

HIGH-RESOLUTION EFFECTS OF MODIFIED EPISODIC FUTURE THINKING:  
PERSONALIZED AGE-PROGRESSED PICTURES IMPROVE RISKY LONG-TERM  
HEALTH DECISIONS

By

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Submitted to the graduate degree program in the Department of Applied Behavioral  
Science and the Graduate Faculty of the University of Kansas in partial fulfillment of the  
requirements for the degree of Master of Arts.

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## Abstract

Many of our everyday choices are associated with outcomes that are both delayed and probabilistic. The tyranny of small decisions describes a chronic pattern of present-bias decisions that result in negative outcomes in the future. The temporal attention hypothesis suggests that individuals' decision making can be improved by focusing attention to temporally distal events and reducing the desire for proximate outcomes. Viewing discounting within a temporal attention framework implies that environmental manipulations that expand the limits of an individual's temporal perspective by bringing focus on temporally distal outcomes, and thereby reducing present bias, may alter his/her degree of discounting. One such manipulation, episodic future thinking (EpFT), has shown to successfully lower discount rates. Several questions remain as to the applicability of EpFT to domains other than temporal discounting. The present experiments examine the effects of a modified EpFT procedure on probability discounting in the context of both a delayed health gain and loss. Results indicate the modified EpFT procedure effectively altered individuals' degree of discounting in the predicted directions and lend further support to the temporal attention hypothesis.

*Keywords:* probability discounting, episodic future thinking, temporal attention, risky decision making, humans

## **Acknowledgements**

First and foremost, I'd like to thank Drs. Derek Reed, Dave Jarmolowicz, and Todd McKerchar for agreeing to serve on my thesis committee. I appreciate your availability, interest, and overall expertise in making this project come to fruition.

Unfortunately, as much as I can try, the words that appear next will do little to convey the impact Dr. Derek Reed has had not only on this project, but on my graduate career as well. As B. F. Skinner put it, I am a locus for a confluence of variables and the strongest of those variables has undoubtedly been Derek. When Derek first became a professor here at the University of Kansas, I was an undergraduate student with but a slim vision of what the next several years would entail. As I finished that year, it became apparent that Derek and I would have a bright, fun, and productive future ahead of us. Through the past few years, Derek has helped me grow tremendously as a student and young professional academic and has provided me countless opportunities of which I'm extremely grateful. I can't thank Derek enough for the enormous amount of time and energy he has contributed to overseeing this project. Without his mentoring, guidance, patience, the occasional kick in the butt, and enthusiasm, this project would not have been possible. I think we both knew from day one of starting my thesis that I would inevitably be asking "outside-the-box" questions, something that our lab enjoys doing. The initial thesis idea evolved over time, being refined with intellectually stimulating conversations typically starting with, "Well, what if we did...". At some point, the decision was made and I began work by making a Visual Basic program. In retrospect what seems like a short time, but not so at all at the time, I started scheduling participants and data collection was underway. Through piloting and refining once again (as I believe

science ought to be done), the project that you will presumably read next took off and data were collected once more. Throughout every step of the way, Derek was available, encouraging, and helpful with whatever questions arose. I am truly grateful for all the help and guidance during this process and I look forward to the next two years. Thank you Derek.

I also can't thank Dr. Dave Jarmolowicz enough for the guidance and keen advice on rigorous experimentation that he has provided. I was very fortunate to have not one, but two exemplary faculty members help me not only conceptualize the project, but provide feedback and suggestions along the way. Although "42" was never the final answer to my questions, Dave always took time out of his busy schedule to sit down with me to discuss questions or concerns I had about the study. Without his push for methodological rigor, there might very well be more holes in my project than in Swiss cheese. With Dave's help, I learned the many questions that need to be asked when designing a study of this kind and I know that this experience will help me tremendously in future projects. For this Dave, I thank you.

This project, in its current form, could not have been accomplished without the training and continued help from Jason Hirst, my fellow graduate student and office mate. He single handedly learned me on the technique of coding. Having programmed very little in the past, and certainly not in Microsoft Visual Basic, Jason taught me how to build a program by scratch. I can recall many days of troubleshooting and debugging, clouded by a sense of frustration and confusion, but in the end we were somehow able to figure it out (well, to be honest, the somehow was usually accomplished through

simultaneous Google searches). Without his help and training, I would not be so much writing this acknowledgements section as I would still be writing my program.

Thank you Amy Henley and Ellie for always being a bright spot when I came home after stressful days of data collection. I appreciate your patience and help throughout this process. I also thank you for the bacon and donuts you brought to my defense. The jury might still be out as to whether that is the reason I passed or not... In any case, without the extreme cuteness of Ellie and the insightful and helpful advice from Amy, this would have been a much rougher road of travel.

Finally, last but not least, I must also thank my undergraduate research assistants Andrea Phillips and Josh Harsin for their help with running sessions. Although I initially thought I would be able to run all of the sessions myself, it quickly became apparent that it was more than just a one person job. Without the daily help of both Andrea and Josh, this project could not have been accomplished. I already miss the fun times we had in the observation room and I wish you two the very best for your futures after your undergraduate careers. Thank you for all the time you devoted to helping me conduct my project.

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## High-Resolution Effects of Modified Episodic Future Thinking:

### Personalized Age-Progressed Pictures Improve Risky Long-Term Health Decisions

Throughout the history of human civilization, many of the great collapses of countries, states, and empires can be attributed to a focus on the present (Diamond, 2005), rather than an eye on the future. This myopic view is exemplified by a chronic pattern of small, almost inconsequential decisions that eventually culminate into a large disastrous problem. Unfortunately, these outcomes are often irreversible. Consider the collapse of Easter Island (Diamond, 1995). It is believed that inhabitants of Easter Island slowly deforested the land in an effort to erect statues, without consideration of the long-term effect on their habitat. As a result, fertile land to grow crops diminished and most of their civilization collapsed after intense violence. This scenario exemplifies *the tyranny of small decisions* (Bickel & Marsch, 2000), a chronic pattern of myopic decisions that seem beneficial for the individual now, but results in suboptimal outcomes later on.

The field of behavioral economics seeks to understand this adverse pattern of decision making by way of discounting (Reed, Niileksela, & Kaplan, 2013). Specifically, discounting occurs when the subjective value of an outcome decreases based on some contextual factor(s) such as the delay to receipt of the outcome (temporal discounting) or the chance of the outcome occurring (probability discounting). Steep temporal discounting (i.e., the value of an outcome decreases rapidly as a function of the delay to receipt) has been shown to be associated with a wide range of substance abuse disorders and other harmful health behaviors (Bickel, Jarmolowicz, Mueller, Koffarnus, & Gatchalian, 2012; Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014; Madden & Bickel, 2010; Yi, Mitchell, Bickel, 2010). By contrast to temporal discounting,

probability discounting occurs when the subjective value of an outcome is devalued as the likelihood of that outcome occurring decreases. Said another way, the value of an outcome is inversely related to the odds against receiving that outcome, such that value decreases as the odds against increases. There is some evidence to suggest that excessive probability discounting is associated with maladaptive outcomes (e.g., pathological gambling, substance abuse), although the literature is mixed (Bickel et al., 2014) and incomplete. In any case, examining discounting and ways to change it might very well be helpful in understanding socially important behavior (Critchfield & Kollins, 2001).

One solution to overcome the potentially adverse pattern of behavioral decision making is by strategically targeting a single-decision event (e.g., point-of-purchase situation) and by using the hyperbolic nature of discounting to its advantage (Ainslie, 1975). A commitment response, another one-time decision making event, is an active form of self-control (Skinner, 1953) where an organism commits to a decision path leading to more favorable long-term outcomes by circumventing preference reversals (Rachlin & Green, 1972), a hallmark characteristic of hyperbolic discounting. Save More Tomorrow™ (Thaler & Benartzi, 2004), one of the most notable programs to promote and help employees save for the future, used commitment responses to allow users to automatically increase their savings rate by a small amount every time they were awarded a pay raise. Compared to those who did not enroll, participants in the Save More Tomorrow™ program had almost quadrupled their savings rate in under four years. In this program, rather than making a series of decisions to increase his/her savings rate every time the employee receives a pay raise, the savings rate increases automatically

circumventing the need to make repeated choices between some amount of money now and more money later.

In an experiment by Hershfield and colleagues (2011) aimed at changing individuals' willingness to save for the future at a point-of-purchase situation, participants made hypothetical investment choices in the presence of a computer-generated model of themselves. While viewing either their computer-generated present- or future-self, participants responded in a computerized investment simulation by sliding a line along a bar to indicate how much of their current income they would allocate to retirement. As participants allocated a smaller percentage of their current income to retirement, the present face's emotion changed and became happier while the future face became sadder (the reverse occurred when allocating relatively more income to retirement). As a result, individuals in the future-self condition allocated a significantly higher percentage of their current income to retirement as compared to those in the present-self condition. Merrill Edge, a large wealth management company, recently introduced this concept of age-progression in their Face Retirement campaign (<http://faceretirement.merrilledge.com/>) in an attempt to influence the user to make wise financial decisions by age-progressing users' faces via a webcam while logging into their online retirement portfolio. These strategies utilizing age progression manipulations used by Hershfield et al. and Merrill Lynch to influence decision making – as related to temporally distal events such as retirement – in the here and now is consistent with the temporal attention hypothesis.

### **Temporal Attention Hypothesis**

The *temporal attention hypothesis* stipulates that individuals tend to perceive time to differing degrees (Bickel, Kowal, & Gatchalian, 2006; Radu, Yi, Bickel, Gross, & McClure, 2011) and that for some individuals, relatively distal events do little to control present behavior. For example, in one study heroin-dependent individuals and matched controls completed two tasks measuring time perspective including the Stanford Time Perception Inventory (STPI; Zimbardo, 1992) and Future Time Perspective (FTP; Wallace, 1956) (Petry, Bickel, & Arnett, 1998). As compared to controls, Petry and colleagues found that heroin addicts scored significantly lower on scales measuring focus on future events and significantly higher on scales measuring focus on present events. Further, when asked to complete fictional stories, heroin addicts completed stories with significantly shorter time frames as compared to controls. These results support the temporal attention hypothesis by demonstrating that individuals perceive time differently.

The temporal attention hypothesis suggests that manipulations that focus attention to temporally distal events may serve as a potential method for improving decision making related to long-term outcomes without the need to target and reduce the desire for proximate outcomes (Radu et al., 2011). Towards this end, one method to improve long-term decision making is through the use of the “explicit-zero” framing where explicit consequences are associated with alternatives. Radu et al. conducted a series of experiments to determine whether the mechanism underlying the “explicit-zero” manipulation was due to an improving sequence, whereby the present valuation of the delayed reward is enhanced, or due to temporal allocation shifted towards the delayed alternative. The researchers found the temporal attention hypothesis was better able to account for similarities in past and future discounting, a phenomenon not predicted by the

improving sequence hypothesis. Techniques that alter temporal attention provide a useful framework for which to change discounting.

