EPISODIC FUTURE THINKING IN A TREATMENT SEEKING ADDICTION SAMPLE

A PILOT STUDY OF EPISODIC FUTURE THINKING IN A TREATMENT SEEKING ADDICTION SAMPLE

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LAY ABSTRACT

People with substance use disorders have a significantly shortened time perspective compared to healthy controls. This means that these individuals struggle with thinking about future events beyond several days to a week. Shortened time perspective can be a significant barrier to addiction treatments that typically focus on long-term positive benefits of sobriety or low-risk use. This study examined whether mindful thinking about future events impacted decision-making and motivation for alcohol and drugs. The study used an experimental protocol known as Episodic Future Thinking (EFT) that involves participants interacting with personalized cues related to positive future events. Prior research using EFT in addiction samples has found that interacting with future cues significantly increases delay of gratification, reduces cigarette use, and decreases reinforcing value of alcohol. In this study, we recruited 28 participants with an alcohol use disorder (AUD). Participants practiced EFT training over a two-week protocol. We tested decision making, alcohol craving, and other variables following a single EFT protocol, and changes in these measures over repeated practice. We found significant changes in alcohol craving, decision making, and mindfulness awareness. The study provides proof-of-concept for using EFT in an AUD treatment population and lays the foundation for future clinical trials of EFT as a complement to existing addiction treatments.

ABSTRACT

Rationale: Individuals with addictive disorders commonly exhibit a shortened temporal window, which interferes with treatment focusing on long-term sobriety. Episodic Future Thinking (EFT) involves generating personalized cues related to anticipated, positive events at various future time points. EFT has been shown to reduce the reinforcing value of addictive substances; however, this has only been shown in non-treatment samples.

Purpose: To examine the feasibility, cumulative, and sustained effects of implementing EFT in a treatment seeking addiction sample over a 1-week protocol on decision-making and alcohol motivation.

Methods: Twenty-eight treatment seeking individuals were randomly assigned to either undergo an EFT intervention or a control Episodic Recent Thinking (ERT) protocol. Assessments were completed at baseline, end of week 1, and a 1-week follow-up. Measures included a delay discounting task, hypothetical alcohol purchase task, clinical outcome measures, and cognitive mechanism measures.

Results: There were significant reductions in alcohol demand indices, delay discounting rates, and an increase in mindful attention awareness after both acute and extended exposure to EFT. Furthermore, the EFT group showed greater reductions compared to the ERT group after extended exposure to their cues.

Conclusion: The results suggest that early implementation of EFT in a treatment seeking addiction sample is beneficial to counteract motivating factors for relapse. This study lays the foundation for future clinical trials for EFT as a supplemental therapy for addictions treatment.

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TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

LIST OF ABBREVIATIONS AND SYMBOLS

EFT: Episodic Future Thinking

ERT: Episodic Recent Thinking

CNDS: Competing Neurobehavioural Decision Systems

AUD: Alcohol Use Disorder

SUD: Substance Use Disorder

SCID: Structured Clinical Interview for Diagnostic Statistics Manual-5

APT: Alcohol Purchase Task

DD: Delay Discounting

BSCQ: Brief Situational Confidence Questionnaire

AUQ: Alcohol Use Questionnaire

CFC: Consideration for Future Consequences

MAAS: Mindful Attention Awareness Scale

EMA: Ecological Momentary Assessment

fMRI: functional Magnetic Resonance Imaging

α: alpha

DECLARATION OF ACADEMIC ACHEIVEMENT

Dr. Michael Amlung and I were responsible for the development of the research questions associated with this project. Dr. Amlung and I collaborated on obtaining ethics approval from the Hamilton Integrated Research Ethics Board and defining the study methodology. I was responsible for recruiting and screening participants, collecting, analyzing and interpreting all data, and writing the manuscript. Once again, thank you to all individuals who were involved in this study.

INTRODUCTION

Substance use disorders are a major public health problem across Canada (Canadian Centre on Substance Abuse, 2010; Canadian Centre on Substance Use and Addiction, 2017, 2018; Rehm et al., 2006). These disorders are associated with substantial negative outcomes, including negative health consequences, interpersonal problems, legal problems, and negative impact on public safety. The scope of this problem is magnified by major barriers to effective addictions treatment. For instance, only 11% of individuals with a substance use disorder received treatment and existing treatments are not universally effective (National Institute on Drug Abuse, 2011). One potential explanation for the mixed impact of treatment for addiction is the role of shortened temporal windows among people with addictive disorders. Temporal windows, also known as temporal perspectives or time horizons, are the period of time an individual can imagine into their own future (Petry, Bickel, & Arnett, 1998). Prior research has shown that when healthy control participants are asked to think about their future, they typically report goals and anticipated activities that are, on average, 5 years in the future (Petry et al., 1998). Individuals with heroin use disorder, however, reported an average temporal window of 9 days (Petry et al., 1998). These shortened time perspectives likely reduce the effects of addiction interventions that seek to increase the likelihood of long-term abstinence or reduction in use of alcohol, tobacco, or drugs. This pattern of cognition emphasizes the problem of now versus the future, in the context of addiction. Many interventions involve emphasizing long-term positive impact of sobriety or low risk use of drugs and alcohol, but these interventions may be less effective if individuals are not able to imagine themselves far enough into the future.

The competing neurobehavioural decision systems (CNDS) model is a neurocognitive mechanism commonly discussed in the context of addiction (Bickel et al., 2007; Bickel & Yi,

2008). It argues that delayed reward discounting, a behavioural economic measure assessing preferences for smaller-sooner rewards versus larger-later rewards, is driven by two competing systems within the brain. The frontal cortical system exerts cognitive control over the subcortical limbic system driving immediate reward seeking. The frontal cortical system responsible for rational decision making is influenced by more broad level factors in decision making such as, awareness of the future and the consequences of current decisions (Atance & O'Neill, 2001). Within addiction, the subcortical limbic system is excessively activated in combination with frontal circuit dysfunction, causing impairment to rational decision-making. Shortened temporal perspectives also confer deficits within frontal executive circuits and rational decision-making by emphasizing the inability to wait for delayed rewards. Since a driving factor in many addictions treatments is the emphasis of long-term sobriety, increasing the temporal perspective of individuals seeking treatment is extremely important.

Advances in the field of cognitive psychology have led to the development of an Episodic Future Thinking (EFT) protocol for lengthening temporal perspectives (Schacter, Addis, & Buckner, 2008). In general, EFT is a cognitive exercise in which participants generate personalized, positive events that they are looking forward to at various future time points. For example, a participant may be looking forward to an upcoming vacation, or attending a concert, or spending time with extended family. Participants are instructed to think about positive events that occur at delays of 1 day, 1 week, 1 month, 6 months, etc. They then generate text or audio cues related to those events. The EFT protocol involves interacting with these personalized cues and examining their impact on various decision-making tasks and other measures. The effects of EFT cues are often compared to a control condition known as Episodic Recent Thinking (ERT) in which participants generate cues related to a positive event in the present or recent past.

A study assessing the effects of EFT on functional brain connectivity finds alterations in functional connectivity dynamically between brain regions, the frontal cortical circuits, involved in executive functioning and decision-making (Wiehler, Petzschner, Stephan, & Peters, 2017). Evidence from these neuroimaging studies suggests that EFT may produce lasting changes in functional connectivity that might restore the balance between the two competing neurobehavioural systems commonly involved in addiction. A study by Benoit et al (2011) observed greater activation in frontal circuit brain regions, indicating greater reward magnitude activation when engaging in episodic future thinking. Furthermore, they demonstrated the medial rostral prefrontal cortex (a region found in the frontal lobe) to be functionally coupled with the hippocampus during EFT, indicating that the frontal circuits use information provided by the hippocampus about the utility of this imagined future event in making decisions in the present. EFT lends an advantage to the frontal circuits, working to normalize the balance between the two competing systems for optimal functioning of both neurobehavioural systems.

Experimental studies in healthy participants have shown that EFT reduces impulsive decision making on delay discounting tasks. Specifically, interacting with personalized future cues resulted in significantly greater preferences for larger delayed rewards relative to smaller immediate rewards (e.g., Peters & Büchel, 2010). This is particularly relevant in the context of addiction since impulsive delay discounting is a hallmark feature of addictive disorders (Amlung, Vedelago, Acker, Balodis, & MacKillop, 2016; Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014; MacKillop et al., 2011). A pattern of significantly greater preference for delayed rewards can also be seen in obese adults after engaging with EFT (Daniel, Stanton, & Epstein, 2013b, 2013a; Stein et al., 2017; Sze, Stein, Bickel, Paluch, & Epstein, 2017). EFT with obese children reduced preferences for small immediate rewards and lowered

energy intake (Daniel, Said, Stanton, & Epstein, 2015). EFT also reduces eating in obese adults within a natural eating environment (O'Neill, Daniel, & Epstein, 2016). Together these studies in healthy and clinical samples support the utility of using EFT to dynamically alter decision-making in positive ways and suggest that it may have potential as an intervention in clinical disorders.

Studies of EFT in addiction samples are limited. Two studies of cigarette smokers found that EFT significantly reduced delay discounting and cigarette smoking (Chiou & Wu, 2016; Stein et al., 2016). A study of individuals with alcohol use disorder (AUD) implemented EFT integrating sensory information for 5 different delays (1 day, 1 week, 1 month, 3 months, and 1 year) and rated those cues on positive valence criteria. Cues were presented on the same screen with the choices in the delay discounting task and immediately before each question in the hypothetical alcohol purchase task. The latter task assesses the reinforcing value of alcohol by asking participants how many drinks they would purchase at varying prices. The study found that a single exposure to EFT cues resulted in significant reductions in impulsive delay discounting (Snider, LaConte, & Bickel, 2016). EFT also reduced alcohol demand, but only at a trend level of statistical significance (Snider et al., 2016). Another study of college student drinkers implementing EFT generated 2 events for 5 different time points (1 day, 2 days, 30 days, 180 days, and 365 days) and the event with the highest positive valence was chosen to be presented immediately before each question in both the delay discounting and hypothetical alcohol purchase task. The study found that EFT significantly reduced delay discounting and alcohol demand (Bulley & Gullo, 2017).

