

Reducing Substance Use with Implementation Intentions: A Treatment for Health Risk
Behaviors

Lara N. Moody

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

Doctor of Philosophy

In

Psychology

Warren K. Bickel, Chair

George A. Clum

Christopher T. Franck

Robert S. Stephens

April 28, 2017

Blacksburg, Virginia

Keywords: Implementation intentions, addiction, health risk behaviors, treatment

Reducing Substance Use with Implementation Intentions: A Treatment for Health Risk
Behaviors

Lara N. Moody

ABSTRACT

Maladaptive habits, such as substance use, that are highly ingrained and automatized behaviors with negative long-term health consequences need effective interventions to promote change towards more healthful behaviors. Implementation intentions, the structured linking of critical situations and alternative, healthier responses, have been shown to improve health-benefiting behaviors such as eating more fruits and vegetables and being more physically active (Sheeran, Milne, Webb, & Gollwitzer, 2005). Here, a laboratory analogue for smoking relapse and a pilot clinical trial of alcohol use are assessed using implementation intention interventions to reduce these health risk behaviors.

In Study 1, heavy smokers completed a smoking resistance task that is a candidate analogue for smoking relapse. Participants were exposed to an in-laboratory implementation intention and/or monetary incentive condition during each of four experimental sessions. The combined implementation intention and monetary incentive condition resulted in the greatest delay to smoking initiation. In Study 2, individuals with alcohol use disorder completed an active or control implementation intention treatment condition. Remotely, both treatment groups received a daily ecological momentary intervention, thrice daily biologic breath alcohol ecological momentary assessments, and once daily self-report ecological momentary assessment of alcohol consumption during the intervention period. The active implementation intention group was associated with a greater reduction in alcohol consumption compared to the control group.

Together, these studies provide experimental and initial clinical evidence for implementation intentions, in conjunction with other effective treatments (Study 1) and technological advancements (Study 2), to intervene on and reduce substance use. This project is the first to use implementation intentions in a laboratory evaluation of smoking resistance and in an initial clinical trial to reduce alcohol consumption in a naturalistic community sample using both ecological momentary assessments and ecological momentary interventions.

Reducing Substance Use with Implementation Intentions: A Treatment for Health Risk
Behaviors

Lara N. Moody

GENERAL AUDIENCE ABSTRACT

The following studies provide evidence for the use of implementation intentions, a planning-based intervention, to reduce health risk behaviors. Implementation intentions are structured if-then statements that help individuals to identify critical situations where health risk behaviors are likely and to predetermine alternative and healthier responses when these situations are encountered. In the first study, nicotine-deprived cigarette smokers completed a laboratory task where they were asked to resist smoking. The participants were exposed to different conditions (implementation intentions and monetary incentives) to help them to resist smoking. The study found that the combination of both implementation intentions and monetary incentives were associated with the longest time to smoking reinitiation; however, the combination of both interventions was not significantly greater than monetary incentives alone. The second study employed implementation intentions as a strategy to reduce alcohol use over a two-week period in individuals with alcohol use disorder. The study found that implementation intentions reduced the amount of alcohol consumed on days where participants were drinking and these reductions were maintained at one-month follow-up. Together, these two studies provide support for translational work that evaluates interventions in the laboratory and then also in clinical trials. Furthermore, these studies show the trans-disease applications of interventions such as implementation intentions across health risk behaviors.

ACKNOWLEDGEMENTS

First and foremost, this dissertation would not have been possible without the help of Dr. Warren K. Bickel for his constant ideas, support, feedback, and funding. I am also grateful for the support and encouragement of my entire committee who have each supported me in an assortment of ways throughout this process. I would also like to thank Lindsey Poe for her help working with participants, managing data, and the production of this document. For their statistical expertise and impeccable senses of humor, I would like to thank Drs. Allison Tegge and Christopher Franck who both provided me excellent consultation on the studies reported here as well as many others. More broadly, the Addiction Recovery Research Center team has provided support for me over the last several years that cannot be quantified but that has certainly led to an exceptionally enjoyable and productive academic period of my life. Finally, I would like to thank the National Institute on Alcohol Abuse and Alcoholism for their early investment in me which provided me the time and resources to dedicate time to these projects.

TABLE OF CONTENTS

GENERAL AUDIENCE ABSTRACT	iv
ACKNOWLEDGEMENTS	v
LIST OF FIGURES	vii
LIST OF TABLES	viii
ABBREVIATIONS	ix
INTRODUCTION	1
MANUSCRIPT 1	8
MANUSCRIPT 2	36
CONCLUSIONS	71
REFERENCES	75
FIGURES	82
APPENDICES	84
APPENDIX 1	84
APPENDIX 2	89
APPENDIX 3	92
APPENDIX 4	95
APPENDIX 5	96
APPENDIX 6	97
APPENDIX 7	98
APPENDIX 8	99
APPENDIX 9	105
APPENDIX 10	106
APPENDIX 11	107
APPENDIX 12	108
APPENDIX 13	111
APPENDIX 14	114

LIST OF FIGURES

Figure 1.1: Time to smoking reinitiation by condition	30
Figure 1.2: Effect size estimates by intervention	31
Figure 2.1: Percent days with no drinking by condition and time	60
Figure 2.2: Change in drinking on days where alcohol was consumed	61
Figure 2.3: Alcohol consumption by treatment condition across all time points	62
Figure 2.4: Stage of Change by time point	63
Figure 1: Diagram of the Theory of Planned Behavior	82
Figure 2: Example of implementation intention if-then structure	83

LIST OF TABLES

Table 1.1: Top 10 Bayesian Information Criterion (BIC) models selected	32
Table 1.2: Mixed effects analysis of variance	33
Table 1.3: Mixed effects model comparisons between conditions	34
Table 1.4: Cox mixed effects model comparisons between conditions	35
Table 2.1: Demographic characteristics by treatment condition	64
Table 2.2: Hurdle regression of primary outcome measures	65
Table 2.3: Treatment acceptability questions and average responses by condition	66
Table 2.4: Hurdle regression of Stages of Change outcome measures	67

ABBREVIATIONS

AA: active implementation intention, active monetary incentive condition

AC: active implementation intention, control monetary incentive condition

AUDIT: Alcohol Use Disorder Identification Test

BIC: Bayesian Information Criterion

CA: control implementation intention, active monetary incentive condition

CO: Carbon Monoxide

CC: control implementation intention, control monetary incentive condition

EMA: Ecological Momentary Assessment

EMI: Ecological Momentary Intervention

QSU: Questionnaire on Smoking Urges

RtC: Readiness to Change Questionnaire

TLFB: Timeline Follow-Back

INTRODUCTION

Reducing Substance Use via Implementation Intentions: A treatment for health risk behaviors

“When the individual is dominated by segmental drives, by compulsions, or by the winds of circumstances, he has lost the integrity that comes only from maintaining major directions of strivings” (Allport, 1955, pp. 50–51).

As expressed by the American psychologist Gordon Allport, behavior can be swayed by momentary states at the cost of long-term rewards and consequences. Perhaps not surprisingly, behaviors that contribute to excess mortality in the United States included health risk behaviors characterized by short term rewards and long term consequences such as tobacco use, poor diet, lack of physical activity, alcohol abuse, illicit substance use, and risky sexual practices (Jamal, Agaku, O’Connor, & King, 2014; Johnson, Hayes, Brown, Hoo, & Ethier, 2014; Woolf & Aron, 2013).

Challengingly, prevention of excess mortality necessitates changes to health risk behaviors and adoption of health-promoting behaviors many years, or even decades, before symptoms of disease emerge. The behavior changes needed are not only far in advance of disease manifestation, but also require more immediate (albeit smaller) costs such as discomfort and inconvenience (Hall & Fong, 2007). Just as some behaviors may be costly in the short-term but have long-term benefits (e.g., eating a low fat diet), health risk behaviors offer short-term benefits and long-term costs. For example, in the case of cigarette smoking, the initial benefits of the behavior, such as avoidance of withdrawal symptoms and improved feelings of well-being,

are much more immediate than the potential future costs, such as harm to physical appearance, cancer, and premature death (Doll, Peto, Boreham, & Sutherland, 2004).

The choice to engage in behaviors that have small short-term benefits at the risk of large long-term costs is a form of suboptimal decision-making. Both humans (Camerer, 2004) and non-human animals (e.g., Kacelnik & Marsh, 2002) are known to make suboptimal decisions. Early efforts to explain suboptimal decision-making in humans resulted in theoretical frameworks such as the Subjective Expected Utility Model (Von Neumann & Morgenstern, 1947), the Theory of Reasoned Action (Ajzen & Fishbein, 1975; Fishbein, 1967), and later the Theory of Planned Behavior (Ajzen, 1985). These theories of decision-making and behavior have been applied to health risk behaviors to understand the tradeoff between small, proximal benefits despite potential large, distal costs and possible avenues for change.

The Theory of Planned Behavior (see Figure 1), built on the Theory of Reasoned Action, added a third component to intentions, the perceived control over the target behavior. Since behavior change is effortful, especially when the behavior is habitual (Maréchal, 2009), changing an ingrained behavior necessitates motivation. According to the Theory of Planned Behavior, motivation and intentions are closely linked in the behavior change process. In fact, intention is undergirded by three constructs: attitude (or the global positive or negative evaluation of a behavior), subjective norms (or the social pressure from those close to you to engage in a behavior), and perceived control (or the perception of ease or difficulty in enacting a behavior; (Ajzen, 1985, 1991; Madden, Ellen, & Ajzen, 1992). Based on the Theory a Planned Behavior, a positive attitude about change, social pressure in favor of change, and perceived ease (or self-efficacy) of one's ability to change lead to the motivation and intent to change behavior.

Habits: The Good and the Bad

“The essence of habit is an acquired predisposition to ways or modes of response” (Dewey, 1922, p. 42).

Habits are extremely strong predictors of future behavior. The ability of habits to predict future behaviors led to the common saying, “most of the time what we do is what we do most of the time” (Townsend & Bever, 2001). Important to note, habit formation is an adaptive process that increases fitness to our environments. Habits offer automatization of behaviors that are by and large survival promoting. Indeed, habits eliminate effortful decision-making and attention by permitting well-learned behavior to be evoked or elicited by either internal or external stimuli. The conservation of habit-forming processes over evolutionary time can be conceptualized as a mechanism to allocate scarce resources (i.e., cognitive decision making). Economists and psychologists postulate that habits continue to exist because they strike a balance between conserving cognitive decision-making resources while also allowing for relative flexibility to changing environments (Aarts, Verplanken, & van Knippenberg, 1998). As such, the propensity to form habits is largely adaptive to the uncertain, variable, and complex environment in which we live. In the words of Theodore Roosevelt, “[h]abit and routine free the mind for more constructive work” (attrib.; see Connolly & Martlew, 1991, p. 97). At their best, habits promote efficiency; however, the same architecture that allows for good, health promoting habits can also aid in the development of chronic health risk behaviors.

In order to intervene on bad, health reducing behaviors, an understanding of deeply rooted and maintained habits is needed. Habits begin with decision-making. As the same or similar decisions are made time and again, decisions become automated such that they require less cognitive resources (Aarts et al., 1998). When making decisions, several potential components contribute to choices including: 1) risk and uncertainty of outcomes (Hsu, Bhatt,

Adolphs, Tranel, & Camerer, 2005; Slovic, 2016), 2) valence (negative, neutral, positive) of outcomes (De Martino, Kumaran, Seymour, & Dolan, 2006), and 3) temporal location of outcomes (Petry, Bickel, & Arnett, 1998). For example, when a person initially makes the decision to smoke a cigarette, possible considerations might include the risk of becoming addicted, how certain he or she is to become addicted, how likely smoking the cigarette is to lead to varying positive (e.g., weight loss, social desirability) or negative (e.g., lung cancer) outcomes, and the temporal location of different possible outcomes (e.g., near immediate appetite suppression compared to relatively distant lung cancer). Once an individual makes the choice to have a first cigarette, the path towards making that choice again has been initiated. Over many repetitions of the decision to smoke a cigarette, both behavioral and physiological habits may be formed. Over time and repetition, habits form as largely unconscious repertoires of potential and increasingly probable behaviors (Hodgson, 2004).

An example of the strength of habits on behavior is provided in the Theory of Planned Behavior research in a study on undergraduate college students to assess the intention-behavior relationship of seatbelt use. The study found support for the components of the model impacting behavior, namely social norms, attitudes, and perceived control; however, the study also found that if the habit of wearing a seatbelt was already established, then the habit was the greatest predictor of seatbelt use (Wittenbraker, Gibbs, & Kahle, 1983). The habit to buckle one's seatbelt is a health promoting behavior that increases the chances for continued health; however, health risk behaviors are subject to the same processes of habit formation. As observed in the above study, once the behavior (i.e., wearing one's seatbelt) had become habitual, the intention was insufficient to change future behaviors. Habits superseding intentions when attempting behavior change poses a unique challenge for changing health risk behaviors that are ingrained as habits.

In some cases, the mechanisms for habit formation may be mismatched with behaviors that do not promote health and fitness, such as substance use. If habits are formed around health risk behaviors, then perturbing the existing habit to change the negative health behavior is essential to increasing health. Moreover, maladaptive habit formation may constitute a common factor across many health risk behaviors (Aarts et al., 1998). If maladaptive habit formation is a shared factor across health risk behaviors (e.g., cigarette smoking and alcohol use), then perturbing habits may be necessary to increasing healthful choices.

Implementation Intentions

Past behavior is a strong predictor of future behavior. Indeed, the predictive power of past behavior often exceeds that of behavioral intention (Orbell & Verplanken, 2010; Verplanken & Orbell, 2003). Moreover, past behaviors that are highly practiced, such as habits, are even more predictive of future behavior because of the automatization of behavior and subsequent increases in effort needed to make behavioral changes (Ouellette & Wood, 1998; Tiffany & Conklin, 2000). Implementation intentions are a strategy to regulate one's behavior through highly structured if-then rules that help to take action towards a goal through behavioral change and habit decomposition (see Figure 2; Gollwitzer, 1999). Moreover, goal intentions, or the stage of motivation to change, is related to the effect size of implementation intentions such that stronger goal intentions are associated with greater change in desired behavior following formation of implementation intentions (Sheeran et al., 2005; Webb & Sheeran, 2006). Importantly, habitual behaviors are less reliant on effortful decision-making processes and more reliant on automated, default cognitive processes, making habitual choices demand specific considerations for intervention (Aarts et al., 1998; Adriaanse, Gollwitzer, De Ridder, de Wit, & Kroese, 2011).

In contrast to intentions which are desired outcomes or goals that an individual is committed to achieving, implementation intentions are the link between an unconditional situation and a subsequent intended behavior. The distinction between motivational and volitional phases underlies the difference between an intention and an implementation intention. By making the mechanism by which a goal will be achieved explicit, implementation intentions provide the bridge between an intention and a desired result. Implementation intentions are theorized to work through two primary pathways, the first is to make the critical cue or situation more accessible to the individual so that it is recognized and the second is that implementation intentions initiate the behavioral response when the cue/situation is presented without conscious deliberation.

Implementation intentions have been successfully employed in fields including increasing healthy consumer choices (Gollwitzer & Sheeran, 2009), increasing cervical cancer screenings (Sheeran & Orbell, 2000), increasing healthy eating (Verplanken & Faes, 1999), and increasing exercise (Milne, Orbell, & Sheeran, 2002). Importantly, health promoting behaviors and health risk behaviors share common factors such as capitalizing on habit formation. Indeed, implementation intentions may be viable not only for increasing health-promoting behaviors but also for decreasing health risk behaviors. If health risk behaviors are also responsive to implementation intention interventions, then implementation intention interventions used for one health risk behavior, such as cigarette smoking, may also work for others. Early evidence suggests that implementation intentions may work to perturb habits associated with a variety of health risk behaviors supporting implementation intentions as a candidate trans-disease intervention.

The extant literature on implementation intention work has focused largely on increasing positive health behaviors (Adriaanse et al., 2010; Adriaanse, de Ridder, & de Wit, 2009; Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; Andersson & Moss, 2011/3; Armitage & Sprigg, 2010; Chapman & Armitage, 2010, 2012; Guillaumie, Godin, Manderscheid, Spitz, & Muller, 2012; Knäuper et al., 2011; Sheeran & Orbell, 2000). A few initial explorations have successfully used implementation intentions to reduce negative health behaviors (Armitage, 2007; Armitage & Arden, 2008; Armitage, Rowe, Arden, & Harris, 2014; Conner & Higgins, 2010). For example, a workplace intervention to reduce cigarette smoking (Armitage, 2007, 2008), a longitudinal study of adolescent cigarette smoking (Conner & Higgins, 2010), and a brief intervention for alcohol using adolescents (Armitage et al., 2014) have indicated that implementation intentions may be an effective tool for reducing health risk behaviors. Since implementation intentions have been shown to be effective in increasing health-promoting behaviors and initial evidence supports their efficacy in health risk behaviors, one has reason to believe that implementation intentions will be effective in reducing and aiding in stopping health risk behaviors.

In the subsequent studies, implementation intentions are evaluated first in a laboratory analogue for smoking relapse as a technique, in combination with monetary incentives, to increase time to relapse. Second, implementation intentions are explored as a technique, in combination with technological advancements, ecological momentary assessments, and ecological momentary interventions to reduce alcohol consumption in a naturalistic setting. Together, these studies sample the possible breadth of research to explore the utility of implementation intentions across addiction research as a tool to reduce substance use.

MANUSCRIPT 1

Title

Toward a Laboratory Model for Psychotherapeutic Treatment Screening: Implementation intentions and incentives for abstinence in an analogue of smoking relapse

Abstract

Despite reductions in cigarette smoking in the US, approximately 40-million Americans are smokers. Innovative interventions are needed to help remaining smokers quit. In order to develop innovative interventions, precise and effective tools are needed to test interventions. Here, a laboratory model of smoking relapse is assessed for its ability detect the increased resistance to smoking across two interventions and for its sensitivity to differing degrees of effectiveness. Nicotine-deprived participants (N = 36) completed, in randomized order, four smoking resistance sessions in a 2 (implementation intentions) x 2 (monetary incentives) within-participants factorial design. Participants completed the smoking resistance task with and without implementation intentions and monetary incentives. Mixed effects and Cox proportional hazard mixed effects models were used to assess delay to smoking initiation across the conditions. The overall effect of the within-between analysis showed a significant effect of condition. Planned comparisons revealed small effect sizes of implementation intentions alone, medium to large effect sizes of monetary incentives alone, and large effect sizes when both interventions were combined. This initial investigation of the smoking resistance paradigm showed sensitivity to smoking reinitiation times across intervention conditions. Individuals resisted smoking significantly more in the presence of monetary incentives and implementation intentions than without these interventions, providing evidence for further examination of these interventions in more translational settings and supporting the use the laboratory analogue to screen future interventions and treatment packages.

Keywords: delay of gratification; cigarette smoking; laboratory analogue; implementation intentions; contingency management

Introduction

“Measurement is never better than the empirical operations by which it is carried out, and... no scale used by mortals is perfectly free of their taint” p. 680 (Stevens, 1946)

 S.S. Stevens wisely pointed out in 1946 that our ability to measure and quantify phenomena is fundamental to the sciences and provides directions for future work to follow. Within the field of health sciences, cigarette smoking stands out as the single leading cause of preventable death worldwide (World Health Organization, 2013). Smoking continues to kill despite seven out of ten smokers indicating a desire to quit. In fact, only 6-7% of smoking attempts result in success (CDC, 2011). The development of tools that can provide measurement of the relative efficacy of single and combined treatments in an efficient manner opens the opportunity for faster and cheaper paths to successful smoking cessation treatments. Human laboratory studies to measure the key elements of treatments and systematically analyzed single and combined interventions in a promising means to identify the most efficacious treatments and then move only those with shown efficacy on to time and resource consuming clinical trials.

Previously, laboratory models of smoking have been used to characterize smoking behavior and as analogues of smoking relapse in psychopharmaceutical evaluations. For example, a laboratory smoking paradigm characterized the effects of manipulating stress (McKee et al., 2011) and alcohol consumption (McKee, Krishnan-Sarin, Shi, Mase, & O’Malley, 2006) on frequency and intensity of cigarette smoking. In addition, models of smoking relapse have been suggested for screening tobacco cessation medications (McKee, 2009), with the laboratory smoking relapse model showing that highly dependent individuals that took varenicline or bupropion were more successful than placebo controls at resisting smoking. These findings

provide binary evidence that both medications are more effective than the control condition (McKee, Weinberger, Shi, Tetrault, & Coppola, 2012). Here we extend on previous research of laboratory analogues for smoking relapse to validate a paradigm for detecting differences in efficacy between behavioral interventions associated with varying degrees of effectiveness.

