Experimental Manipulation of

Motivation and Self-Efficacy for Self-Control

by

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ABSTRACT

Self-control has been shown to be an important influence behind a variety of risk and protective behaviors, such as substance abuse. Although prior research points to the existence of multiple dimensions of self-control, this concept is not consistently defined and frequently only studied as a conglomerate in clinical research. The current study sought to examine how two experimental manipulations of subcomponents of self-control (motivation and self-efficacy) affect real-world consumptive behavior after accounting for executive function. Additionally, the validity and reliability of a brief state survey measure of perceived self-control capacity, internal motivation, and external motivation was tested. The goal was to examine how basic scientific principles involved in self-control translate into clinically relevant behaviors, which may inform understanding of momentary lapses in self-control behavior, potentially leading to novel prevention and intervention efforts. 94 college students completed a 1-2 hour laboratory protocol during which they completed survey and laboratory-based tasks of self-control and related behaviors, executive function, and ad libitum alcohol consumption. Results showed that the self-efficacy manipulation successfully increased perceived self-control capacity, although this did not lead to a significant reduction in consumption. The motivation manipulation neither increased motivation nor reduced consumption in this sample. However, the brief state survey measure of self-control subcomponents demonstrated strong test-retest reliability and distinction from trait self-control, demonstrating its viability for use in future research. By elucidating the relationships between specific mechanisms of self-control, laboratory-based tasks and manipulations, and real-world consumptive behaviors, prevention and intervention efforts for problems such as alcohol

abuse may be tailored to the needs of the individual and made more impactful and cost-effective.

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TABLE OF CONTENTS

Page

Page

APPENDIX

LIST OF TABLES

Table Page

LIST OF FIGURES

Self-control, commonly defined as the general concept of regulating one's behavior (and sometimes also thoughts and emotions), has been linked to a broad range of life outcomes and behaviors. Individuals who exhibit high levels of self-control tend to exercise a variety of protective behaviors and achieve associated positive life outcomes such as high academic achievement, better interpersonal relationships, higher levels of physical exercise, healthier diets, and more weight loss success (Tangney, Baumeister, & Boone, 2004; Schroder, Ollis, & Davies, 2013). Conversely, the lack of good self-control is recognized as a strong longitudinal predictor of serious risks such as substance dependence, poor physical health, financial problems, and criminality (Moffitt et al., 2011). Trait-like habitual self-control is further associated with positive health outcomes above and beyond in-the-moment resistance of impulses (Schroder et al., 2013), suggesting that there is more to the concept of self-control than inhibition alone. Nevertheless, our understanding of the multidimensional nature of self-control is still evolving.

Although some researchers view self-control as a unidimensional construct, ranging from poor to good behavioral control (e.g., Dick et al., 2010), others subscribe to a dual process model, which posits that good and poor self-control function through different mechanisms (Hofmann, Friese, & Strack, 2009). From the point of view of a dual systems perspective, good self-control is a more deliberate top-down regulatory process that involves monitoring and adjusting one's behavior in anticipation of consequences, delaying gratification, inhibiting problematic behaviors, and engaging in goal-directed behaviors. Poor self-control, on the other hand, is seen as a more automatic bottom-up impulse that interferes with the ability to plan, delay gratification, anticipate

consequences, and modify one's behavior appropriately. Speaking to this distinction, prior studies have found only modest negative correlations (-.13 to -.50) between measures of good and poor self-control (Pearson, Kite, & Henson, 2013). The proposed study focuses on the concept of "good" or top-down self-control, with measures of bottom-up impulsivity included as potential covariates to isolate the impact of top-down self-control on consumptive behavior.