These findings suggest that EFT has significant effects on relevant aspects of decision making and motivation for alcohol/tobacco. Therefore, EFT may be a useful complement to

existing addiction treatments; however, no studies have examined the impact of EFT in individuals in treatment for substance use disorder. The temporal duration of EFT effects has also not been systematically evaluated. The goal of the current study is to conduct and determine the feasibility of an experimental study of EFT and ERT on decision making and alcohol motivation in a sample of currently treatment seeking individuals with AUD. The first aim is to assess the feasibility of implementing EFT and ERT using low-tech solutions in the face of the lack of technology at many addictions treatment centres. The second aim is to examine whether EFT reduces impulsive choice behaviour or reduces subjective and objective measures of alcohol motivation, both after an acute exposure to EFT and an extended period of practice with EFT over a week.

METHODS

Participants

Participants were recruited from the "Program" level of treatment from Men's Addiction Services Hamilton (MASH) and WomanKind Addiction Service (WK). The "Program" level at both facilities is defined as the time when patients are out of acute withdrawal and stabilized to actively participate in treatment. They are sex-specific sites for addiction services, both of whom are affiliated with St. Joseph's Healthcare Hamilton. The inclusion criteria for the study were: (1) currently between the ages of 18-55, (2) fluent in the English language, (3) self-reported heavy drinking (5 drinks for men and 4+ drinks for women within a single drinking episode) within the last 6 months, (4) diagnosis of moderate or severe Alcohol Use Disorder according to the Diagnostic Statistics Manual-5 (DSM-5), and (5) currently receiving treatment for AUD in Program level at either MASH or WK. Individuals who endorsed the use of other substances

(e.g., cannabis, heroin, cocaine, etc.) were allowed to participate as long as alcohol was their primary substance of choice. Participants were excluded from the study if they met any of the exclusion criteria: (1) significant anhedonia in the past week, as indicated by a score of 3 or greater on the Snaith–Hamilton Pleasure Scale, (2) history of stroke, seizures, or traumatic brain injury resulting in loss of consciousness, (3) history of severe psychiatric disorders (Schizophrenia-spectrum, Bipolar Disorder, Posttraumatic Stress Disorder), and (4) currently in acute withdrawal or detoxification stage of treatment. All inclusion and exclusion criteria, except for the DSM-5 diagnosis of AUD, were assessed with an in-person or over the phone screening interview with potential participants. The DSM-5 diagnosis of moderate or severe AUD was assessed using a Structured Clinical Interview for DSM-5 (SCID) with the participant during session 1. Primary substance of choice was also confirmed during session 1 along with any other substances that individuals endorsed within the past 6 months.

Twenty-eight participants were enrolled into the study, with 26 individuals completing both Sessions 1 and 2. The final sample, with complete and valid data, included 26 participants.

Procedure

All participants underwent a two-week experimental protocol. After being enrolled in the study, participants completed Session 1, a two-hour session in which the first hour consisted of administering a battery of questionnaires and neurocognitive tasks, as well as the SCID to determine the severity of their AUD diagnosis. In the second hour, participants were randomized to either the EFT or ERT condition. The participants and the experimenter generated their cues. A standardized procedure based on previous research was used to generate personalized episodic event cues (Daniel et al., 2013b; Snider et al., 2016). Participants assigned to the EFT condition were asked to generate personalized cues corresponding to four future time periods: 1 day, 1

week, 1 month, and 6 months. Participants assigned to ERT condition were asked to generate personalized cues corresponding to four recent past time periods: 12 hours ago, 1 day ago, 3 days ago, and 1 week ago. Each event was rated on a scale of 1 to 5 for positivity, vividness, and ease of imagination first by the participant and then by the experimenter. In order to accept the cue, the cue had to be rated 4 out of 5 at a minimum on all three criteria by both the participant and experimenter. The research assistant guided the participant through a multi-step process that incrementally adds details to the event cues. The result was a 2-3 sentence cue that describes the entire scene, and a short 1-sentence cue that summarizes the event. These cues were written in first-person present tense language (e.g., "I am doing event X with person Y"). After generating the event cues, participants completed an initial EFT/ERT Decision-Making Paradigm to examine the acute impact of EFT/ERT cues. The assessment comprises a delay discounting paradigm, an alcohol purchase task, and a subjective affect/craving assessment. During the delay discounting and alcohol purchase task paradigm, each participant's event cues were presented on the screen alongside each choice. The baseline session ended with an explanation of the procedures for daily cue practice (described below).

In between Session 1 and 2, participants had 3 days of practice with their cues. These were done to assess the cumulative effect of repeated practice. Participants were provided with a printout of their cues for each time interval (for a copy of the practice slip, refer to Supplemental Figure 1). Once per day for three days (e.g., Tue, Wed, Thurs.), participants were asked to write out each cue (by hand) two times. The back of the form contained a brief assessment of craving, time spent thinking of about their cues, etc. They recorded their participant ID number, date, and time on the slip and once completed deposited it in a locked drop box, located on site within each respective facility. Research assistants collected the slips to record completion of daily practice.

Each slip was colour coded to each day for the purposes of assigning compensation for participation.

After the 3 days of daily practice with their cues, participants completed Session 2, lasting approximately 1.5 hours. An abbreviated battery of questionnaires from the baseline session was re-administered. Participants also completed the EFT/ERT Decision Making Paradigm a second time. All participants received treatment as usual while enrolled in the study.

Finally, we arranged for the 1-week follow up interview that was conducted either by phone or in-person (based on participant preferences). Over the next week, participants were not explicitly instructed to continue their daily cue practice nor were they provided with any additional payment for practice. We conducted a brief interview with participants that involved questions about frequency of self-initiated practice, delay discounting, craving, readiness to change, and self-efficacy. For this study, the 1-week follow-up interview was not analyzed due to low completion rates (for more details, see results).

Incentives were paid in the form of gift cards for local stores that did not carry a license to sell alcohol. Participants received $25 for completing each of the in-person sessions, up to $10 for completing daily practice, and $10 for the follow-up interview. Participants received their compensation for each of the sessions as they completed them. Total maximum compensation for all study activities was $70 CAD. The incentives for daily practice of cues were awarded based on incremental scaling, in which participants received $2 for completing one slip, $5 for completing two slips, and $10 for completing all three slips. This study was approved by the Hamilton Integrated Review Ethics Board (HiREB Project #4134).

Measures

All participants underwent an extensive battery of questionnaires and tasks assessing demographics, substance use, alcohol use, alcohol demand, alcohol use motives, impulsivity, craving, mindfulness, and mood states. However, for the present study, a subset of these measures was analyzed. All measures listed below were administered twice, once at baseline and once at session 2. The exceptions to this include the APT and DD tasks which were administered 3 times: first at baseline, next after acute exposure to EFT/ERT, and finally after extended practice with EFT/ERT.

EFT/ERT Decision Making Paradigm Measures

Alcohol Purchase Task (APT). Alcohol demand was assessed using a validated hypothetical APT approach. The APT asks participants how many standard-sized drinks they would consume across 15 prices ranging from free to $20/drink, in ascending order. A standard instructional set was used. Participants were instructed to assume that no alcohol was consumed before making these choices, they cannot drink these drinks elsewhere, they consume all drinks as if they were real, they cannot stockpile drinks for later, and assume the alcohol and money was real when making choices. This task was administered in both a non-cued and cued version relating to the EFT/ERT Decision Making Paradigm (refer to Supplemental Figure 2 for an example of the non-cued and cued version).

Adjusting Amount Delay Discounting Task (DD). Monetary discounting was assessed in this study using the 5-choice trial adjusting amount delay discounting task (Koffarnus & Bickel, 2014). On each of the trials, participants indicated whether they would prefer to receive $100 at a specific time point in the future, which corresponded to one of the time points within their cues, or a smaller immediate reward now. The task is adjusting amount based, so it indicates that the

immediate amount for the 5-choices changes and this change is dependent on the previous choice. For example, when you start with a question that asks "Would you prefer $50 now or $100 in 1 week", if you choose $50, your next choice would be $25 now versus $100 in 1 week. The task adjusts the immediate amount by adding or subtracting half the amount from the previous immediate choice. It is added when the delayed choice is made and subtracted when the immediate reward is chosen. This task was administered in both a non-cued and cued version relating to the EFT/ERT Decision Making Paradigm (refer to Supplemental Figure 3 for an example of the non-cued and cued version).

Clinically-Oriented Measures

Brief Situational Confidence Questionnaire (BSCQ). Situational confidence to resist using drugs or alcohol in a variety of situations was assessed using the BSCQ. Participants were given a standard instructional set in which they answered the 8-items in relation to their alcohol use or primary drug of choice. Participants were instructed to imagine themselves right now for the situations and indicate on the scale from 0 – 100 (not at all confident – totally confident) and how confident they are in being able to resist drinking heavily or use their primary drug of choice.

Alcohol Use Questionnaire (AUQ). The AUQ is an 8-item inventory of statements in which participants select their agreement with each statement on a 7-point Likert scale from strongly disagree (1) to strongly agree (7). All statements within the AUQ relate to craving.

Readiness Rulers. The readiness rulers are 3 visual analogue scales in which participants are asked to select on a scale from 1 to 10: (1) how important it is to change their alcohol use, (2) how ready they are to change their alcohol use, and (3) how confident they are that they could change their alcohol use.

Cognitive Measures

Consideration of Future Consequences (CFC). The CFC scale is designed to assess how much participants consider the future when making decisions in the present. The scale consists of 12 statements which participants rate on a scale from 1 – 5, ranging from extremely uncharacteristic to extremely characteristic.

Mindfulness Attention Awareness Scale (MAAS). The MAAS is a 5-item questionnaire asking participants to rate each of the 5 statements on a 6-point Likert scale ranging from almost always to almost never. Participants were instructed to indicate how frequently or infrequently they currently have each experience, and answer according to what really reflects their experience, not what they imagine it should be. Lastly, participants were instructed to treat each item separately when making their decisions.

Data Analysis Plan

Results on the APT were checked for non-systematic responses using published procedures (Stein, Koffarnus, Snider, Quisenberry, & Bickel, 2015), resulting in the exclusion of zero participants from data analyses. Four observed demand indices were generated from raw consumption and expenditure values: (1) intensity is self-reported consumption at free price; (2) Breakpoint is the price that suppressed self-reported consumption to zero; (3) O_{max} is the maximum observed expenditure; and (4) P_{max} is the price point corresponding to O_{max}. Lastly, elasticity was derived using the exponential demand curve equation: $\log(Q) = \log(Q_0) + k(e^{-\alpha Q0C} - 1)$. Elasticity, also known as alpha (α), is the proportionate slope of the demand curve (Hursh & Silberberg, 2008). Q_0 is defined as the parameter representing consumption at a price of zero, k is range of the dependent variable in logarithmic units (this is a constant), α represents the rate of change in the exponential curve, and C is defined as the cost of each reinforcer. In this model,

Q_0 was fixed to the observed mean Intensity for each group. We determined the shared k-value across all curve fits by the following. We considered the range in observed consumption values, and calculated the following, K = log(max consumption – min consumption) + 0.5, where the max is the highest consumption across all of the APT values, and the min is the minimum consumption across all the APT values. This value came to 1.82, and that was the k-value we used for all curve fits, standardizing the equation for all of the models. Next, the k-values for delay discounting were log-transformed to normalize the distribution prior to being used for data analysis.