Another way to allocate temporal attention towards distal outcomes is through the use of episodic future thinking (EpFT)<sup>1</sup> (Koffarnus, Jarmolowicz, Mueller, and Bickel, 2013). In contrast to other framing manipulations, EpFT requires an active, overt response by the participant prior to making any intertemporal tradeoff decisions (Atance & O’Neill, 2001). Participants typically identify several events they plan to attend in the future and these events are assigned different delays. When faced with the intertemporal tradeoff options, these subject specific cues are displayed in an attempt to influence participant decision making.

To examine the effects of EpFT on rates of discounting, Peters and Büchel (2010) recruited 30 healthy participants who reported events they had planned within the next seven months. Delays used in the subsequent discounting task were determined by matching the time until the planned event such that events happening relatively soon were associated with shorter delays and events happening later were associated with longer delays. Participants then completed two sessions of delay discounting tasks and were told that one of their choices would be randomly picked and the consequence delivered at the conclusion of the experiment. During half of the discounting trials, a subject-specific cue (e.g., trip to Paris) determined during the prescan interview was presented underneath the delay associated with the delayed option. In the remaining half of the trials, no subject-specific cue was presented. Results indicate discounting rates obtained during the EpFT trials were significantly lower than in the control trials.

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<sup>1</sup>I adopt the acronym “EpFT” rather than “EFT” as to not confuse readers with executive functioning training, another emerging technology to modulate rates of discounting.

More recently, researchers examined the effects of EpFT on changes in delay discounting and number of food calories consumed among 26 overweight or obese women (Daniel, Stanton, & Epstein, 2013). Participants were randomly assigned to either a control or EpFT condition, where recently experienced (derived from a blog provided by the experimenters; control group) or possible future events (EpFT) were created and used as cues for the two groups in later experimental tasks. During the delay discounting task, participants in the control group were instructed to think about events from the blog and those in the experimental group about possible future events they provided earlier. In an *ad libitum* eating task, participants rated the sensory appeal of various foods and subsequently were provided free access to food for 15 min all while the cues were present. Participants in the EpFT condition displayed significantly less discounting and consumed significantly fewer calories as compared to those in the control condition.

As discussed earlier, a potential method to allocate attention towards distal outcomes is through the use of EpFT manipulations and, indeed, several studies have successfully done so as evidenced by a change in temporal discounting rates (Daniel et al., 2013; Lin & Epstein, 2014; Peters & Büchel, 2010). Several questions regarding EpFT, however, remain unanswered. First, I am aware of no study that has explicitly applied an EpFT procedure to alter probability discounting. Second, it is unknown whether the effect of EpFT on rates of discounting can be achieved through different means other than using subject-specific tags (e.g., computer-generated future-self images; Hershfield et al., 2011). Third, EpFT studies have primarily dealt with monetary discounting and while Daniel and colleagues showed EpFT influenced eating behavior, it is unclear whether EpFT can influence decision making in the context of health decisions.



Finally, to my knowledge, EpFT has only been explicitly applied to discounting of gains. It is unclear whether an EpFT procedure will influence discounting of losses in a probabilistic choice scenario.

## **The Present Experiments**

Viewing discounting within a temporal attention framework implies that environmental manipulations that expand the limits of an individual's temporal perspective by bringing focus on temporally distal outcomes (e.g., EpFT) may alter degree of discounting. Although EpFT manipulations tend to use subject specific cues alone to produce changes in discounting, the current project attempts to alter degree of discounting through a novel approach. Given the several unanswered questions surrounding the applicability of EpFT procedures, the current experiments sought to examine the combined effects of computer-generated images (Hershfield et al., 2011) and an EpFT (through the use of a Future Health Questionnaire [FSQ]) procedure on probability discounting of a delayed health gain (Experiment 1) and loss (Experiment 2).

### **Experiment 1**

#### **Participants, Setting, and Materials**

Five undergraduate females ranging in age from 19 to 23 years old ( $M = 21$ ,  $SD = 1.87$ ) recruited from an introductory class in applied behavior analysis participated (see Appendix A for participant recruitment script). Material in the introductory class covers only basic behavior analytic content (e.g., reinforcement, extinction, stimulus control) so class content did not interfere the procedures used in the current study. Participants completed an informed consent approved by the University of Kansas Human Subjects Committee Lawrence Kansas at the start of the first session (Appendix B).

Approximately 3-6 blocks of trials were conducted each day within a 60 min session. In exchange for each 60 min session completed, participants earned .50% of extra credit added to their final grade in the class from which they were recruited.

Participants completed sessions in a small 2.2 m by 2 m operant room with a darkened one-way observation mirror on one side and used a mouse to interact with a probabilistic choice task running on a Windows 7 based Dell PC and 21" wide-aspect monitor. Upon completion of the experiment, participants completed a standard demographics form (Appendix C), answered several questions regarding their thoughts about the experiment (Appendix D), and were debriefed.

**Computer-generated images.** At the beginning of the first session, the researcher obtained three (direct, left, and right profiles) digital photographs (using a Kodak EasyShare M580 camera) of the participant's face during which s/he was instructed to remain with a neutral emotion. These photographs were used in conjunction with FaceGen Modeller software from Singular Inversions© (Hershfield et al., 2011; <http://www.facegen.com/modeller.htm>) and Adobe® Photoshop® to create realistic computer-generated face and to render five unique computer-generated images of the participant's face (Figure 1; see Appendix E for a thorough description of how these images were created).

**Future-self questionnaire.** A questionnaire was developed in order to direct participants' attention to their future-self, akin to previous EpFT studies. This future-self questionnaire (FSQ) was administered before the start of each block in the experimental manipulation phase. The FSQ consisted of four questions and a box below each question where the participant wrote in their answer. The questions were as follows: (1) *What will*

*you be doing as your career in 30 years?, (2) Describe the ideal spouse you will have in 30 years:, (3) How many kids will you have in 30 years?, and (4) Describe the type of home you will have in 30 years:.*

## **Procedure**

Upon arriving at the first session, participants completed the informed consent form and the researcher obtained three – one direct and two side profile (left and right) – digital photographs of the participant’s face during which s/he was instructed to remain with a neutral emotion. After the informed consent and photographs were obtained, the participant completed a practice trial prior to starting the probabilistic choice task. In order to rule out repeated testing effects and to account for the possibility that the effects of a future thinking manipulation on probability discounting might not reverse, the current study used a non-concurrent multiple baseline design across participants.

**Probabilistic choice task.** Participants responded on a probabilistic choice task designed using Microsoft Visual Basic® 2010. During this task, participants moved the position of a slider on a visual analogue scale (VAS; Johnson & Bruner, 2012; Kaplan, Reed, & McKerchar, 2014) to indicate their responses. Appendix F displays the input screen used by the experimenter to initialize the settings prior to each block of trials. To familiarize participants with the nature of the VAS, a practice trial was administered at the start of the first block during the first session (Appendix G). During the practice trial, the participant read the following instructions:

*“The following questions will ask you to indicate your answers on a scale. Before you begin, it will be helpful to practice using the cursor. Here is an example of how to use the maker: Imagine you are asked to guess the temperature of this*

*room. You believe the temperature is 68 degrees Fahrenheit. Thus, you must click on the marker and – without releasing the click – slide the marker to 68, and then release your click. The number below the line will indicate the location of the cursor. Go ahead and slide the marker to 68 degrees and click submit.”*

A 13.9 cm wide VAS, a submit button, and a label displaying the value associated with the VAS cursor location were located below the instructions. A value of “0” was displayed if the VAS cursor was set all the way to the left whereas a value of “100” was displayed if the VAS cursor was set all the way to the right. Participants were required to slide the VAS cursor to 68 degrees and submit the correct response before continuing on to the main portion of the probabilistic choice task. When participants slid the cursor to the correct value, a box appeared allowing them to continue (Appendix H). If the participant did not correctly set the cursor to 68 degrees, a box appeared with the following instructions:

*“Please drag the marker to the correct value.”*

**Baseline.** At the start of every block of trials, the following instructions were presented for 45 s (Appendix I):

*“Welcome to our experiment!*

*The purpose of the present study is to measure how likely you would be to continue and/or quit a particular hobby.*

*Please make your decisions as if all scenarios involved were real. There are no correct or incorrect answers.*

*On the following screens, you will sometimes see a bar with a triangular cursor. You will use the cursor to scroll along the bar to decide how likely you would be to continue/quit a particular hobby.*

*You will have several seconds until a button appears to submit your choice. Please submit your choice when the button appears.*

*If you do not understand these instructions, please ask the researcher any questions you may have now. If you do understand these instructions, please click the button below.”*

Once 45 s elapsed, a button with the text, “I have read and understand these instructions” appeared directly below the instructions. After clicking the button to proceed, participants read and answered the following health related question associated with a probabilistic gain:

*“Imagine you are in perfect health and enjoy a particular hobby.*

*You learn that **quitting this hobby permanently will increase your chances of being alive and cancer-free by XX% in 30 years.***

*How likely are you to **quit** this hobby?”*

The value of XX, indicating the probabilities, was shown in descending order across all trials: 95, 90, 75, 50, 25, 10, and 5%. Response values ranged from 0-100% likely to quit. In an attempt to match real-world contingencies related to health outcomes and specifically cancer risk, the gain and loss (Experiment 2) outcomes associated with each question were set at a fixed 30 yr delay.

At the beginning of each trial, only the probabilistic health question was displayed. After 5 s a VAS, a button that read “Submit”, and label that read, “Note: By

clicking submit, you will move on to the next question,” appeared directly below the question. Participants responded to the question by sliding a cursor along the VAS and clicked the button to progress to the next trial. Labels lay to the left and right ends of the VAS. The label on the left read “Not at all likely” and the label on the right read “Extremely likely.” Unlike the practice trial, participants’ movement of the cursor rendered no feedback on the value associated with the cursor position. The VAS and button were displayed for 10 s. Either after 10 s or when the participant clicked the submit button, the VAS, button, and label disappeared for 5 s and the blackout period began during which the entire screen turned black. If 10 s elapsed without a response by the participant, the program recorded an omission and proceeded to the blackout period.

The amount of time for which the blackout period was in effect depended upon the latency between when the submit button became visible and when the participant clicked the submit button. The blackout period lasted for a minimum of 14 s but could last up to an additional 9 s depending upon the latency of the participant to respond. For example, if the participant clicked the submit button 4 s after the appearance of the submit button, the remaining 6 s were added to the blackout duration. This aspect of the program not only ensured all trials lasted approximately 45 s but also ensured that participants were unable to end the block, and thus, session, early by responding quickly.