Much of the literature in the area of clinical psychology has focused on studying trait or dispositional self-control via self-report measures. One of the most commonly used measures, the Brief Self-Control Scale (BSCS; Tangney et al., 2004), is a 13-item single factor questionnaire that taps into various self-control behaviors. The convenience of this measure has facilitated research into many domains of self-control and related behaviors across different populations and disciplines. However, it is possible that this unidimensional measure of self-control fails to capture important subcomponents of top-down regulatory control. Consistent with this possibility, bottom-up or "poor" self-control has clearly been demonstrated to be multidimensional in nature and there are well-validated measures to capture these dimensions. For example, the UPPS Impulsive Behavior Scale separates impulsivity into sensation seeking, urgency, and lack of perseverance and premeditation (Whiteside & Lynam, 2001). High sensation seeking and lack of premeditation consistently predict alcohol use, while elevated urgency and lack of perseverance predict alcohol problems but not use (Magid & Colder, 2007; Magid, MacLean, & Colder, 2007). Given the multidimensional nature of poor self-control, it seems likely that top-down or "good" self-control may also contain multiple facets.

In fact, several multidimensional models of self-control based on the BSCS have been proposed. Ferrari, Stevens, and Jason (2009) examined self-control in a clinical sample of adults in residential abstinence-based recovery programs and found that the BSCS split into two factors. They noted that the impulsivity factor, which consisted of 4 of the 13 BSCS items, was more strongly related to length of abstinence than the general self-discipline factor, which consisted of the remaining items. It important to note that the 4 items they used to make up the construct of what they called impulsivity were the only 4 non-reverse-scored items on the BSCS and their factor analysis may have therefore been influenced by phrasing effects. Nevertheless, they noted that, while this made theoretical sense and was generally supported by previous literature, the overall variance explained by this factor analysis was less than optimal. Maloney, Grawitch, and Barber (2012) similarly tested a two-factor model using 8 of the higher loading BSCS items and identified restraint and impulsivity as separate factors. Based on online surveys with undergraduates and community adults, they found that restraint and impulsivity differentially predicted counterproductive workplace behaviors and emotional exhaustion. A third study examined the potential distinction between initiatory and inhibitory self-control in two samples of students (de Ridder, de Boer, Lugtig, Bakker, & van Hooft, 2011). The authors performed confirmatory factor analyses of a two-factor model based on their theoretical categorization of 10 of the 13 BSCS items and found reasonable model fit. Not surprisingly, they found that inhibitory self-control better predicted engagement in undesired health and academic behaviors, while initiatory self-control better predicted engagement in desired behaviors.

More recently, Lindner, Nagy, and Retelsdorf (2015) tested these three two-factor models against a one-factor model of the BSCS in two samples of German vocational and university students. They found that all three multidimensional models had better model fit than the unidimensional model (although overall model fit was generally not acceptable) across samples, with the strongest replication support for the Ferrari et al. (2009) model. Again, they noted that this model may have been confounded by phrasing effects. When they looked at external validity via relationships with perceived academic and work-related outcome variables, they found that the subscales related differentially to the outcomes in all three models. However, they found that overall, the unidimensional model either outperformed or was very similar to the other models in terms of predicting outcomes, and therefore concluded that a unidimensional model may be more parsimonious and cost-effective. This conclusion was based on the observation that the three proposed two-factor models of the BSCS did not provide sufficiently stronger predictive power than the unidimensional conceptualization to merit its rejection. Nevertheless, the patterns of improvement in model fit and differential relationships with outcomes point to a potentially multidimensional nature of self-control that may not have yet been adequately captured.

Further support for the potential multidimensionality of self-control comes from lab-based studies of "ego-depletion." While most researchers agree that self-control cannot be exercised indefinitely, the mechanism of its decline is elusive. Much of the early work on self-control was dominated by the strength model (Baumeister, Bratslavsky, Muraven, & Tice, 1998), which views self-control as a limited resource that can be depleted with use. The literature is replete with experiments examining this "ego

depletion" phenomenon, defined as the exhaustion of internal resources or capacity to engage in self-control. In practice, ego depletion is operationalized as worse self-control behavior observed on subsequent self-control tasks. Although the strength model dominated the early work on this topic, studies have now implicated many potential mechanisms for diminishing self-control performance on later tasks of self-control. Potential mechanisms, for example, include engaging in decision-making (Vohs et al., 2014), viewing one's capacity for self-control as limited (Job, Dweck, & Walton, 2010), and emotional labor (Diestel, Rivkin, & Schmidt, 2015). The heterogeneity of these influences on self-control performance has led many researchers to call into question the idea that depletion of a limited resource is truly responsible for the observed phenomenon.