For Part 1 of analyses, descriptive statistics were used to assess the feasibility of running EFT within a treatment seeking addiction sample without any access to technology. Descriptive statistics analyzed included: percent completed sessions, percent completed slips, and reasons for incomplete data or withdrawal from study.

For Part 2 of analyses, demographics at baseline were first assessed between the EFT and ERT groups. T-tests were run to determine baseline differences between the groups. Second, repeated measures ANOVAs were run to assess changes in the four observed demand indices and delay discounting for each of the groups at 3 different time points: baseline, acute, and extended. Third, repeated measures ANOVAs were run to examine changes in cognitive variables such as: craving, situational confidence to resist alcohol/drug use, consideration of future consequences, mindfulness, and willingness to change alcohol use. These were analyzed to explore the potential mechanisms by which participants may have changed their behaviour. Repeated measures ANOVAs were utilized to compare scores across time points and to obtain effect sizes across time points and groups, as indicated by partial eta-squared.

RESULTS

Part 1: Feasibility

One of the primary aims for this study was to evaluate the feasibility of implementing an EFT/ERT protocol for a treatment seeking addiction sample within an active program centre. Since the treatment centres we recruited from did not allow patient access to Wi-Fi or any other sources of technology, it was a challenge to develop a protocol that would work around this. Evaluating our feasibility, we found that 64% of our participants completed the full 2-week protocol. However, breaking it down further, we saw that we lost 2 participants (7%) to short-term completion, indicating that they only completed Session 1, whereas, we lost 10 participants (35.7%) to long-term follow up, indicating they completed both in-person sessions but not the 1-week follow up interview. Between the two sessions, participants completed practice slips for either EFT or ERT. 92.8% completed slip 1, 85.7% completed slip 2, and 82.1% completed slip 3; indicating relatively high compliance with the protocol during week one of the study. Due to low completion rates for the follow-up interview, data from the interview were not analyzed within the current study. The most prevalent reasons for this low completion rate included participants willingly leaving the treatment centres, not leaving contact information when they left, and if they did leave contact information, we were unable to reach them.

Part 2: Changes as a Function of EFT/ERT

Baseline Differences

We first assessed baseline differences between the EFT and ERT groups on our variables of interest before our main analyses were run. We found only Breakpoint was significantly different at baseline between the EFT and ERT groups ($t(26) = 2.26$, $p = 0.03$). For all measures

compared between groups at baseline, refer to Table 1. Furthermore, for the full breakdown of the demographics for the sample, please refer to Table 2.

Behavioural Economic Demand

Behavioural economic demand for alcohol was assessed and evaluated using the four observed demand indices: Intensity, Breakpoint, O_{max}, and P_{max}. The APT was administered at 3 times, so we ran repeated measures ANOVAs across the three time points for each index to assess changes over time either as a result of EFT or ERT.

First, a repeated measures ANOVA for Intensity within the EFT group revealed reductions in Intensity from baseline to the acute time point ($F(1,13) = 9.36$, $p = 0.009$, $\eta_p^2 = 0.419$), as well as baseline to the extended time point ($F(1,12) = 26.67$, $p < 0.001$, $\eta_p^2 = 0.69$). However, the reduction from acute to extended was not significant ($F(1,12) = 3.09$, $p = 0.104$, $\eta_p^2 = 0.205$). On the other hand, for the ERT group the same pattern of reductions was observed in Intensity, baseline to acute ($F(1,13) = 10.92$, $p = 0.006$, $\eta_p^2 = 0.457$) and baseline to extended ($F(1,12) = 7.59$, $p = 0.017$, $\eta_p^2 = 0.387$) being significant reductions but acute to extended being non-significant ($F(1,12) = 0.039$, $p = 0.847$, $\eta_p^2 = 0.003$). An important note here is that the magnitude of reduction from baseline to extended was greater for the EFT group ($\eta_p^2 = 0.69$) than the ERT group ($\eta_p^2 = 0.387$) (illustrated in Figure 2A).

Second, Breakpoint was assessed for changes. For the EFT group, we saw significant reductions in Breakpoint from baseline to extended ($F(1,12) = 21.37$, $p = 0.001$, $\eta_p^2 = 0.64$), and acute to extended ($F(1,12) = 7.18$, $p = 0.02$, $\eta_p^2 = 0.374$) but not baseline to acute ($F(1,13) = 3.38$, $p = 0.089$, $\eta_p^2 = 0.206$). However, for the ERT group, we saw significant reductions from baseline to acute ($F(1,13) = 6.71$, $p = 0.022$, $\eta_p^2 = 0.34$) and baseline to extended ($F(1,12) = 14.36$, $p =$

0.003, $\eta_p^2 = 0.545$), but not from acute to extended ($F(1,12) = 0.072$, p = 0.793, $\eta_p^2 = 0.006$). From acute to extended, the EFT group had a greater magnitude of reduction in Breakpoint than the ERT group (illustrated in Figure 2B).

Third, changes in O_{max} were assessed. For the EFT group, scores from baseline to acute did not show a significant reduction ($F(1,12) = 4.09$, p = 0.07, $\eta_p^2 = 0.254$), however, scores from baseline to extended ($F(1,11) = 21.09$, p = 0.001, $\eta_p^2 = 0.657$) and acute to extended ($F(1,11) = 8.33$, p = 0.015, $\eta_p^2 = 0.431$) did show significant reductions in O_{max}. On the other hand, for the ERT group, significant reductions were only seen from baseline to acute ($F(1,13) = 5.12$, p = 0.041, $\eta_p^2 = 0.283$), however, baseline to extended ($F(1,12) = 3.75$, p = 0.08, $\eta_p^2 = 0.238$) and acute to extended ($F(1,12) = 0.029$, p = 0.867, $\eta_p^2 = 0.002$) are non-significant. Results of the reductions across the 3 time points are illustrated in Figure 2C.

Fourth, for $P_{max,}$, for the EFT group, there were no significant reductions for P_{max} from baseline to acute ($F(1,13) = 0.305$, p = 0.590, $\eta_p^2 = 0.023$), but there were significant reductions in P_{max} from baseline to extended ($F(1,12) = 9.57$, p 0.009, $\eta_p^2 = 0.444$) and from acute to extended ($F(1,12) = 6.44$, p = 0.026, $\eta_p^2 = 0.349$). Meanwhile, for the ERT group, there were no significant reductions in P_{max} for any of the comparisons: baseline to acute ($F(1,13) = 1.58$, p = 0.231, $\eta_p^2 = 0.109$), baseline to extended ($F(1,12) = 3.62$, p = 0.081, $\eta_p^2 = 0.232$), and acute to extended ($F(1,12) = 1.67$, p = 0.221, $\eta_p^2 = 0.122$). Reductions of P_{max} within the EFT group can be seen in Figure 2D.

Lastly, for elasticity (denoted by α) in the EFT group, we found significant changes from baseline ($\alpha = 0.0016$) to extended ($\alpha = 0.0045$) and acute ($\alpha = 0.0018$) to extended ($\alpha = 0.0045$). These differences were confirmed by extra-sum-of-squares tests comparing alpha values between

the time periods (BL-EXT: $F(1,28) = 104$, $p < 0.0001$; AC-EXT: $F(1,28) = 68$, $p < 0.0001$). There was no significant change in elasticity for the EFT group from baseline ($\alpha = 0.0016$) to acute ($\alpha = 0.0018$), confirmed by an extra-sum-of-squares test ($F(1,28) = 2.9$, $p = 0.1005$). On the other hand, for the ERT group, there were significant changes from baseline ($\alpha = 0.0021$) to acute ($\alpha = 0.004$) and baseline ($\alpha = 0.0021$) to extended ($\alpha = 0.0035$). Changes were confirmed using extra-sum-of-squares tests (BL-AC: $F(1,28) = 52$, $p < 0.0001$; BL-EXT: $F(1,28) = 40$, $p < 0.0001$). However, there was no significant change from acute ($\alpha = 0.004$) to extended ($\alpha = 0.0035$), confirmed by an extra-sum-of-squares test ($F(1,28) = 2.8$, $p = 0.1045$).

Delay Discounting

Another behavioural economic index assessed was monetary delay discounting. The log-transformed k-values were assessed for this measure. Again, we ran repeated measures ANOVAs to assess changes in log(k) across three time points: baseline, acute, and extended. For the EFT group, we found significant reductions in log(k) from baseline to acute ($F(1,13) = 14.57$, $p = 0.002$, $\eta_p^2 = 0.529$) and baseline to extended ($F(1,12) = 29.61$, $p < 0.001$, $\eta_p^2 = 0.712$), but not acute to extended ($F(1,12) = 0.09$, $p = 0.927$, $\eta_p^2 = 0.001$). On the other hand, the ERT group showed no significant reductions in log(k) from any of the comparisons: baseline to acute ($F(1,13) = 2.94$, $p = 0.11$, $\eta_p^2 = 0.184$), baseline to extended ($F(1,12) = 0.37$, $p = 0.556$, $\eta_p^2 = 0.030$), and acute to extended ($F(1,12) = 0.92$, $p = 0.356$, $\eta_p^2 = 0.071$).

Clinically Oriented Measures

For each clinical variable of interest, we ran a repeated measure ANOVA assessing across 2 time points: baseline and extended. Prior to analysis, the 8-items of the BSCQ were averaged into a total score that was used for analyses. When analyzing the BSCQ for both groups, we saw no significant changes (EFT: $F(1,12) = 0.162$, $p = 0.695$, $\eta_p^2 = 0.013$; ERT:

$F(1,12) = -0.133$, $p = 0.896$, $\eta_p^2 = 0.001$). With the AUQ, again, there were no significant changes from baseline to extended for either group (EFT: $F(1,12) = 0.804$, $p = 0.387$, $\eta_p^2 = 0.063$; ERT: $F(1,12) = 0.687$, $p = 0.423$, $\eta_p^2 = 0.054$). Lastly, analyzing the readiness rulers, there were no significant changes from baseline to extended for either group across all three rulers (EFT: $F(1,12) = 0.12$ to 1.79, $p > 0.05$, $\eta_p^2 = 0.01$-0.13; ERT: $F(1,12) = 0.13$ to 2.54, $p > 0.05$, $\eta_p^2 = 0.011$-0.175).