Immediately following each block, the researcher calculated area under the curve (AUC; Myerson, Green, & Warusawitharana, 2001):

$$AUC = \sum (x_2 - x_1) \left[ \frac{(y_1 + y_2)}{2} \right] \quad (1)$$

using *Discounter* software ([www.smallnstats.com](http://www.smallnstats.com)) and graphed the corresponding value to determine whether stability criteria had been met. Data were only included if they met

Johnson and Bickel's (2008) criteria for systematic discounting. Visual inspection was used to verify there was no increasing or decreasing monotonic trend during the last three data points in order to proceed to the next phase.

***Modified episodic future thinking (mEpFT) procedure.*** During the mEpFT phase, participants were shown a full-size (neutral) image of their computer-generated future-self prior to completing each block of the probabilistic choice task. During the first block of this phase, participants were told the following:

*“I'm going to ask you several questions. As I'm reading these questions please look at yourself 30 years in the future and think about your answers to these questions. You do not need to say your answers out loud; I'd just like you to think about your answers. After I am done asking you these questions, I'll give you time to write your answers to these questions.”*

After the experimenter finished asking the questions, participants wrote their answers on the FSQ. Once the participant completed the questionnaire, the researcher reentered the room, started the program, and the participant began the probabilistic choice task. The same probabilistic health question used in baseline was used during this phase.

Upon starting the probabilistic choice task, but before being able to respond to the question via the VAS, participants viewed five pictures of their future self with the five unique emotions as described earlier (Appendix J). The future-self computer-generated images were ordered from left to right from sad to happy and occupied space on the screen right below the VAS. The VAS was divided into five sections, each corresponding with a single future-self picture. After the pictures were displayed for 5 s, they disappeared and the VAS appeared for 10 s. After 10 s, a submit button on the bottom of

the page, along with a label that read, “Note: By clicking submit, you will move on to the next question,” appeared for 10 s (Appendix K). Once the participant clicked the submit button, one of the five future-self pictures appeared for 5 s followed by a blackout period where the entire screen turned black (Appendix L). The blackout period functioned the same as in baseline. The picture that was presented following the participant’s selection was associated with the location of the cursor on the VAS. That is, if the cursor was in the first section (VAS values between 0-20) when the participant submitted his/her response, the picture on the far left was displayed following submission.

### **Data Analysis**

Prior to any data analyses, the seven probability values (ranging from 95% to 5%) were converted to odds in favor values using the following equation:

$$\Theta = (1 - p) / p \quad \text{Equation (2)}$$

where  $\Theta$  is the odds in favor and  $p$  is the probability. The resulting values were as follows: .053, .111, .333, 1, 3, 9, and 19.

The primary dependent measure of interest was the likelihood of quitting the particular hobby with values ranging from 0% to 100% likely in both the baseline and mEpFT phases. By plotting the likelihood values of both phases, a standardized area between the curves was obtained by first calculating the area under the curve for each phase, standardizing these values out of one by dividing the total area possible by the obtained areas, and finally subtracting these standardized values from one another. A secondary measure of interest was the stability of reported likelihood values over the course of the experiment.



## Results

For each participant, two discounting curves were plotted using the mean reported likelihood of quitting at each probability from the last three blocks of baseline and first three blocks of the mEpFT phase. Comparisons between the last three blocks of baseline and the first three blocks of the mEpFT phase, rather than between baseline and the last three blocks of the mEpFT phase, were made because I was primarily interested in the immediate change in the reported likelihood of quitting, akin to a point-of-purchase setting. Figure 2 shows these curves with error bars showing one standard error of the mean. To better visualize the difference in the reported likelihood of quitting at the smaller odds in favor values, semi-log scaled insets are displayed within each graph. Participants GP1, GP2, and GP3 show robust increases in the likelihood of quitting with mEpFT (increased area shaded) whereas GP4 and GP5 show very little difference. GP1 and GP4 show the greatest increase in likelihood of quitting at the smaller odds against values, whereas little if any increase was seen for GP2 and GP5. Traditional area under the curve (Myerson et al., 2001; Equation 1) was calculated for each participant during each block and is displayed in Table 1. However, to compare the change in area under the curves for each participant, I calculated a standardized area between each participant's two curves from Figure 2. I did this by taking the area under each curve, standardizing it against the largest possible area, and subtracting the area under the mEpFT curve from the area under the baseline curve.

Figure 3 shows the standardized area between the curves, rank ordered from greatest change to least change. Four out of the five participants displayed an increase in standardized area between the curves with GP4 showing no increase.

To show specific changes in the reported likelihood of quitting as a result of the mEpFT manipulation, participants' reported likelihood at each odds in favor value for the last three blocks in baseline and first and last three blocks of the experimental manipulation were averaged and are displayed in Figure 4. On average, the most pronounced shifts in reported likelihood occurred at the 25% and 10% probabilities. That is, levels in the reported likelihood of quitting remained relatively stable for the larger probabilities, but larger changes occurred as probabilities decreased. Given the data in Figure 4 display aggregate data, I further explored individual's reported likelihood of quitting using higher resolution analyses.

Figure 5 shows individual's reported likelihood of quitting at each probability across consecutive blocks. Participants GP1, GP3, and GP5 show the clearest demonstration of differentiation in reported likelihood to quit between the different probability values. The immediate effect of mEpFT on reported likelihood is best illustrated by examining these levels prior to and following the implementation of mEpFT. As can be seen for GP1, small increases across the likelihood values were seen after the phase change across all probability values, with the largest increases at 25% (12.5 to 35.3) and 10% (0 to 18.9). Tying back to Figures 1 and 2 where there was little shading in the area between the curves and the associated 0% change in the standardized area between the curves for GP4, these patterns can be seen by the relatively small change in level prior to and following the phase change.

## **Discussion**

The goal of Experiment 1 was to determine the extent to which exposure to a mEpFT (i.e., computer-generated future-self images and completion of a FSQ) would

alter participants' reported likelihood of quitting a particular hobby when the quitting the hobby would result in a delayed, yet probabilistic health *gain*. Exposure to these stimuli resulted in an increased reported likelihood of quitting for four out of the five participants across a range of probabilities, with the most notable increases occurring at the 10% and 25% probabilities. To my knowledge, this is the first demonstration of an EpFT derivative to change degree of probability discounting of a health gain.

At the aggregate level, the largest changes in the reported likelihood to quit the hobby occurred at the 10% and 25% probabilities. However, some participants showed larger increases at other probabilities (e.g., GP1, GP3; see Figure 5) whereas some participants showed decreases at a number of different probabilities (e.g., GP2; 75%). It may be the case that a ceiling effect contributed to the relatively small changes in the largest probabilities. For example, although the reported likelihood of quitting by GP5 decreased for the second largest probability (90%) immediately following the phase change, levels of reported likelihood just prior to the phase change were high (98.2 vs. 97.99). The potential ceiling effect may have been a result of the wording of the question: "How likely are you to **quit** this hobby?" With such high probabilities associated with the health gain (e.g., 95%, 90%) and the already high reported likelihood of quitting during baseline, it may have been the case that there was little room for the reported likelihoods to increase. To address this potential limitation, I used different wording of the question in Experiment 2.

Although the results show that the manipulation altered the degree of discounting in the predicted direction, these changes were only demonstrated in the context of a health gain. However, the delayed and probabilistic outcomes associated with many

health related decisions are often negative and it is unknown whether similar changes would be observed in the context of a health loss. Experiment 2 explored whether the current experimental manipulation would result in changes in discounting in the context of a health loss.

## **Experiment 2**

The purpose of Experiment 2 was to examine the effects of the mEpFT on probability discounting of a delayed health loss. I hypothesized that following the experimental manipulation participants will report a lower likelihood of continuing a particular hobby as compared to baseline.

### **Participants, Setting, and Materials**

Five undergraduate females ranging in age from 19 to 21 years ( $M = 20.2$ ,  $SD = .84$ ) and one undergraduate male (22 years old; LP5) recruited from an introductory class in applied behavior analysis participated. All other aspects of the experiment including compensation, session and block duration, materials, and setting were the same as Experiment 1.

### **Computer-generated images**

The same procedure from Experiment 1 to create the computer-generated images was used in the current experiment.

### **Future-self questionnaire**

The FSQ contained the same questions as in Experiment 1.

### **Procedure**

All aspects of the experiment were the same as in Experiment 1 except for the wording of the probabilistic health question and the ordering of the five unique computer-generated images. Participants in the current experiment read the following question:

*“Imagine you are in perfect health and enjoy a particular hobby.*

*You learn that **continuing this hobby one more time will increase your risk of dying of cancer by XX% in 30 years.***

*How likely are you to **continue** this hobby?”*

The same probabilities from Experiment 1 were used in the current experiment: 95, 90, 75, 50, 25, 10, and 5%. Response values also ranged from 0-100% likely to continue. Unlike Experiment 1 where the ordering from left to right of the five unique computer-generated images underneath the VAS ranged from sad to happy, this ordering was reversed such that the happy face was now closest to the “Not at all likely” label.

### **Data Analysis**

Data were analyzed using the same methods as in Experiment 1.

### **Results**

Similar to Experiment 1, for each participant two discounting curves were plotted using the mean reported likelihood of continuing at each probability from the last three blocks of baseline and first three blocks of the mEpFT phase. Figure 6 shows these curves with error bars showing one standard error of the mean. To better visualize the difference in the reported likelihood of quitting at the smaller odds against values, semi-log scaled insets are displayed within each graph. Participants LP4 and LP6 showed the greatest area between the curves at the smaller odds against values, whereas three out of the six LP1, LP3, and LP5 showed little to no area between the curves. Traditional area

under the curve (Myerson et al., 2001; Equation 1) was calculated for each participant during each block and is displayed in Table 2. As in Experiment 1, I standardized the change in area under the curves for each participant to make direct comparisons by standardizing each of the two curves for each participant in Figure 6 and subtracting the area under the mEpFT curve from the area under the baseline curve.

Figure 7 displays the percent change in standardized area between the curves, rank ordered from greatest to least change. All participants except LP5 showed a negative percent change in the area between the curves. This is expected given I hypothesized that exposure to the experimental manipulation would decrease the reported likelihood of continuing the hobby. To further evaluate where these changes occurred with respect to probability values, the next two figures display data using higher resolution analyses.

To show specific changes in the reported likelihood of quitting as a result of the mEpFT manipulation, participants' reported likelihood at each odds in favor value for the last three blocks in baseline and first and last three blocks of the experimental manipulation were averaged and are displayed in Figure 8. Following the phase change, the largest decreases in the average likelihood of continuing occurred at the 5%, 10%, and 25% probabilities. Although there was a small decrease at the 75% probability, substantial overlap in the largest probabilities ( $\geq 50\%$ ) still occurred. During the last three blocks of the mEpFT phase, levels of the likelihood of continuing associated with the largest probabilities ( $\geq 50\%$ ) increased to roughly 25% and almost exclusive overlap occurred for all the probabilities other than 5% and 10%. To further explore these changes in the reported likelihood of continuing across blocks, I next present individual reports.