The overarching goal was to develop a laboratory model that was sensitive to differences between two known and different behavioral treatments. A smoking resistance task, also called a delay of gratification task, with nicotine-deprived smokers was used as a laboratory analogue, or model, of smoking relapse. Importantly, for the purpose of ascertaining the sensitivity of this laboratory analogue for smoking relapse, we chose two interventions that have already been shown to aid in smoking cessation and are associated with differing magnitudes of effectiveness. The first intervention, implementation intentions, is a strategy to regulate behavior through highly structured if-then rules that help to take action towards a goal through behavioral change and habit decomposition (Gollwitzer, 1999). Implementation intentions has, to the best of our knowledge, been examined in four studies to evaluate its efficacy in helping individuals to quit smoking. The individual effect sizes from these studies were $\eta^2(1, N = 90) = 3.26$, which is an approximate d equal to 0.39 (Armitage, 2007), $\eta^2 = 0.11$, which is an approximate d equal to 0.70 (Armitage, 2008), $\eta^2 = 0.12$, which is an approximate d equal to 0.75 (Armitage & Arden, 2008), and $d = 0.41$ (Armitage, 2016). Taken together, these studies report an average Cohen's d of 0.56, which convention dictates to be a medium effect (Cohen, 1992).

The second intervention, a laboratory model of contingency management, provided monetary incentives as reinforcers for resisting smoking. Contingency management has received robust support as a treatment to reduce health risk behaviors including cigarette smoking (Cooney et al., 2016; Correia & Benson, 2006; Higgins & Solomon, 2016; Ram, Tuten, &

Chisolm, 2016; Roll, 2005). Monetary incentives for continued abstinence during a smoking resistance session provide a potential laboratory analogue of empirically supported contingency management treatments (Lussier, Heil, Mongeon, Badger, & Higgins, 2006; Prendergast, Podus, Finney, Greenwell, & Roll, 2006). Previous evidence from smoking resistance tasks support monetary incentives as an effective means to increase time to smoking reinitiation (Mueller et al., 2009). In a meta-analysis by Prendergast (2006) the effect size across seven monetary-incentive contingency management studies for tobacco cessation reported an average effect of d equal to 0.71 which is in the medium to large range (Cohen, 1992).

In the current study, the goal was to determine the sensitivity of a candidate experimental analogue of smoking relapse when used with behavioral interventions. If this laboratory method was adequately sensitive then it should demonstrate not only that these interventions are effective in delaying laboratory lapses to cigarette smoking but also should be able to distinguish between the effectiveness of these two interventions.

Methods

Participants

The Virginia Polytechnic Institute and State University Institutional Review Board approved all procedures and practices implemented in this experiment (see Appendix 1). Thirty-seven adults from Roanoke, Virginia and surrounding areas completed the study. One participant was excluded due to completing a different monetary incentive schedule, leaving a sample of 36 participants. Given the within-participants design, 36 participants provides adequate power to detect medium effect sizes based on Cohen's d conventions which state that .2, .5, and .8 are small, medium, large, respectively (Cohen, 1992; Faul, Erdfelder, Lang, & Buchner, 2007). Volunteers were recruited via flyers, online advertisements, and by contacting past participants

through the Addiction Recovery Research Center database. Eligible participants (a) were between the ages of 18 and 65; (b) smoked an average of 10 cigarettes a day or more; (c) were not using prescription medications that might affect smoking or nicotine metabolism; and (d) were not using smokeless tobacco or alternative products regularly, as defined as 10 or more times in the past month. Additionally, potentially eligible participants were excluded if they were pregnant or had immediate plans to move away from the area. Participants were invited to attend five sessions, including a consent session and four experimental sessions for which a period of smoking abstinence prior to the sessions was required. Participants were allocated preceding the first experimental session to a randomized sequence of the four sessions to control for order effects. The four conditions comprised all combinations of control or active implementation intentions and control and active monetary incentive conditions.

To evaluate the efficacy of the interventions, the laboratory-based smoking resistance task was used to measure smoking relapse, as defined by the time of smoking initiation after a period of smoking abstinence. A customized USB-compatible 5v/16MHz board and breadboard (Sparkfun, Niwot, CO) attached by tubing to a mouthpiece (Salem Precision Machine, Salem, VA) that held the cigarette was used to automatically trigger the apparatus when smoking behavior occurred.

Procedure

Data collection took place across five sessions (i.e. consent and four experimental sessions) in the Addiction Recovery Research Center. Compensation for completion of all five sessions was \$130 plus earnings from the monetary incentive conditions. Following informed consent, participants provided a satiated measure of breath carbon monoxide (CO; collected with a hand-held monitor; Bedfont Scientific Ltd, Kent, England), completed baseline smoking

measures (discussed below), a brief familiarization exercise with the behavioral smoking rooms and the smoking resistance mouthpiece, and specifically, were shown how to load a new cigarettes into the mouthpiece in preparation for the experimental sessions. Following the first session, participants were instructed to abstain from smoking 10-12 hours prior to coming in for the experimental sessions and informed that nicotine deprivation would be assessed as less than half of the baseline CO taken during the consent session. During the experimental sessions, participants were seated in a negative airflow behavioral smoking room. After CO deprivation assessment, participants completed the Questionnaire of Smoking urges (QSU), followed by appropriate intervention worksheets (discussed below).

Participants were provided with a pack of their usual brand of cigarettes and one of the cigarettes was preloaded into the mouthpiece of the smoking device. If or when the participant chose to smoke, the smoking apparatus detected airflow and triggered the end of the smoking resistance task. Participants remained in the smoking booth with *ad libitum* access to their usual brand of cigarettes until the end of the 120 minute session. During all experimental sessions the smoking resistance task was on the computer screen and displayed the available incentives (which incentive structure was determined by individual session allocation to active or control monetary incentive condition) for resisting smoking in two minute increments. In addition, during all sessions participants completed an implementation intention worksheet (which worksheet was determined by individual session allocation to active or control implementation intention condition).

Interventions

Implementation Intentions. Gollwitzer (1999) proposed an automated method, implementation intentions, to effectively narrow the gap between goal setting and attainment.

Implementation intentions involve linking a critical situation with an immediate, appropriate response, and have been used across multiple health-related situations to overcome various habits, including smoking (Armitage, 2007, 2016; Armitage & Arden, 2008; Conner & Higgins, 2010). While goal intentions specify an endpoint (“I intend to reach Y”), implementation intentions specify the when, where, and how (“If I encounter situation X, then I will immediately respond with planned reaction Y”). When goal pursuit is simple and planned, a critical situation can be recognized and immediately countered with a fixed response as opposed to a habitual behavior.

The active implementation intentions used in this study followed the “if-then” format and related a critical smoking situation to a relevant response. Participants were first presented with seven critical situations (e.g., “I am tempted to smoke when I am craving a cigarette”) and 11 appropriate responses (e.g., “I will do other things with my hands instead of smoking”; see Appendix 2). Participants were asked to link as many or as few appropriate responses that applied to them by drawing a line between the critical situation and response. Finally, participants were instructed to pick three of the situation-response pairs, or as many as chosen if less than three, and write them word-for-word in sentence form, including the “if” at the beginning, and the “then” before the response (e.g., “If I am tempted to smoke when I am craving a cigarette, then I will do other things with my hands instead of smoking.”).

During the control condition, participants were asked to check as many critical situations and responses that applied to them without drawing any line or link between the two. Participants were then instructed to pick three situations *or* responses and write them as incomplete statements (e.g., “I am tempted to smoke when I think about a cigarette”; see Appendix 3).

Whereas during the active sessions lines were drawn to link the two, the control sessions required only a check mark.

Monetary Incentives. Contingency management is widely accepted as an efficacious treatment in the field of substance abuse (Lussier et al., 2006; Prendergast et al., 2006). Mueller et al. (2009) tested numerous monetary incentive schedules, a contingency management strategy, as a method to promote sustained cigarette abstinence in a controlled lab setting that modeled real-world smoking relapse. In the current study, the active monetary incentive condition used an already validated (Mueller et al., 2009) linear reinforcement schedule while the control condition provided no monetary incentive for delaying smoking initiation.

The active monetary incentive condition provided money to the participant the longer they waited to smoke. The incentive accumulated over time and started with \$0.15 and the amount awarded decreased by \$0.002 every two minutes (see Appendix 4). The amount of the incentive received was rounded to the nearest cent for every two minutes waited to smoke (functionally reducing by one cent every 10 minutes). The amount of the current incentive available for not smoking for two minutes was displayed on the computer screen where the participant was seated, and the screen stated “Smoke using the cigarette holder if you wish.” If the participant did not smoke for the entire 120 minute session, the monetary incentive received was \$5.46. If the participant chose to smoke at any time during the session, the amount of incentive they received during the time they waited was shown on the screen and no additional incentives were accrued. Specifically, the screen stated “Final earnings: \$X.XX. Staff will notify you when the session is over.”

Alternatively, the control monetary incentive condition did not offer any money for the duration of the two hour session. The amount available for every two minutes, \$0.00, was

displayed on the computer screen, and similar to the active condition, the screen changed once the participant decided to initiate smoking (e.g., “Finals earnings: \$0.00”). The participant received \$0.00 no matter the time of smoking initiation, even if they chose to abstain for the full session.

Measures

Questionnaire on Smoking Urges - Brief (QSU). The QSU is a 10-item self-report questionnaire that assesses cigarette craving. The QSU was administered at the beginning of each experimental session using the Qualtrics survey platform (Provo, UT). Each question applied a seven-point Likert scale (1=strongly disagree; 7=strongly agree) and participants were asked to indicate their level of agreement with each statement (see Appendix 5). The total score on the QSU was calculated for each session.

Timeline Follow-Back (TLFB). The TLFB is a retrospective calendar-based measure of daily substance use, previously used and validated in cigarette smoking populations (Robinson, Sobell, Sobell, & Leo, 2014; Sobell & Sobell, 1995). Participants were provided with a calendar and asked to report number of cigarettes smoked per day for the 30 days prior to the consent session (see Appendix 6). Participants also reported cigarettes smoked for days in between each subsequent session to establish that participants had not quit smoking mid-study. Additionally, participants were asked about the frequency of use of any other tobacco products such as cigars, e-cigarettes, and chew, and about products potentially used to help quit or cut down on smoking, such as nicotine patches or nicotine gum.

Statistical Analysis

Demographic characteristics were reported. To address the possibility that other variables might affect the association between condition and time to smoking reinitiation, an exhaustive

model selection routine, the Bayesian Information Criterion (BIC; Schwarz, 1978), was used to determine which covariates should be modeled alongside the condition variable. The purpose was to determine what characteristics were associated with delay to reinitiation, statistically adjust for those, and then compare task condition (active or control implementation intentions, and active or control monetary incentives) to time to reinitiation after accounting for other characteristics. The BIC uses an exhaustive search strategy and weighs the likelihood of a model for a given set of data with a penalty term for complexity, such that a model with fewer candidate variables will be chosen over a more complex model if the predictive ability of both models is similar. The *bestglm* package in R (McLeod & Xu, 2010) was used to assess the candidate models and the model with the lowest BIC was then extended to include the variable of interest, condition. Covariates included in the model selection routine were: age, years of education, gender, income, average cigarettes smoked over the last 30 days from TLFB, QSU at start of each experimental session, and CO level at start of each experimental session.

The primary outcome measure, time to smoking reinitiation, was defined as the time of initial inhalation from the cigarette. The analysis was completed in the following two ways. First, time to smoking reinitiation was assessed using a linear mixed effects model with the *lme4* package in R (Bates, Sarkar, Bates, & Matrix, 2007) followed by a four-way analysis of variance (ANOVA) of condition (control implementation intention, control monetary incentive; control implementation intention, active monetary incentive; active implementation intention, control monetary incentive; and active implementation intention, active monetary incentive). This analysis excluded censored data points where participants did not smoke for the entire session resulting in the exclusion of 12 values from the active implementation intentions, active monetary incentive condition, 11 from the control implementation intention, active monetary

incentive condition, 8 from the active implementation intention, control monetary incentive condition, and 6 from the control implementation intention, control monetary incentive condition. No significant difference between proportion of censored values was detected between conditions ($\chi^2(3)=4.47, p=0.22$).

Effect sizes of the comparisons were reported using a variation of Cohen's d where the contrast estimates from the two conditions being compared were divided by the random effects residual standard error, which was 1,701. Conventions for interpreting these effect sizes are 0.20, 0.50, and 0.80, and are small, medium, and large, respectively (Cohen, 1992). Second, to better account for censored values, a Cox proportional hazards mixed effects regression model was also conducted using the *coxme* package in R (Therneau, 2012). The Cox mixed effects model was fit to the time to smoking reinitiation across conditions to obtain hazard ratios with adjustment for model selected covariates and random effects.

Results

The participants ($n = 36$) had the following characteristics (mean \pm sd): age (years): 40.69 \pm 10.62, education (years): 12.53 \pm 1.88, average number of cigarettes smoked per day over the past 30 days: 22.70 \pm 12.04, average QSU at start of each session: 5.01 \pm 1.37, and average CO level at start of each experimental session: 8.08 \pm 3.88. The sample included 23 males (63.89%). Income was skewed (skew = 1.17) with median monthly income of \$375 and interquartile range \$0-\$850.

The BIC model selection routine included QSU at start of each experimental session in the best fitting model. See Table 1.1 for summary of top ten selected models. QSU at start of each experimental session was included alongside condition and participant (the random effect) as predictors of time to smoking reinitiation in the mixed effects model. The within-between

analysis with Satterthwaite approximation for degrees of freedom from the ANOVA table (see Table 1.2) indicated the within-participant factor of condition was significant ($F_{(3,69.46)} = 6.55, p < 0.001$) while the between-participant factor of average QSU score before each experimental session was not significant ($F_{(1,51.75)} = 0.25, p = 0.62, ns$).

Paired t-tests using Tukey multiple comparison correction indicate significant effects in three of the six comparisons between conditions (see Table 1.3 and Figure 1.1). Effect sizes were calculated for all comparisons (see Table 1.3). The comparisons between the active implementation intention, active monetary incentive condition and active implementation intention, control monetary incentive condition ($d=0.87$) and the control implementation intention, active monetary incentive condition and control implementation intention, control monetary incentive condition ($d=0.82$) both provide an estimate of the effect size of the monetary incentive condition. The comparison between control implementation intentions, active monetary incentives and active implementation intentions, active monetary incentives ($d=0.26$) and the comparison of control implementation intentions, control monetary incentives and active implementation intentions, control monetary incentives ($d=0.21$) provide estimates of the effect size of the implementation intention intervention alone. The control implementation intention, control monetary incentive condition and active implementation intention, active monetary incentive condition ($d=1.08$) comparison gives an estimate of the combined effect of implementation intentions and monetary incentives (see Figure 1.2).

Time to smoking reinitiation was fitted with adjustment for the QSU, condition, and participant (random effect) using Cox proportional hazards mixed effects regression (see Table 1.4). Both the QSU ($\chi^2_{(df=1)}=4.86, p=0.03$) and condition ($\chi^2_{(df=3)}=64.87, p<0.001$) were significantly associated with time to smoking reinitiation. Higher QSU score was associated with

decreased time to smoking reinitiation (adjusted hazard ratio=1.39, $p=0.02$). The percent change in the hazard when the QSU increases by one unit can be estimated as $100(\exp(\beta)-1)$, indicating that for every unit increase in QSU score before a smoking resistance session, the hazard for smoking increased by an average of about 39%. Consistent with the mixed effects model, the active implementation intention, active monetary incentive condition was associated with a decrease in the hazard for smoking reinitiation of about 73.67% compared to the control implementation intentions, control monetary incentive condition (adjusted hazard ratio=0.26, $p<0.001$). The control implementation intention, active monetary incentive condition was associated with a decrease in the hazard for smoking reinitiation of about 59.25% compared to the control implementation intention, control monetary incentive condition (adjusted hazard ratio=0.41, $p<0.001$). The active implementation intention, control monetary incentive condition was associated with a non-significant decrease in the hazard for smoking reinitiation of about 32.60% compared to the control implementation intention, control monetary incentive condition (adjusted hazard ratio=0.67, $p=0.13$, *ns*).

Discussion

The current study aimed to assess the smoking resistance paradigm as an experimental analogue for behavioral smoking cessation treatments and, further, to test the ability of the laboratory model to measure the relative effectiveness of the selected treatments. Efficient and effective mediums for testing candidate treatments are necessary to identify those treatments that should be tested in more costly and large scale clinical trials. This initial assessment of a smoking resistance task as a laboratory-based analogue for behavioral interventions for smoking cessation sets the stage for future work testing additional treatments and treatment packages. The smoking resistance paradigm provides an efficient modality to examine potential interventions

and this study provides the first evidence that the smoking resistance paradigm could be used to compare relative efficacy of single and combined psychotherapeutic treatment packages.

Implementation intentions and monetary incentives have differing degrees of efficacy in clinical trials. Previous studies have found implementation intentions and monetarily-incentivized contingency management to be effective in the treatment of cigarette smoking with medium effect sizes reported for implementation intentions and medium to large effect sizes reported for monetarily-incentivized contingency management. By testing two interventions with different prior evidence of effect sizes in clinical settings, we were able to assess if this paradigm is in fact sensitive to the magnitude of the effect of the intervention. Importantly, the effect sizes observed using the laboratory versions of implementation intentions (average $d = 0.24$) and monetarily-incentivized contingency management (average $d = 0.85$) are comparable, at least in order of magnitude, to those effect sizes reported in clinical trials of these interventions ($d = 0.56$ and 0.71 , respectively). Furthermore, given the sensitivity of this laboratory-based analogue to measure the magnitude of effects of different behavioral interventions, it could also be used to evaluate treatment packages to assess for improvements in treatment efficacy when treatments are delivered in conjunction. Indeed, in the current study, implementation intentions in conjunction with monetary incentives resulted in the greatest effect size ($d = 1.08$), indicating that the combined treatment delivery may result in greater efficacy for smoking cessation than either treatment delivered alone (see Figure 1.2).

Specific to the interventions assessed in this proof of concept study, time to smoking reinitiation was significant after adjusting for unique participant characteristics and the QSU score from the start of each experimental session in the mixed effects and Cox mixed effects models. The BIC variable selection indicated QSU score as best accounting for variance, after

the penalty for model complexity, of the candidate covariates. Given the QSU is a molar measure of overall craving and urge to smoke, the relationship with delay of smoking is intuitive. Indeed, early and consistent work has found that subjective experiences of craving are associated with increased smoking behavior (Droungas, Ehrman, Childress, & O'Brien, 1995; Killen & Fortmann, 1997). The QSU was not significant in the mixed model analysis but was significant in the Cox mixed effects model. The Cox mixed effects model makes better use of the censored smoking sessions which may make it more sensitive to detecting the effect of the QSU.

In both the mixed effects model and Cox mixed effects analyses, the greatest differences were observed when the monetary incentive was present in one condition and not in the other (see Table 1.3 and Table 1.4). Consistent with laboratory findings of Mueller et al. (2009) and contingency management trials by Higgins et al. (2000) and Preston et al. (2002) these results support the use of linear and descending monetary incentives to lengthen the time to smoking reinitiation after a period of abstinence. As indicated in Figure 1.1, greater time to smoking reinitiation was evident in both the conditions that included monetary incentives when compared to those without monetary incentives.

A weakness that warrants discussion is that the sample size of the current study was only powered to detect medium to large effects and, as such, was not powered to detect differences in interventions with smaller effects. To this end, the implementation intention intervention on its own did not significantly increase time to smoking reinitiation in this proof of concept study. The effect sizes for implementation intentions alone estimated in the current study (between $d = .28$ and $.36$) are consistent with the small to medium effect sizes observed in previous clinical trials of implementation intentions (Armitage, 2007, 2008, 2016; Armitage & Arden, 2008). Future studies may wish to enroll larger samples in order to be better powered to detect small, though

potentially clinically relevant, effects. Furthermore, longer laboratory sessions may provide more sensitivity in screening candidate interventions by reducing the number of individuals that resist smoking for the entire session. Future assessments of this laboratory analogue of smoking relapse may incorporate other potentially important variables such as individual motivation to quit to see if some interventions are effective regardless of motivation or intention to quit while others may be selectively effective for individuals that are more ready for change. Finally, future studies may wish to provide follow up sessions to assess for possible prolonged effects of interventions on real world smoking behavior.

As Stevens articulated decades ago, developing measurement tools with increasing sensitivity helps to advance science (Stevens, 1946). The current study aimed to validate a smoking resistance paradigm to measure relative efficacy of various psychotherapeutic interventions and intervention packages. If future evaluations of this paradigm show continued sensitivity to treatment efficacy that approximates the effectiveness of interventions observed in clinical trials and clinics, then this type of laboratory analogue could become an early screener for candidate psychotherapeutic treatments and could save time and money in the efforts to help individuals to quit smoking.