Cognitive Variables

The same pattern was observed with the CFC, no significant changes from baseline to extended for either group (EFT: $F(1,12) = 4.58$, $p = 0.053$, $\eta_p^2 = 0.276$; ERT: $F(1,12) = 2.35$, $p = 0.152$, $\eta_p^2 = 0.163$). For the MAAS, we saw significant increases in mindfulness awareness for both the EFT ($F(1,12) = 36.39$, $p < 0.001$, $\eta_p^2 = 0.752$) and ERT ($F(1,12) = 23.8$, $p < 0.001$, $\eta_p^2 = 0.665$) groups from baseline to extended. The EFT group had a greater magnitude increase in MAAS score than the ERT group.

DISCUSSION

The current study investigated the feasibility and effects of EFT/ERT on alcohol motivation and decision-making in a treatment seeking addiction sample. We assessed decision-making and alcohol motivation after acute and extended exposure to EFT/ERT. Meanwhile, we assessed clinical outcomes and cognitive variables at pre-exposure and after extended exposure to EFT/ERT. Results provided ample evidence to support the feasibility of EFT/ERT for one week out of the two-week protocol. The first week of the two-week protocol had very high adherence in which participants completed both sessions one and two, with a majority of

participants also completing their daily practice slips. It was during the second week protocol, when participants were left to their own devices, that we saw a significant drop in adherence with the protocol. This gives us a possible window where implementing a protocol like EFT would be most effective with a treatment seeking addiction population. This is in accordance with studies assessing relapse with addictive disorders, showing that the first few weeks are the most vulnerable time for patients (Breese et al., 2005; Dawson, Goldstein, & Grant, 2007; Sinha, 2007).

On the other hand, looking at our behavioural economic variables we saw a more tenuous pattern emerging. Across the four observable alcohol demand indices, we found reductions in scores between the baseline to acute time points, regardless of whether it was an effect of EFT or ERT. The reduction was seen in both the EFT and ERT groups, with the EFT group showing significant reductions in Intensity, Breakpoint, and P_{max}, whereas the ERT group showed significant reductions in Intensity, Breakpoint, and O_{max}. This pattern of results indicates that within this population, a single dose of episodic thinking, regardless of whether it is oriented to the future or present/recent past, is enough to change behavioural economic demand. Frontline clinicians can potentially target the decision-making mechanism clients seeking treatment are utilizing and intervene early in treatment to reduce motivation for alcohol, potentially even other substances. Another significant reduction seen is from baseline to extended. Within this time point comparison, there were significant reductions in Intensity, Breakpoint, and O_{max} among the EFT group, while there were significant reductions in Intensity and Breakpoint among the ERT group. These results suggest, overall, that both EFT and ERT are effective over an extended dosage of episodic thinking in impacting delay discounting, suggesting a dose-dependent relationship. However, it should be noted that the EFT group displayed greater improvements in

delay discounting measures compared to the ERT group. Results suggest that while ERT may help in the short term by engaging frontal executive functions, the dose-dependent relationship is stronger with the EFT condition, where after acute exposure, EFT leads to greater reduction with practice, while ERT does not. Comparing the third time point scores to the acute time point, we observed significant reductions in the EFT group for Breakpoint, O_{max}, and P_{max}, whereas there were none for the ERT group. This further lends support to the suggestion that while any sort of episodic thinking in the short term is effective, with long-term practice, EFT shows greater efficacy in reducing alcohol demand than ERT.

Elasticity (denoted by α), the derived index in alcohol demand, shows a different pattern than the observable demand indices. Lower alpha values correspond to less elastic demand, in which individuals are still willing to purchase more drinks at higher prices; thus, the slope of the demand curve is more gradual. This pattern is typical of individuals with alcohol use disorder, in which lower alpha values are seen for individuals with greater severity compared to lower severity AUD. For both groups there was an overall significant change in elasticity from baseline to the extended time point. The alpha value increased from baseline to extended, indicating participants are reducing their predicted consumption more steeply as the price per drink increases. However, only the ERT group has significant changes from baseline to acute and the EFT group has significant changes from acute to extended. This supports our other results for alcohol demand, where we saw a greater efficacy of EFT with extended exposure compared to the ERT group. As seen in the alpha values, the ERT group went from 0.004 to 0.0035 from acute to the extended time point whereas the EFT group went from 0.0018 to 0.0045. Alpha for the EFT group increased from baseline to the extended time point indicating more elastic demand post-EFT intervention. Comparing this change to the ERT group displays ERT is not

able modify elasticity from baseline to the extended time point as alpha remains the same. These results were novel since the two studies which analyzed elasticity in alcohol demand did not show any significant effects pre and post EFT or ERT (Bulley & Gullo, 2017; Snider et al., 2016).

In addition to alcohol demand, delay discounting was another behavioural economic measure that was assessed. Within our delay discounting analysis, again, comparing the three different time points, only EFT showed significant reductions in delay discounting between baseline to acute and baseline to extended. These results suggest that EFT is effective at reducing impulsive choice-making among a treatment seeking addiction sample, which indicates a potential target for clinicians to reduce the risk of relapse due to impulsive decisions at the beginning of treatment.

Furthermore, these patterns of results are also consistent with previous research studies that have analyzed the effects of EFT and ERT within an addictions sample, specifically alcohol users. Our results are consistent with Bulley & Gullo (2017), who showed reduced delayed reward discounting rates and a reduction in alcohol demand intensity for the EFT implementation of generating two cues for 4 different time points within the future among 48 undergraduate students. A similar pattern of results was reported by Snider et al. (2016) in which preference for delayed rewards is increased and Intensity of alcohol demand is decreased among a sample of 50 individuals with alcohol use disorder assessed by both the AUDIT and SCID, similar to our study. Lastly, another study assessing the effects of EFT among alcohol users found no overall group differences in delay discounting between EFT and a control group, however, they illustrate a rate-dependent relationship of EFT with delay discounting (Snider et al., 2018). They show a greater change with increasing engagement in EFT compared to their

control group, which received no prospective thinking paradigm. Overall, these previous studies assessing the effects of EFT on samples of alcohol users show very similar results to our data. One big difference between the methods of previous research and our study is our sample of treatment seeking individuals meeting criteria for AUD. The sample difference potentially explains why significant reductions were observed across all alcohol demand indices, whereas previous studies only showed reductions in Intensity. Our results are contradictory to the findings of Snider et al. (2016) where the relationship between EFT and delay discounting was moderated by lower scores on the AUDIT indicating that individuals with lower severity AUD's showed greater reductions compared to those with more severe AUD. A potential explanation for the inconsistency is our treatment seeking addiction sample. Our sample may have been more motivated to engage with their cues and change their valuation of alcohol and motivation for alcohol compared to the sample in Snider et al. (2016).

The observed changes in behavioural economic variables, alcohol demand and delay discounting are consistent with a change in the competing neurobehavioural decision making systems model (CNDS) (Bickel et al., 2007). These results indicate, at least at a behavioural level, that both EFT and ERT may be engaging the frontal executive circuits to balance the dysfunction seen in the two competing systems in addiction. This is also consistent with findings from previous literature showing reductions in alcohol demand and delay discounting (Bulley & Gullo, 2017; Snider et al., 2018, 2016). The results also suggest that EFT may be balancing the systems to a greater degree than ERT given the larger effect sizes for the reductions seen in both alcohol demand and delay discounting. Future studies utilizing functional magnetic resonance imaging (fMRI), a brain imaging technique used to measure changes in brain activation, could explore brain changes from baseline to acute and acute to extended time points as a function of

EFT interventions. Imaging the brain before, during, and after EFT would allow us to determine whether there is dysfunction between the two competing neurobehavioural systems and whether EFT helps balance the two systems.

Beyond assessing changes in behavioural economic assessments, we also analyzed baseline to extended practice changes in cognitive and clinical variables that potentially could explain the behavioural changes observed within the APT and DD tasks. However, analyzing the changes in multiple measures revealed only significant increases in the MAAS total score for both the EFT and ERT conditions. The MAAS is a measure of mindfulness awareness; observing significant increases in both conditions for this measure is expected as episodic thinking is very mentally intensive, where participants are imagining situations either in the past or future that are extremely detailed, vivid, and emotionally pleasant. It is possible that the act of creating and engaging with these extremely detailed cues made all participants, regardless of condition, more aware of their mental state and their cognitions. Other cognitive measures analyzed included: craving (AUQ), consideration of future consequences (CFC), readiness to change alcohol use patterns (readiness rulers), and confidence to resist using alcohol or drugs in different situations (BSCQ). None of these measures yielded significant changes from baseline to extended practice. One potential explanation is that these variables are extremely complex and even more complex within an individual seeking treatment and one measure to assess each cognitive process is not sensitive enough to observe changes in the short-term. Another possibility is that EFT or ERT needs to be administered for a greater length of time and with greater control to observe changes in more complex cognitions.

Overall, within this pilot study, we observed some moderate changes in behavioural economic measures as a result of our EFT and ERT implementations. However, we failed to

observe reliable changes across all behavioural economic indices; furthermore, we did not find changes within cognitive processes that could potentially explain the observed pattern of behavioural economic results. These patterns of results could be due a multitude of factors, including some major limitations. One major limitation is that this is a pilot study with only 14 individuals per group giving a total sample of 28 participants for the study. This is not a large enough sample size to give us sufficient statistical power within our analyses. It is possible that the low sample sizes for each group led to the highly variable pattern of results observed. Another major limitation of this study was remaining in contact with participants throughout their enrollment within the study and for follow-up, as indicated by the 64% completion rate of the full two-week protocol. The transient nature of this population as well as the barriers from lack of access to technology hindered both data collection and evaluation of adherence to the protocol for participants. Furthermore, this is a treatment seeking addiction sample already receiving treatment for their alcohol and/or substance use disorder. It is possible that some participants were more engaged with their treatment than others and as we were not on site with these participants in residence, it is difficult to piece together whether or not changes seen in either group are due to EFT or ERT alone. Additionally, while steps were taken to ensure that participants completed the daily practice on time and in a proper manner according to our protocol, we cannot say for certain that these rules were adhered to. Future studies could use technology to ensure that participants are engaging with their cues for a controlled amount of time. Other limitations of this study include a sample limited to chronic alcohol and/or substance users living within the Hamilton area at the time of treatment. Whether these results generalize to other populations is yet to be determined. Furthermore, the sample was predominantly Caucasian, whether EFT and ERT would be effective for other races/ethnicities needs to be

addressed. Prior studies indicate individuals from racial minorities with alcohol and/or substance disorders face greater social and psychological barriers in seeking treatment (Vaeth, Wang-Schweig, & Caetano, 2017), possibly preventing them from fully engaging with EFT or ERT.