Although the specific mechanisms of worsening performance on successive self-control tasks remain a topic of debate, motivation seems to play a critical role beyond the influence of self-control capacity. There is considerable research into the interplay between motivation and self-control behavior, and many researchers favor the impact of motivation to achieve outcomes of interest over other models, such as the energy/glucose model of self-control (Molden et al., 2012). Brain imaging studies also suggest that motivation for self-control is related to unique brain mechanisms. For example, Kouneiher, Charron, & Koechlin (2009) found that motivation is a dissociable function associated with the prefrontal cortex, and Locke & Braver (2008) found evidence of changes in brain activity based on whether or not participants were incentivized with reward or punishment.

In a meta-analysis of 83 studies of ego depletion conducted by Hagger, Wood, Stiff, & Chatzisarantis (2010), results indicated that motivational incentives promoted better performance after a depleting task, suggesting that sufficient motivation can overcome depletion of self-control resources. Another recent meta-analysis of ego depletion by Carter, Kofler, Forster, & McCullough (2015) found little evidence that a depleting task affects future laboratory tasks, regardless of level of motivation. These findings are in direct opposition to the strength model of self-control, which presumes that the capacity to control oneself is affected by exertion. However, it is possible that this inconsistency could be resolved with a more thorough examination of the subcomponents of self-control.

Although findings have not always been consistent across studies, prior works suggests that it is important to determine whether depletion happens when people are incapable of exercising further self-control or when they no longer want to (Muraven & Slessareva, 2003). Beyond the distinction between motivation and capacity for self-control, Inzlicht & Schmeichel (2012) suggest that attention may play a critical role. They suggest that engaging in a self-control task may reduce motivation to continue to control oneself, while also reducing attention to cues signaling the need for self-control and increasing attention to reward cues. This model fits well with the attention allocation model of alcohol response, which posits that alcohol narrows the range of cues one can focus on to only those that are most salient (Steele & Josephs, 1988), which are often cues for reward. This may explain, at least in part, why self-control failures occur under alcohol intoxication. Attention may also be an important component of one's capacity to

exert self-control, as the capacity for self-control depends upon one's ability to attend to cues related to self-control and inhibit cues related to reward.

It is important to note that diminished self-control does not inevitably lead to greater risk behavior due to changes in attentional control. This model argues that diminished self-control performance reflects a motivated reprioritization of goals (Inzlicht, Schmeichel, & Macrae, 2014), which may result in either positive or negative behaviors. Consistent with this idea, prior studies have demonstrated that altered states of self-control priorities are associated with various protective behaviors, such as greater social reciprocity (Halali, Bereby-Meyer, & Meiran, 2014). The attention allocation model of alcohol effects similarly suggests that intoxicated impairment of attention allocation can lead to health protective as well as health risk behaviors (Steele & Josephs, 1990), and there is empirical work to support this premise (MacDonald, Fong, Zanna, & Martineau, 2000). In many ways, the process model and attention allocation model maintain the idea of self-control capacity, though capacity is focused on attention, and diminished attentional capacity may only lead to risky behavior when the context (e.g., stronger cues for reward) supports such behavior. The process model, in particular, further supports the unique role of motivation, as distinct from capacity.

Although experimental studies show strong evidence for the importance of motivation in self-control behavior, results of survey-based studies suggest that motivation may be less important than skills or capacity. For example, Duckworth et al. (2015) examined self-control-related mechanisms behind the gender difference in children's grades in school by using a general umbrella measure of top-down and bottom-up self-control behaviors, as well as motivation to perform well in school. They found