Individual reports of likelihood of continuing across consecutive blocks are displayed in Figure 9. Note the ascending sequence of probability values associated with the legend. Several patterns emerge when examining data at this level of analysis. First, the large decreases in level associated with the two smallest probability values can be seen for participants LP1, LP2, LP4, and LP6. Participants LP1, LP4, and LP6 show an immediate decrease in the reported likelihood of continuing following exposure to mEpFT, whereas LP2 shows a more gradual decline across the first three blocks of mEpFT. LP4 and LP6 also show a large and immediate decrease associated with probability values larger than 5% and 10%. Interesting patterns were observed for participants LP1, LP4, and LP6. For LP6, there was an initial convergence in the reported likelihood of continuing immediately following the phase change. However, across blocks, the data paths became more differentiated and mostly returned to baseline levels (note the decrease from baseline levels for the highest probabilities, 90% and 95%). Participant LP4's reported likelihood of continuing also converged following the phase change but did not return to baseline levels. LP1 showed a gradual return to baseline levels towards the end of the mEpFT phase. Finally, LP3 showed a distinct pattern in that the reported likelihood of continuing was either very high (100%) or very low (0%) with little variability. Taken together, for most participants a clear decrease in likelihood of continuing occurred after the phase change with levels beginning to return to those similar in baseline towards the end of the phase.

### **Discussion**

The goal of Experiment 2 was to examine the effects of exposure to a mEpFT (i.e., computer-generated future-self images of the participant's face and completion of

the FSQ) on degree of probabilistic discounting of a delayed health *loss*. Five out of the six participants demonstrated a decrease in the reported likelihood of continuing the hobby after exposure to the experimental manipulation. This is the first study of which I am aware that has explicitly examined the effects of an EpFT manipulation to a probabilistic health loss.

The largest changes in reported likelihood to continue occurred at the smallest probabilities, specifically 5%, 10%, and 25%. Visual inspection suggests there were larger changes at the lower probabilities for the health loss than the health gain. This might be due to framing effect where the health loss was perceived as more aversive than the health gain, in line with prospect theory (Tversky & Kahneman, 1986, 1992). Conclusions should be tempered as the framing of the wording of the two health questions are not statistically equivalent. Previous studies examining the “framing effect” have typically used statistically equivalent outcomes (e.g., Tversky & Kahneman, 1981); however, the health related questions in the current study differ based on the initial level of risk. For example, quitting a hobby that otherwise increases the risk of developing cancer by 95% is not the same as a 5% chance of being alive and well by continuing the hobby. Although I phrased the questions as to match real-world contingencies, akin to what an individual might be told by a doctor, future researchers should address this limitation by stating exact risk (e.g., continuing a certain hobby will result in a 95% risk of dying of cancer), rather than a relative increase in risk.

Another potential reason why I might not have seen changes at the larger probabilities might be due to floor effects. In Figure 9, almost 0% reported likelihood levels are seen associated with the 90% and 95% probabilities for five out of the six



participants. Thus, when faced with a health loss given continuation of a hobby, reported likelihood was already low during baseline so there was little room for those reports to decrease following the mEpFT procedure.

### **General Discussion**

The goal of the current experiments was to determine the extent to which exposure to computer-generated future-self images and completion of a FSQ in a mEpFT procedure would alter participants' reported likelihood of quitting or continuing a hobby resulting a delayed, but probabilistic health gain or loss, respectively. Indeed, four out of the five participants in Experiment 1 and five out of the six participants in Experiment 2 displayed changes in the predicted direction in their reported likelihood to quit/continue. This is the first study, of which I am aware, to apply an EpFT manipulation in an effort to alter individuals' degree of probability discounting in the context of a health gain and loss.

Although evidence suggests delay discounting and probability discounting are affected by different variables (Estle, Green, Myerson, & Holt, 2006; Green, Myerson, & O'Donoghue, 1999; Yi, de la Piedad, & Bickel, 2006), and thus might be separate processes (Jarmolowicz, Bickel, Carter, Franck, & Mueller, 2012; Green & Myerson, 2013), it is interesting that the mEpFT procedure used in the current study resulted in robust changes in probability discounting of both gains and losses. These results lend support for the temporal attention hypothesis by demonstrating a change in individuals' degree of probability discounting using a manipulation aimed to focus attention to temporally distal events (e.g., EpFT).

It could be the case that participants in the current study responded to the probabilities as participants in previous EpFT studies responded in respect to delays. Further support for this notion and the temporal attention hypothesis, by way of the EpFT procedure, comes from the conceptualization that uncertainty and delay are analogous (Weber & Chapman, 2005) and that the more uncertain the event is, the more psychologically distant it is perceived (Todorov, Goren, & Trope, 2007; Wakslak, Trope, Liberman, & Alony, 2006). Although their preparation was quite different than the current one, Weber and Chapman found that, in some cases, not only did delay eliminate the certainty effect (i.e., overweighting certain outcomes) but also that risk eliminated the immediacy effect (i.e., overweighting immediate outcomes). This might suggest that temporal attention can be allocated to aspects other than distal outcomes and that the mEpFT procedure used in the current study did change participants' responses to the probabilistic aspect of the health question. Future research might examine the extent to which techniques that have been shown to modify delay discounting also alter probability discounting. In addition, I kept the delay constant throughout both experiments as not to confound interpretations. As such, it would be beneficial to replicate the current findings while also manipulating delay in a parametric-like fashion, akin to Vanderveldt and colleagues' procedure (2014), to determine whether such interactions between delay and risk are present.

Even though the probabilistic health question was delayed, the mEpFT procedure effectively changed individuals' degree of probability discounting for both gains and losses. These results have immediate, applied implications within the realm of promoting healthy behavior. Framing effects are a reliable phenomenon (Kühberger, 1998) and

depending on the outcome of engaging (or failure to engage) in a particular behavior, framing the outcome in terms of a gain or a loss might be differentially effective in promoting the desired behavior (Rothman, Bartels, Wlaschin, & Salovey, 2006). The type of framing used in the current study best aligns with Levin, Schneider and Gaeth's (1998) typology of a *goal frame*. A goal frame, often used in health-related scenarios, attempts to enhance the evaluation of a specific outcome or behavior and the outcome can be framed to focus attention on obtaining a positive consequence (gain frame) or avoid a negative consequence (loss frame) (Levin et al., 1998; p. 167). In a review of 28 research articles that used goal frames to change behavior, Levin and colleagues found the loss frame to be more effective in changing behavior. Although direct comparisons between the two experiments in the current study cannot be made given the differences in the question used (e.g., quitting vs continuing the hobby), visual inspection of the data (Figures 2 and 6) suggests the loss frame resulted in a greater change in the reported likelihood of quitting/continuing. A future study might evaluate the effects of the two kinds of frames while keeping the question (e.g., quitting vs continuing the hobby) constant. Nonetheless, the results from the current study demonstrate the mEpFT procedure was effective at changing behavior regardless of the frame.

The current study has applied implications for manipulating decision making at the point of purchase. As discussed earlier, Merrill Edge's Face Retirement campaign is currently using software to "age" potential clients (similar to the current study) in an attempt to influence online investment decisions. I believe it is possible apply these age morphing techniques, along with other targeted questions and evaluation forms, to influence decision making in a number of domains other than money and to make the

“tyranny of small decisions” (Bickel & Marsch, 2000) work for, rather than against, the individual. For example, it might be possible to create a mobile device application that will automatically render future computer-generated images of the user’s face and combine this with information regarding the current weight, resting heart rate, and blood pressure of the user as well as the last time the user worked out to project a probabilistic risk assessment of not engaging in any exercise for that day. Integration between applications that manage health and money tracking, along with more sophisticated forms of image capturing, will allow for interventions such as these to be readily accessible.

Since this is the first study to apply an EpFT derivative to probability discounting and the probabilistic choice task contained a delayed element, the extent to which the same manipulation would alter probability discounted sans a delayed component is unknown. Had the mEpFT procedure merely targeted the delayed aspect of the health outcome, I might have expected the reported likelihood of continuing/quitting to change either systematically across all the probability values or nonsystematically at all. Nevertheless, a logical next step would be to remove the delayed aspect of the probabilistic question to isolate the effects of EpFT on probability discounting. However, the results are promising given the ubiquity of everyday choices that involve both delayed and probabilistic components (e.g., Bickel & Marsch, 2000; Green & Myerson, 2004; Vanderveldt et al., 2014).

As with many previous discounting studies, (Bickel, Odum, & Madden, 1999; Dixon & Holton, 2009; Dixon, Marley, & Jacobs, 2003; Johnson & Bickel, 2002; Odum, Madden, Badger, & Bickel, 2000) the current study used hypothetical outcomes rather than real outcomes, posing a potential limitation to my methodology. However, previous

research comparing real and hypothetical outcomes has found both types of outcomes are discounted similarly (Dixon, Lik, Green, & Myerson, 2013; Johnson & Bickel, 2002; Madden, et al., 2004; Madden, Begotka, Raiff, & Kastern, 2003). As Odum (2011) points out, discounting tasks ask questions that are qualitatively different from typical self-report measures (e.g., asking about *past* behavior), which may be one reason for the better correspondence between real and hypothetical outcomes. In addition, there are usually no “right” or “wrong” answers as the participant is simply reporting their likelihood of engaging in some behavior or choosing between options. Relevant to the current study, it would be difficult, if not impossible, to directly deliver the health related consequences used in the probabilistic choice task. I conceptualized the health questions as ones an individual might encounter when consulting with a doctor or trained physician, a situation with which many people probably have experience. Notwithstanding the novel aspect of the probabilistic choice question, participants discounted the risks associated with the hobby systematically and all data passed Johnson and Bickel’s (2008) criteria for nonsystematic data.

An additional limitation surrounds the mEpFT component entailing the age progressed images. It could have been the case that for some participants, their computer-generated face was too dissimilar from what they might imagine themselves to look like in 30 years from now. Previous EpFT literature suggests that the more vivid subject-specific cues are, or the reported degree of imagery (i.e., high vs. low), the greater the change in degree of discounting (Peters & Büchel, 2010). The difference between how participants viewed their computer-generated future-self and their perceptions of how their future self will look like may have contributed to differences in the change in

discounting across the participants. However, during debriefing, I asked participants to rate on a Likert scale (1=extremely dissimilar to 7=extremely similar) the degree to which the images looked like them. The average rating by participants in Experiment 1 was 4.5 ( $SD = 1$ ) and the average rating by participants in Experiment 2 was 3.75 ( $SD = 1.25$ ). These differences in scores may have contributed to the idiosyncratic effects observed with respect to change in reported likelihood across the various probabilities, in terms of the majority of participants showing changes in the predicted direction at the lower probabilities and for some participants, increases at other probabilities.