A direct future study that should be conducted is a replication of this study with a larger sample of individuals seeking treatment for their alcohol and/or substance use disorder to assess whether implementing EFT/ERT in this low-tech manner can produce changes in behavioural economic indices as well as cognitive mechanisms. As mentioned before, future studies should implement EFT and ERT within a treatment seeking addiction sample using technology to ensure contact is maintained with participants throughout the study as well as ensure adherence to experimental protocol by controlling the amount of time that participants are engaging with their cues. This approach can be addressed by ecological momentary assessment (EMA), which is the use of technology to assess behaviours, motivations, and cognitions in real-time within an ecological context (Shiffman, Stone, & Hufford, 2008). EMA has been used extensively with samples of college students to assess motivations, cognitions, and behaviours surrounding heavy episodic drinking (Cohn, Hunter-Reel, Hagman, & Mitchell, 2011; Hufford, Shields, Shiffman, Paty, & Balabanis, 2002; Riordan, Conner, Flett, & Scarf, 2015). Applying this methodology in combination with EFT for individuals returning to the community after treatment could be a way for participants to resist the urges to drink or use substances by engaging with their cues to orient themselves to the future when making decisions in the present. As stated previously, future studies can use fMRI before, during, and after participants engage in EFT or ERT to show the functional changes that arise as a result of practicing EFT or ERT. The results of this study would provide more direct empirical data on whether EFT and ERT are actually changing brain

activity patterns in order to re-balance the competing system by increasing activity within the frontal executive circuits.

In conclusion, this study lays the foundation for future work to be conducted using EFT as a potential supplementary therapeutic technique in order to modify the behaviour of individuals seeking treatment so that they remain in treatment for a longer period.

REFERENCES

Amlung, M., Vedelago, L., Acker, J., Balodis, I., & MacKillop, J. (2016). Steep delay discounting and addictive behavior: a meta-analysis of continuous associations. *Addiction*, *112*(1), 51–62. https://doi.org/10.1111/add.13535

Atance, C., & O'Neill, D. (2001). Episodic future thinking. *Trends in Cognitive Neuroscience*, *5*(12), 533–539. https://doi.org/10.1016/s1364-6613(00)01804-0

Benoit, R. G., Gilbert, S. J., & Burgess, P. W. (2011). A Neural Mechanism Mediating the Impact of Episodic Prospection on Farsighted Decisions. *Journal of Neuroscience*, *31*(18), 6771–6779. https://doi.org/10.1523/jneurosci.6559-10.2011

Bickel, W., Johnson, M., Koffarnus, M. N., MacKillop, J., & Murphy, J. G. (2014). The Behavioral Economics of Substance Use Disorders: Reinforcement Pathologies and Their Repair. *Annual Review of Clinical Psychology*, *10*(1), 641–677. https://doi.org/10.1146/annurev-clinpsy-032813-153724

Bickel, W., Miller, M., Yi, R., Kowal, B., Lindquist, D., & Pitcock, J. (2007). Behavioral and neuroeconomics of drug addiction: Competing neural systems and temporal discounting processes. *Drug and Alcohol Dependence*, *90*(SUPPL. 1), S85–S91. https://doi.org/10.1016/j.drugalcdep.2006.09.016

Bickel, W., & Yi, R. (2008). Temporal discounting as a measure of executive function: Insights from the competing neuro-behavioral decision system hypothesis of addiction. In *Advances in Health Economics and Health Services Research* (Vol. 20, pp. 289–309). https://doi.org/10.1016/S0731-2199(08)20012-9

Breese, G. R., Chu, K., Dayas, C. V., Funk, D., Knapp, D. J., Koob, G. F., … Weiss, F. (2005). Stress enhancement of craving during sobriety: A risk for relapse. *Alcoholism: Clinical and*

Experimental Research, *29*(2), 185–195. https://doi.org/10.1097/01.ALC.0000153544.83656.3C

Bulley, A., & Gullo, M. J. (2017). The influence of episodic foresight on delay discounting and demand for alcohol. *Addictive Behaviors*, *66*, 1–6. https://doi.org/10.1016/j.addbeh.2016.11.003

Canadian Centre on Substance Abuse. (2010). *Substance abuse in Canada: Concurrent disorders: Highlights*. Ottawa. Retrieved from http://www.ccsa.ca/

Canadian Centre on Substance Use and Addiction. (2017). *Alcohol (Canadian Drug Summary)*. Ottawa. https://doi.org/978-1-77178-206-7

Canadian Centre on Substance Use and Addiction. (2018). *Methamphetamine (Canadian Drug Summary)*. Ottawa. Retrieved from www.ccsa.ca

Chiou, W.-B., & Wu, W.-H. (2016). Episodic Future Thinking Involving the Nonsmoking Self Can Induce Lower Discounting and Cigarette Consumption. *Journal of Studies on Alcohol and Drugs*, *78*(1), 106–112. https://doi.org/10.15288/jsad.2017.78.106

Cohn, A., Hunter-Reel, D., Hagman, B., & Mitchell, J. (2011). Promoting Behavior Change from Alcohol Use Through Mobile Technology: The Future of Ecological Momentary Assessment. *Alcoholism: Clinical and Experimental Research*, *35*(12), 2209–2215. https://doi.org/10.1111/j.1530-0277.2011.01571.x

Daniel, T. O., Said, M., Stanton, C. M., & Epstein, L. H. (2015). Episodic future thinking reduces delay discounting and energy intake in children. *Eating Behaviors*, *18*, 20–24. https://doi.org/10.1016/j.eatbeh.2015.03.006

Daniel, T. O., Stanton, C. M., & Epstein, L. H. (2013a). The future is now: Comparing the effect of episodic future thinking on impulsivity in lean and obese individuals. *Appetite*, *71*, 120–

125. https://doi.org/10.1016/j.appet.2013.07.010

Daniel, T. O., Stanton, C. M., & Epstein, L. H. (2013b). The Future Is Now: Reducing Impulsivity and Energy Intake Using Episodic Future Thinking. *Psychological Science*, *24*(11), 2339–2342. https://doi.org/10.1177/0956797613488780

Dawson, D. A., Goldstein, R. B., & Grant, B. F. (2007). Rates and correlates of relapse among individuals in remission from DSM-IV alcohol dependence: A 3-year follow-up. *Alcoholism: Clinical and Experimental Research*, *31*(12), 2036–2045. https://doi.org/10.1111/j.1530-0277.2007.00536.x

Hufford, M. R., Shields, A. L., Shiffman, S., Paty, J., & Balabanis, M. (2002). Reactivity to ecological momentary assessment: An example using undergraduate problem drinkers. *Psychology of Addictive Behaviors*, *16*(3), 205–211. https://doi.org/10.1037/0893-164X.16.3.205

Hursh, S. R., & Silberberg, A. (2008). Economic Demand and Essential Value. *Psychological Review*, *115*(1), 186–198. https://doi.org/10.1037/0033-295X.115.1.186

Koffarnus, M. N., & Bickel, W. (2014). A 5-trial adjusting delay discounting task: Accurate discount rates in less than one minute. *Experimental and Clinical Psychopharmacology*, *22*(3), 222–228. https://doi.org/10.1037/a0035973

MacKillop, J., Amlung, M., Few, L., Ray, L., Sweet, L., & Munafò, M. (2011). Delayed reward discounting and addictive behavior: A meta-analysis. *Psychopharmacology*, *216*(3), 305–321. https://doi.org/10.1007/s00213-011-2229-0

National Institute on Drug Abuse. (2011). *Drug Facts: Treatment Statistics*. Bethesda. Retrieved from www.drugabuse.gov/related-

O'Neill, J., Daniel, T. O., & Epstein, L. H. (2016). Episodic future thinking reduces eating in a

food court. *Eating Behaviors*, *20*, 9–13. https://doi.org/10.1016/j.eatbeh.2015.10.002

Peters, J., & Büchel, C. (2010). Episodic Future Thinking Reduces Reward Delay Discounting through an Enhancement of Prefrontal-Mediotemporal Interactions. *Neuron*, *66*(1), 138–148. https://doi.org/10.1016/j.neuron.2010.03.026

Petry, N. M., Bickel, W. K., & Arnett, M. (1998). Shortened time horizons and insensitivity to future consequences in heroin addicts. *Addiction*, *93*(5), 729–738. https://doi.org/10.1046/j.1360-0443.1998.9357298.x

Rehm, J., Baliunas, D., Brochu, S., Fischer, B., Gnam, W., Patra, J., … Taylor, B. (2006). *the Costs of Substance Abuse in Canada 2002 Highlights*. *Canadian Centre On Substance Abuse* (Vol. 1). Ottawa. Retrieved from www.ccsa.ca

Riordan, B., Conner, T., Flett, J., & Scarf, D. (2015). *A Brief Orientation Week Ecological Momentary Intervention to Reduce University Student Alcohol Consumption. Journal of studies on alcohol and drugs* (Vol. 76). Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/26098027

Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events: Concepts, data, and applications. *Annals of the New York Academy of Sciences*, *1124*, 39–60. https://doi.org/10.1196/annals.1440.001

Shiffman, S., Stone, A., & Hufford, M. (2008). Ecological Momentary Assessment. *Annual Review of Clinical Psychology*, *4*, 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415

Sinha, R. (2007). The Role of Stress in Addiction Relapse. Retrieved from https://link-springer-com.libaccess.lib.mcmaster.ca/content/pdf/10.1007%2Fs11920-007-0050-6.pdf

Snider, S. E., Deshpande, H. U., Lisinski, J. M., Koffarnus, M. N., LaConte, S. M., & Bickel, W.