References

- Armitage, C. J. (2007). Efficacy of a brief worksite intervention to reduce smoking: the roles of behavioral and implementation intentions. *Journal of Occupational Health Psychology, 12*(4), 376–390.
- Armitage, C. J. (2008). A volitional help sheet to encourage smoking cessation: a randomized exploratory trial. *Health Psychology, 27*(5), 557–566.
- Armitage, C. J. (2016). Evidence That Implementation Intentions Can Overcome the Effects of Smoking Habits. *Health Psychology*. <https://doi.org/10.1037/hea0000344>
- Armitage, C. J., & Arden, M. A. (2008). How useful are the stages of change for targeting interventions? Randomized test of a brief intervention to reduce smoking. *Health Psychology, 27*(6), 789–798.
- Bates, D., Sarkar, D., Bates, M. D., & Matrix, L. T. (2007). The lme4 package. *R Package Version*. Retrieved from <ftp://ftp.uni-bayreuth.de/pub/math/statlib/R/CRAN/doc/packages/lme4.pdf>
- CDC. (2011). Quitting smoking among adults--United States, 2001-2010. *MMWR. Morbidity and Mortality Weekly Report, 60*(44), 1513–1519.
- Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155–159.
- Conner, M., & Higgins, A. R. (2010). Long-term effects of implementation intentions on prevention of smoking uptake among adolescents: a cluster randomized controlled trial. *Health Psychology, 29*(5), 529–538.
- Cooney, J. L., Cooper, S., Grant, C., Sevarino, K., Krishnan-Sarin, S., Gutierrez, I. A., & Cooney, N. L. (2016). A Randomized Trial of Contingency Management for Smoking Cessation During Intensive Outpatient Alcohol Treatment. *Journal of Substance Abuse*

Treatment. <https://doi.org/10.1016/j.jsat.2016.07.002>

- Correia, C. J., & Benson, T. A. (2006). The use of contingency management to reduce cigarette smoking among college students. *Experimental and Clinical Psychopharmacology*, *14*(2), 171–179.
- Droungas, A., Ehrman, R. N., Childress, A. R., & O'Brien, C. P. (1995). Effect of smoking cues and cigarette availability on craving and smoking behavior. *Addictive Behaviors*, *20*(5), 657–673.
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191.
- Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *The American Psychologist*, *54*(7), 493.
- Higgins, S. T., & Solomon, L. J. (2016). Some Recent Developments on Financial Incentives for Smoking Cessation Among Pregnant and Newly Postpartum Women. *Current Addiction Reports*, *3*(1), 9–18.
- Higgins, S. T., Wong, C. J., Badger, G. J., Ogden, D. E., & Dantona, R. L. (2000). Contingent reinforcement increases cocaine abstinence during outpatient treatment and 1 year of follow-up. *Journal of Consulting and Clinical Psychology*, *68*(1), 64–72.
- Killen, J. D., & Fortmann, S. P. (1997). Craving is associated with smoking relapse: findings from three prospective studies. *Experimental and Clinical Psychopharmacology*, *5*(2), 137–142.
- Lussier, J. P., Heil, S. H., Mongeon, J. A., Badger, G. J., & Higgins, S. T. (2006). A meta-analysis of voucher-based reinforcement therapy for substance use disorders. *Addiction*,

101(2), 192–203.

- McKee, S. A. (2009). Developing human laboratory models of smoking lapse behavior for medication screening. *Addiction Biology*, 14(1), 99–107.
- McKee, S. A., Krishnan-Sarin, S., Shi, J., Mase, T., & O'Malley, S. S. (2006). Modeling the effect of alcohol on smoking lapse behavior. *Psychopharmacology*, 189(2), 201–210.
- McKee, S. A., Sinha, R., Weinberger, A. H., Sofuoglu, M., Harrison, E. L. R., Lavery, M., & Wanzer, J. (2011). Stress decreases the ability to resist smoking and potentiates smoking intensity and reward. *Journal of Psychopharmacology*, 25(4), 490–502.
- McKee, S. A., Weinberger, A. H., Shi, J., Tetrault, J., & Coppola, S. (2012). Developing and validating a human laboratory model to screen medications for smoking cessation. *Nicotine and Tobacco Research*, 14(11), 1362–1371.
- McLeod, A. I., & Xu, C. (2010). bestglm: Best subset GLM. URL [http://CRAN.R-Project.Org/package= Bestglm](http://CRAN.R-Project.Org/package=Bestglm). Retrieved from <http://ftp.cs.pu.edu.tw/network/CRAN/web/packages/bestglm/vignettes/bestglm.pdf>
- Mueller, E. T., Landes, R. D., Kowal, B. P., Yi, R., Stitzer, M. L., Burnett, C. A., & Bickel, W. K. (2009). Delay of smoking gratification as a laboratory model of relapse: effects of incentives for not smoking, and relationship with measures of executive function. *Behavioural Pharmacology*, 20(5-6), 461–473.
- Prendergast, M., Podus, D., Finney, J., Greenwell, L., & Roll, J. (2006). Contingency management for treatment of substance use disorders: a meta-analysis. *Addiction*, 101(11), 1546–1560.
- Preston, K. L., Umbricht, A., & Epstein, D. H. (2002). Abstinence reinforcement maintenance contingency and one-year follow-up. *Drug and Alcohol Dependence*, 67(2), 125–137.

- Ram, A., Tuten, M., & Chisolm, M. S. (2016). Cigarette Smoking Reduction in Pregnant Women With Opioid Use Disorder. *Journal of Addiction Medicine, 10*(1), 53–59.
- Robinson, S. M., Sobell, L. C., Sobell, M. B., & Leo, G. I. (2014). Reliability of the Timeline Followback for cocaine, cannabis, and cigarette use. *Psychology of Addictive Behaviors, 28*(1), 154–162.
- Roll, J. M. (2005). Assessing the feasibility of using contingency management to modify cigarette smoking by adolescents. *Journal of Applied Behavior Analysis, 38*(4), 463–467.
- Schwarz, G. (1978). Estimating the Dimension of a Model. *Annals of Statistics, 6*(2), 461–464.
- Sobell, L. C., & Sobell, M. B. (1995). Alcohol timeline followback users' manual. *Toronto, Canada: Addiction Research Foundation.*
- Stevens, S. S. (1946). On the theory of scales of measurement. Retrieved from http://psychology.okstate.edu/faculty/jgrice/psyc3214/Stevens_FourScales_1946.pdf
- Therneau, T. (2012). coxme: mixed effects Cox models. R package version 2.2-3. *Vienna: R Foundation for Statistical Computing.*
- World Health Organization. (2013). WHO Report on the Global Tobacco Epidemic. Retrieved from http://www.who.int/iris/bitstream/10665/85380/1/9789241505871_eng.pdf

Figure 1.1: Time to smoking reinitiation by condition.

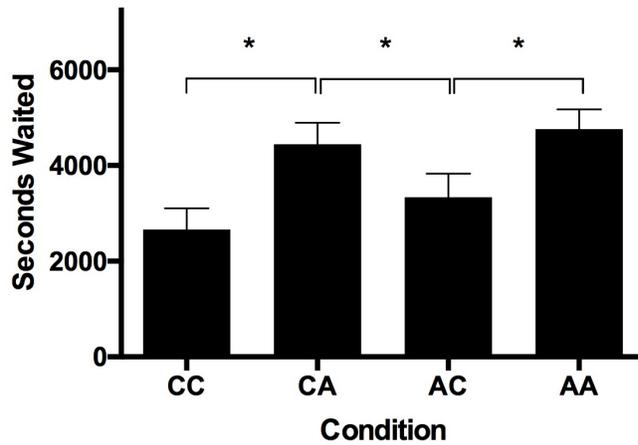


Figure 1.1: Average time to smoking reinitiation by condition. * indicates significance, CC = control implementation intentions, control monetary incentive, CA = control implementation intention, active monetary incentive, AC = active implementation intention, control monetary incentive, AA = active implementation intention, active monetary incentive.

Figure 1.2: Effect size estimates by intervention.

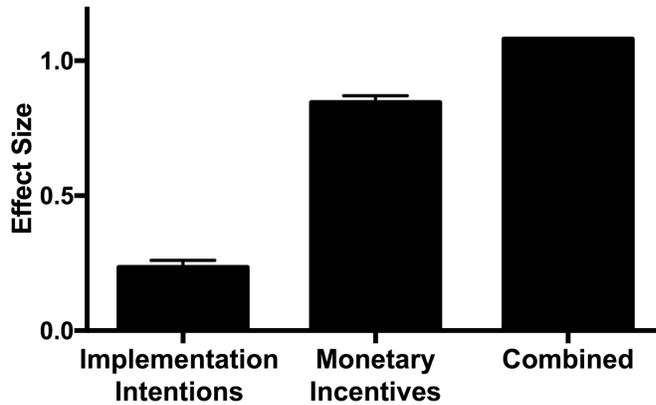


Figure 1.2: Effect size estimates by intervention (i.e., implementation intentions, monetary incentives, or the combination of both) + SEM. Effect sizes were calculated for each comparison between conditions and depicted using bar graphs. Implementation intentions and monetary incentives are comprised of the average of the two effect size estimates for each of these conditions alone and the combined plot is from the single estimate of the effects of both monetary incentives and implementation intentions on delay to smoking reinitiation.

Table 1.1: Top 10 Bayesian Information Criterion (BIC) models selected.

Model	Age	Education	Gender	Income	Avg. Cigarettes	pre-session QSU	pre-session CO	Criterion
1						+		2278.91
2					+	+		2282.87
3			+			+		2282.91
4				+		+		2283.33
5	+					+		2283.82
6						+	+	2283.85
7		+				+		2283.88
8				+		+	+	2286.44
9								2286.90
10				+	+	+		2287.28

+ indicates the candidate variable was included in the model. The lower the criterion score the better the model fit. The first model, indicating best fit, was selected to be included in the subsequent analyses.

Table 1.2: Mixed effects analysis of variance.

Analysis of Variance				
	<i>df</i>	SS	<i>F</i>	<i>p</i>
Condition	3	56885440	6.55	< 0.001
QSU	1	713135	0.25	0.62

Table 1.3: Mixed effects model comparisons between conditions.

Comparison	Estimate	Contrast SE	p-value	Effect Size
AA vs. CC	1829.4	472.2	< 0.001	1.08
AC vs. CC	357.3	448.2	0.78	0.21
CA vs. CC	1386.5	467.5	0.02	0.82
AC vs. AA	-1472.1	478.8	0.01	0.87
CA vs. AA	-442.9	489.8	0.80	0.26
CA vs. AC	1029.2	464.2	0.12	0.61

Comparisons between conditions. CC = control implementation intentions, control monetary incentive, CA = control implementation intention, active monetary incentive, AC = active implementation intention, control monetary incentive, AA = active implementation intention, active monetary incentive. Bolded values indicate significance after Tukey's multiple comparison correction.

Table 1.4: Cox mixed effects model comparisons between conditions.

Comparison	β	Adjusted		z	p
		Hazard Ratio	SE		
AA vs CC.	-1.33	0.26	0.27	-4.85	<0.001
AC vs. CC	-0.39	0.67	0.26	-1.50	0.44
CA vs. CC	-0.90	0.41	0.26	-3.40	<0.01
AC vs. AA	0.94	2.56	0.27	3.44	< 0.01
CA vs. AA	0.44	1.55	0.26	1.69	0.33
CA vs. AC	-0.50	0.60	0.25	-1.99	0.19

Comparisons between hazard ratios. CC = control implementation intentions, control monetary incentive, CA = control implementation intention, active monetary incentive, AC = active implementation intention, control monetary incentive, AA = active implementation intention, active monetary incentive.

MANUSCRIPT 2

Title

To Drink More or to Drink Less? Distinguishing between effects of implementation intentions on decisions to drink and how much to drink.

Abstract

Introduction: Alcohol drinking is a highly ingrained and automatized behavior with negative long-term health consequences. Efficient designs and effective interventions to decrease alcohol consumption are needed. A pilot intervention using implementation intentions, a behavioral intervention that links critical situations with prescribed reactions to reduce drinking, was assessed using a remote assessment and delivery framework.

Methods: Individuals with alcohol use disorder completed either an active ($n = 18$) or control ($n = 17$) implementation intention intervention and were asked to reduce alcohol consumption over the course of two weeks. Daily ecological momentary interventions of individually tailored active or control implementation intentions were delivered via text message. Alcohol consumption was assessed once daily with ecological momentary assessments (EMAs) of drinks consumed the previous day. Additionally, thrice daily biologic samples of breath alcohol content were collected with Soberlink cellular breathalyzer devices to assess reliability of self-reports.

Daily monetary earnings for providing EMAs were deposited remotely onto debit cards.

Results: Although the groups were similar on number of no drinking days, on drinking days the active implementation intentions group reduced alcohol consumption both compared to the control group and compared to baseline drinking.

Discussion: The implementation intention intervention was associated with a modest decrease in alcohol consumption on drinking days. Implementation intentions may have helped individuals with a desire to cut down or quit drinking to reduce habitual drinking behaviors by creating alternative and healthier prescribed behaviors in situations with a high likelihood of drinking.

Future studies may combine implementation intentions with other treatments to help individuals to stop or reduce alcohol consumption.

Introduction

Alcohol use disorders are major contributors of morbidity and mortality in the United States and worldwide (Rehm et al., 2009). Treatments to help individuals cut back on alcohol use may help to reduce the overall burden of disease. Reducing alcohol consumption is associated with a decrease in risk for several types of cancer, mental health problems such as depression, and heart disease (Rehm et al., 2003). Here, a pilot clinical trial using ecological momentary assessments (EMAs) and ecological momentary interventions (EMIs) was employed to test the real-world efficacy of individually tailored implementation intentions on alcohol use reductions.

Implementation intentions, or the structured if-then statements to link high risk situations with predetermined alternative healthier behaviors (Gollwitzer, 1999), are different from common action planning used in many psychosocial interventions. Specifically, implementation intentions are set in an “if-then” framework whereas action planning is typically a “when, where, and how” format. Implementation intentions increase healthy behaviors (e.g., de Vet, Oenema, & Brug, 2011/7; Guillaumie, Godin, Manderscheid, Spitz, & Muller, 2012) and accumulating evidence suggests that implementation intentions are also effective in reducing unhealthy behaviors (e.g., Armitage, 2007, 2008, 2016; Sullivan & Rothman, 2008) including alcohol consumption (Armitage, 2009a; Armitage & Arden, 2012; Norman & Wrona-Clarke, 2016).

The current study provides two improvements to build on previous research showing that implementation intentions can help to reduce drinking. First, technological and assessment advancements to improve accuracy of measurement of alcohol consumption. Second, the frequent remote collection of alcohol consumption provides the ability to disentangle the effect of implementation intentions on two processes associated with alcohol reduction: (1) abstaining from alcohol and (2) reducing amount of alcohol consumption when drinking.

Technological and assessment advancements included the use of daily self-report and thrice daily biologic EMAs. EMAs are recommended in the field of substance use research as strategies to increase accuracy and provide a finer degree of monitoring participant substance use (Shiffman, 2009). They provide frequent measurements of alcohol consumption both through self-report and biologic measurements. Indeed, previous work in alcohol users has shown a tendency to underreport alcohol use on the TLFB compared to daily drink tracking (Carney, Tennen, Affleck, Del Boca, & Kranzler, 1998; Searles, Helzer, & Walter, 2000). In the current study a combination of both self-report and biological EMAs provides a rigorous strategy to track participant drinking behaviors and to verify using biologic measures with the added benefit of collecting EMAs remotely so as to reduce barriers to participation and to increase external validity of the measurements.

Building on the innovations of EMAs, EMIs have more recently been recommended to provide continuous prompting or cueing of participants outside of the laboratory (Cohn, Hunter-Reel, Hagman, & Mitchell, 2011; Heron & Smyth, 2010). Recent work has shown initial success of EMIs, in combinations with EMAs, at reducing alcohol consumption (Riordan, Conner, Flett, & Scarf, 2015). Here, EMIs of the participant-tailored active or control implementation intention cues were provided via daily text message to participants throughout the intervention period.

The current study capitalizes on the availability of technological advancements to efficiently test low cost and easily delivered intervention to reduce the burden of alcohol consumption. The research team had three hypotheses that: (1) active implementation intentions would be associated with a greater reduction in alcohol consumption than the control implementation intention group, (2) biologic and self-reported EMAs would be correlated indicating consistency and reliability of the self-reported EMAs and, (3) participant stage of

change would be associated with alcohol consumption such that participants in the active stage of change would drink less than those in the contemplation or precontemplation stage regardless of treatment condition.

Methods

Participants completed either an active or control implementation intention intervention. From the original sample (n=36), one participant in the control condition was excluded because of self-reported deliberate and inaccurate responding. To gain a representative sample, participants were recruited in a range of social and working settings, including flyers, online advertisements, and referrals in Roanoke, Virginia and surrounding areas. Eligible participants (a) were between the ages of 18 and 65; (b) met criteria for alcohol use disorder, as defined by three or more symptom criteria based on the DSM-5 (American Psychiatric Association, 2013); and (c) reported a desire to cut down or quit drinking. Individuals who were pregnant or lactating, taking over-the-counter medicines containing alcohol, or had immediate plans to move away from the area were excluded. Additionally, for safety purposes a score of 23 or greater on the Alcohol Withdrawal Symptom Checklist (a score indicative of the requirement for medical oversight during alcohol detoxification, see Pittman et al., 2007; see Appendix 7) was exclusionary to avoid participants cutting down on alcohol use if medical management was likely to be needed. These participants were offered resources for withdrawal symptoms and provided contact information for local medical facilities.

Procedures

The Virginia Polytechnic Institute and State University Institutional Review Board approved all methods and protocols in the current study. All participants provided informed consent (see Appendix 8). Participants were invited to attend four sessions, including a baseline

(consent), intervention, post-intervention, and 1-month follow-up assessment. Participants were allocated to active ($n = 18$) or control ($n = 17$) implementation intention treatment condition. Participants were assigned to groups with a variation of the Frane (1998) procedure wherein new participants were allocated to the group that yielded the least overall significant difference across three pre-selected variables (i.e. average daily drinking during the baseline period, Treatment Services Review (McLellan, Alterman, Cacciola, Metzger, & O'Brien, 1992; see Appendix 9) total score, and number of years drinking alcohol) with a 0.8 probability, which left an element of random assignment. Stated differently, this means that any given participant had a 20% chance of random assignment and an 80% chance of being allocated to the group that minimized differences across the pre-selected variables.

Baseline period. During a baseline assessment session participants completed the Readiness to Change Questionnaire (Nick Heather, Gold, & Rollnick, 1991) and Alcohol Use Disorder Identification Test (AUDIT; J. B. Saunders, Aasland, Babor, de la Fuente, & Grant, 1993).

Readiness to Change Questionnaire. This measure is a 12-item instrument wherein participants indicated their level of agreement (-2=strongly disagree; +2=strongly agree) on questions about how they feel about current drinking habits (see Appendix 11). Previously, factor analysis of the questions have divided them such that four questions contribute to each of the stages of changes considered in this questionnaire (precontemplation, contemplation, or action). The participant was considered to be in the stage of change that had the highest score at the end of the measure.

AUDIT. The AUDIT is a 10-item self-report questionnaire developed by the World Health Organization and assesses alcohol use, drinking behaviors, and problems related to

alcohol use (John B. Saunders, Aasland, Babor, de La Fuente, & Grant, 1993; see Appendix 10). AUDIT scores range from 0 to 40 where 0 indicates no alcohol use.

Following this session, participants were instructed to drink as usual and were prompted via text message to give daily self-reports of previous-day drinking for one week. If participants did not have a cell phone or did not want to use a personal cell phone, then one was provided for use throughout the study. No intervention was implemented during the baseline period. Reports of any alcohol consumption on at least two of the baseline days indicated eligibility to continue.

Intervention period. After completion of the baseline period, participants were assigned to a treatment condition, completed the active or control implementation intentions interventions worksheet, and were asked to try to cut back on drinking over the following two weeks.

Implementation intentions. Proposed by Gollwitzer (1999), implementation intentions are an automated method aimed to decrease disparity between goal setting and attainment. This method first seeks to identify a critical risky situation (e.g., attending a party where others are drinking) and then to develop automated appropriate responses (e.g., avoiding friends who are drinking or attending meetings with others who are attempting to remain abstinent). Consistent with implementation intentions cues used by Armitage and Arden (2012), the cues were adapted from the transtheoretical model (Prochaska & Diclemente, 1983) and are recommended for use in the planning intervention literature (Armitage, 2009b). The implementation intention worksheets consisted of a list of 24 critical risky situations (e.g., “I am tempted to drink when things are not going my way and I am frustrated”) followed by a list of 24 possible appropriate responses (e.g., “I will stop to think about how my drinking is hurting people around me”).