My mEpFT procedure was additionally limited by the open-ended nature of the FSQ. It is possible that asking participants to self-generate the hobby might have differentially affected how participants responded to the question. For example, one participant reported that the hobby she was thinking of was indoor tanning whereas another participant reported she was thinking of smoking cigarettes, even though she was not a current smoker. Use of a concrete hobby or activity that participants identify beforehand might make effects more consistent across participants and may even increase the effects I obtained. Further, more robust effects might occur with clinical populations with the hobby being engaging in their activity or consuming their substance of abuse. A logical next step would be to simply layer the age progression component used in the current study onto more standard EpFT procedures (e.g., use of subject-specific tags; Peters & Büchel, 2010).

Certain aspects of the probabilistic choice task pose limitations for the current study. The program was written such that every trial lasted approximately 45 s and was done so in an effort to standardize block duration. As a result, participants had a total of

10 s to respond during each trial and depending upon how quickly the participant responded, the remainder of that 10 s was added to that trial's blackout period. While these aspects were included so that participants could not respond faster in an attempt to end the session quicker, there were instances where a participant failed to respond within 10 s and when that occurred, the program recorded an omission. An omission occurred on at least one trial for all but one participant (GP4) in Experiment 1 and all but two (LP4 and LP6) participants in Experiment 2. However, of those participants who did omit a response on at least one trial, the average number of omissions per person was 2.25 ( $R = 1-4$ ;  $STD = 1.04$ ) and these omissions typically occurred during the first or second block of baseline. Therefore, the number of omitted trials comprised only 2% of the total number of trials. Although it does not appear the time constraint had a systematic effect on individuals' degree of discounting, Ebert (2001) found that participants who were under a time constraint of 3 s displayed lower rates of delay discounting but only for the first half of the session. In addition, Dixon and colleagues (2013) found that when blackout periods contingent on immediate choices were used to hold reinforcement rate constant, participants displayed little to no discounting, whereas more typical discounting was observed when the aforementioned blackouts were absent. Several differences might account for why I observed more "typical" patterns of discounting even with the use of blackout periods. First, participants in the current study had more time to respond (e.g., 10 s) as compared to Ebert's study. While the effect obtained in his study was in the opposite direction as other studies that have taxed executive functioning (Hinson, Jameson, & Whitney, 2003), similar to Ebert's, my study asked individuals to report a single value (e.g., likelihood of continuing/quitting) rather than to make a choice between

options. It is unknown whether time constraints affect discount rates the same way when individuals report a single value as when they have to choose between options. Second, the aforementioned studies assessed delay discounting, not probability discounting.

While the probabilistic choice question did have a delayed component, delays were not systematically altered and pitted against an explicit immediate outcome as is more often the case in delay discounting studies.

Finally, while I employed a novel VAS procedure to assess degree of discounting, previous literature has supported the use of the VAS as a feasible response medium (Johnson & Bruner, 2013; Kaplan et al., 2014), especially in the contexts of questions where money is not easily equated. Degree of discounting as calculated using area under the curve (Myerson et al., 2001) remained relatively stable throughout the duration of the experiment even though trials and sessions were presented separately, corroborating the test-retest reliability analysis of the VAS (Johnson & Bruner, 2013). This demonstrates a promising approach to examine discounting across a wide range of domains.

In sum, results from the current study suggest EpFT was effective in changing degree of probability discounting of both a delayed health gain and loss. These results expand the scope of both the temporal attention hypothesis and the EpFT literature. The current study also demonstrates the applied utility in using EpFT and framing to change behavior, especially in the context of health outcomes and situations in which a one-time decision making event is important to target. As such, research examining experimental variables that impact delay discounting and related processes (e.g., temporal perspective, reinforcer value, risky choice), particularly those that produce lasting effects, is of great interest.



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Table 1

*Area Under the Curve*

Participant	Block												
	1	2	3	4	5	6	7	8	9	10	11	12	13
GP1	0.129	0.081	0.087	<b>0.235</b>	<b>0.233</b>	<b>0.327</b>	<b>0.231</b>	<b>0.303</b>	<b>0.238</b>	<b>0.197</b>	<b>0.257</b>	-	-
GP4	0.143	0.125	0.137	<b>0.125</b>	<b>0.136</b>	<b>0.149</b>	<b>0.165</b>	<b>0.131</b>	<b>0.104</b>	<b>0.144</b>	<b>0.151</b>	-	-
GP3	0.132	0.140	0.163	0.097	0.091	<b>0.164</b>	<b>0.210</b>	<b>0.208</b>	<b>0.089</b>	<b>0.093</b>	<b>0.229</b>	<b>0.299</b>	<b>0.058</b>
GP5	0.206	0.191	0.235	0.191	0.193	<b>0.245</b>	<b>0.215</b>	<b>0.246</b>	<b>0.201</b>	<b>0.204</b>	<b>0.194</b>	-	-
GP2	0.369	0.119	0.187	0.236	0.069	0.113	0.057	0.148	0.079	<b>0.245</b>	<b>0.206</b>	<b>0.105</b>	-

*Note:* Non-bolded values indicate baseline phase and bolded values indicate mEpFT phase.

Table 2

*Area Under the Curve*

Participant	Block											
	1	2	3	4	5	6	7	8	9	10	11	12
LP3	0.863	0.857	0.873	<b>0.853</b>	<b>0.679</b>	<b>0.615</b>	<b>0.601</b>	<b>0.708</b>	<b>0.684</b>	<b>0.612</b>	<b>0.666</b>	-
LP6	0.823	0.895	0.886	0.905	<b>0.659</b>	<b>0.664</b>	<b>0.722</b>	<b>0.840</b>	<b>0.892</b>	<b>0.865</b>	-	-
LP5	0.687	0.561	0.744	0.683	<b>0.725</b>	<b>0.731</b>	<b>0.724</b>	<b>0.721</b>	-	-	-	-
LP1	0.430	0.462	0.527	0.610	0.614	<b>0.447</b>	<b>0.470</b>	<b>0.497</b>	<b>0.487</b>	<b>0.518</b>	<b>0.597</b>	<b>0.588</b>
LP2	0.637	0.676	0.687	0.682	0.689	<b>0.665</b>	<b>0.558</b>	<b>0.380</b>	<b>0.516</b>	<b>0.483</b>	<b>0.473</b>	-
LP4	0.358	0.477	0.609	0.632	0.512	0.565	0.653	0.664	<b>0.107</b>	<b>0.196</b>	<b>0.200</b>	<b>0.198</b>

*Note.* Non-bolded values indicate baseline phase and bolded values indicate mEpFT phase.

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***A: Actual Photo of First Author***



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***B: Nonaged Computer-Generated Image***



---

***C: Future-Self Computer-Generated Images***



Figure 1

Example images of the age progression. The top image (A) is an actual photo of the first author. The middle image (B) is the nonaged computer-generated image created by using the photo of the first author. Although participants in the experiment never saw their

nonaged computer-generated images, creating a nonaged image was necessary to create the future-self images and so I display that here. The bottom images (C) are three future-self computer-generated images with three emotions (from left to right): sad, neutral, and happy. Participants saw two additional images that approximated a balance between the sad and neutral images and between the happy and neutral images.

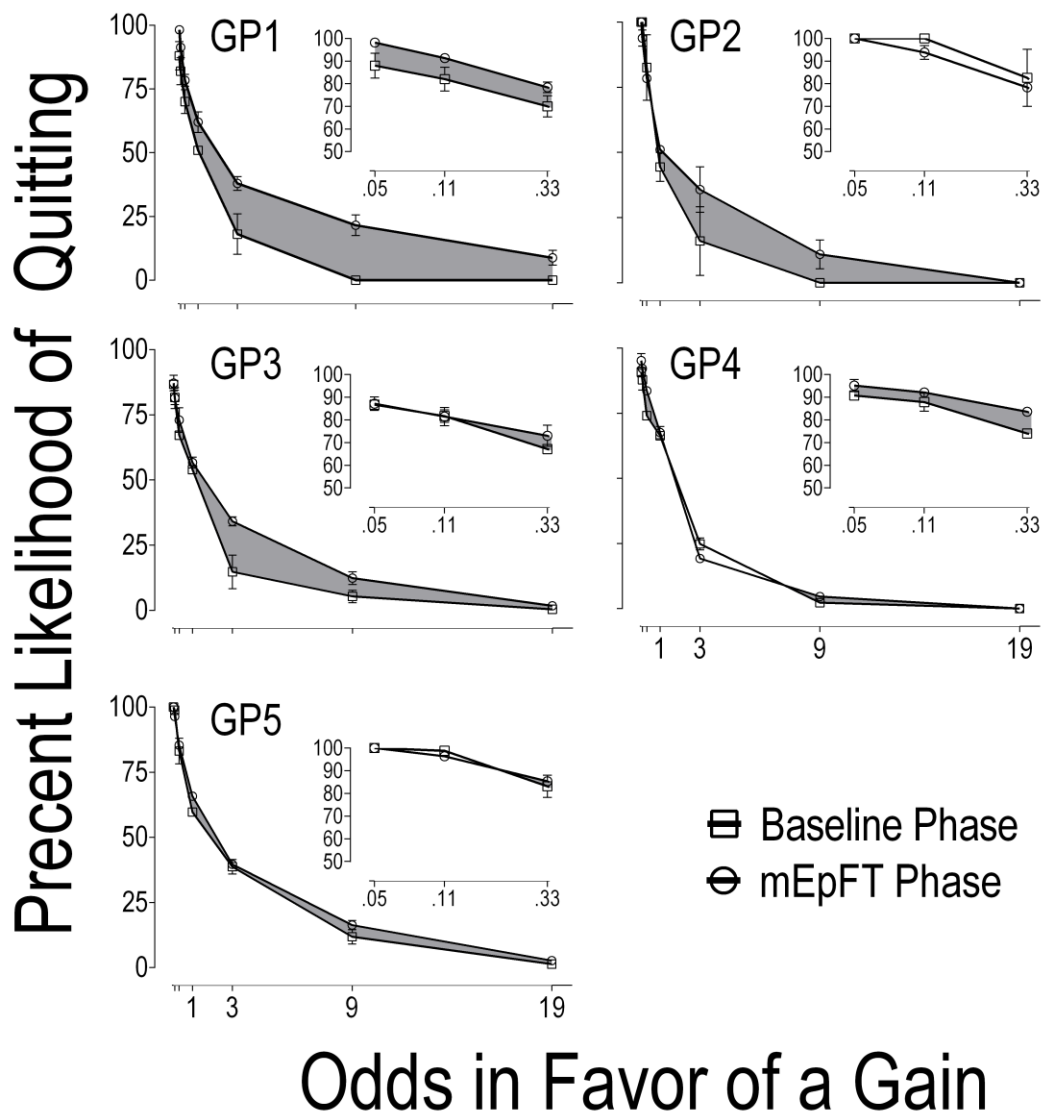


Figure 2

Mean ( $\pm$  SEM) likelihood of quitting for last three blocks of baseline (open squares) and first three blocks of mEpFT (open circles) phases. The shaded area between the curves indicates area change (a negative effect is represented by a lack of shading between indifference points for GP4). Semi-log inserts provided for the smaller odds in favor values.