K. (2018). Working Memory Training Improves Alcohol Users' Episodic Future Thinking: A Rate-Dependent Analysis. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *3*(2), 160–167. https://doi.org/10.1016/j.bpsc.2017.11.002

Snider, S. E., LaConte, S. M., & Bickel, W. K. (2016). Episodic Future Thinking: Expansion of the Temporal Window in Individuals with Alcohol Dependence. *Alcoholism: Clinical and Experimental Research*, *40*(7), 1558–1566. https://doi.org/10.1111/acer.13112

Stein, J. S., Koffarnus, M. N., Snider, S. E., Quisenberry, A. J., & Bickel, W. (2015). Identification and management of nonsystematic purchase task data: Toward best practice. *Experimental and Clinical Psychopharmacology*, *23*(5), 377–386. https://doi.org/10.1037/pha0000020

Stein, J. S., Sze, Y. Y., Athamneh, L., Koffarnus, M. N., Epstein, L. H., & Bickel, W. K. (2017). Think fast: rapid assessment of the effects of episodic future thinking on delay discounting in overweight/obese participants. *Journal of Behavioral Medicine*, *40*(5), 832–838. https://doi.org/10.1007/s10865-017-9857-8

Stein, J. S., Wilson, A. G., Koffarnus, M. N., Daniel, T. O., Epstein, L. H., & Bickel, W. K. (2016). Unstuck in time: episodic future thinking reduces delay discounting and cigarette smoking. *Psychopharmacology*, *233*(21–22), 3771–3778. https://doi.org/10.1007/s00213-016-4410-y

Sze, Y. Y., Stein, J. S., Bickel, W. K., Paluch, R. A., & Epstein, L. H. (2017). Bleak Present, Bright Future: Online Episodic Future Thinking, Scarcity, Delay Discounting, and Food Demand. *Clinical Psychological Science*, *5*(4), 683–697. https://doi.org/10.1177/2167702617696511

Vaeth, P. A. C., Wang-Schweig, M., & Caetano, R. (2017). Drinking, Alcohol Use Disorder, and

Treatment Access and Utilization among U.S. Racial/Ethnic Groups HHS Public Access. *Alcoholism: Clinical and Experimental Research*, *41*(1), 6–19. https://doi.org/10.1111/acer.13285

Wiehler, A., Petzschner, F. H., Stephan, K. E., & Peters, J. (2017). Episodic Tags Enhance Striatal Valuation Signals during Temporal Discounting in pathological Gamblers. *ENeuro*, *4*(3), ENEURO.0159-17.2017. https://doi.org/10.1523/eneuro.0159-17.2017

APPENDIX A – Figures and Tables

Figure 1. Two-week experimental protocol for participants.

Timeline participants follow as they complete the two-week experimental protocol after being enrolled in the study. Boxes below timeline indicate the timepoints at which measures were assessed across the experimental protocol.

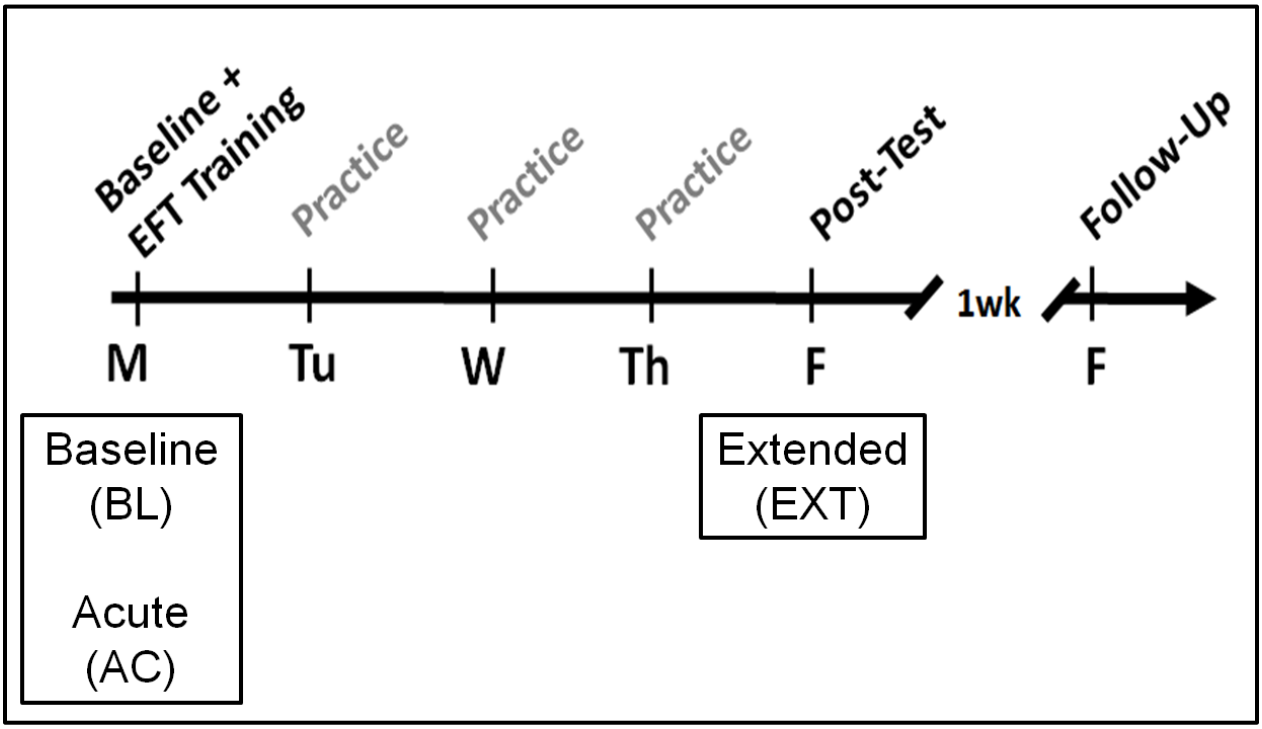


Figure 2. Percent reduction graphs illustrating changes in alcohol demand indices across three time points of assessment.

Across all panels, unfilled markers represent the EFT group while filled markers represent the ERT group across three assessment time points. Panel A represents mean intensity scores, where lower scores indicate lower consumption of alcohol at free price. Panel B represents mean breakpoint scores, where lower scores represent smaller price points at which consumption is suppressed to zero. Panel C represents mean O_{max} scores, where lower scores indicate a smaller maximum expenditure. Lastly, panel D represents mean P_{max} scores, where lower scores indicate a lower price point corresponding to O_{max}.

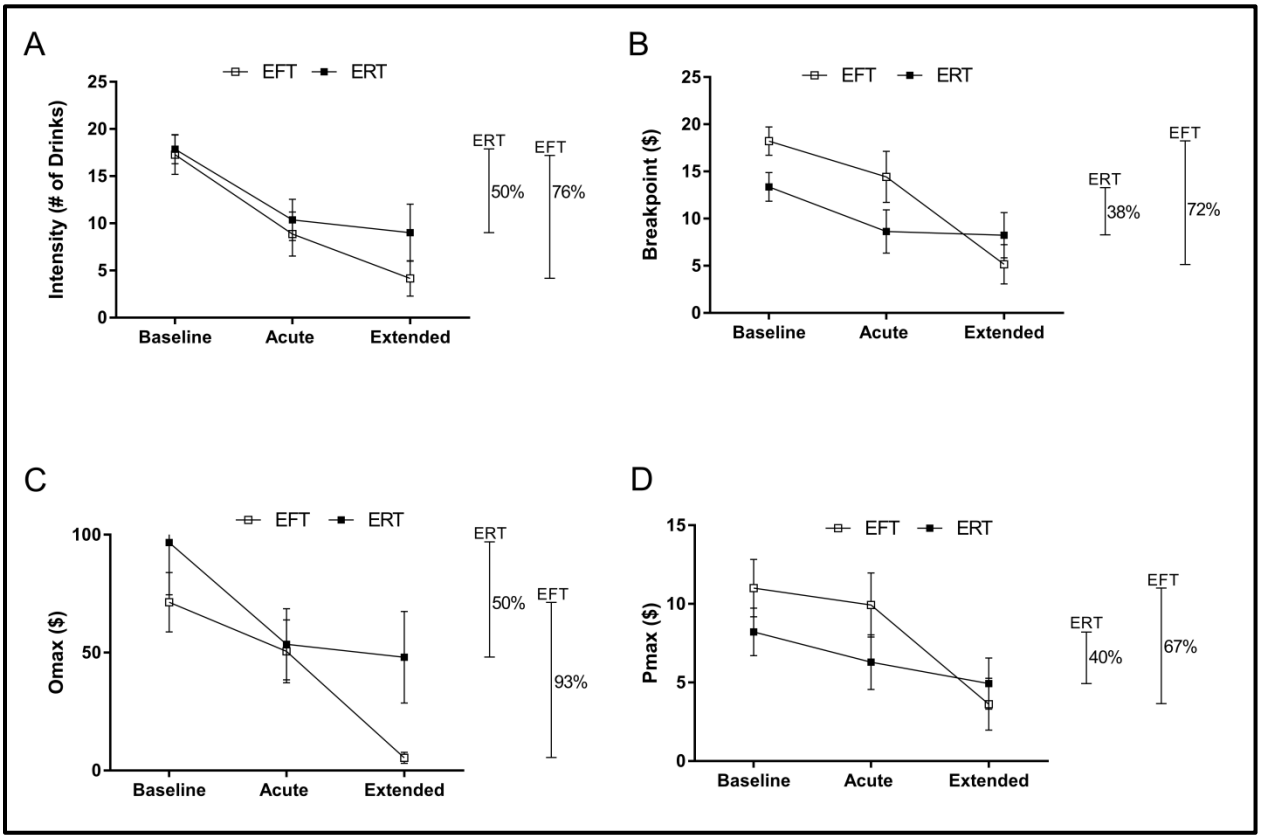


Figure 3. Percent reduction graph illustrating changes in delay discounting rates across three time points of assessment.

Unfilled markers represent the EFT group while filled markers represent the ERT group across three assessment time points. Log(k) scores are plotted on the y-axis, where more negative means less impulsive choices.