The active group followed an “if-then” format, wherein participants were asked to pick at least three critical situations where they are tempted to drink and to link them with appropriate

responses that they believe might help reduce drinking by drawing a line between those applicable to them. Following this, they were asked to pick the three linked situations and behaviors that they believed would most helpful to them and write them in sentence form, starting with an “if” in front of the critical situation, and a “then” in front of the response (e.g., “If I am tempted to drink when there are arguments and conflicts, then I will put things around my home that remind me not to drink”; see Appendix 12).

Consistent with the methods of Armitage and Arden (2012), participants in the control group were asked to check critical situations and responses without connecting or drawing any line between the two. Participants were then asked to pick the three they believed would be most helpful to them to help them cut down on drinking and to write in sentence form (e.g., “I am tempted to drink when I am having fun with friends”; see Appendix 13).

Self-reported EMAs. Daily self-reports of previous-day drinking were collected throughout the baseline and intervention period. Participants were compensated \$1 that was immediately and electronically transferred to a reloadable debit card (<https://greenphire.com/>) for providing these daily reports regardless of alcohol consumption.

Biologic EMAs. During an in-lab session, participants were instructed on how to use the Soberlink breathalyzer device (www.soberlink.net) and selected thrice daily timepoints for submitting the Soberlink breathalyzer samples over a two-week intervention period, including a morning, afternoon, and evening time point that were spaced at least six hours apart. This precise fuel cell breathalyzer is compact and photographs the user mid-submission, making it ideal to collect biologic samples while limiting in-person contact during the two-week intervention phase. After each Soberlink submission, the device automatically uploads the breathalyzer results and picture of the user to a centralized, secure website made available to research staff.

Participants continued to report drinks consumed the previous day through text message. To encourage treatment compliance, participants were compensated \$1 for each on-time breathalyzer submissions regardless of BrAC. Between the self-report and biologic EMAs, participants could earn up to \$4 per day, deposited daily on the study debit card.

Daily EMIs. Once daily EMIs were texted to participants throughout the intervention period. Each daily EMI was one of the participant's three selected tailored implementation intention cue (active or control) provided verbatim as the participant wrote the cue during the intervention session.

Post-intervention session. The intervention phase was followed by post-intervention session where participants were compensated \$50 for successful return of study materials including the Soberlink device and a study cell phone if used. Participants also completed a brief Treatment Acceptability questionnaire (see supplemental materials).

Follow-up period. Participants were invited back for a one-month follow-up session that could fall anywhere from 3-5 weeks following the completion of the intervention period. During the follow-up session, participants completed a timeline followback (TLFB) of daily alcohol consumption since completion of the intervention period (Sobell & Sobell, 1995; see Appendix 14).

Statistical Methods

The AUDIT scores and demographic characteristics between treatment conditions were compared using two sample t-tests and Chi-square tests for continuous and categorical variables, respectively.

Implementation intentions compared to control intervention. The effect of implementation intentions on alcohol consumption was evaluated. Since alcohol consumption

showed many days of zero drinking, a two-step hurdle mixed model was used (Atkins, Baldwin, Zheng, Gallop, & Neighbors, 2013). First, a mixed effects logistic regression was used to model the probability a participant would drink on a given day. Second, a gamma mixed regression was fit to model the number of drinks in a day that a participant consumed given they consumed alcohol. The hurdle mixed model was:

$$\log(p/(1-p))=b_{0l}+b_{1l}\text{Condition} +b_{2l}\text{Time point} +b_{3l}\text{Condition*Time point} + b_{4l}\text{Participant} + e_{0li}$$

$$\log(E[\text{drinks}_{ti} | \text{drinks} > 0])=b_{0g}+b_{1g}\text{Condition} +b_{2g}\text{Time point} +b_{3g}\text{Condition*Time point} + b_{4g}\text{Participant} + e_{0gi}$$

where i is the index of the participant, t is the day in the study, and l and g indicate parameters from the logistic and gamma models, respectively, and p is the proportion of drinking days. Condition and time point are fixed effects and participant ID is a random effect. One advantage of hurdle models is that they provide a straightforward interpretation as all zero values are modeled solely in the logistic regression component. While the overall fit of hurdle models and zero-inflated models are frequently similar (Madden, 2008), this approach allows for two distributional characteristics to be modeled separately, (1) the probability that an individual will drink or not drink on a given day, and (2) how many drinks an individual will consume if that individual drinks. Note, a zero-inflated poisson regression was not appropriate because on several days and by several participants non-integer values for number of drinks (e.g., 3.5 drinks) were reported. The hurdle model was implemented using the *glmmadmb* package (Skaug, Nielsen, Magnusson, & Bolker, 2013) which allows for mixed random effects and zero inflation. A binomial distribution was used to model the logistic regression and a Gamma distribution was

used with the zero-truncated discrete probability distribution function. Model-adjusted least square means are reported for significant variables in the model.

Correlations between self-report and biologic EMAs. Reliability of EMAs of daily drinks consumed were biologically verified against the average of the three daily remote breath alcohol measurements using Pearson product-moment correlations. A two-sample *t*-test of the participant correlations between self-report and biologic EMAs was then used to compare between treatment conditions to ensure consistent reporting across groups.

Alcohol consumption at one-month follow-up. To look at possible persistence of effects of the intervention on drinking across time points, including at one-month follow-up a mixed model was used. The mixed model adjusted for time point (baseline, intervention, follow-up) and treatment condition (active, control) to assess for changes in average reported drinking (collected using self-reported daily EMAs for baseline and intervention and average daily drinks from the TLFB at follow-up). Overall model effects in addition to model-adjusted means and standard errors are reported.

Treatment acceptability. Descriptive statistics of treatment acceptability questions are reported for both treatment conditions. Independent samples *t*-tests were used to compare between treatment groups.

Influence of stages of change on alcohol consumption. Consistent with the above two-step hurdle regression model, a mixed effects logistic regression and Gamma distribution regression were employed to look for effects of the Readiness for Change (Nick Heather et al., 1991) stages of change on drinking from baseline to intervention. Similar to the model used above, the hurdle mixed model used was:

$$\log(p/(1-p))=b_{0l}+b_{1l}\text{Stage of Change} +b_{2l}\text{Time point} +b_{3l}\text{Stage of Change*Time point} + b_{4l}\text{Participant} + e_{0li}$$

$$\log(E[\text{drinks}_{ti} | \text{drinks} > 0])=b_{0g}+b_{1g}\text{Stage of Change} +b_{2g}\text{Time point} +b_{3g}\text{Stage of Change*Time point} + b_{4g}\text{Participant} + e_{0gi}$$

where i is the index of the participant, t is the day in the study, and l and g indicate parameters from the logistic and gamma models, respectively, and p is the proportion of drinking days, as above.

Results

AUDIT scores and demographic characteristics were compared between the treatment conditions (Table 2.1). Two-sample t -tests indicate that AUDIT score ($t=-0.52, p=0.61$), age ($t=-0.32, p=0.75$), education ($t=-0.47, p=0.64$), and income ($t=0.09, p=0.93$) did not differ between the treatment and control groups. Similarly, Chi-square test of independence indicates the active and control condition did not significantly differ with regard to gender ($X^2=0.69, p=0.41$) or race ($X^2=0.04, p=0.84$).

Implementation Intentions Compared to Control Intervention

To model the effect of treatment on the number of daily drinks, a hurdle (two-stage) model was implemented. First, a mixed effects logistic regression was used to model if a participant consumed alcohol or did not consume alcohol on a given day (Table 2.2). Figure 2.1 describes the percent of days in which alcohol was consumed for each group. The time point (i.e., baseline or intervention) was significant in the logistic regression model ($z=2.02, p=0.04$), indicating that during the baseline period participants were more likely to have days where alcohol was consumed than during the intervention period (OR=1.98, 95% CI [1.02,3.84]).

Second, a Gamma mixed effects regression was used to model the number of drinks consumed for days when drinking was observed ($r^2=.44$; Table 2.2). This model indicated a significant interaction between condition and time point ($z=2.23$, $p=0.03$). During the baseline period, control participants consumed a model-adjusted average of 6.17 (SE=0.97) drinks per day and active participants consumed an average of 5.36 (SE=1.48) drinks per day. In the intervention period, control participants consumed a model-adjusted average of 5.88 (SE=0.86) drinks per day while active participants consumed an average of 4.27 (SE=1.10) drinks per day (see Figure 2.2).

Correlations between Self-report and Biologic EMAs

Pearson product-moment correlation between each average daily BrAC and daily ecological momentary assessment of previous day drinks during the intervention period showed a positive significant correlation ($r=0.34$, $t=7.44$, $p<0.001$). The correlations between self-reported drinks and BrAC were not significantly different between conditions ($t=-1.29$, $p=0.21$).

Alcohol Consumption at One-month Follow-up

Alcohol consumption, reported as average drinks per day that were collected using the TLFB from the end of the intervention period to the one-month follow-up session. Average drinks across time points (baseline, intervention, and follow-up) were investigated to see if reductions in alcohol consumption persisted beyond the intervention period. Due to attrition, only 27 (active = 12, control = 15) of the 35 participants from the previous analyses completed the follow-up session (attrition rate=22.86%). The mixed regression modeled average drinks across fixed effects of time point and treatment conditions as well as random effects of participant. The average drinks during the one-month follow-up period were significantly less than average drinks during the baseline period ($z=-2.79$, $p<0.01$). Average drinks during the

intervention period were not significantly less than average drinks during the baseline period ($z=-1.73, p=0.08, ns$). No significant difference of treatment condition across average reported drinks was detected ($z=-0.57, p=0.57, ns$). The overall model was significant ($F(2,24)=12.77, p<0.001, R^2=0.52$). Model-adjusted alcohol consumption by condition (active, control) and time point (baseline, intervention, follow-up) are shown in Figure 2.3.

Treatment Acceptability

Average responses to questions about treatment acceptability (see Supplemental Materials 2) are provided in Table 2.3. No significant differences were detected between treatment conditions using two-samples t-test for any of the adherence questions (test statistics are also reported in Table 2.3).

Influence of Stages of Change on Alcohol Consumption

In a secondary analysis, the pre-intervention Stage of Change from the Readiness for Change questionnaire (Nick Heather et al., 1991) was evaluated with regard to alcohol consumption in a two-step regression model (see Table 2.4). Note, one participant was excluded from these analyses because they did not complete the Readiness for Change Questionnaire, thereby resulting in 17 active treatment and 17 control treatment participants. Also note, the participants were not evenly distributed across stage of change categories and this may limit the interpretation of the following results. In the logistic mixed effect regression, participants in the precontemplation and contemplation stages of change had significantly ($z=2.03, p=0.04; z=2.46, p=0.01$, respectively) more drinking days than participants in the action stage of change. In the mixed effect Gamma regression ($r^2=.43$), participants in the precontemplation ($z=2.29, p=0.02$) and contemplation ($z=3.06, p<0.01$) stage of change were also associated with significantly more alcohol consumption compared on days where alcohol was consumed compared to participants

in the active stage of change. No significant effects were detected in either the logistic or Gamma regression for time point (baseline or intervention) or the time point by stage of change interaction. Model-adjusted average drinks by stage of change (precontemplation, contemplation, or action) and time point (baseline or intervention) are shown in Figure 2.4.

Discussion

This initial examination of a predominantly remote implementation intention treatment for alcohol use disorders capitalizes on technology to achieve frequent assessments of alcohol use and deliver intervention prompts repeatedly throughout treatment. Moreover, the frequent EMAs of daily drinking provide the unique ability to distinguish between days of abstinence and days with drinking in order to identify more precisely the drinking processes influences by implementation intentions. Seven primary findings are discussed below.

First, participants in the active group reduced alcohol consumption more than the control group on drinking days. Two components of alcohol use were considered: (1) the amount of alcohol consumed on days when drinking was reported was evaluated using the mixed model Gamma regression and (2) the decision to drink or not to drink on a given day was investigated using the mixed model logistic regression. The active implementation intention treatment was associated with a significant reduction in drinking. The model-adjusted average reduction in alcohol consumption from baseline to intervention was 1.61 drinks per day in the active implementation intention treatment condition compared to an average reduction of 0.80 drinks per days in the control condition (see Figure 2.2). The active implementation intention treatment was associated with a two-fold reduction in alcohol consumed on days when individuals made the choice to drink and draws attention to the importance of forming and then linking the if-then

statements that constitute implementation intentions above and beyond just identifying critical situations and responses in the absence of linking these plans together.

Second, the intervention period was associated with significantly more days where participants made the choice to abstain from drinking altogether, regardless of treatment condition (see Figure 2.1). The logistic regression showed a significant increase in no drinking days during the intervention period compared to the baseline period across treatment groups. The overall reduction in drinking days compared to baseline may be due to all participants: (1) being asked to try not to drink during the intervention period, (2) completing worksheets with critical situations and responses related to drinking (see Supplementary Materials 1), (3) being prompted for daily self-report and thrice daily biologic EMAs of drinking, and (4) receiving daily EMIs of (active or control) tailored cues.

Third, the use of technologically-advanced methods are a strength of the current study. The EMAs and EMIs were used successfully throughout the study and the correlation between self-report and BrAC EMAs indicates positive significant concordance between the self-report and biologic assessment measures. Moreover, the use of EMAs and EMIs to remotely assess and intervene reduce participant burden, especially for those who live in rural areas where health care may not be easily accessible. In addition, the Soberlink breathalyzer that was used to schedule and collect thrice daily biologic EMAs includes a number of technological advancements to facilitate remote breath samples of alcohol use and verify the identity of the user.

Fourth, participants that completed the follow-up session showed a significant reduction in alcohol consumption that was maintained across both treatment conditions compared to baseline consumption (see Figure 2.3). One limitation of the follow-up data, in contrast to the baseline and intervention drinking data, was that follow-up data was collected using the TLFB as

opposed to daily EMAs. Prior evidence indicates that TLFB is associated with slight underreporting of use in alcohol users compared to EMAs (Carney et al., 1998; Searles et al., 2000) and the difference in measurement procedures may account for the observed reduction in alcohol consumption.

Fifth, participants recognized the convenience of the study design and rated the use of cell phones for study communication, the use of the Soberlink device for breath alcohol samples, and the use of the debit card system to remit payments above three on a scale from one to four (see Table 2.3). Furthermore, no differences in participant acceptability were observed between the active and control treatment groups. This finding is consistent with the study's aim to provide highly similar experiences for both active and control participants with the one exception of active participants linking the critical situations and alternative responses into if-then statements. The similarity in participant experiences between conditions as observed through the treatment acceptability responses lends support to the implementation intention manipulation being the cause for the reduction in alcohol consumption observed in the active implementation intention condition.

Sixth, stage of change, as determined with the Readiness to Change questionnaire (Nick Heather et al., 1991), showed a significant effect both on days of abstinence and on amount of alcohol consumed on drinking days (see Table 2.4 and Figure 2.4). The active stage of change was associated with less drinking, regardless of condition, than the contemplation and precontemplation stage. However, while these findings are consistent with previous research (N. Heather, Rollnick, & Bell, 1993; Rollnick, Heather, Gold, & Hall, 1992; Vik, Culbertson, & Sellers, 2000), in this pilot trial the distribution of stages to change are uneven

(precontemplation=2, contemplation=29, action=3) and these results should be interpreted with caution.

Finally, several weaknesses of the current study warrant mentioning. This study was conducted both as a proof of concept using biologic and self-report EMAs and daily EMIs to examine interventions and as a test of an implementation intention intervention to reduce alcohol use. As such, the sample size is small and some analyses, especially the stage of change hurdle model do not include adequate sample size to confidently speak to the relationship between stage of change and drinking behaviors. Another weakness is the lack of intent to treat analysis of the one-month follow-up drinking assessment. The follow-up drinking may be underestimated both because, as mentioned previously, this time point was collected using the TLFB measure and also because nearly a quarter of participants did not return for this follow-up session. Future studies may wish to continue to assess drinking using EMAs following the intervention period to better capture persistence in intervention effects.

The current report provides evidence of the efficacy of implementation intentions to reduce alcohol consumption on drinking days. In addition, this study exemplifies the merits of using novel technology to collect frequent biologic assessments and daily self-reports of drinking in conjunction in daily intervention prompts. Future, larger scale studies using EMAs and EMIs will help to move the field of planning-based interventions forward as established strategies to reduce health risk behaviors.

References

- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. Arlington: American Psychiatric Publishing. Retrieved from <http://www.lsw2014.org/StanMcCrackenDSMV.pdf>
- Armitage, C. J. (2007). Efficacy of a brief worksite intervention to reduce smoking: the roles of behavioral and implementation intentions. *Journal of Occupational Health Psychology, 12*(4), 376–390.
- Armitage, C. J. (2008). A volitional help sheet to encourage smoking cessation: a randomized exploratory trial. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association, 27*(5), 557–566.
- Armitage, C. J. (2009a). Effectiveness of experimenter-provided and self-generated implementation intentions to reduce alcohol consumption in a sample of the general population: A randomized exploratory trial. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association, 28*(5), 545.
- Armitage, C. J. (2009b). Is there utility in the transtheoretical model? *British Journal of Health Psychology, 14*(2), 195–210.
- Armitage, C. J. (2016). Evidence That Implementation Intentions Can Overcome the Effects of Smoking Habits. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*. <https://doi.org/10.1037/hea0000344>
- Armitage, C. J., & Arden, M. A. (2012). A volitional help sheet to reduce alcohol consumption in the general population: a field experiment. *Prevention Science: The Official Journal of the Society for Prevention Research, 13*(6), 635–643.

- Atkins, D. C., Baldwin, S. A., Zheng, C., Gallop, R. J., & Neighbors, C. (2013). A tutorial on count regression and zero-altered count models for longitudinal substance use data. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*, 27(1), 166–177.
- Carney, M. A., Tennen, H., Affleck, G., Del Boca, F. K., & Kranzler, H. R. (1998). Levels and patterns of alcohol consumption using timeline follow-back, daily diaries and real-time“ electronic interviews.” *Journal of Studies on Alcohol*, 59(4), 447–454.
- Cohn, A. M., Hunter-Reel, D., Hagman, B. T., & 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.
- de Vet, E., Oenema, A., & Brug, J. (2011/7). More or better: Do the number and specificity of implementation intentions matter in increasing physical activity? *Psychology of Sport and Exercise*, 12(4), 471–477.
- Frane, J. W. (1998). A method of biased coin randomization, its implementation, and its validation. *Drug Information Journal*, 32(2), 423–432.
- Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *The American Psychologist*, 54(7), 493.
- Guillaumie, L., Godin, G., Manderscheid, J.-C., Spitz, E., & Muller, L. (2012). The impact of self-efficacy and implementation intentions-based interventions on fruit and vegetable intake among adults. *Psychology & Health*, 27(1), 30–50.
- Heather, N., Gold, R., & Rollnick, S. (1991). *Readiness to change questionnaire: User’s manual*. National Drug and Alcohol Research Centre, University of New South Wales Kensington, Australia.

- Heather, N., Rollnick, S., & Bell, A. (1993). Predictive validity of the Readiness to Change Questionnaire. *Addiction*, *88*(12), 1667–1677.
- Heron, K. E., & Smyth, J. M. (2010). Ecological momentary interventions: incorporating mobile technology into psychosocial and health behaviour treatments. *British Journal of Health Psychology*, *15*(Pt 1), 1–39.
- Madden, D. (2008). Sample selection versus two-part models revisited: the case of female smoking and drinking. *Journal of Health Economics*, *27*(2), 300–307.
- McLellan, A. T., Alterman, A. I., Cacciola, J., Metzger, D., & O'Brien, C. P. (1992). A New Measure of Substance Abuse Treatment Initial Studies of the Treatment Services Review. *The Journal of Nervous and Mental Disease*, *180*(2), 101.
- Norman, P., & Wrona-Clarke, A. (2016). Combining self-affirmation and implementation intentions to reduce heavy episodic drinking in university students. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*, *30*(4), 434–441.
- Pittman, B., Gueorguieva, R., Krupitsky, E., Rudenko, A. A., Flannery, B. A., & Krystal, J. H. (2007). Multidimensionality of the Alcohol Withdrawal Symptom Checklist: A Factor Analysis of the Alcohol Withdrawal Symptom Checklist and CIWA-Ar. *Alcoholism, Clinical and Experimental Research*, *31*(4), 612–618.
- Procheska, J. O., & Diclemante, C. C. (1983). Stage of processes of self change of smoking: Toward an integrative model. *Journal of Consulting and Clinical Psychology*, *56*, 520–528.
- Rehm, J., Mathers, C., Popova, S., Thavorncharoensap, M., Teerawattananon, Y., & Patra, J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use

- and alcohol-use disorders. *The Lancet*, 373(9682), 2223–2233.
- Rehm, J., Room, R., Graham, K., Monteiro, M., Gmel, G., & Sempos, C. T. (2003). The relationship of average volume of alcohol consumption and patterns of drinking to burden of disease: an overview. *Addiction*, 98(9), 1209–1228.
- Riordan, B. C., Conner, T. S., Flett, J. A. M., & Scarf, D. (2015). A Brief Orientation Week Ecological Momentary Intervention to Reduce University Student Alcohol Consumption. *Journal of Studies on Alcohol and Drugs*, 76(4), 525–529.
- Rollnick, S., Heather, N., Gold, R., & Hall, W. (1992). Development of a short “readiness to change” questionnaire for use in brief, opportunistic interventions among excessive drinkers. *Addiction*, 87(5), 743–754.
- Saunders, J. B., Aasland, O. G., Babor, T. F., de la Fuente, J. R., & Grant, M. (1993). Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption-II. *Addiction*, 88(6), 791–804.
- Saunders, J. B., Aasland, O. G., Babor, T. F., de La Fuente, J. R., & Grant, M. (1993). Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption-II. *Addiction*, 88(6), 791–804.
- Searles, J. S., Helzer, J. E., & Walter, D. E. (2000). Comparison of drinking patterns measured by daily reports and timeline follow back. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors*, 14(3), 277–286.
- Shiffman, S. (2009). Ecological momentary assessment (EMA) in studies of substance use. *Psychological Assessment*, 21(4), 486–497.