that the better grades in girls were partially explained by girls' self-control behavior (as measured by the BSCS and impulsivity). However, contrary to teachers' judgments, girls were not necessarily more motivated to do well in school than boys. Similarly, Baay, de Ridder, Eccles, van der Lippe, & van Aken (2014) examined how self-control and motivation affect job search behavior. Self-control was measured using the BSCS and motivation to find a job was examined via a similar self-report measure that looked at both intrinsic and extrinsic sources of motivation based on the theory of Ryan & Deci (2000). This study found that searching for a job was much more strongly predicted by self-control than by motivation, and that this relationship was independent of motivation. The authors concluded that people who engaged in more proactive job searching behaviors may have done so because of adaptive habits or skills that are independent of motivation, and that job search interventions which frequently focus on boosting motivation should instead focus on bolstering self-control skills. Although these survey studies failed to find significant effects of motivation on behavior, this may have been a result of the particular behaviors under study. It may be that certain goals, such as job or grade attainment, are uniformly highly motivating, making variability in their achievement depend more on things like ability/skill and self-efficacy than motivation.

Given conflicting findings across lab and survey-based studies, it appears critical to capture both motivation and capacity when trying to understand self-control. To support such efforts, our team conducted several studies to support the development of a new self-report measure that captures both capacity and motivation for self-control (MASC; Papova & Corbin, manuscript submitted for publication; see Appendix A). Results suggested three distinct subscales (perceived capacity, internal motivation,

external motivation) with good internal consistency reliability. In addition, validity analyses indicated that motivation better predicted behaviors with greater motivational variability, such as substance use. Although motivation uniquely predicted certain behaviors, so did perceived capacity, further highlighting the need to capture both components to understand self-control behavior.

Although it is clearly linked to behavioral outcomes, it is difficult to know what is actually being captured by self-reports of capacity for self-control. Baumeister and colleagues might suggest that perceived self-control capacity is the total resource available, whereas Inzlicht and colleagues might focus more on an individual's ability to utilize said resource. While either or both of these mechanisms may be critical to self-control capacity, such distinctions would be difficult to measure precisely based on self-reports. Moreover, self-reports of perceived capacity are unlikely to overlap completely with the actual ability to engage in self-control. In fact, one might argue that perceived self-control capacity simply reflects self-efficacy, or the belief in one's ability to engage in self-control. In truth, perceived capacity is likely to reflect both the ability and the belief in one's ability to engage in self-control. Thus, efforts to examine the effects of self-efficacy for self-control may help isolate remaining variance due to the individual's "capacity" for self-control.

Unfortunately, comparatively little research has been conducted on self-efficacy for self-control, despite the fact that self-efficacy has long been viewed as an important driver of behavior, effort, and persistence (Bandura, 1977). In one of the few studies of relevance to self-efficacy for self-control, Gröpel and Kehr (2014) found that participants who were high on implicit achievement motives performed better on a Stroop task after

mastering a frustrating achievement task, presumably because they felt more capable after having experienced success. In an experimental study, Hutchinson, Sherman, Martinovic, & Tenenbaum, (2008) manipulated self-efficacy via false feedback and found that participants in the heightened self-efficacy condition found effortful physical tasks less strenuous, more enjoyable, and exhibited greater tolerance of these tasks than participants in the lowered self-efficacy or control conditions. These findings speak to the potential importance of self-efficacy for engaging in self-control behavior, though more research in this area is clearly needed.

In addition to further research on self-efficacy for self-control, the field would benefit from greater effort to integrate findings across survey and experimental studies. Almost all survey research thus far has been theoretically grounded in a trait model of self-control, whereas state self-control has primarily been examined through experimental manipulations and their impact on tasks that measure executive cognitive function (ECF). This separation may reflect, at least in part, differences in the way that social psychology studies (self-report) and cognitive science studies (experimental manipulations of task performance) tend to measure self-control. This lack of communication between disciplines within psychology regarding the study self-control makes it difficult to integrate findings about state and trait self-control.

In an effort to bridge this gap between disciplines, Hofmann, Schmeichel, & Baddeley (2012) recognized the potential value of desegregating the ECF and self-control literatures. They examined the three ECF domains proposed in 2012 by Miyake & Friedman (inhibition, switching, and updating) and found that each of these domains relates to self-control in a unique way. They concluded that these executive functions

promote self-control and training them may ultimately help improve self-regulation. Other studies have also found that ECF, particularly inhibition, is relevant to self-control behaviors such as ad libitum alcohol consumption (Field & Jones, 2017). Therefore, ECF is an important prerequisite for the ability to engage in self-control, but likely does not entirely account for it.