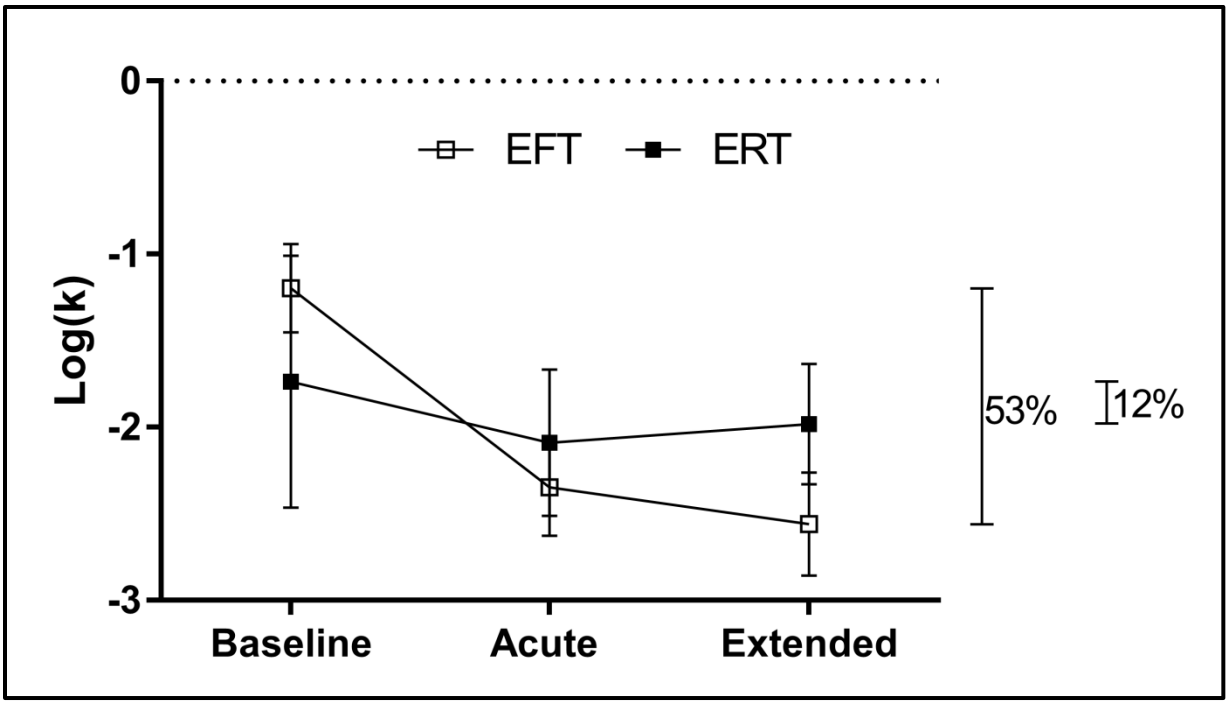


Figure 4. Percent change graphs illustrating changes in clinical outcome variables across three time points of assessment.

Across all panels, unfilled markers represent the EFT group while filled markers represent the ERT group across three assessment time points. In panel A, the average BSCQ score, calculated across 8-tems, is plotted on the y-axis, where higher scores indicate greater situational confidence. In panel B, the total AUQ score is plotted on the y-axis, where higher scores mean greater alcohol craving.

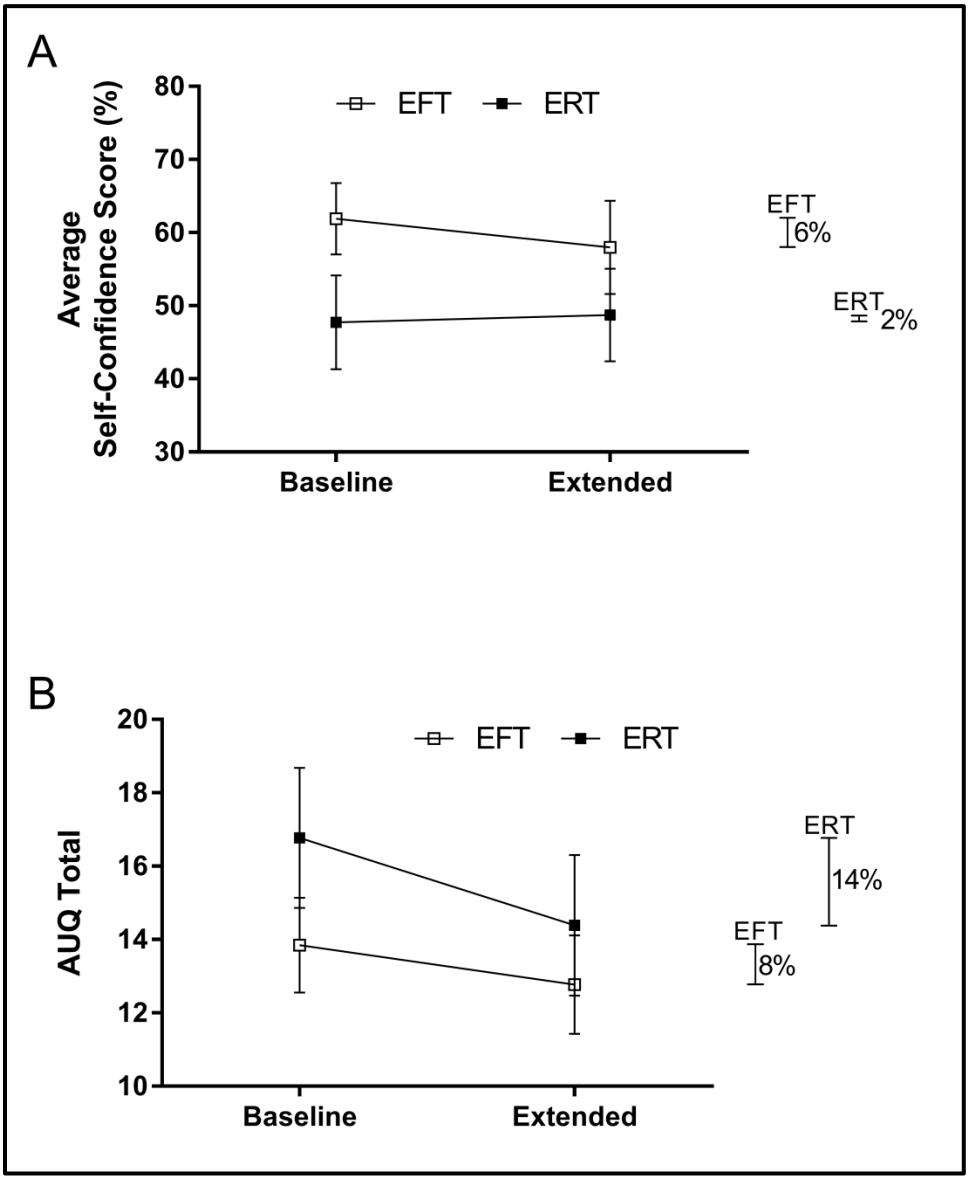


Figure 5. Percent change graphs illustrating changes in cognitive mechanism variables across three time points of assessment.

Across all panels, unfilled markers represent the EFT group while filled markers represent the ERT group across three assessment time points. In panel A, total MAAS score is plotted on the y-axis, where higher scores indicate more mindful attention awareness. In panel B, total CFC score is plotted on the y-axis, where higher scores indicate more consideration for future consequences.

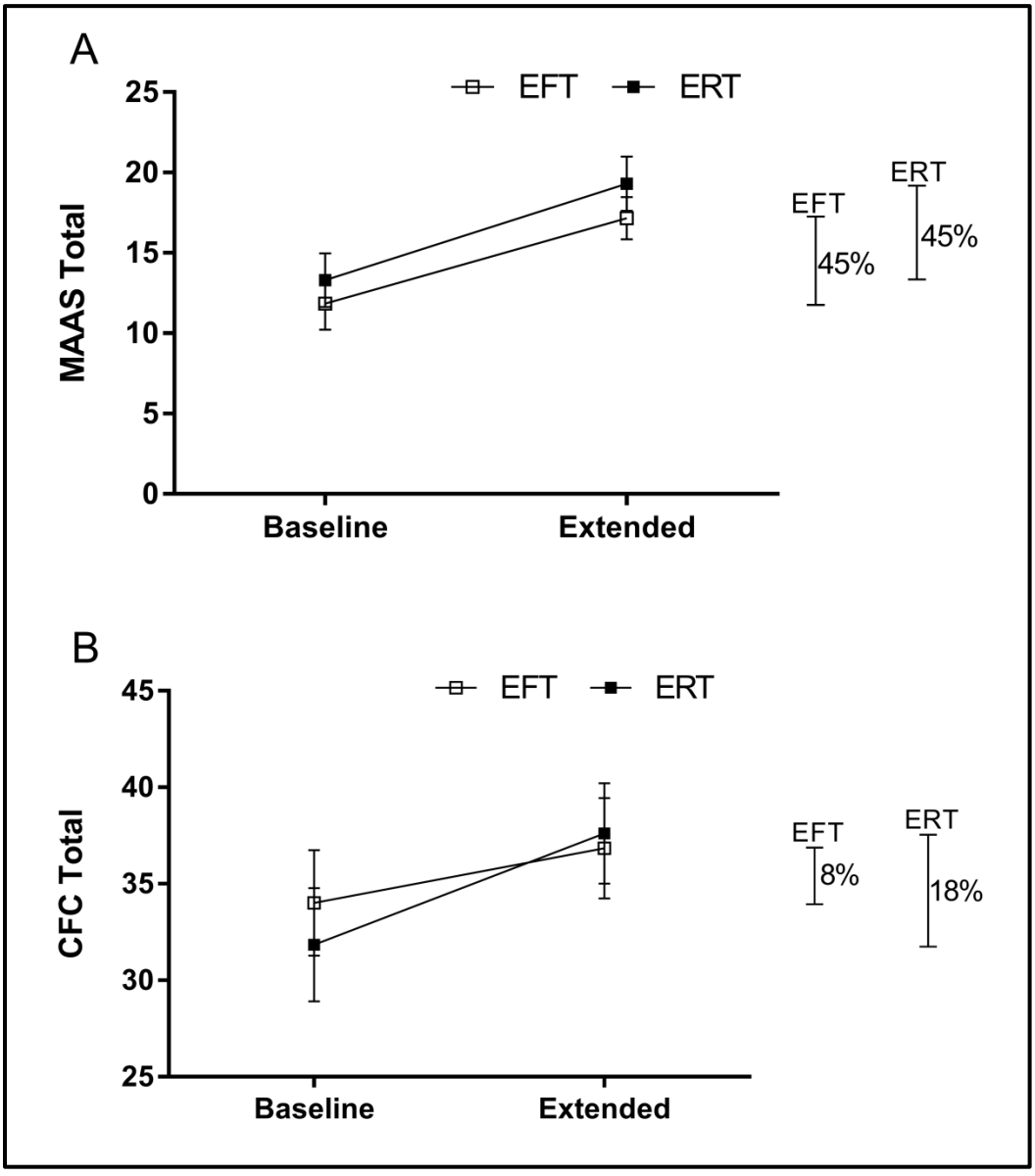


Table 1. Baseline differences between EFT and ERT groups in variables of interest.