Skaug, H., Nielsen, A., Magnusson, A., & Bolker, B. (2013). Glmmadmb package (0.6. 7.1 edn).

See [Http://glmmadmb.R-Forge.R-Project.Org](http://glmmadmb.R-Forge.R-Project.Org).

Sobell, L. C., & Sobell, M. B. (1995). Alcohol timeline followback users' manual. *Toronto,*

Canada: Addiction Research Foundation.

Sullivan, H. W., & Rothman, A. J. (2008). When planning is needed: Implementation intentions

and attainment of approach versus avoidance health goals. *Health Psychology: Official*

Journal of the Division of Health Psychology, American Psychological Association,

27(4), 438–444.

Vik, P. W., Culbertson, K. A., & Sellers, K. (2000). Readiness to change drinking among heavy-

drinking college students. *Journal of Studies on Alcohol, 61(5), 674–680.*

Figures

Figure 2.1: Percent days with no drinking by condition and time.

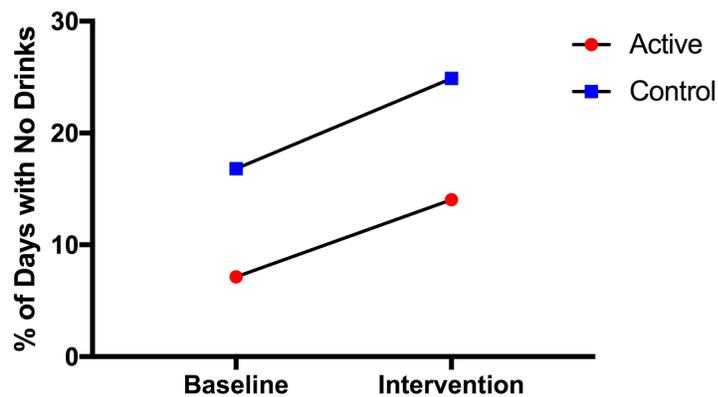


Figure 2.1: The percent of abstinent days, as assessed through daily self-report of alcohol consumption, are shown for both conditions during the baseline and intervention period.

Figure 2.2: Change in drinking on days where alcohol was consumed.

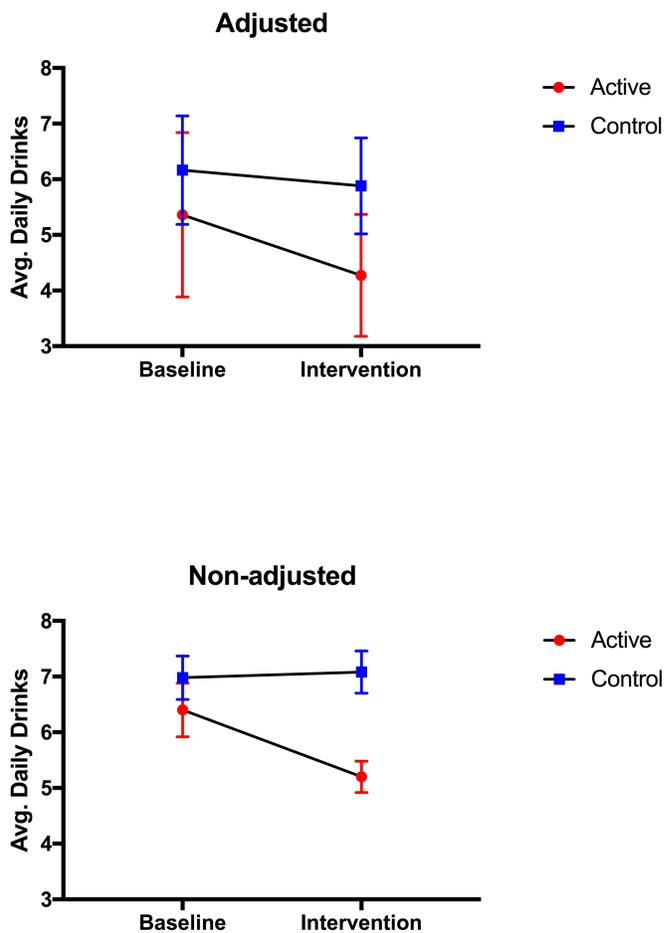
Figure 2.2: Model-adjusted (top panel) and unadjusted (bottom panel) average drinks \pm SE from baseline to intervention period by condition on days when drinking occurred.

Figure 2.3: Alcohol consumption by treatment condition across all time points.

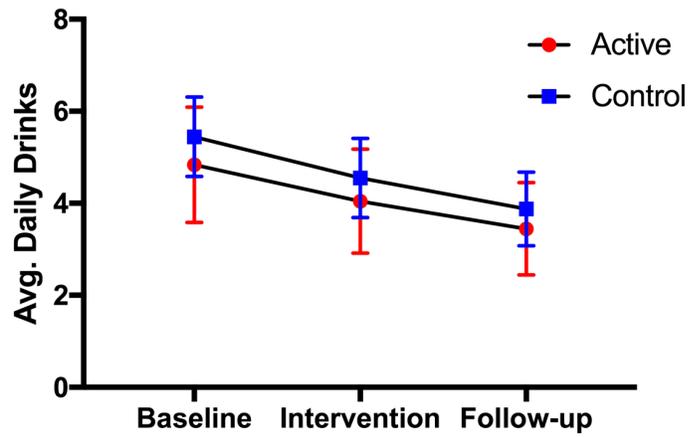


Figure 2.3: Model-adjusted average drinks by time point and condition. Note: Only participants that completed all time points (n=27) were included in this analysis and figure.

Figure 2.4: Stage of Change by time point.

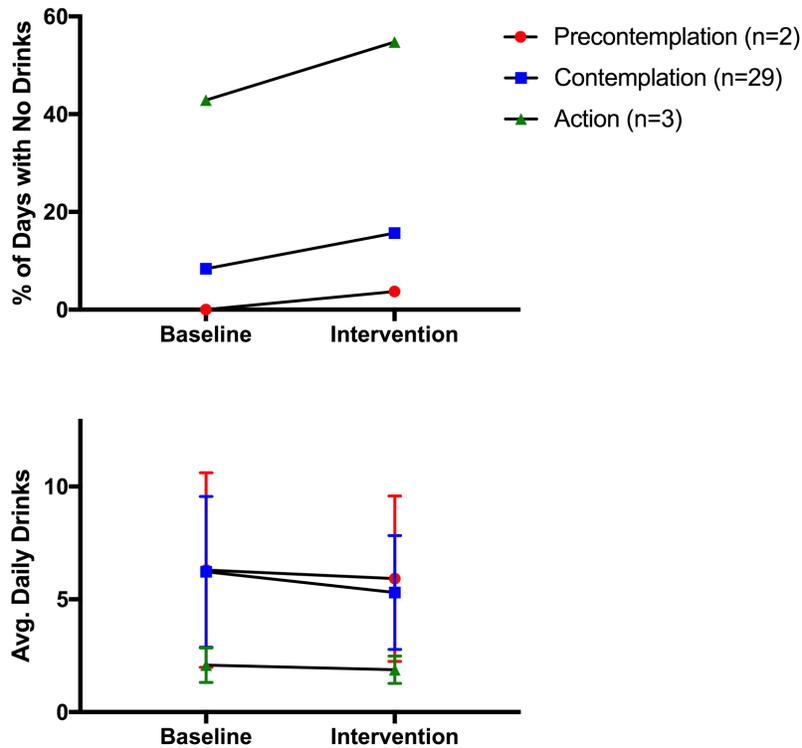


Figure 2.4: Top panel shows percent of days abstaining from alcohol by stage of change and time point. Bottom panel depicts model-adjusted mean \pm SE on days when drinking was reported by stage of change and time point.

Tables

Table 2.1: Demographic characteristics by treatment condition

	Active	Control
AUDIT	18.78 (7.42)	20.00 (6.54)
Age	38.89 (11.58)	40.24 (12.91)
Education (in years)	12.94 (2.18)	13.35 (2.85)
Gender (% male)	66.6	52.9
Income	1235.5 (1574.9)	1186.06 (1586.05)
Race		
Black	8	7
White	10	10

AUDIT total score, age, education and income show mean (standard deviation). Gender shows percent of sample that is male. Race shows number of individuals reporting as black or white, no individuals reported being from other racial groups.

Table 2.2: Hurdle regression of primary outcome measures.

	B	SE	z	p
Mixed Model Logistic Regression				
Condition	1.30	0.85	1.52	0.13
Timepoint	0.68	0.34	2.02	0.04
Condition x Timepoint	0.28	0.59	0.49	0.62
Gamma Mixed Model Regression				
Condition	-0.32	0.20	-1.56	0.12
Timepoint	0.05	0.06	0.80	0.42
Condition x Timepoint	0.18	0.08	2.23	0.03

Table 2.3. Treatment acceptability questions and average responses by condition.

Questions	Active	Control	<i>t</i>	<i>p</i>
How satisfied are you with the ability of this treatment to help you reduce your alcohol use?	2.78 (0.94)	2.59 (1.18)	0.52	0.60
How difficult is it to adhere to the scheduled requirements?	3.11 (0.90)	3.00 (1.12)	0.32	0.75
How convenient is it to use the SOBERLINK device?	3.44 (0.78)	3.82 (0.39)	1.82	0.08
How convenient is it to use a cell phone to communicate with us?	3.67 (0.77)	3.76 (0.56)	0.43	0.67
How convenient is it to use the debit card system to receive payments?	3.61 (0.98)	3.88 (0.33)	1.11	0.28
Taking all things into account, how satisfied are you with this treatment?	3.17 (0.92)	3.18 (0.95)	0.03	0.98

Average responses and standard deviations are reported for each condition in addition to *t*-value and *p*-values. Treatment acceptability questions were rated by participants after completion of the intervention session on a scale from 1 to 4 where 1 = very [dissatisfied, difficult, inconvenient] and 4 = very [satisfied, easy, convenient].

Table 2.4: Hurdle regression of Stages of Change outcome measures.

	B	SE	z	p
Mixed Model Logistic Regression				
Time point	0.55	0.58	0.95	0.34
Precontemplation Stage of Change	4.33	2.13	2.03	0.04
Contemplation Stage of Change	2.98	1.21	2.46	0.01
Precontemplation Stage of Change x Time point	9.62	212.44	0.05	0.60
Contemplation Stage of Change x Time point	0.35	0.67	0.05	0.96
Gamma Mixed Model Regression				
Time point	0.10	0.17	0.57	0.57
Precontemplation Stage of Change	1.14	0.50	2.29	0.02
Contemplation Stage of Change	1.03	0.34	3.06	<0.01
Precontemplation Stage of Change x Timepoint	-0.04	0.23	-0.16	0.87
Contemplation Stage of Change x Timepoint	0.06	0.18	0.33	0.74

Supplemental Materials

Supplemental Material 1: Implementation intentions critical situations and responses that were presented to both active and control treatment condition participants.

Critical Situations

I am tempted to drink when I am excited
 I am tempted to drink when I am with others who are drinking a lot
 I am tempted to drink when things are not going my way I am frustrated
 I am tempted to drink when I am really happy
 I am tempted to drink when my friends push me to keep up with their drinking
 I am tempted to drink when I am feeling depressed
 I am tempted to drink when I am having fun with friends
 I am tempted to drink when other people encourage me to have a drink
 I am tempted to drink when I am very anxious and stressed
 I am tempted to drink when I am offered a drink by someone
 I am tempted to drink when I am feeling angry
 I am tempted to drink when things are going really well for me
 I am tempted to drink when I go to a party where there is a lot of drinking
 I am tempted to drink when there are drinking games going on
 I am tempted to drink when I am with someone I am attracted to
 I am tempted to drink when I am with others who are focusing on drinking
 I am tempted to drink when I am feeling shy
 I am tempted to drink when I feel like keeping up with my friends drinking
 I am tempted to drink when I am nervous about being socially outgoing
 I am tempted to drink when I am concerned about someone
 I am tempted to drink when I see others drinking at a bar or at a party
 I am tempted to drink when I am very worried
 I am tempted to drink when I have the urge to try just one drink to see what happens
 I am tempted to drink when I dream about taking a drink

Responses

I will keep things around my home or work that remind me not to drink
 I will engage in some physical activity when I get the urge to drink
 I will do something nice for myself for making efforts to change
 I will talk with at least one special person about my drinking experiences
 I will tell myself that I can choose to change or not to change
 I will stop to think about how my drinking is hurting people around me
 I will consider that feeling good about myself includes my drinking behavior

I will talk to someone in my life that helps me to face my drinking problem
I will remove things from my home or work that remind me of drinking
I will calm myself when I get the urge to drink
I will avoid people who encourage drinking
I will avoid situations that encourage me to drink
I will try to think about other things when I begin to think about drinking
I will make myself aware that I can choose to overcome my drinking if I will want to
I will do something else instead of drinking when I need to deal with tension
I will tell myself that if I try hard enough I can keep from drinking
I will leave places where people are drinking
I will stay away from places I generally associated with my drinking
I will spend time with people who reward me for not drinking
I will attend meetings to express how emotionally destructive drinking is in my life
I will make commitments to myself not to drink
I will change my diet to help me overcome drinking
I will go places where drinking is not generally accepted
I will think about the type of person I will be if I am in control of my drinking

Supplemental Material 2: Treatment Acceptability questions with scales.

How satisfied are you with the ability of this treatment to help you reduce your alcohol use?

(1) Very dissatisfied (2) Somewhat dissatisfied (3) Somewhat satisfied (4) Very satisfied

How difficult is it to adhere to the scheduled requirements?

(1) Very difficult (2) Somewhat difficult (3) Somewhat difficult (4) Very difficult

How convenient is it to use the SOBERLINK device?

(1) Very inconvenient (2) Somewhat inconvenient (3) Somewhat convenient (4) Very convenient

How convenient is it to use a cell phone to communicate with us?

(1) Very inconvenient (2) Somewhat inconvenient (3) Somewhat convenient (4) Very convenient

How convenient is it to use the debit card system to receive payments?

(1) Very inconvenient (2) Somewhat inconvenient (3) Somewhat convenient (4) Very convenient

Taking all things into account, how satisfied are you with this treatment?

(1) Very dissatisfied (2) Somewhat dissatisfied (3) Somewhat satisfied (4) Very satisfied

CONCLUSIONS

Summary

Implementation intentions address the gap between intention and behavior in theories of health behavior change. Moreover, implementation intentions are simple and, as such, have an intuitive appeal for large-scale dissemination. By requiring a low response burden, they are comparatively easy to implement across several modes of delivery and at a relatively low cost. The studies reported here show the incremental appeal of planning interventions such as implementation intentions in a laboratory and naturalistic clinical trial setting.

The first study found that implementation intentions, in conjunction with monetary incentives, were associated with the greatest time to resist smoking in a laboratory analogue for cigarette smoking relapse. However, the combination of implementation intentions and monetary incentives was not significantly greater than monetary incentives alone. These results may indicate: (1) that the effects of implementation intentions intervention may not be effective or captured by the smoking analogue task or (2) that since the implementation intention effect is smaller than the monetary incentive effect, the implementation intention effect may not be robust enough to detect given the limited sample size. While both of these possibilities may contribute to the failure to detect a significant difference between the conditions that measured the effects of implementation intentions alone, the orderly results observed between the four experimental sessions suggests that the primary reason may be an inadequate sample size. Specifically, the results showed that the control implementation intentions and control monetary incentive condition smoked the most quickly, followed by the active implementation intention, control monetary incentive condition, then the control implementation intention, active monetary

incentive and finally the active implementation intention and active monetary incentive condition waited the longest to smoke. In addition to looking at larger samples to detect possible small but clinically significant effects, future work using the smoking resistance paradigm may wish to test other treatment combinations in order to assess for possible additive or perhaps even multiplicative effects that may help individuals to quit smoking.

The second study also assessed implementation intentions but with several differences from the first study. To begin with, the second study looked at alcohol users in a more naturalistic setting wherein the participants visits to the laboratory were minimized and the majority of assessments and treatments were conducted remotely using ecological momentary assessments and interventions. The study's goal was to meet the needs of planning-based interventions by providing a rigorous initial investigation of implementation intentions with the long term goal of testing this intervention in a more large scale setting. The primary findings were that the implementation intention intervention was associated with a greater decrease in drinks consumed on drinking days compared to the control group and both treatment conditions reduced drinking days during the intervention period. Furthermore, in both treatment groups, the reduction in drinks continued to be observed one-month after the completion of the intervention. These findings may indicate that implementation intentions do not increase self-control to resist having a drink (as suggested by implementation intentions not decreasing drinking vs. non-drinking days compared to the control condition) but rather that implementation intentions may help to reduce consumption once drinking has begun by activating other selected alternative responses. These preliminary results are promising both for the implementation intention intervention as a possible technique to reduce alcohol use through large scale dissemination and also for the further development of the EMA and EMI paradigm that, across groups, was

associated with a reduction in drinks for at least one-month following completion of the intervention period.

Taken together, these two studies lend support for further investigation of both techniques for studying candidate treatments for health risk behaviors as well as moderate support for the use of implementation intentions as a specific means for reducing substance use. As expressed by Dr. Allport decades ago, salient and habitual unhealthy behaviors, such as smoking and drinking, require intentional disruption to cause meaningful change. Implementation intentions provide a means to interrupt and redirect the “segmental drives” and “winds of circumstance” that dictate negative health behavior and to offer alternative directions for an individual’s behavior.

Future Directions

Future work may wish to unearth the relationship between executive function and the intention to behavior transition. The theoretical framework of the Competing Neurobehavioral Decision System may be useful to understand such an endeavor. The Competing Neurobehavioral Decision System is a dual decision model that reflects the relative balance between the impulsive decision system and the executive decision system (Bickel et al., 2007). This model, while largely consistent with a wide variety of dual system approaches, uniquely suggests that failure to behave as previously intended results from an imbalance wherein the executive decision system exerts relatively less control.

In the case of negative health behaviors, implementation intentions may be a means to stop or attenuate undesired behaviors even in the absence of regulatory balance between the executive and impulsive decision systems proposed in the Competing Neurobehavioral Decision System hypothesis. For example, an early investigation of implementation intentions in frontal

lobe patients found that implementation intentions increased performance in these executive process deficient individuals more than in college students (Lengfelder & Gollwitzer, 2001). These results support the idea that implementation intentions may bypass cognitive resources and act on the same level as other impulsively driven behaviors and habits. However, a contradictory report found that executive function moderates the intention to change and behavior change relationship such that people with strong intention and strong executive function were uniquely successful at behavior change (Hall, Fong, Epp, & Elias, 2008). Future studies looking at the relationship between the Competing Neurobehavioral Decision System and successful behavior change may help to clarify the optimal role of implementation intentions in health risk behavior treatment by providing targeted subgroups that will respond most strongly to this intervention.

REFERENCES

- Aarts, H., Verplanken, B., & van Knippenberg, A. (1998). Predicting Behavior From Actions in the Past: Repeated Decision Making or a Matter of Habit? *Journal of Applied Social Psychology, 28*(15), 1355–1374.
- Adriaanse, M. A., de Ridder, D. T. D., & de Wit, J. B. F. (2009). Finding the critical cue: implementation intentions to change one's diet work best when tailored to personally relevant reasons for unhealthy eating. *Personality & Social Psychology Bulletin, 35*(1), 60–71.
- Adriaanse, M. A., Gollwitzer, P. M., De Ridder, D. T. D., de Wit, J. B. F., & Kroese, F. M. (2011). Breaking habits with implementation intentions: a test of underlying processes. *Personality & Social Psychology Bulletin, 37*(4), 502–513.
- Adriaanse, M. A., Oettingen, G., Gollwitzer, P. M., Hennes, E. P., de Ridder, D. T. D., & de Wit, J. B. F. (2010). When planning is not enough: Fighting unhealthy snacking habits by mental contrasting with implementation intentions (MCII). *European Journal of Social Psychology, 40*(7), 1277–1293.
- Adriaanse, M. A., Vinkers, C. D. W., De Ridder, D. T. D., Hox, J. J., & De Wit, J. B. F. (2011). Do implementation intentions help to eat a healthy diet? A systematic review and meta-analysis of the empirical evidence. *Appetite, 56*(1), 183–193.
- Ajzen, I. (1985). From Intentions to Actions: A Theory of Planned Behavior. In P. D. D. J. Kuhl & J. Beckmann (Eds.), *Action Control* (pp. 11–39). Springer Berlin Heidelberg.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211.