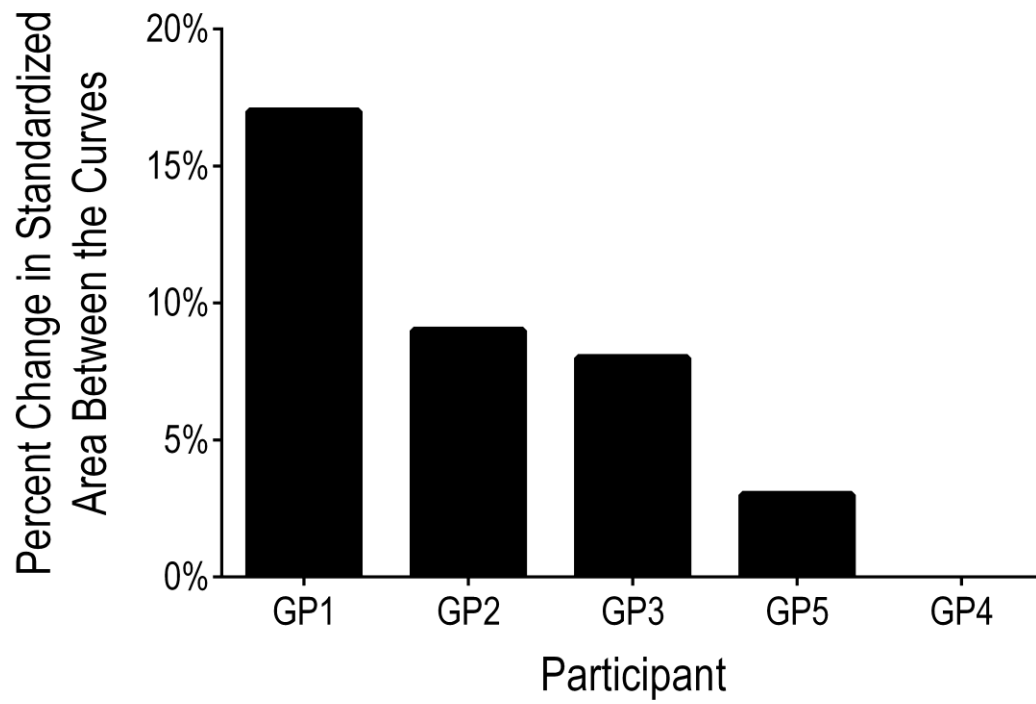


Figure 3

Percent change in standardized area between the curves.

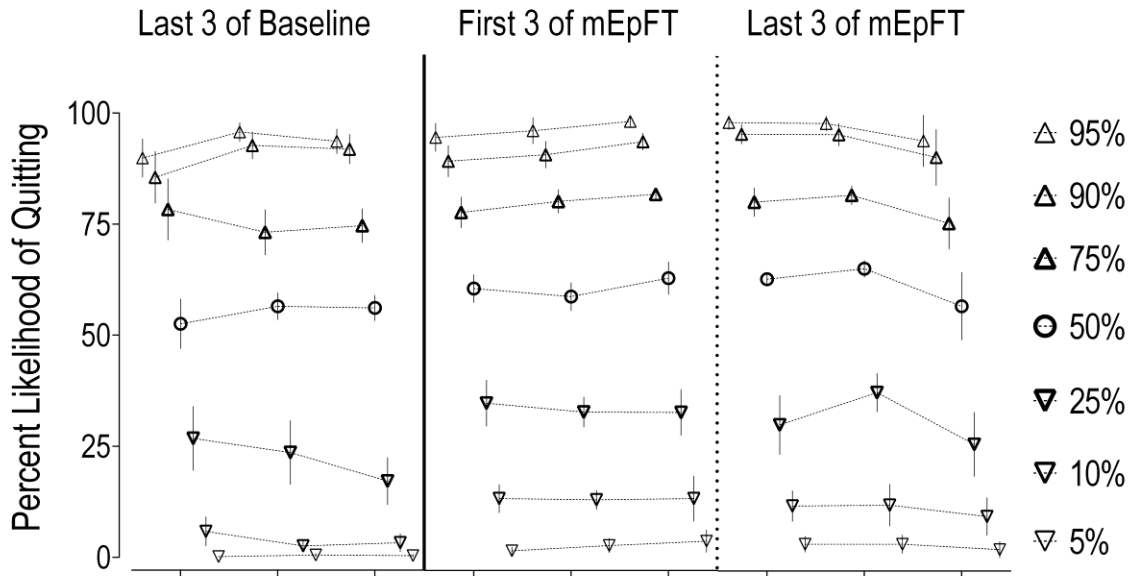


Figure 4

Mean ( $\pm$  SEM) likelihood of quitting at each probability value for all participants. Major phase change line indicates the change from baseline to mEpFT phase and minor phase change line indicates the separation between the first three sessions and last three sessions of the mEpFT phase.

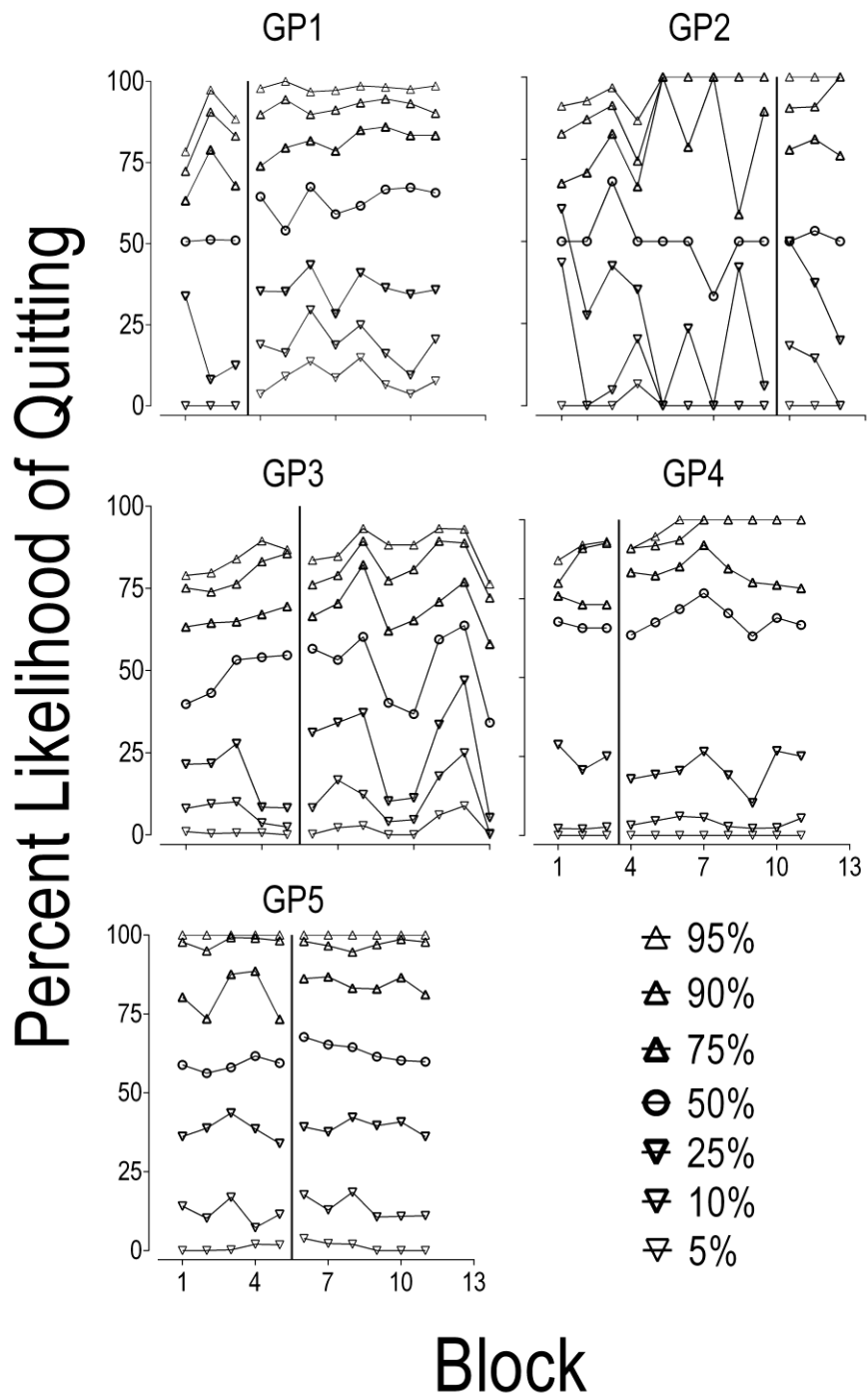


Figure 5

Likelihood of quitting at each probability value across consecutive blocks. Major phase change line indicates transition from baseline to mEpFT phase.