	EFT Group		ERT Group				
Measure	**M**	**SD**	**M**	**SD**	**df**	**t**	**p**
Age	41.3571	10.21769	38.4286	10.12776	26	.762	.453
Sex	1.4286	.51355	1.3571	.49725	26	.374	.712
Education	13.1429	3.10972	13.2143	2.39161	26	-.068	.946
Income	2.5000	1.74312	3.5714	2.34404	26	-1.372	.182
AUDIT	24.8571	8.11321	28.6429	6.64029	26	-1.351	.188
Intensity	17.2857	7.84885	17.8571	5.78934	26	-.219	.828
Breakpoint	18.2143	5.63203	13.3571	5.73259	26	2.261	.032
O_{max}	71.3846	45.35331	96.7143	83.02217	25	-.973	.340
P_{max}	11.0000	6.87246	8.2143	5.65928	26	1.171	.252
Log(k)	-1.1972	.95757	-1.7359	1.59788	26	1.082	.289
AUQ	14.2143	4.69334	16.8571	6.61998	26	-1.219	.234
BSCQ	57.96	22.361	44.91	24.612	26	1.469	.154
MAAS	11.8571	5.64129	13.5000	5.81444	26	-.759	.455
CFC	33.2143	9.91641	31.9286	10.16377	26	.339	.737
Shipley Verbal	30.7857	4.35322	27.8571	4.29413	26	1.792	.924

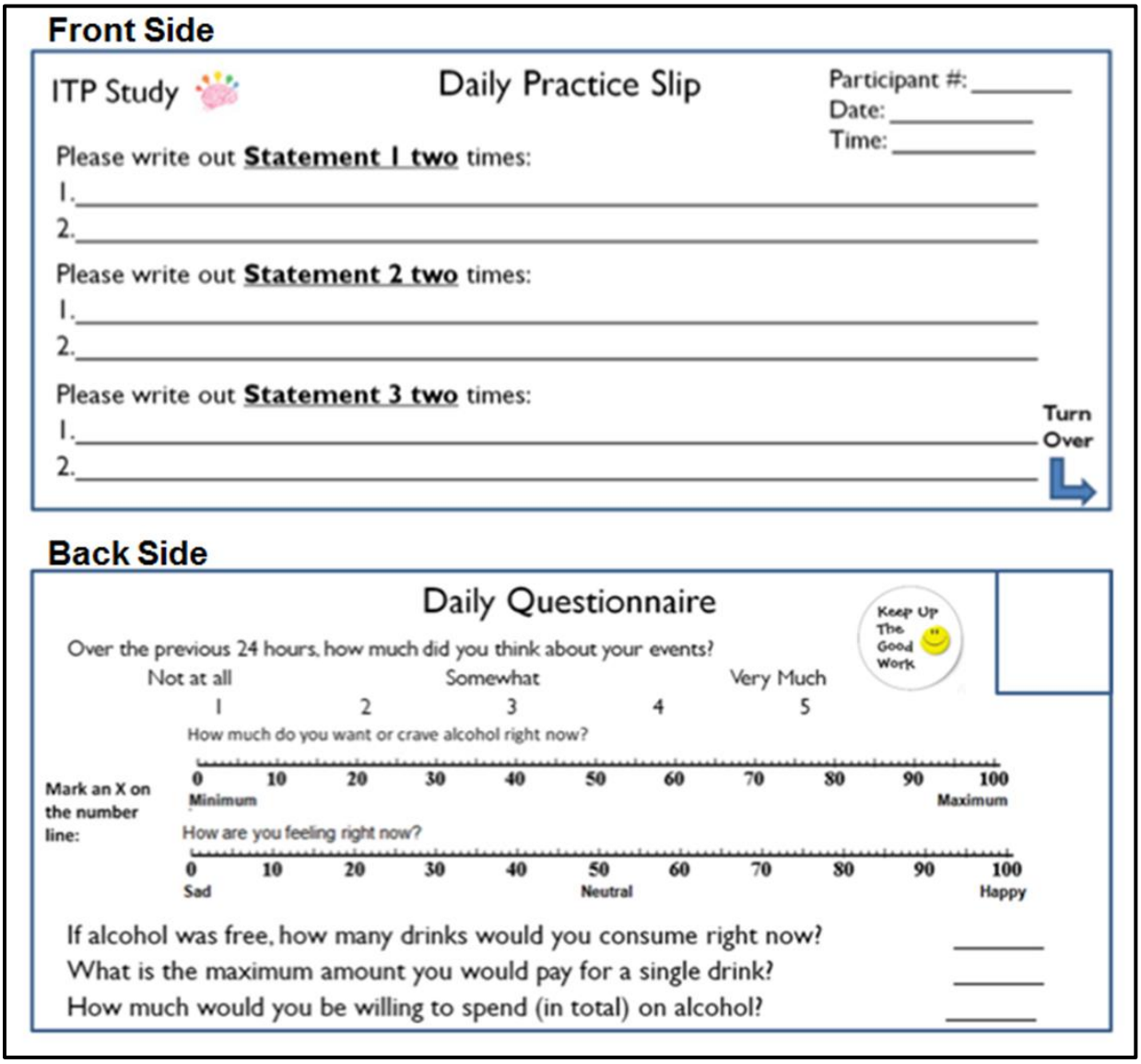
Table 2. Demographic variables for both EFT and ERT groups at baseline.

	EFT Group		**ERT Group**	
Measure	**M**	**SD**	**M**	**SD**
Age (years)	41.3571	10.21769	38.4286	10.12776
Sex (% Female)	43%		36%	
Education (years)	13.1429	3.10972	13.2143	2.39161
Median Income ($)	$22,500		$37,500	
AUDIT	24.8571	8.11321	28.6429	6.64029
Intensity (# of drinks)	17.2857	7.84885	17.8571	5.78934
Breakpoint ($)	18.2143	5.63203	13.3571	5.73259
O_{max} ($)	71.3846	45.35331	96.7143	83.02217
P_{max} ($)	11.0000	6.87246	8.2143	5.65928
Log(k)	-1.1972	.95757	-1.7359	1.59788
AUQ	14.2143	4.69334	16.8571	6.61998
BSCQ	57.96	22.361	44.91	24.612
MAAS	11.8571	5.64129	13.5000	5.81444
CFC	33.2143	9.91641	31.9286	10.16377
Shipley Verbal	30.7857	4.35322	27.8571	4.29413

APPENDIX B - Supplemental Figures

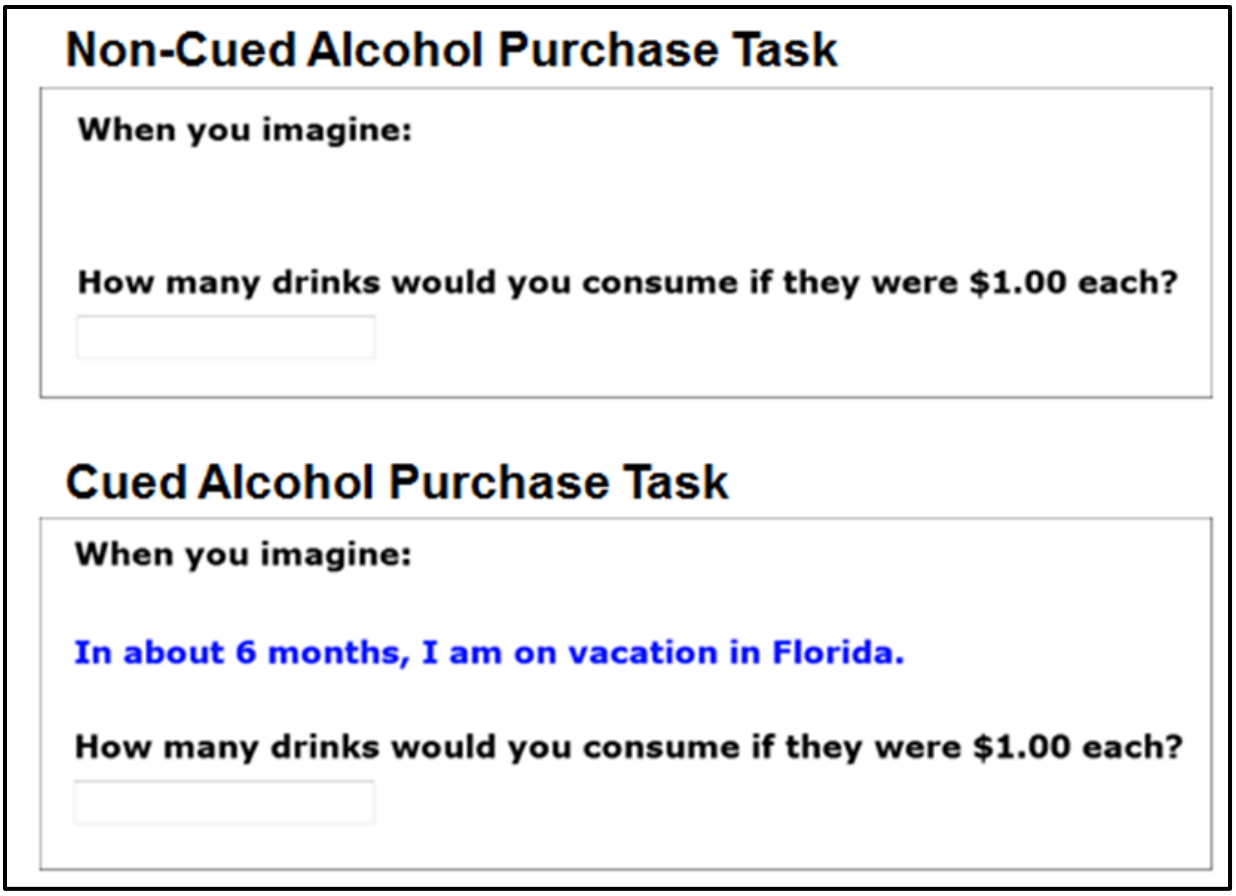
Supplemental Figure 1. Screenshots of daily practice slips.

Participants completed one slip once per day for a total of three days in between session 1 and session 2. Participants hand wrote the short version of their cues twice for each time point on the front and answered a few questions about craving, mood, and alcohol demand on the back.



Supplemental Figure 2. Illustrated example of the non-cued and cued versions of the alcohol purchase task.

Participants completed the non-cued version during session 1 at baseline. The cued version was completed twice: once during session 1 after exposure to EFT/ERT and the second time at session 2 after extended practice.



Supplemental Figure 3. Illustrated example of the non-cued and cued versions of the delay discounting task.

Participants completed the non-cued version during session 1 at baseline. The cued version was completed twice: once during session 1 after exposure to EFT/ERT and the second time at session 2 after extended practice.