- Ajzen, I., & Fishbein, M. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.
- Allport, G. W. (1955). *Becoming; Basic Considerations for a Psychology of Personality*. Yale University Press.
- Andersson, E. K., & Moss, T. P. (2011/3). Imagery and implementation intention: A randomised controlled trial of interventions to increase exercise behaviour in the general population. *Psychology of Sport and Exercise, 12*(2), 63–70.
- Armitage, C. J. (2007). Efficacy of a brief worksite intervention to reduce smoking: the roles of behavioral and implementation intentions. *Journal of Occupational Health Psychology, 12*(4), 376–390.
- Armitage, C. J. (2008). A volitional help sheet to encourage smoking cessation: a randomized exploratory trial. *Health Psychology, 27*(5), 557–566.
- Armitage, C. J., & Arden, M. A. (2008). How useful are the stages of change for targeting interventions? Randomized test of a brief intervention to reduce smoking. *Health Psychology, 27*(6), 789–798.
- Armitage, C. J., Rowe, R., Arden, M. A., & Harris, P. R. (2014). A brief psychological intervention that reduces adolescent alcohol consumption. *Journal of Consulting and Clinical Psychology, 82*(3), 546–550.
- Armitage, C. J., & Sprigg, C. A. (2010). The roles of behavioral and implementation intentions in changing physical activity in young children with low socioeconomic status. *Journal of Sport & Exercise Psychology, 32*(3), 359–376.
- Bickel, W. K., Miller, M. L., Yi, R., Kowal, B. P., Lindquist, D. M., & Pitcock, J. A. (2007). Behavioral and neuroeconomics of drug addiction: competing neural systems and temporal

- discounting processes. *Drug and Alcohol Dependence*, 90 Suppl 1, S85–91.
- Camerer, C. F. (2004). Prospect theory in the wild: Evidence from the field. *Advances in Behavioral Economics*, 148–161.
- Chapman, J., & Armitage, C. J. (2010). Evidence that boosters augment the long-term impact of implementation intentions on fruit and vegetable intake. *Psychology & Health*, 25(3), 365–381.
- Chapman, J., & Armitage, C. J. (2012). Do techniques that increase fruit intake also increase vegetable intake? Evidence from a comparison of two implementation intention interventions. *Appetite*, 58(1), 28–33.
- Conner, M., & Higgins, A. R. (2010). Long-term effects of implementation intentions on prevention of smoking uptake among adolescents: a cluster randomized controlled trial. *Health Psychology*, 29(5), 529–538.
- Connolly, K. J., & Martlew, M. (1991). *Psychologically speaking: A book of quotations*. Wiley-Blackwell.
- De Martino, B., Kumaran, D., Seymour, B., & Dolan, R. J. (2006). Frames, biases, and rational decision-making in the human brain. *Science*, 313(5787), 684–687.
- Dewey, J. (1922). *Human Nature and Conduct: An Introduction to Social Psychology*.
- Doll, R., Peto, R., Boreham, J., & Sutherland, I. (2004). Mortality in relation to smoking: 50 years' observations on male British doctors. *BMJ*, 328(7455), 1519.
- Fishbein, M. (1967). Attitude and the prediction of behavior. *Readings in Attitude Theory and Measurement*, 477–492.
- Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *The American Psychologist*, 54(7), 493.

- Gollwitzer, P. M., & Sheeran, P. (2009). Self-regulation of consumer decision making and behavior: The role of implementation intentions. *Journal of Consumer Psychology: The Official Journal of the Society for Consumer Psychology*.
- Guillaumie, L., Godin, G., Manderscheid, J.-C., Spitz, E., & Muller, L. (2012). The impact of self-efficacy and implementation intentions-based interventions on fruit and vegetable intake among adults. *Psychology & Health, 27*(1), 30–50.
- Hall, P. A., & Fong, G. T. (2007). Temporal self-regulation theory: A model for individual health behavior. *Health Psychology Review, 1*(1), 6–52.
- Hall, P. A., Fong, G. T., Epp, L. J., & Elias, L. J. (2008). Executive function moderates the intention-behavior link for physical activity and dietary behavior. *Psychology & Health, 23*(3), 309–326.
- Hodgson, G. M. (2004). Reclaiming habit for institutional economics. *Journal Of Economic Psychology, 25*(5), 651–660.
- Hsu, M., Bhatt, M., Adolphs, R., Tranel, D., & Camerer, C. F. (2005). Neural systems responding to degrees of uncertainty in human decision-making. *Science, 310*(5754), 1680–1683.
- Jamal, A., Agaku, I. T., O'Connor, E., & King, B. A. (2014). Current cigarette smoking among adults—United States, 2005–2013. *MMWR. Morbidity and Mortality Weekly Report*. Retrieved from <http://www.cdc.gov/MMWR/preview/mmwrhtml/mm6347a4.htm>
- Johnson, N. B., Hayes, L. D., Brown, K., Hoo, E. C., & Ethier, K. A. (2014). CDC National Health Report: leading causes of morbidity and mortality and associated behavioral risk and protective factors—United States, 2005--2013. *Morbidity and Mortality Weekly Report. Surveillance Summaries, 63*(Suppl 4), 3–27.

- Kacelnik, A., & Marsh, B. (2002). Cost can increase preference in starlings. *Animal Behaviour*, *63*(2), 245–250.
- Knäuper, B., McCollam, A., Rosen-Brown, A., Lacaille, J., Kelso, E., & Roseman, M. (2011). Fruitful plans: adding targeted mental imagery to implementation intentions increases fruit consumption. *Psychology & Health*, *26*(5), 601–617.
- Lengfelder, A., & Gollwitzer, P. M. (2001). Reflective and reflexive action control in patients with frontal brain lesions. *Neuropsychology*, *15*(1), 80–100.
- Madden, T. J., Ellen, P. S., & Ajzen, I. (1992). A Comparison of the Theory of Planned Behavior and the Theory of Reasoned Action. *Personality & Social Psychology Bulletin*, *18*(1), 3–9.
- Maréchal, K. (2009). An Evolutionary Perspective on the Economics of Energy Consumption: The Crucial Role of Habits. *Journal of Economic Issues*, *43*(1), 69–88.
- Milne, S., Orbell, S., & Sheeran, P. (2002). Combining motivational and volitional interventions to promote exercise participation: protection motivation theory and implementation intentions. *British Journal of Health Psychology*, *7*(Pt 2), 163–184.
- Orbell, S., & Verplanken, B. (2010). The automatic component of habit in health behavior: habit as cue-contingent automaticity. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*, *29*(4), 374–383.
- Ouellette, J. A., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behavior predicts future behavior. *Psychological Bulletin*, *124*(1), 54.
- 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.
- Sheeran, P., Milne, S., Webb, T. L., & Gollwitzer, P. M. (2005). *Implementation intentions and*

health behaviour. Bibliothek der Universität Konstanz.

- Sheeran, P., & Orbell, S. (2000). Using implementation intentions to increase attendance for cervical cancer screening. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association, 19*(3), 283–289.
- Slovic, P. (2016). *The Perception of Risk*. Routledge.
- Tiffany, S. T., & Conklin, C. A. (2000). A cognitive processing model of alcohol craving and compulsive alcohol use. *Addiction, 95 Suppl 2*, S145–53.
- Townsend, D. J., & Bever, T. G. (2001). *Language speech and communication. Sentence comprehension: The integration of habits and rules*. Cambridge, MA: The MIT Press.
- Verplanken, B., & Faes, S. (1999). Good intentions, bad habits, and effects of forming implementation intentions on healthy eating. *European Journal of Social Psychology, 29*(5-6), 591–604.
- Verplanken, B., & Orbell, S. (2003). Reflections on Past Behavior: A Self- Report Index of Habit Strength. *Journal of Applied Social Psychology*. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1111/j.1559-1816.2003.tb01951.x/full>
- Von Neumann, J., & Morgenstern, O. (1947). *Theory of games and economic behavior*, 2nd rev. ed. Retrieved from <http://psycnet.apa.org/psycinfo/1947-03159-000>
- Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*(2), 249–268.
- Woolf, S. H., & Aron, L. (2013). *U.S. Health in International Perspective: Shorter Lives, Poorer Health*. National Academies Press.
- Wttenbraker, J., Gibbs, B. L., & Kahle, L. R. (1983). Seat belt attitudes, habits, and behaviors:

An adaptive amendment to the Fishbein model. *Journal of Applied Social Psychology*,
13(5), 406–421.

FIGURES

Figure 1: Diagram of the Theory of Planned Behavior. Adapted from Ajzen (1991).

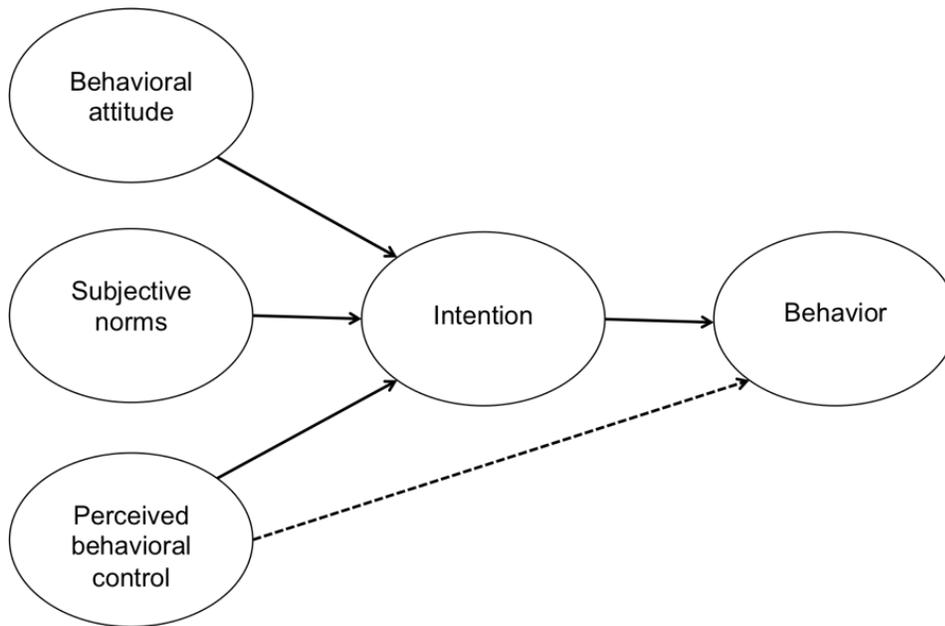


Figure 2: Example of implementation intention if-then structure.

Implementation Intention Intervention

Active

IF *critical situation*, THEN *response*.

e.g., If I am in a situation where other people are drinking, then I will leave the situation and spend time with friends that do not drink.

APPENDICES

APPENDIX 1

Example of Informed Consent Form for Study 1**Title:** *Implementation Intentions-Study 1 (III)***Protocol #15-608****Principal Investigator:** Warren K. Bickel, Ph.D.**Institution:** Virginia Tech Carilion Research Institute**Purpose of the Study**

You are being asked to volunteer for a research study. The purpose of this study is to assess the delay to smoking initiation under varying conditions. You are invited to participate in this study because you are a cigarette smoker. You will randomly be enrolled in one out of four conditions of this study.

Organization and Funding Source

This study is being conducted at the Virginia Tech Carilion Research Institute (VTCRI) and funded by the National Institute of Drug Abuse.

Number of Participants

Up to one hundred (100) individuals are expected to enroll in this study at VTCRI.

In order to be eligible for this study, you must be 18-65 years of age at the time of enrollment. This study will involve adults who are cigarette smokers. Pregnant or lactating women are not eligible to participate in this study.

We will stop your participation if your answers or performance suggest that it is not appropriate for you to continue in the study or if you do not, or are unable to, complete any of the study procedures. We may also stop your participation if you have evidence of a current unstable medical illness or an unmanaged psychiatric or neurological disorder. Violation of VTCRI policies may also result in the research team withdrawing you from the study. We may also stop an ongoing session, or end your participation in the study, because we have collected all the information we need.

Description and Procedures

You will complete self-report screening measures designed to assess your smoking behaviors, your psychiatric history, and any past or current drug use. There are no “right” or “wrong” answers. We want you to answer the questions honestly and thoughtfully.

After obtaining informed consent, each time you attend a session, including today, you will be asked to provide a urine sample, which will be tested for drugs of abuse and pregnancy (if applicable). If you are a pregnant female or lactating, you cannot participate. We will also ask you to provide a breath sample to test for recent alcohol use with a breathalyzer and a breath sample to measure recent smoking using a carbon monoxide (CO) monitor.

You will be asked about your past medical history focusing on chronic (and current) medical problems, medications, and substance use. You will be asked to complete several questionnaires including computerized tasks about your craving to smoke cigarettes and decision-making. If you qualify for the study and agree to continue, you will be invited to participate in four smoking sessions where you will complete a 2-hour task in which you can choose to smoke a real cigarette in the laboratory. Each session will last about 2.5 hours.

You may be asked to abstain from smoking for at least 10 hours prior to these visits. Before each session, you must give breath readings that will indicate any recent smoking.

Risks/Discomforts/Inconveniences

There will be no direct costs for your participation, although there are risks. One risk is possible embarrassment. This may result from answering questions that you consider sensitive.

Some of our questions will ask for information about medical and psychiatric conditions and drug use. This study includes the risks of potential nicotine withdrawal (dizziness, increased heart rate, headache, irritability, sleepiness, decreased alertness, difficulty concentrating, impatience, sleeplessness, and increased eating). Additionally, because the present experiment may provide cigarettes for you to smoke, you might experience adverse effects associated with the use of cigarettes (e.g., nausea or dizziness). In addition, loss of confidentiality is another potential risk. We will make every effort to protect your confidentiality should you participate in the study. There is also the possibility that you may become bored or uncomfortable during the research sessions.

If medical problems occur during the course of the study, we will determine whether you should continue. If necessary, referrals will be provided. If you have questions concerning the study, please contact Warren K. Bickel, the Principal Investigator at 540-526-2088 (office).

Possible Benefits

There will be no direct benefit to you from participating in this study. However, it is hoped that the information gained from the study will help in developing smoking cessation treatments. Smokers may be able to stop smoking from your participation in this study although this cannot

be guaranteed. No promise or guarantees of direct personal benefit to you are being made to encourage you to participate.

Voluntary Participation and Confidentiality

Your participation in this study is voluntary. You are free to decline participation in this study or withdraw from it at any time. If you are a Virginia Tech student, you may withdraw from the study without affecting your academic standing (i.e., your student status and evaluations will not be affected). We will act in accordance with the guidelines for the protection of human research participants issued by the Institutional Review Board (IRB) and Office of Research Compliance (ORC). Your identity on records relevant to this study will not be made public. Any publications resulting from this research will not mention your name or any other personally identifying information.

It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research. The sponsor (VTCRI) or their appointed designees as well as the IRB, ORC, or other institutional oversight offices will be granted direct access to your original medical and research records for verification of data. If your record is used or distributed for government purposes, it will be done under conditions that will protect your privacy to the fullest extent possible, consistent with laws relating to public disclosure of information and the law-enforcement responsibilities of the agencies. You will be informed of any significant new findings that may relate to your continued participation in this study.

The study team must release certain information to the appropriate authorities if at any time during the study there is concern that child abuse or elder abuse has possibly occurred or you disclose a desire to harm yourself or others.

Your name and social security information must be collected per the Virginia Tech Controller's Office policy.

Compensation

In return for your time, effort, and travel expenses, you will receive compensation according to the guidelines listed below.

- Visit 1 = \$10.00
- Visit 2 = \$15.00
- Visit 3 = \$20.00
- Visit 4 = \$25.00
- Visit 5 = \$30.00

The maximum amount of compensation you will receive for all visits is \$100.

Upon completion of all five sessions, participants will be paid a completion bonus of \$30.

You may also receive up to an additional \$11.46 based on your choices in two of the four delay to gratification smoking tasks that will occur in two of the four sessions between visit 2-5.

The total maximum you could earn for the study is \$152.92.

Your compensation will be paid by check or reloadable prepaid card issued by Greenphire ClinCard (www.myclincard.com), an FDIC-insured payment provider that specializes in clinical trial stipend payments that comply with IRB privacy regulations and considerations. At the beginning of the study, you will receive a prepaid MasterCard debit card that can be used anywhere that accepts MasterCard. As payments are earned in the course of the study, additional funds will be added to your account. Funds are immediately available when added and you can check your balance as desired. Should you participate in multiple studies within one year and if you receive compensation in excess of \$600.00 in any one calendar year, then by law, Virginia Tech is required to file a Form 1099 with the IRS. For any amount less than \$600.00, it is up to you as the participant to report any additional income, as Virginia Tech will not file Form 1099 with the IRS.

Alternative to Participation

You do not have to participate in this study if you do not wish to. The alternative to participating in this study is not participating. This is not a treatment study. If you should choose to seek treatment either before or after your participation in this study, there are a number of options. Most types of treatment for nicotine dependence involve some form of counseling and medication. A national help line, 1-800- QUITNOW (1-800-784-8669) offers free assistance and referrals.

Freedom to Withdraw

You are free to decline participation in this study or withdraw from it at any time.

Future Research Opportunities

If you would like to be contacted regarding future opportunities for research participation, please check the box below.

- Yes, please contact me regarding future research opportunities.

Subject's Responsibilities

I voluntarily agree to participate in this study. I have the following responsibilities:

- Answer questions about health and past and current drug use

- Abstain from smoking cigarettes (and using other nicotine products) for at least 10 hours prior to lab visits 2-5.

Subject's Permission/Statement of Consent

The purpose and voluntary nature of this study, as well as the potential benefits and risks that are involved have been explained to me. I have read the Consent Form and conditions of the project. I have been able to ask questions and express concerns, which have been satisfactorily responded to by the study team. I have been told that I will be given a copy of this consent form. I hereby acknowledge the above and give my informed and free consent to be a participant in this study. I recognize that I am not waiving any of my rights as a research participant by signing this consent form.

If you have questions about this study, please contact Dr. Warren K. Bickel, the Principal Investigator at 540-526-2088 (phone)/wkbickel@vtc.vt.edu (e-mail). If you have any questions about your rights as a research subject or concerning a research related injury, you can call Dr. David M. Moore at the Virginia Tech Institutional Review Board for the Protection of Human Subjects at 540-231-4991 (phone) /moored@vt.edu (e-mail).

APPENDIX 2

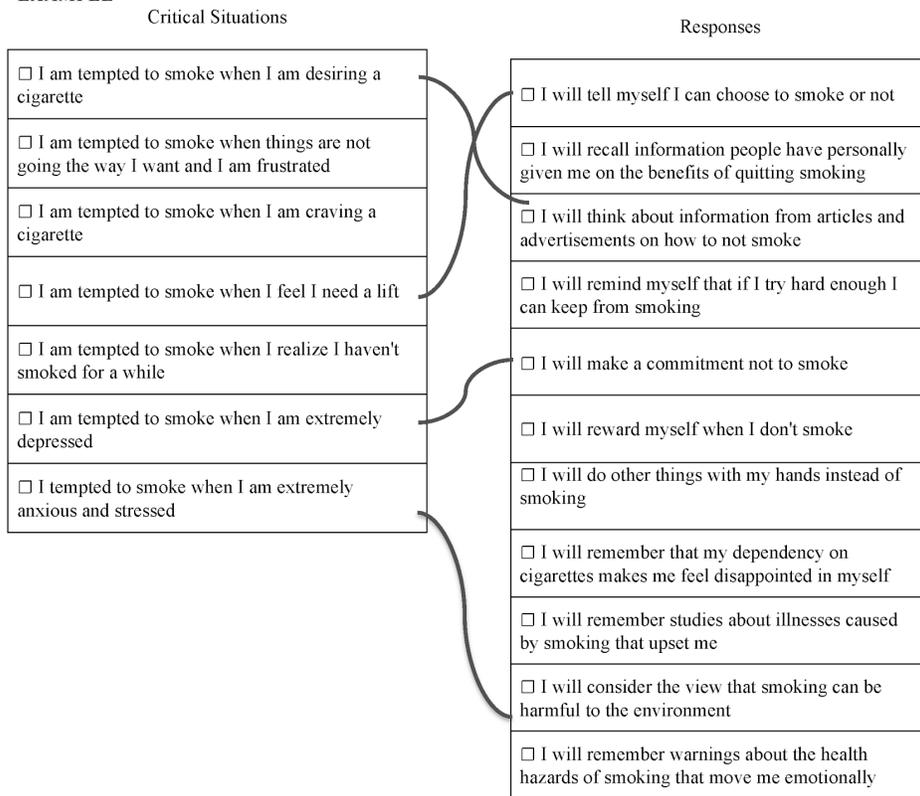
Study 1 Active Implementation Intention Worksheet

Participant ID:

Session #:

Link critical situations with appropriate responses that you might find useful by drawing a line between them. You may link as many as you like.