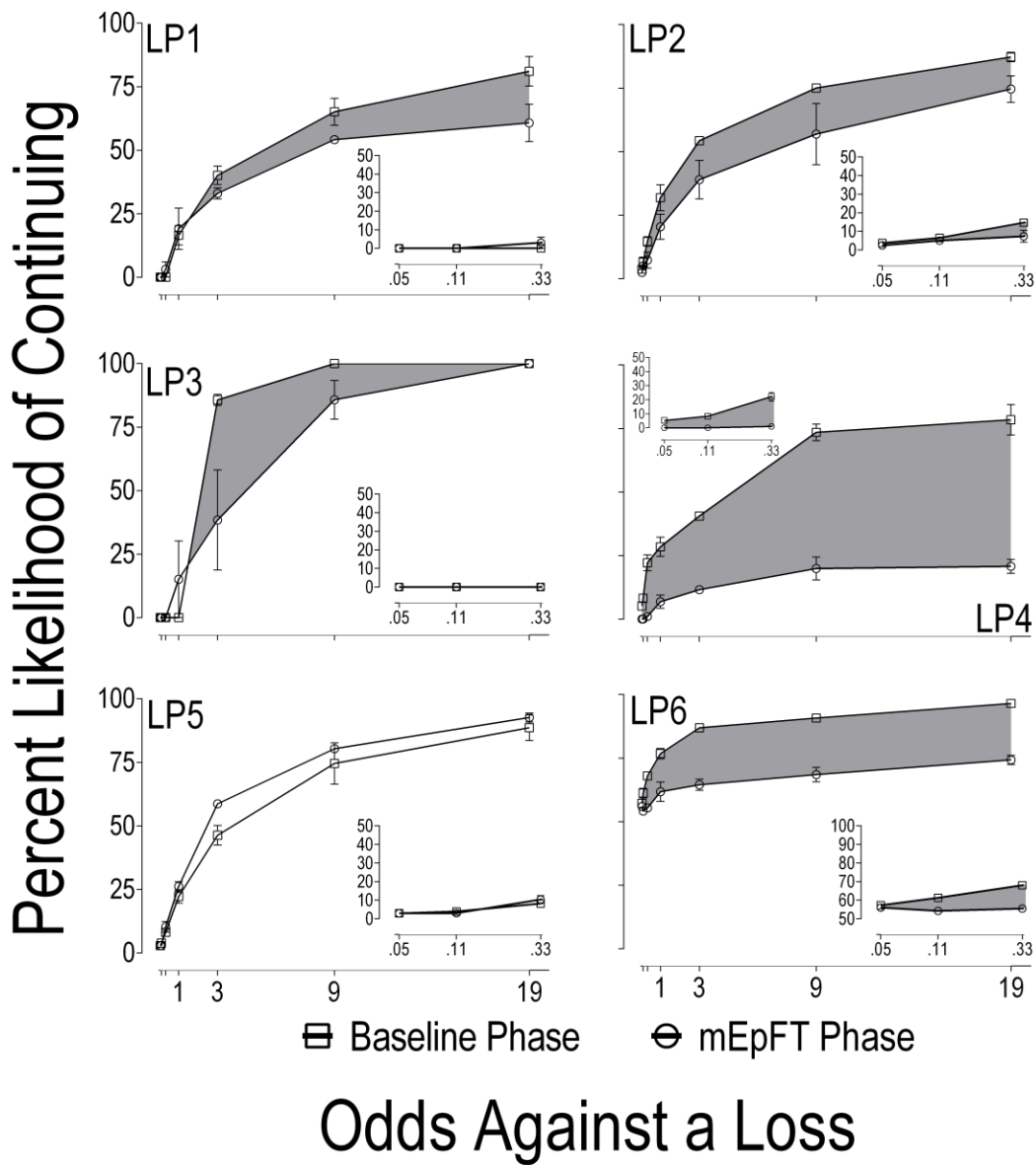


Figure 6

Mean ( $\pm$  SEM) likelihood of continuing for last three blocks of baseline (open squares) and first three blocks of mEpFT (open circles) phases. The shaded area between the curves indicates area change (a negative effect is represented by a lack of shading between indifference points for LP5). Semi-log inserts provided for the smaller odds against values.

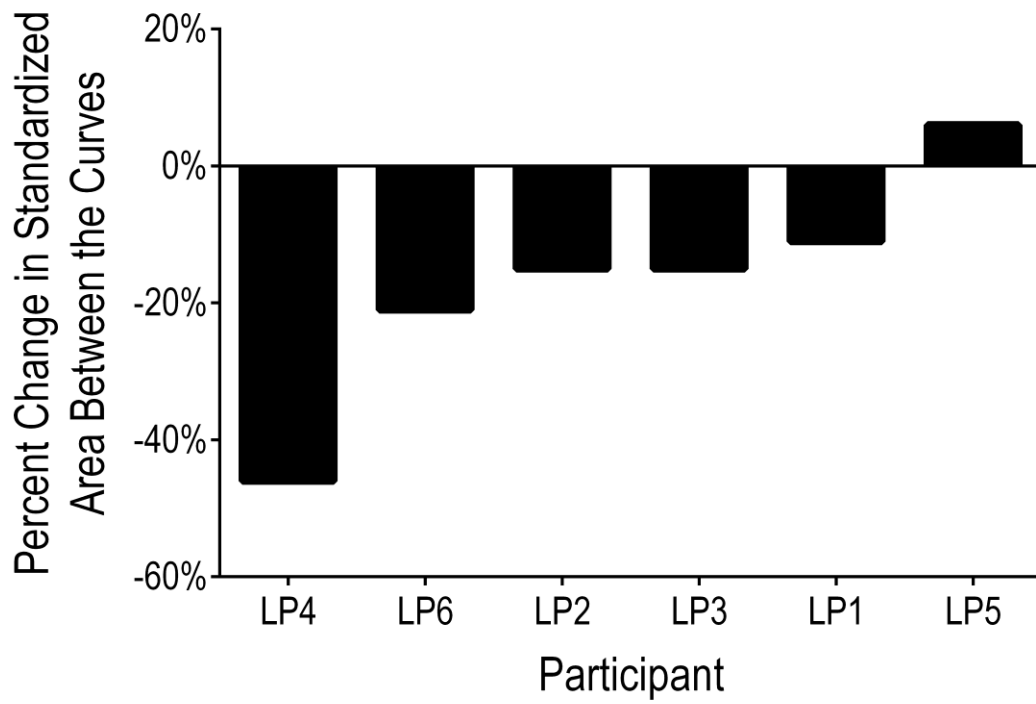


Figure 7

Percent change in standardized area between the curves.

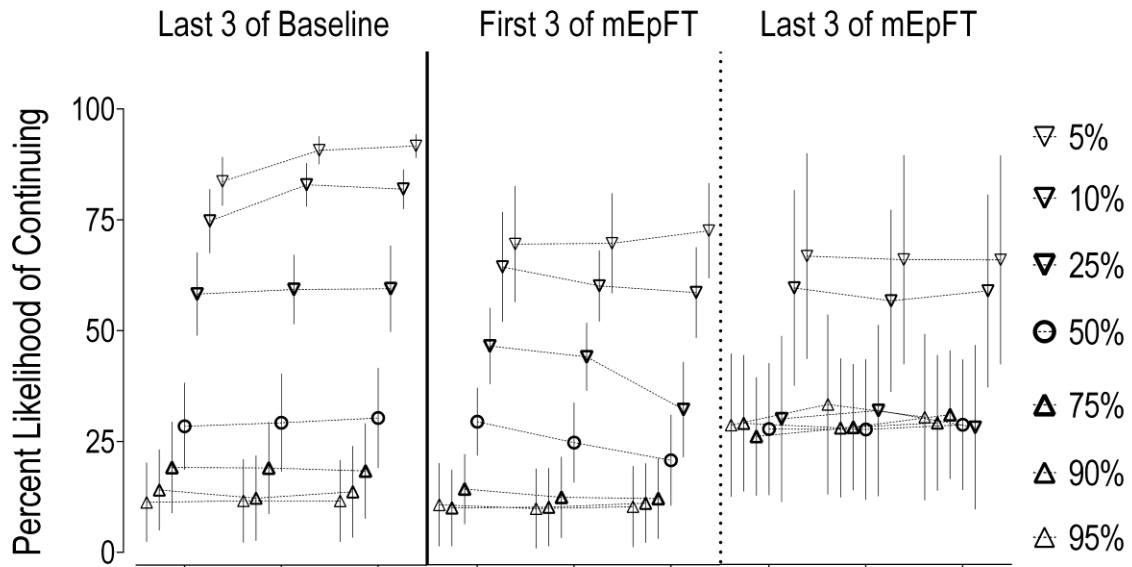


Figure 8

Mean ( $\pm$  SEM) likelihood of continuing at each probability value for all participants.

Major phase change line indicates the change from baseline to mEpFT phase and minor phase change line indicates the separation between the first three sessions and last three sessions of the mEpFT phase. Note that unlike Figure 4, the topmost symbols are associated with the smallest probability values and the bottommost with the largest probability values.

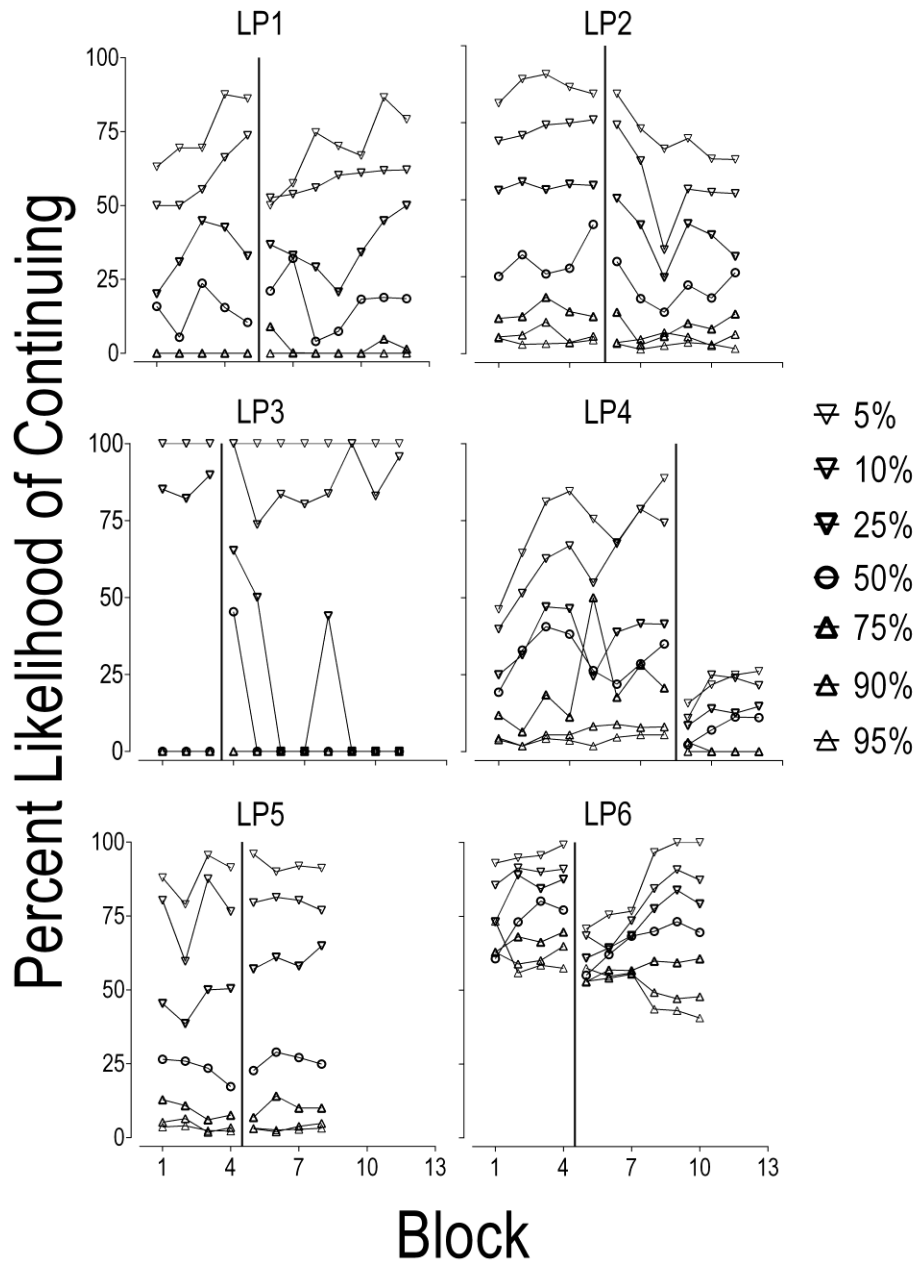


Figure 9

Likelihood of continuing at each probability value across consecutive blocks. Major phase change line indicates transition from baseline to mEpFT phase. Note that unlike Figure 4, the topmost symbols are associated with the smallest probability values and the bottommost with the largest probability values.