Within the social psychology literature, a meta-analysis of three questionnaires that measure trait bottom-up and top-down self-control found small to medium effects ($|\rho|$ = .19 to .26) of self-control on behavior (de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012). In addition to the self-report literature already reviewed, studies have found that trait self-control is predictive of subjective wellbeing through mechanisms such as avoidance and successful resolution of goal conflict (Hofmann, Luhmann, Fisher, Vohs, & Baumeister, 2014). However, changes in states related to self-control may also be important in understanding self-control behavior. While there are certainly limitations to using self-report measures, there are also many reasons why they are widely used and there is compelling evidence for the validity of their results (Ericsson & Simon, 1980; Haeffel & Howard, 2010). Thus, a more specific and sensitive measure of state self-control may lead to advances in our understanding of self-control in real-world settings.

State self-control is commonly overlooked in the self-report literature due, at least in part, to the lack of available self-report instruments with established reliability and validity. This is a major gap in the literature given that manipulations of self-control result in changes in performance on in-the-moment task performance using tasks that tap into executive cognitive function (ECF). For instance, as previously mentioned, a

phenomenon that resembles depletion, or a reprioritization of goals, occurs after participants are asked to engage in tasks that require effortful control. This depleted state can also be altered in a laboratory environment via the provision of motivation to continue to engage in self-control, such as monetary incentives (Brewer, Lau, Wingert, Ball, & Blais, 2017). Thus, although ECF can be characterized as a relatively stable trait, lab-based studies suggest that state ECF in the lab is important in understanding self-control behavior in the moment. Self-report measures of state self-control may have similar utility, and integration of self-report and behavioral measures of self-control may provide valuable insights regarding the factors that contribute to self-control behavior.

It is also important to improve our understanding of how state self-control relates to real-world behavioral outcomes, as most prior experimental research has focused on behavioral task performance as outcomes rather than real-world behaviors such as substance use. Furthermore, research into the specificity of self-control across various domains of life functioning is needed because it is unclear whether self-control is a general resource or whether different aspects of self-control relate uniquely to different behavioral outcomes. Speaking to potentially unique effects across different behaviors, a meta-analysis of three measures of self-control found large variation in effects of self-control across life domains such as achievement and adjustment (de Ridder et al., 2012). Moreover, a study of attention cues found that, when self-control is primed in one domain, it can help facilitate self-control in another domain (Kleiman, Trope, & Amodio, 2016). These findings point to the need to investigate various behaviors of interest separately as they relate to self-control. One such behavior that the current proposal hopes to explore is substance use.

Within the substance use literature, self-control failure has been extensively studied as domain-specific impaired control over alcohol use (Heather, Tebbutt, Mattick, & Zamir, 1993). For example, paradigms that provide incentives for participants to control their ad libitum alcohol consumption have found that participants struggle to exercise self-control even when their motivation to do so is bolstered (Leeman et al., 2013). In summary, multiple domains of self-control have been found to be an important predictor of alcohol use and consequences (Glassman, Werch, & Jobli, 2007; Wills, Walker, Mendoza, & Ainette, 2006). There is also evidence that interventions aimed at bolstering self-control, such as mindfulness meditation, may be useful in the treatment of addiction (Tang, Posner, Rothbart, & Volkow, 2015; Walters, 2000). The proposed study will therefore examine self-control in relation to alcohol consumption.

As noted previously, the field of self-control research may greatly benefit from a translational approach that brings together the examination of trait and state changes in self-control and separates the state-trait distinction from the behavioral task (e.g., ECF) vs. self-report distinction. While state self-report measures may be best suited to capturing motivation and self-efficacy for self-control, behavioral measures of performance on ECF tasks may better capture the "capacity" for engaging self-control mechanisms. One of the goals of the current proposal is to examine the extent to which self-control behavior is driven by trait ECF and how much additional variance can be accounted for by manipulations of state motivation and self-efficacy. Additionally, the proposed study will test the viability of a brief self-report measure of state self-control subcomponents (see Appendix B), and the extent to which scores on this measure

correspond to changes in self-control behavior following manipulations of state motivation and self-efficacy.