EXAMPLE



Participant ID:

Session #:

Link critical situations with appropriate responses that you might find useful by drawing a line between them. You may link as many as you like.

Critical Situations

<input type="checkbox"/> I am tempted to smoke when I am desiring a cigarette
<input type="checkbox"/> I am tempted to smoke when things are not going the way I want and I am frustrated
<input type="checkbox"/> I am tempted to smoke when I am craving a cigarette
<input type="checkbox"/> I am tempted to smoke when I feel I need a lift
<input type="checkbox"/> I am tempted to smoke when I realize I haven't smoked for a while
<input type="checkbox"/> I am tempted to smoke when I am extremely depressed
<input type="checkbox"/> I am tempted to smoke when I am extremely anxious and stressed

Responses

<input type="checkbox"/> I will tell myself I can choose to smoke or not
<input type="checkbox"/> I will recall information people have personally given me on the benefits of quitting smoking
<input type="checkbox"/> I will think about information from articles and advertisements on how to not smoke
<input type="checkbox"/> I will remind myself that if I try hard enough I can keep from smoking
<input type="checkbox"/> I will make a commitment not to smoke
<input type="checkbox"/> I will reward myself when I don't smoke
<input type="checkbox"/> I will do other things with my hands instead of smoking
<input type="checkbox"/> I will remember that my dependency on cigarettes makes me feel disappointed in myself
<input type="checkbox"/> I will remember studies about illnesses caused by smoking that upset me
<input type="checkbox"/> Then I will consider the view that smoking can be harmful to the environment
<input type="checkbox"/> Then I will remember warnings about the health hazards of smoking that move me emotionally

Participant ID:

Session #:

Pick 3 situations-responses **pairs** that you linked previously (or as many as you linked if less than 3) and write them below. Add "if" to the start of the situation and "then" to the start of the response to create a sentence like the example below.

EXAMPLE: IF I am tempted to smoke when there are arguments and conflict with family and friends, THEN I will put things around my home that remind me not to smoke

1)

2)

3)

APPENDIX 3

Study 1 Control Implementation Intention Worksheet

Participant ID:

Session #:

Check critical situations and responses that you might find useful. You may check as many as you like.

EXAMPLE

Critical Situations

<input checked="" type="checkbox"/> I am tempted to smoke when I am desiring a cigarette
<input type="checkbox"/> I am tempted to smoke when things are not going the way I want and I am frustrated
<input type="checkbox"/> I am tempted to smoke when I am craving a cigarette
<input checked="" type="checkbox"/> I am tempted to smoke when I feel I need a lift
<input type="checkbox"/> I am tempted to smoke when I realize I haven't smoked for a while
<input checked="" type="checkbox"/> I am tempted to smoke when I am extremely depressed
<input checked="" type="checkbox"/> I am tempted to smoke when I am extremely anxious and stressed

Responses

<input checked="" type="checkbox"/> I will tell myself I can choose to smoke or not
<input type="checkbox"/> I will recall information people have personally given me on the benefits of quitting smoking
<input checked="" type="checkbox"/> I will think about information from articles and advertisements on how to not smoke
<input type="checkbox"/> I will remind myself that if I try hard enough I can keep from smoking
<input checked="" type="checkbox"/> I will make a commitment not to smoke
<input type="checkbox"/> I will reward myself when I don't smoke
<input type="checkbox"/> I will do other things with my hands instead of smoking
<input type="checkbox"/> I will remember that my dependency on cigarettes makes me feel disappointed in myself
<input type="checkbox"/> I will remember studies about illnesses caused by smoking that upset me
<input checked="" type="checkbox"/> I will consider the view that smoking can be harmful to the environment
<input type="checkbox"/> I will remember warnings about the health hazards of smoking that move me emotionally

Participant ID:

Session #:

Check critical situations and responses that you might find useful. You may check as many as you like.

Critical Situations

<input type="checkbox"/> I am tempted to smoke when I am desiring a cigarette
<input type="checkbox"/> I am tempted to smoke when things are not going the way I want and I am frustrated
<input type="checkbox"/> I am tempted to smoke when I am craving a cigarette
<input type="checkbox"/> I am tempted to smoke when I feel I need a lift
<input type="checkbox"/> I am tempted to smoke when I realize I haven't smoked for a while
<input type="checkbox"/> I am tempted to smoke when I am extremely depressed
<input type="checkbox"/> I am tempted to smoke when I am extremely anxious and stressed

Responses

<input type="checkbox"/> I will tell myself I can choose to smoke or not
<input type="checkbox"/> I will recall information people have personally given me on the benefits of quitting smoking
<input type="checkbox"/> I will think about information from articles and advertisements on how to not smoke
<input type="checkbox"/> I will remind myself that if I try hard enough I can keep from smoking
<input type="checkbox"/> I will make a commitment not to smoke
<input type="checkbox"/> I will reward myself when I don't smoke
<input type="checkbox"/> I will do other things with my hands instead of smoking
<input type="checkbox"/> I will remember that my dependency on cigarettes makes me feel disappointed in myself
<input type="checkbox"/> I will remember studies about illnesses caused by smoking that upset me
<input type="checkbox"/> Then I will consider the view that smoking can be harmful to the environment
<input type="checkbox"/> Then I will remember warnings about the health hazards of smoking that move me emotionally

Participant ID:

Session #:

Pick 3 situations **OR** responses that you chose previously (or as many as you chose if less than 3) and write them word-for-word below as shown in the examples below.

EXAMPLE: I am tempted to smoke when there are arguments and conflicts with family and friends

EXAMPLE: I put things around my home that remind me not to smoke

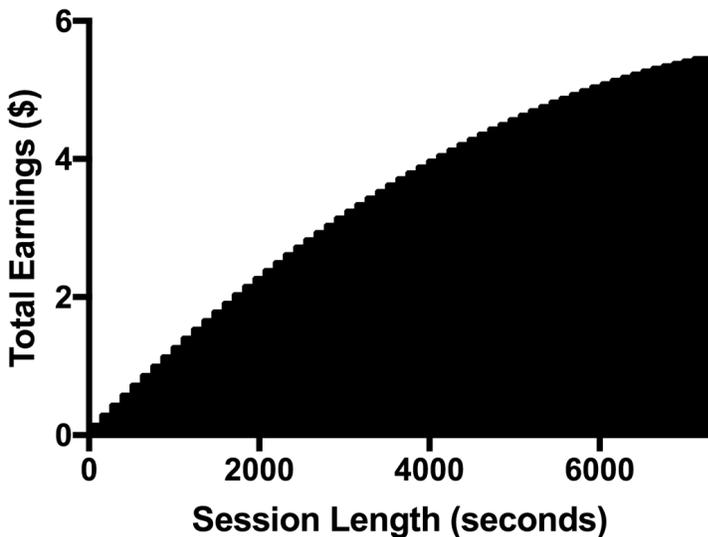
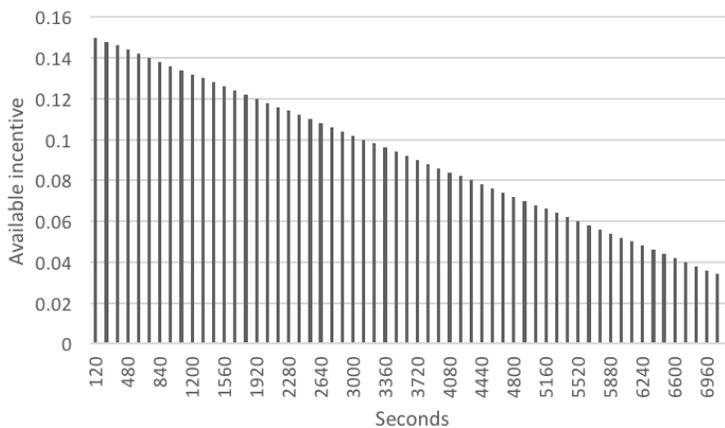
1)

2)

3)

APPENDIX 4

Monetary Incentive Schedule. During active monetary incentive conditions of Study 1, participants received cumulative incentives starting at 15 cents and decreasing by 0.002 cents per 120 seconds of resisting smoking reinitiation (see top graph). Functionally, this means that the amount of the incentive reduced by one cent every 10 minutes. The amount of the monetary incentive continued to accumulate until the participant smoked or the session ended. If participants resisted smoking the entire two-hour session, the earning for the entire session would be \$5.46 (see bottom graph).



APPENDIX 7

Alcohol Withdrawal Checklist (AWCL).

* Please check the most appropriate response for each item. How much have you experienced the following symptoms in the past 24 hours?

	Not at all	Light	Moderate	Significant	Extreme
Nervousness	<input type="radio"/>				
Sweating	<input type="radio"/>				
Tremor	<input type="radio"/>				
Nausea	<input type="radio"/>				
Vomiting	<input type="radio"/>				
Abdominal pain	<input type="radio"/>				
Seizures	<input type="radio"/>				
Poor appetite	<input type="radio"/>				
Hallucinations	<input type="radio"/>				
Irritation/dysphoria	<input type="radio"/>				
Confusion	<input type="radio"/>				
Chill	<input type="radio"/>				
Headache	<input type="radio"/>				
Craving for alcohol	<input type="radio"/>				
Depression	<input type="radio"/>				
Weakness/Lack of Energy	<input type="radio"/>				
Sleep disturbances	<input type="radio"/>				

APPENDIX 8

Example of Informed Consent for Study 2

Informed Consent for Participants

In Research Projects Involving Human Subjects

Title: Implementation Intentions-Study 2 (III)

Protocol: 15-955

Principal Investigators: Warren K. Bickel, Ph.D.

Institution: Virginia Tech Carilion Research Institute

Purpose of the Study

You have been asked to come to the Virginia Tech Carilion Research Institute (VTCRI) because you may qualify for this study. Your participation in this study will help us learn more about an intervention for alcohol use.

Organization and Funding Source

This study is being conducted by the VTCRI and will be funded by the National Institute on Alcohol Abuse and Alcoholism.

Number of Participants

We will enroll up to 200 participants in this study.

Participation

To participate in this study you must be 18-65 years old, meet criteria for alcohol dependence, and have a desire to quit or cut down on your drinking. Pregnant women are not eligible for this study, and a urine screen will be collected from all females to test for pregnancy at the beginning of the study. Participants using prescribed or over-the-counter medicines containing alcohol will also be excluded from participation.

To determine if it is safe and appropriate for you to join this study, we will ask you to complete several questionnaires. We may stop your participation if there is evidence that you have a current unstable medical illness and/or an unmanaged psychiatric or neurological disorder. We will stop your participation if your answers or performance suggest that it is not safe and appropriate for you to continue in the study. Violation of research center policies may result in the research team withdrawing you from the study. We may also stop your participation if you do not or are unable to complete any of the study procedures. We may also stop an ongoing

session, or end your participation in the study because we have collected all the information we need.

You are free to stop your participation at any time. You may talk with other people about your decision to participate in this study, although we suggest avoiding confirming participation in this study to maintain confidentiality. You do not have to answer any questions that make you feel uncomfortable. There are no “right” or “wrong” answers; we want you to answer the questions honestly and thoughtfully. If it is safe and appropriate for you to continue in the study, you will then complete questionnaires and computerized tasks that will measure some of your preferences and abilities.

Description and Procedures

This study will require you to complete approximately 4 visits to the VTCRI including today’s consent session. These sessions will be approximately 2 hours each. We will ask you some questions to make sure participation in the study is safe for you. We will also collect information (e.g. age, education) from you that we need to analyze our data. We will give you a detailed description of what it will be like to be in the study and answer any questions you have.

You will be asked to provide daily self-report assessments of previous-day drinking and current withdrawal symptoms over a cell phone for a 6-day period. You will then be invited to return to the laboratory to be provided with a SOBERLINK breathalyzer and given instruction in its use. You will also be provided with a prepaid cell phone (if necessary) and you will receive a \$50 study completion bonus at the end of the study provided these devices are returned.

You will either be allowed to use your own personal cell phone for study communications or receive a prepaid cell phone. If you choose to use a phone we provide, it will be restricted so that you will only be able to communicate with study personnel and 911 service. If you choose to use your personal cell phone for study communications and pay for text messages and/or phone calls on a per unit basis, we will reimburse you for the cost of those messages and calls conducted as part of this study. To protect your privacy, we recommend that a password-protected lock be enabled on the cell phone used for this study, and that the device remain locked when not in use.

When you return to VTCRI after the initial 6-day period to receive a SOBERLINK breathalyzer, you will complete a worksheet that gives possible risky situations for alcohol consumption and also provides possible strategies to minimize the risk of drinking. The intervention period will last for 14 consecutive days, with three breathalyzer screens per day. You will be asked to designate a time at the start of the hour at which each of the three breathalyzer screens will be scheduled each day. You will be asked to choose an assessment time shortly after you usually awaken, shortly before you go to bed at night, and one throughout the day. You will be allowed to choose any times for the screens, provided that they are each separated by at least 6 hours.

You will be reminded via text message when a sample is to be collected, and samples will be accepted up to 15 minutes before the scheduled time and 60 minutes after the scheduled time, giving you 75 minutes total to submit the sample. Also, during this 14-day period, as you did during the initial 6-day period, you will also self-report your previous-day alcohol use with a text message and/or phone call.

To complete scheduled breathalyzer samples, you will simply blow into the SOBERLINK device for 4 seconds. During the breath sample collection, a picture is automatically taken of you, which can be compared to a reference picture taken when you first receive the SOBERLINK device. The SOBERLINK device will automatically upload the breathalyzer results, your location, and your picture to a centralized, secure website where the data will be available to research staff. Research staff will monitor these results, verify that the picture matches a reference picture for you, and you will receive compensation based on completed breath samples.

Assessment sessions will be conducted prior to the intervention, immediately following the intervention, and at a 1-month follow-up. During assessment sessions, we will collect some measures of your alcohol and drug use and ask you to complete a number of questionnaires and tasks. We will ask you to complete a battery of questionnaires and tasks grouped into three general categories including measures of your substance use, measures of treatment acceptability, and measures of alcohol value and sensitivity.

Remote delivery of payments

You will be paid with a reloadable prepaid card issued by Greenphire ClinCard (www.myclincard.com), an FDIC-insured payment provider that specializes in clinical trial stipend payments that comply with IRB privacy regulations and considerations. At intake, you will receive a prepaid MasterCard debit card that can be used anywhere that accepts MasterCard. As payments are earned in the course of the study, additional funds will be added to your account. Funds are immediately available when added and you can check your balance as desired.

Risks/Discomforts/Inconveniences

One risk of participating in this study is possible embarrassment. This may result from answering questions that you consider sensitive. Some of our questions will ask for information about medical and psychiatric conditions and drug use.

Alcohol-dependent adults that reduce drinking might experience mild alcohol withdrawal (e.g., anxiety, agitation, headache, hypertension, insomnia, irritability). Participants who are likely to experience more than mild withdrawal symptoms may be excluded from the study. Neither the researchers, VTCRI, or Virginia Tech have money set aside to cover the cost of any resulting

medical treatment, and any costs associated with that treatment would be the responsibility of the participant.

In addition, loss of confidentiality is another potential risk of participation. We will make every effort to protect your confidentiality should you participate in this study. Study data will be secured and breathalyzer transmissions are encrypted and secured. However, there is a potential that data could be intercepted affecting your employability or probation status. To protect against this risk, we recommend that the cell phone used for study communications be locked when not in use. There is also the possibility you may become bored during the research sessions.

If problems occur during the course of the study we will determine whether you should continue. If necessary, referrals will be provided. If you have questions concerning the study, please contact Warren K. Bickel, the Principal Investigator at 540-526-2088 (office).

Possible Benefits

You may benefit from possible reduction in alcohol use or cessation of alcohol use. The project involves minimal risk to confidentiality or other personal rights or to physical or emotional health.

Voluntary Participation and Confidentiality

Your participation in this study is voluntary. You are free to decline participation in this study or withdraw from it at any time. If you are a Virginia Tech student, you may withdraw from the study without affecting your academic standing (i.e., your student status and evaluations will not be affected). We will act in accordance with the guidelines for the protection of human research participants issued by the Institutional Review Board (IRB) and Office of Research Compliance (ORC). Your identity on records relevant to this study will not be made public. Any publications resulting from this research will not mention your name or any other personally identifying information.

It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research. The sponsor (VTCRI) or their appointed designees as well as the IRB, ORC, or other institutional oversight offices will be granted direct access to your original research records for verification of data. If your record is used or distributed for government purposes, this will be done under conditions that will protect your privacy. You will be informed of any significant new findings that may relate to your continued participation in this study.

The study team must release certain information to the appropriate authorities if at any time during the study there is concern that child abuse or elder abuse has possibly occurred or you disclose a desire to harm yourself or others.

Compensation

You will receive \$15 compensation for the consent session, up to \$6 compensation for completing the daily self-reports of alcohol use during the initial 6-day period, \$30 compensation for the pre-intervention assessment session, and up to \$56 for submitting the breathalyzer samples and reporting previous-day drinking for the 14-day intervention period. You will also receive \$30 for each of the two additional assessment sessions and \$50 for returning your SOBERLINK device and prepaid cell phone (if applicable). These payments will be up to \$217 per participant, but may be less.

If you receive compensation greater than \$600.00 for research participation (not limited to this study), the amount received will be reported to the IRS and you will receive an IRS 1099 Form. We will collect social security numbers and retain them for IRS and auditing purposes.

Alternative to Participation

You do not have to participate in this study if you do not wish to. Your employment status, student status, grades, extracurricular activities, or medical treatment will not be affected in any way. You can find a list of local AA meetings at <http://aaroanoke.org/> and other treatment services in the area at

http://local.soberrecovery.com/Alcohol_Rehab_Roanoke_VA-r1298538-Roanoke_VA.html.

We are not affiliated with or endorse the services listed in either of these resources.

Subject's Responsibilities

I voluntarily agree to participate in this study. I have the following responsibilities:

- Answer questions about health, and past and current substance and alcohol use
- Provide breath samples to test for recent alcohol use
- Complete laboratory assessments
- Notify the researchers if I experience any discomfort or would like to discontinue participation from this study
- Let the researchers know if I have any comments, questions or concerns regarding participation in this study

Subject's Permission/Statement of Consent

The purpose and voluntary nature of this study, as well as the potential benefits and risks that are involved have been explained to me. I have read the Consent Form and conditions of the project. I have been able to ask questions and express concerns, which have been satisfactorily responded to by the study team. I have been told that I will be given a copy of this consent form. I hereby acknowledge the above and give my informed and free consent to be a participant in this study. I

recognize that I am not waiving any of my rights as a research participant by signing this consent form.

If you have questions about this study, please contact Dr. Warren Bickel, the Principal Investigator at 540-526-2088 (Telephone)/wkbickel@vtc.vt.edu (e-mail). If you have any questions about your rights as a research subject or concerning a research related injury, you can call Dr. David M. Moore at the Virginia Tech Institutional Review Board for the Protection of Human Subjects at 540-231-4991 (Telephone)/moored@vt.edu (e-mail).

APPENDIX 9

Treatment Services Review Questionnaire.

* How many days in the past week have you:

	Number of days
drank any alcohol?	... ▾
drank any alcohol to the point of intoxication?	... ▾
been in inpatient treatment for an alcohol problem?	... ▾
received medication to help you to detoxify from alcohol?	... ▾
received medication to prevent you from drinking?	... ▾
received a blood alcohol test (e.g., breathalyzer)?	... ▾

* How many times in the past week have you:

	Number of times
attended an alcohol education session?	... ▾
attended an AA or 12-step meeting?	... ▾
attended an alcohol relapse prevention meeting?	... ▾
had a significant discussion pertinent to your alcohol problems in an individual session?	... ▾
had a significant discussion pertinent to your alcohol problems in a group session?	... ▾

APPENDIX 10

Readiness to Change Questionnaire (RtC).

