my refusal to participate will involve no penalty or loss of rights to which I am entitled. I may withdraw from this study at any time without penalty [or loss of other benefits to which I am entitled].

I have been told my rights as a research subject, and I voluntarily consent to participate in this study. I have been told what the study is about and how and why it is being done. All my questions have been answered.

I will receive a signed and dated copy of this consent form.

Signature of Participant (*or Legally Authorized Representative**) Date

Signature of Person Obtaining Consent Date

Signature of Investigator Date

D. Basic Demographic Form

Participant ID:

Age:

Sex:

What is your major:

What is your political affiliation?

Are you married? Y N

How many people live in your household?

E. Acceptance and Action Questionnaire Version II

AAQ-II

Below you will find a list of statements. Please rate how true each statement is for you by circling a number next to it. Use the scale below to make your choice.

1	2	3	4	5	6	7
Never true	**very seldom true**	**seldom true**	**sometimes true**	**frequently true**	**almost always true**	**always true**

1.	My painful experiences and memories make it difficult for me to live a life that I would value.	1	2	3	4	5	6	7
2.	I'm afraid of my feelings.	1	2	3	4	5	6	7
3.	I worry about not being able to control my worries and feelings.	1	2	3	4	5	6	7
4.	My painful memories prevent me from having a fulfilling life.	1	2	3	4	5	6	7
5.	Emotions cause problems in my life.	1	2	3	4	5	6	7
6.	It seems like most people are handling their lives better than I am.	1	2	3	4	5	6	7
7.	Worries get in the way of my success.	1	2	3	4	5	6	7

F. Pilot Study 1 Scenarios

The following is the list of intended scenarios that participants in this study will respond to. As the project progresses, the wording of these types of scenarios may change.

Loss

Assume you have just purchased a new car. The dealer informs you that the final price of the car does not include a newly initiated carbon tax. You have the option of paying the tax now, or deferring it to later date. Choose how you would pay the carbon tax below.

Imagine that a policy went into place that assessed carbon offsets for households in your area, and you were required to choose between the two options below. Which option would you choose to pay the offset below?

Assume you are late on making a rent payment for your dwelling. The landlord offers you a choice in how to assess the late penalty. Choose how you would pay the penalty below.

Imagine that you borrowed some money from your friend a few months ago. Your friend calls and says he'd like the money back today, but gives you an option on how to pay him back. Choose how you would pay the money owed?

Gain

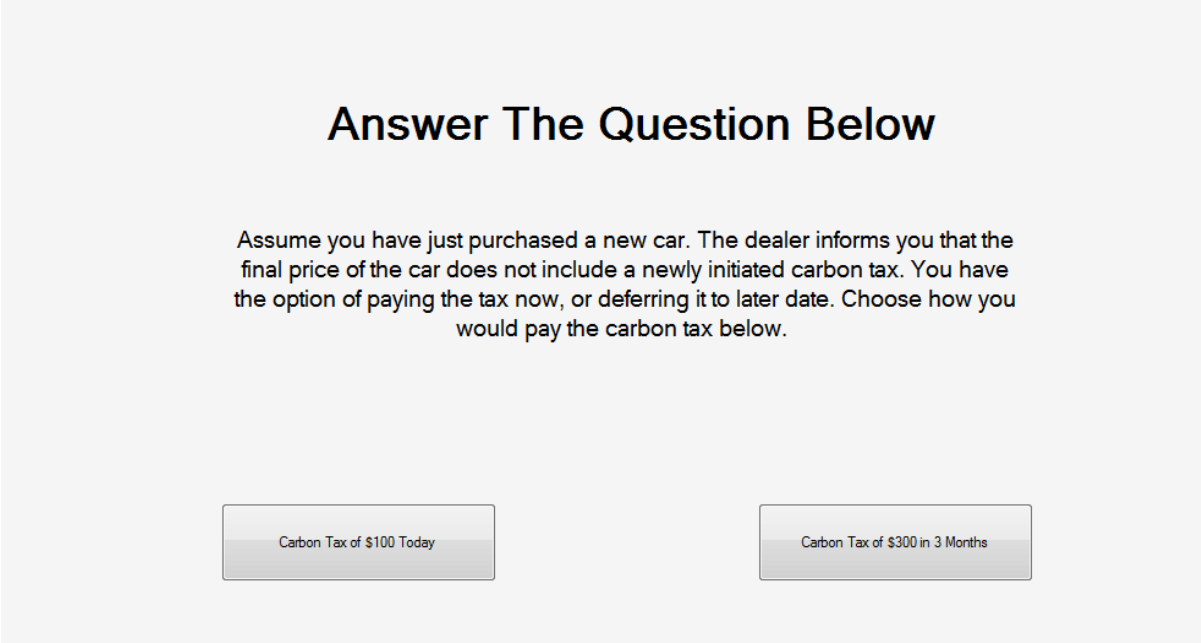
Assume you are to inherit a sum of money. You are contacted and told that the entire amount cannot be disbursed right away, but a smaller proportion could be given immediately. Which option would you choose to accept the inheritance?

Suppose you receive a letter that there was an error on your tax return this last year, and you are entitled to a refund. There are two payment options to disburse the refund. Choose how you would accept the refund?

Imagine that you loan money to a close friend. They call you and inform you that they will eventually have all of the money, but are curious if you would accept a lower amount. Which choice would you select below for the money you are owed?

Pretend that you are contacted because you have won a contest. The prize money cannot be distributed all at once, but you can elect to accept a smaller payment sooner. Which option would you choose to accept your winnings?

G. Screen Shot from Pilot Study 1



H. FITB Scenarios

Gain

Suppose you can receive $(x amount of money) in (x amount of time). What is the lowest amount you'd accept today rather than wait the (x amount of time).

Assume you are to inherit $(x amount of money). You are contacted and told that the entire amount cannot be disbursed for (x amount of time), but a smaller proportion could be given immediately. What is the lowest amount you'd accept today rather than wait the (x amount of time).

Imagine that you loan $(X amount of money) to a close friend. They call you and inform you that they will have all of the money in (X amount of time), but are curious if you would accept a lower amount today. What is the lowest amount you'd accept today rather than wait the (x amount of time).

Loss

Suppose you have to pay $(x amount of money) in (x amount of time). What is the highest amount you would put toward this amount today?

Assume you have just purchased a new car. The dealer informs you that the final price of the car does not include a newly initiated carbon tax of $(x amount of money). You have the option of paying some of the tax now, or deferring the entire tax to a later date. What is the highest amount you would put toward this tax today?

Imagine that you borrowed $(x amount of money) from your friend a few months ago. Your friend calls and says he'd like the some of the money back today and the rest in (x amount of time). What is the highest amount you would pay today?

I. Screen Shot for Phase 2 Program