## Appendix A

### **Announcement of Opportunity to Participate in Research**

We would like to announce the opportunity to participate in a research project studying choice-making during a computerized procedure. During the study, you will make different investment related decisions that relate to a hypothetical scenario. As you make these choices, you will see computer generated images of yourself which will be created using digital photographs of your face taken during the first session. You will need to be available to return 5 – 10 times for 45-60 minutes on different days in order to be eligible to participate. Your total time commitment will thus be about 5 – 10 hours.

Participants will be compensated with extra credit for their participation in the study. You will earn  $\frac{1}{2}$  of 1% point for each session attended. The amount of total extra credit depends on the number of session attended.

## Appendix B

### TEAR-OFF INFORMED CONSENT STATEMENT

#### **Consumer Valuation via a VAS and Associated Stimuli**

##### INTRODUCTION

*The Department of Applied Behavioral Science at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.*

##### PURPOSE OF THE STUDY

*The purpose of the proposed investigation is to evaluate decision-making regarding hypothetical outcomes (i.e., differently valued purchases) in college undergraduate students.*

##### PROCEDURES

*By participating in this study, you will be asked to make decisions about investing money or engaging/quitting in a hobby detrimental to one's health in a hypothetical scenario. Digital photographs will be taken of your face and be used to create computer generated images which you might subsequently see while making these decisions. These digital photographs will be stored on a secure electronic server and will be deleted once the computer generated images are created. For each session lasting approximately 45-60 minutes, you will come and make these decisions by simply sliding a bar on the screen. You will be asked to make approximately 10-30 of these decisions during one session. Total time commitment will be approximately 2-10 hours over the course of several weeks.*

##### RISKS

*No risks are anticipated with participation in this study.*

##### BENEFITS

*Your participation in this study will indirectly benefit society by providing our scientific field with information on how college students make choices under varying instructions.*

##### PAYMENT TO PARTICIPANTS

*Participants will be compensated by receiving 1/2 of 1% point of extra credit for each session attended. This extra credit will be applied to their undergraduate ABSC course from which they were recruited.*

#### **PARTICIPANT CONFIDENTIALITY**

*Your name will not be associated in any publication or presentation with the information collected about you or with the research findings from this study. Instead, the researcher will use a study number or a pseudonym rather than your name. Your identifiable information will not be shared unless required by law or you give written permission.*

#### **REFUSAL TO SIGN CONSENT AND AUTHORIZATION**

*You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from the University of Kansas or to participate in any programs or events of the University of Kansas. However, if you refuse to sign, you cannot participate in this study.*

#### **CANCELLING THIS CONSENT AND AUTHORIZATION**

*You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to: Derek D. Reed, Ph.D., BCBA-D, 1000 Sunnyside Avenue Room 4048 DHDC, Lawrence, KS 66045*

*If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.*

**QUESTIONS ABOUT PARTICIPATION** should be directed to:

*Brent A. Kaplan, B.G.S.  
Principal Investigator  
Department of Applied Behavioral Science  
4085 Dole Human Development Center  
University of Kansas  
Lawrence, KS 66045*

**OR**

*Derek D. Reed, Ph.D., BCBA-D  
Faculty Supervisor & Co-Investigator  
Department of Applied Behavioral Science  
4048 Dole Human Development Center  
University of Kansas  
Lawrence, KS 66045*

**PARTICIPANT CERTIFICATION:**

*I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call (785) 864-7429 or (785) 864-7385, write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email irb@ku.edu.*

I agree to take part in this study as a research participant. By my signature I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

Course: ABSC \_\_\_\_\_

\_\_\_\_\_  
Type/Print Participant's Name

\_\_\_\_\_  
Date

\_\_\_\_\_  
Participant's Signature



Appendix C

Birthdate:	Month (##): _____ Date (##): _____ Year (####): _____ _____
I am a:	(please circle your response below) Male Female
My major is:	
My year in school is:	
My current marital status is:	(please circle your response below) Single, never married Married Separated Divorced Widowed
My approximate yearly income is:	(please circle your response below) Under \$10,000 \$10,000 - \$19,999 \$20,000 - \$29,999 \$30,000 - \$39,999 \$40,000 - \$49,999 \$50,000 - \$74,999 \$75,000 - \$99,999 \$100,000 - \$150,000 Over \$150,000 Rather not say
Have you ever received a professional diagnosis of ADD/ADHD?	(please circle your response below) YES NO
Have you gambled in any form (examples could include, but are not limited to: lotto tickets, bingo, keno, poker, blackjack, roulette, slot machines, wagering on horses or sports, dice, etc.) two or more times in the past month?	(please circle your response below) YES NO

*Your responses will remain anonymous. All data sheets, including this demographics questionnaire, will be stored in a locked filing cabinet in the lead researcher's locked office.*

## Appendix D

1. What were your overall impressions of the study?
2. What was the hobby that you were thinking of while answering the questions?
3. Was anything hard to understand?
4. Did you notice the pictures?
5. Did the pictures affect how likely you were to quit/continue the hobby?
6. What did you like least about the experiment?
7. Do you think participating in this study will affect your real life decisions?
8. Why did you choose the values that you did?
9. Was the question confusing?
10. Did you notice the facial expressions on the pictures?
11. What were your thoughts on the questions about your future self?
12. On a scale from 1-7 with 1 being extremely dissimilar and 7 being extremely similar, how closely do you feel the computer generated pictures resembled you?

## Appendix E

First, the researcher uploaded the straight-on photograph to FaceGen Modeller's PhotoFit feature and subsequently tagged several key features of the participant's face (e.g., eyes, ears, mouth, and chin) to maximize accuracy of the model. The two side profile pictures were only used if PhotoFit was unable to produce an accurate model. Once created, the researcher "aged" the model by sliding two "Age" bars (e.g., shape and color) to the maximum level (approximately 65 years old). The new aged picture was saved as the "Neutral" image. Using the neutral image as a base, the researcher modified it to produce four additional pictures reflecting changes in emotion. Two pictures reflected a sad emotion and two pictures reflected a happy emotion. For one of the two pictures reflecting the sad emotion, the researcher adjusted the sliding bar corresponding with "Expression: Sad" (located under the Morph tab of FaceGen Modeller) half-way of the maximum and manually adjusted the outside of the mouth down slightly. This produced the "Neutral Sad" picture. For the second sad image, the researcher adjusted the aforementioned slider to the maximum and further adjusted the outside of the mouth down. This produced the "Sad" picture. To create the first happy image, the researcher manipulated the "Smile: Mouth Closed" slider halfway of the maximum and manually adjusted the outside of the mouth slightly. This picture was saved as the "Neutral Happy" image. To create the second happy image, the researcher manipulated the aforementioned slider to the maximum and further adjusted the outside of the mouth. This newly created picture was saved as the "Happy" image. FaceGen's PhotoFit feature does not retain the hair during the modeling process; therefore, using Adobe Photoshop the researcher extracted the hair from the original digital photograph and cropped it onto the newly

computer-generated images. Contrast and saturation settings were modified to change the original color of the participant's hair to gray.

# Appendix F

Participant ID:

Session:

Show Pictures?  
 Yes  
 No

Gain/Loss  
 Gain  
 Loss

Practice Trial  
 Practice Trial

Real Time Feedback  
 Real Time Feedback



## Appendix G

The following questions will ask you to indicate your answers on a scale. Before you begin, it will be helpful to practice using the cursor. Here is an example of how to use the marker:

Imagine you are asked to guess the temperature of this room.

You believe the temperature is 68 degrees Fahrenheit. Thus, you must click on the marker and -- without releasing the click -- slide the marker to 68, and then release your click.

The number below the line will indicate the location of the cursor.

Go ahead and slide the marker to 68 degrees and click Submit:



Submit

## Appendix H

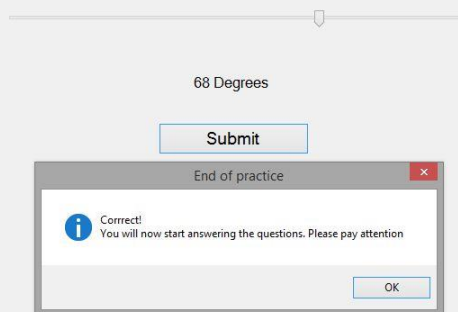
The following questions will ask you to indicate your answers on a scale. Before you begin, it will be helpful to practice using the cursor. Here is an example of how to use the marker:

Imagine you are asked to guess the temperature of this room.

You believe the temperature is 68 degrees Fahrenheit. Thus, you must click on the marker and -- without releasing the click -- slide the marker to 68, and then release your click.

The number below the line will indicate the location of the cursor.

Go ahead and slide the marker to 68 degrees and click Submit:



## Appendix I

### General Instructions

Welcome to our experiment!

The purpose of the present study is to measure how likely you would be to continue and/or quit a particular hobby.

Please make your decisions as if all scenarios involved were real. There are no correct or incorrect answers.

On the following screens, you will sometimes see a bar with a triangular cursor. You will use the cursor to scroll along the bar to decide how likely you would be to continue/quit a particular hobby.

You will have several seconds until a button appears to submit your choice. Please submit your choice when the button appears.

If you do not understand these instructions, please ask the researcher any questions you may have now. If you do understand these instructions, please click the button below.

I have read and understand these instructions



## Appendix J

Imagine you are in perfect health and enjoy a particular hobby.

You learn that **quitting this hobby permanently will increase your chances of being alive and cancer-free by 95%** in 30 years.

How likely are you to quit this hobby?

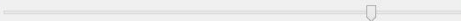


## Appendix K

Imagine you are in perfect health and enjoy a particular hobby.

You learn that **quitting this hobby permanently will increase your chances of being alive and cancer-free by 90%** in 30 years.

How likely are you to quit this hobby?

Not Likely At All  Extremely Likely

Note: By clicking yes, you will move on to the next question

## Appendix L

Imagine you are in perfect health and enjoy a particular hobby.

You learn that **quitting this hobby permanently will increase your chances of being alive and cancer-free by 90%** in 30 years.

How likely are you to quit this hobby?