* The following questions are designed to identify how you personally feel about your drinking right now. Please read each of the following questions carefully, and then decide whether you agree or disagree with the statements. Please select the answer of your choice to each question.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
I don't think I drink too much.	<input type="radio"/>				
I am trying to drink less than I used to.	<input type="radio"/>				
I enjoy my drinking, but sometimes I drink too much.	<input type="radio"/>				
Sometimes I think I should cut down on my drinking.	<input type="radio"/>				
It's a waste of time thinking about my drinking.	<input type="radio"/>				
I have just recently changed my drinking habits.	<input type="radio"/>				
Anyone can talk about wanting to do something about drinking, but I am actually doing something about it.	<input type="radio"/>				
I am at the stage where I should think about drinking less alcohol.	<input type="radio"/>				
My drinking is a problem sometimes.	<input type="radio"/>				
There is no need for me to think about changing my drinking habits.	<input type="radio"/>				
I am actually changing my drinking habits right now.	<input type="radio"/>				
Drinking less alcohol would be pointless for me.	<input type="radio"/>				

APPENDIX 11

Alcohol Use Disorders Identification Test (AUDIT).

The Alcohol Use Disorders Identification Test: Interview Version Read questions as written. Record answers carefully. Begin the AUDIT by saying "Now I am going to ask you some questions about your use of alcoholic beverages during this past year." Explain what is meant by "alcoholic beverages" by using local examples of beer, wine, vodka, etc. Code answers in terms of "standard drinks". Place the correct answer number in the box at the right.	
1. How often do you have a drink containing alcohol? (0) Never [Skip to Qs 9-10] (1) Monthly or less (2) 2 to 4 times a month (3) 2 to 3 times a week (4) 4 or more times a week	<input type="checkbox"/>
2. How many drinks containing alcohol do you have on a typical day when you are drinking? (0) 1 or 2 (1) 3 or 4 (2) 5 or 6 (3) 7, 8, or 9 (4) 10 or more	<input type="checkbox"/>
3. How often do you have six or more drinks on one occasion? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily Skip to Questions 9 and 10 if Total Score for Questions 2 and 3 = 0	<input type="checkbox"/>
4. How often during the last year have you found that you were not able to stop drinking once you had started? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	<input type="checkbox"/>
5. How often during the last year have you failed to do what was normally expected from you because of drinking? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	<input type="checkbox"/>
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	<input type="checkbox"/>
7. How often during the last year have you had a feeling of guilt or remorse after drinking? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	<input type="checkbox"/>
8. How often during the last year have you been unable to remember what happened the night before because you had been drinking? (0) Never (1) Less than monthly (2) Monthly (3) Weekly (4) Daily or almost daily	<input type="checkbox"/>
9. Have you or someone else been injured as a result of your drinking? (0) No (2) Yes, but not in the last year (4) Yes, during the last year	<input type="checkbox"/>
10. Has a relative or friend or a doctor or another health worker been concerned about your drinking or suggested you cut down? (0) No (2) Yes, but not in the last year (4) Yes, during the last year	<input type="checkbox"/>
Record total of specific items here	
If total is greater than recommended cut-off, consult User's Manual.	

APPENDIX 12

Study 2 Active Implementation Intention Worksheet

EXAMPLE

Date:

Participant ID:

Link critical situations with appropriate responses that you might find useful by drawing a line between them. You may link as many as you like.

Critical Situations	Responses
<input type="checkbox"/> I am tempted to drink when I am excited	<input type="checkbox"/> I will will keep things around my home or work that remind me not to drink.
<input type="checkbox"/> I am tempted to drink when I am with others who are drinking a lot	<input type="checkbox"/> I will will engage in some physical activity when I get the urge to drink.
<input type="checkbox"/> I am tempted to drink when things are not going my way and I am frustrated	<input type="checkbox"/> I will do something nice for myself for making efforts to change.
<input type="checkbox"/> I am tempted to drink when I am really happy	<input type="checkbox"/> I will talk with at least one special person about my drinking experiences.
<input type="checkbox"/> I am tempted to drink when my friends push me to keep up with their drinking	<input type="checkbox"/> I will tell myself that I can choose to change or not to change.
<input type="checkbox"/> I am tempted to drink when I am feeling depressed	<input type="checkbox"/> I will stop to think about how my drinking is hurting people around me.
<input type="checkbox"/> I am tempted to drink when I am having fun with friends	<input type="checkbox"/> I will consider that feeling good about myself includes changing my drinking behavior.
<input type="checkbox"/> I am tempted to drink when other people encourage me to have a drink	<input type="checkbox"/> I will talk to someone in my life that helps me to face my drinking problem.
<input type="checkbox"/> I am tempted to drink when I am very anxious and stressed	<input type="checkbox"/> I will remove things from my home or work that remind me of drinking.
<input type="checkbox"/> I am tempted to drink when I am offered a drink by someone	<input type="checkbox"/> I will calm myself when I get the urge to drink.
<input type="checkbox"/> I am tempted to drink when I am feeling angry	<input type="checkbox"/> I will avoid people who encourage drinking.
<input type="checkbox"/> I am tempted to drink when things are going really well for me	<input type="checkbox"/> I will avoid situations that encourage me to drink.
<input type="checkbox"/> I am tempted to drink when I go to a party where there is a lot of drinking	<input type="checkbox"/> I will try to think about other things when I begin to think about drinking.
<input type="checkbox"/> I am tempted to drink when there are drinking games going on	<input type="checkbox"/> I will make myself aware that I can choose to overcome my drinking if I will want to.
<input type="checkbox"/> I am tempted to drink when I am with someone I am attracted to	<input type="checkbox"/> I will do something else instead of drinking when I need to deal with tension.
<input type="checkbox"/> I am tempted to drink when I am with others who are focusing on drinking	<input type="checkbox"/> I will tell myself that if I try hard enough I can keep from drinking.
<input type="checkbox"/> I am tempted to drink when I am feeling shy	<input type="checkbox"/> I will leave places where people are drinking.
<input type="checkbox"/> I am tempted to drink when I feel like keeping up with my friends drinking	<input type="checkbox"/> I will stay away from places I generally associated with my drinking.
<input type="checkbox"/> I am tempted to drink when I am nervous about being socially outgoing	<input type="checkbox"/> I will spend time with people who reward me for not drinking.
<input type="checkbox"/> I am tempted to drink when I am concerned about someone	<input type="checkbox"/> I will attend meetings to express how emotionally destructive drinking is in my life.
<input type="checkbox"/> I am tempted to drink when I see others drinking at a bar or at a party	<input type="checkbox"/> I will make commitments to myself not to drink.
<input type="checkbox"/> I am tempted to drink when I am very worried	<input type="checkbox"/> I will change my diet to help me overcome drinking.
<input type="checkbox"/> I am tempted to drink when I have the urge to try just one drink to see what happens	<input type="checkbox"/> I will go places where drinking is not generally accepted.
<input type="checkbox"/> I am tempted to drink when I dream about taking a drink	<input type="checkbox"/> I will think about the type of person I will be if I am in control of my drinking.

Date:

Participant ID:

Link critical situations with appropriate responses that you might find useful by drawing a line between them. You may link as many as you like.

Critical Situations	Responses
<input type="checkbox"/> I am tempted to drink when I am excited	<input type="checkbox"/> I will keep things around my home or work that remind me not to drink.
<input type="checkbox"/> I am tempted to drink when I am with others who are drinking a lot	<input type="checkbox"/> I will engage in some physical activity when I get the urge to drink.
<input type="checkbox"/> I am tempted to drink when things are not going my way and I am frustrated	<input type="checkbox"/> I will do something nice for myself for making efforts to change.
<input type="checkbox"/> I am tempted to drink when I am really happy	<input type="checkbox"/> I will talk with at least one special person about my drinking experiences.
<input type="checkbox"/> I am tempted to drink when my friends push me to keep up with their drinking	<input type="checkbox"/> I will tell myself that I can choose to change or not to change.
<input type="checkbox"/> I am tempted to drink when I am feeling depressed	<input type="checkbox"/> I will stop to think about how my drinking is hurting people around me.
<input type="checkbox"/> I am tempted to drink when I am having fun with friends	<input type="checkbox"/> I will consider that feeling good about myself includes changing my drinking behavior.
<input type="checkbox"/> I am tempted to drink when other people encourage me to have a drink	<input type="checkbox"/> I will talk to someone in my life that helps me to face my drinking problem.
<input type="checkbox"/> I am tempted to drink when I am very anxious and stressed	<input type="checkbox"/> I will remove things from my home or work that remind me of drinking.
<input type="checkbox"/> I am tempted to drink when I am offered a drink by someone	<input type="checkbox"/> I will calm myself when I get the urge to drink.
<input type="checkbox"/> I am tempted to drink when I am feeling angry	<input type="checkbox"/> I will avoid people who encourage drinking.
<input type="checkbox"/> I am tempted to drink when things are going really well for me	<input type="checkbox"/> I will avoid situations that encourage me to drink.
<input type="checkbox"/> I am tempted to drink when I go to a party where there is a lot of drinking	<input type="checkbox"/> I will try to think about other things when I begin to think about drinking.
<input type="checkbox"/> I am tempted to drink when there are drinking games going on	<input type="checkbox"/> I will make myself aware that I can choose to overcome my drinking if I will want to.
<input type="checkbox"/> I am tempted to drink when I am with someone I am attracted to	<input type="checkbox"/> I will do something else instead of drinking when I need to deal with tension.
<input type="checkbox"/> I am tempted to drink when I am with others who are focusing on drinking	<input type="checkbox"/> I will tell myself that if I try hard enough I can keep from drinking.
<input type="checkbox"/> I am tempted to drink when I am feeling shy	<input type="checkbox"/> I will leave places where people are drinking.
<input type="checkbox"/> I am tempted to drink when I feel like keeping up with my friends drinking	<input type="checkbox"/> I will stay away from places I generally associated with my drinking.
<input type="checkbox"/> I am tempted to drink when I am nervous about being socially outgoing	<input type="checkbox"/> I will spend time with people who reward me for not drinking.
<input type="checkbox"/> I am tempted to drink when I am concerned about someone	<input type="checkbox"/> I will attend meetings to express how emotionally destructive drinking is in my life.
<input type="checkbox"/> I am tempted to drink when I see others drinking at a bar or at a party	<input type="checkbox"/> I will make commitments to myself not to drink.
<input type="checkbox"/> I am tempted to drink when I am very worried	<input type="checkbox"/> I will change my diet to help me overcome drinking.
<input type="checkbox"/> I am tempted to drink when I have the urge to try just one drink to see what happens	<input type="checkbox"/> I will go places where drinking is not generally accepted.
<input type="checkbox"/> I am tempted to drink when I dream about taking a drink	<input type="checkbox"/> I will think about the type of person I will be if I am in control of my drinking.

Date:

Participant ID:

Pick 3 situation-response **pairs** that you linked previously (or as many as you linked if less than 3) and write them below. Pick the 3 you think will be most useful for you. Add "if" the the start of each situation and "then" to the start of each response to create a sentence like the example below.

EXAMPLE: *IF I am tempted to drink when there are arguments and conflicts, THEN I will put things around my home that remind me not to drink.*

1)

2)

3)

APPENDIX 13

Study 2 Control Implementation Intention Worksheet

EXAMPLE

Date:

Participant ID:

Check critical situations and responses that you might find useful. You may check as many as you like.

Critical Situations	Responses
<input type="checkbox"/> I am tempted to drink when I am excited	<input checked="" type="checkbox"/> I will keep things around my home or work that remind me not to drink.
<input type="checkbox"/> I am tempted to drink when I am with others who are drinking a lot	<input type="checkbox"/> I will engage in some physical activity when I get the urge to drink.
<input checked="" type="checkbox"/> I am tempted to drink when things are not going my way and I am frustrated	<input checked="" type="checkbox"/> I will do something nice for myself for making efforts to change.
<input type="checkbox"/> I am tempted to drink when I am really happy	<input type="checkbox"/> I will talk with at least one special person about my drinking experiences.
<input type="checkbox"/> I am tempted to drink when my friends push me to keep up with their drinking	<input type="checkbox"/> I will tell myself that I can choose to change or not to change.
<input checked="" type="checkbox"/> I am tempted to drink when I am feeling depressed	<input checked="" type="checkbox"/> I will stop to think about how my drinking is hurting people around me.
<input checked="" type="checkbox"/> I am tempted to drink when I am having fun with friends	<input type="checkbox"/> I will consider that feeling good about myself includes changing my drinking behavior.
<input type="checkbox"/> I am tempted to drink when other people encourage me to have a drink	<input type="checkbox"/> I will talk to someone in my life that helps me to face my drinking problem.
<input type="checkbox"/> I am tempted to drink when I am very anxious and stressed	<input checked="" type="checkbox"/> I will remove things from my home or work that remind me of drinking.
<input type="checkbox"/> I am tempted to drink when I am offered a drink by someone	<input type="checkbox"/> I will calm myself when I get the urge to drink.
<input type="checkbox"/> I am tempted to drink when I am feeling angry	<input type="checkbox"/> I will avoid people who encourage drinking.
<input type="checkbox"/> I am tempted to drink when things are going really well for me	<input type="checkbox"/> I will avoid situations that encourage me to drink.
<input type="checkbox"/> I am tempted to drink when I go to a party where there is a lot of drinking	<input type="checkbox"/> I will try to think about other things when I begin to think about drinking.
<input checked="" type="checkbox"/> I am tempted to drink when there are drinking games going on	<input checked="" type="checkbox"/> I will make myself aware that I can choose to overcome my drinking if I will want to.
<input type="checkbox"/> I am tempted to drink when I am with someone I am attracted to	<input type="checkbox"/> I will do something else instead of drinking when I need to deal with tension.
<input type="checkbox"/> I am tempted to drink when I am with others who are focusing on drinking	<input type="checkbox"/> I will tell myself that if I try hard enough I can keep from drinking.
<input checked="" type="checkbox"/> I am tempted to drink when I am feeling shy	<input type="checkbox"/> I will leave places where people are drinking.
<input type="checkbox"/> I am tempted to drink when I feel like keeping up with my friends drinking	<input type="checkbox"/> I will stay away from places I generally associated with my drinking.
<input type="checkbox"/> I am tempted to drink when I am nervous about being socially outgoing	<input type="checkbox"/> I will spend time with people who reward me for not drinking.
<input type="checkbox"/> I am tempted to drink when I am concerned about someone	<input checked="" type="checkbox"/> I will attend meetings to express how emotionally destructive drinking is in my life.
<input type="checkbox"/> I am tempted to drink when I see others drinking at a bar or at a party	<input type="checkbox"/> I will make commitments to myself not to drink.
<input type="checkbox"/> I am tempted to drink when I am very worried	<input type="checkbox"/> I will change my diet to help me overcome drinking.
<input type="checkbox"/> I am tempted to drink when I have the urge to try just one drink to see what happens	<input checked="" type="checkbox"/> I will go places where drinking is not generally accepted.
<input checked="" type="checkbox"/> I am tempted to drink when I dream about taking a drink	<input type="checkbox"/> I will think about the type of person I will be if I am in control of my drinking.

Date:

Participant ID:

Check critical situations and responses that you might find useful. You may check as many as you like.

Critical Situations	Responses
<input type="checkbox"/> I am tempted to drink when I am excited	<input type="checkbox"/> I will keep things around my home or work that remind me not to drink.
<input type="checkbox"/> I am tempted to drink when I am with others who are drinking a lot	<input type="checkbox"/> I will engage in some physical activity when I get the urge to drink.
<input type="checkbox"/> I am tempted to drink when things are not going my way and I am frustrated	<input type="checkbox"/> I will do something nice for myself for making efforts to change.
<input type="checkbox"/> I am tempted to drink when I am really happy	<input type="checkbox"/> I will talk with at least one special person about my drinking experiences.
<input type="checkbox"/> I am tempted to drink when my friends push me to keep up with their drinking	<input type="checkbox"/> I will tell myself that I can choose to change or not to change.
<input type="checkbox"/> I am tempted to drink when I am feeling depressed	<input type="checkbox"/> I will stop to think about how my drinking is hurting people around me.
<input type="checkbox"/> I am tempted to drink when I am having fun with friends	<input type="checkbox"/> I will consider that feeling good about myself includes changing my drinking behavior.
<input type="checkbox"/> I am tempted to drink when other people encourage me to have a drink	<input type="checkbox"/> I will talk to someone in my life that helps me to face my drinking problem.
<input type="checkbox"/> I am tempted to drink when I am very anxious and stressed	<input type="checkbox"/> I will remove things from my home or work that remind me of drinking.
<input type="checkbox"/> I am tempted to drink when I am offered a drink by someone	<input type="checkbox"/> I will calm myself when I get the urge to drink.
<input type="checkbox"/> I am tempted to drink when I am feeling angry	<input type="checkbox"/> I will avoid people who encourage drinking.
<input type="checkbox"/> I am tempted to drink when things are going really well for me	<input type="checkbox"/> I will avoid situations that encourage me to drink.
<input type="checkbox"/> I am tempted to drink when I go to a party where there is a lot of drinking	<input type="checkbox"/> I will try to think about other things when I begin to think about drinking.
<input type="checkbox"/> I am tempted to drink when there are drinking games going on	<input type="checkbox"/> I will make myself aware that I can choose to overcome my drinking if I will want to.
<input type="checkbox"/> I am tempted to drink when I am with someone I am attracted to	<input type="checkbox"/> I will do something else instead of drinking when I need to deal with tension.
<input type="checkbox"/> I am tempted to drink when I am with others who are focusing on drinking	<input type="checkbox"/> I will tell myself that if I try hard enough I can keep from drinking.
<input type="checkbox"/> I am tempted to drink when I am feeling shy	<input type="checkbox"/> I will leave places where people are drinking.
<input type="checkbox"/> I am tempted to drink when I feel like keeping up with my friends drinking	<input type="checkbox"/> I will stay away from places I generally associated with my drinking.
<input type="checkbox"/> I am tempted to drink when I am nervous about being socially outgoing	<input type="checkbox"/> I will spend time with people who reward me for not drinking.
<input type="checkbox"/> I am tempted to drink when I am concerned about someone	<input type="checkbox"/> I will attend meetings to express how emotionally destructive drinking is in my life.
<input type="checkbox"/> I am tempted to drink when I see others drinking at a bar or at a party	<input type="checkbox"/> I will make commitments to myself not to drink.
<input type="checkbox"/> I am tempted to drink when I am very worried	<input type="checkbox"/> I will change my diet to help me overcome drinking.
<input type="checkbox"/> I am tempted to drink when I have the urge to try just one drink to see what happens	<input type="checkbox"/> I will go places where drinking is not generally accepted.
<input type="checkbox"/> I am tempted to drink when I dream about taking a drink	<input type="checkbox"/> I will think about the type of person I will be if I am in control of my drinking.

Date:

Participant ID:

Pick 3 situations **or** responses that you chose previously (or as many as you chose if less than 3). Pick the 3 you think will be most useful for you. Write them word-for-word below as shown in the examples below.

EXAMPLE: *I am tempted to drink when there are arguments and conflicts with family and friends*

EXAMPLE: *I put things around my home that remind me not to drink*

1)

2)

3)

APPENDIX 14

Timeline Followback for Alcoholic Drinks.

Timeline Followback: Alcohol

Fill in the blanks of the following statements:

I typically buy _____ (number of drinks) per **day / week / month** (circle one).

When I buy this amount, this typically costs \$_____.

I typically drink _____ standard drinks per day.

On the days that I drink, I am drunk for approximately _____ hours.

PARTICIPANT ID XC0000
TODAY'S DATE 4/12/17

QUANTITY CHART	
1 standard drink is equal to	
One 12-ounce glass or can of beer	<input type="checkbox"/>
One 5-ounce glass of wine	<input type="checkbox"/>
One drink containing 1 shot of liquor	<input type="checkbox"/>

Instructions

1. Start by marking events on the calendar that fell within this time frame. Some of these might include: birthdays, appointments, sports events, payday, church, alcohol purchase, and stressful situations. Write the event on the calendar on the day it occurred.
2. Thinking about the events in your life that are written on the calendar, what is the longest number of days you went without drinking at all, not even once? How many days? When did that occur? Mark alcohol free days on the calendar by writing 0 on those days.
3. Now, think about your typical pattern of use (if you have one). Start with weekdays. What time of day do you start drinking and when do you stop? How many drinks would that be? You stated above how you use alcohol, so just mark on the calendar what you had based on the terms used in the chart above. Now do the same for weekends. Use the events on your calendar as a memory aid.
4. Now think about different than average days. What happened to make your alcohol use different? Mark on the calendar, in standard drinks, how much alcohol you used on these days.
5. When you have completed the calendar, each day should contain a response about whether you used alcohol and how much you used. Although we want you to complete the calendar as accurately as possible, we realise that it is hard for anyone to recall things perfectly. So, if you're not exactly sure whether something happened on a Monday or a Thursday of a certain week, just give it your best guess. Or if you can't remember whether you had 2 or 4 drinks, choose the middle of the range. The important thing is that 2 to 4 drinks is very different than 6 to 8 drinks.

Calendar

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
			March 16	17	18	19
March 20	21	22	23	24	25	26
March 27	28	29	30	31	April 1	2
April 3	4	5	6	7	8	9
April 10	11	12				