In summary, the proposed study attempts to bridge several gaps in the literature. First, the proposed study was the first to examine how experimental manipulations of subcomponents of self-control (motivation and self-efficacy) affect real-world consumptive behavior. Second, the impact on behavior was examined after accounting for three domains of ECF to demonstrate the extent to which motivation and self-efficacy for self-control add to the understanding of ad libitum consumption beyond basic cognitive functions necessary for engagement of self-control. Third, a brief state survey measure of several subcomponents of self-control was tested to see if it is viable to use when thorough experimental manipulation may not be possible. By translating basic scientific principles involved in self-control into clinically relevant behaviors, this work may inform our understanding of momentary lapses in self-control behavior, potentially leading to novel prevention and intervention efforts, and the tailoring of these efforts to the unique needs of each individual.

The proposed study tested the following hypotheses. First, motivation and self-efficacy manipulations were expected to result in less ad libitum consumption of drinks presumed to contain alcohol, relative to the control condition, controlling for baseline ECF. Second, the motivation manipulation was expected to exert a stronger influence on ad lib consumption relative to the self-efficacy manipulation. Third, the state version of the MASC was expected to be sensitive to changes in self-control motivation and perceived capacity resulting from their relevant manipulations. In other words, the motivation manipulation was expected to increase external motivation given the external

nature of the motivation manipulation (but not internal motivation or perceived capacity), which was expected to correlate with ad lib consumption. Similarly, the self-efficacy manipulation was expected to increase perceived capacity (but not internal or external motivation), which was expected to correlate with ad lib consumption. In the control condition, state self-control measures (motivation and perceived capacity) were expected to remain relatively unchanged or show minor declines due to fatigue, and these measures were not expected to correlate significantly with ad lib consumption.

Method

Participants

One-hundred eleven students enrolled in introductory psychology courses at Arizona State University who were at least 21 years of age were successfully recruited via email following the verification of their eligibility. Eligibility criteria included being at least 21 years of age and non-abstinent drinker status. Eligible participants were sent an email invitation to schedule an appointment and come in for a 1-2-hour in-person session at a simulated bar laboratory. Seventeen of 111 participants were excluded from analyses to preserve the integrity of the data. Participants were excluded if they did not believe the drinks contained alcohol or if an extraneous variable could have affected their results. Specifically, 14 participants who estimated their BAC as 0 on a questionnaire immediately following ad lib consumption, or did not receive this questionnaire (as it was added to the protocol later) and questioned whether or not the drinks contained alcohol on the debriefing survey, were excluded. One participant was excluded because he indicated that he had to leave immediately after the protocol to get to an exam. Thus, he had an incentive to get through the protocol quickly and consume less alcohol. One participant

was excluded due to an administrative error, which resulted in the participant having 5 extra minutes to consume the drinks. One participant was excluded for excessive distractibility based on supervisor observation.

The final sample for analyses comprised 94 students. They were predominantly male (64.9%) with a mean age of 23.31 (SD = 3.518). Race/ethnicity was 57.4% White, 20.2% Asian, 17 % Hispanic, 5.3% Black, 3.2% Middle Eastern, and 2.1% Other. They had a mean preference for mixed vodka beverages of 6.4 (SD = 2.53) on a 0-10 scale, drank alcohol a mean of 1.71 (SD = 1.16) times per week with a mean of 3.18 (SD = 2.05) drinks per occasion, and binge drank on a mean of 3.46 (SD = 3.66) days per month.

Measures

Demographic variables. During large group testing and prior to enrollment in the current study, participants were asked about their gender, race/ethnicity, and age. Age was used to determine eligibility. They were asked these questions again during the baseline survey battery to protect confidentiality and avoid linking data from the large group testing with data for the current study.

Self-control. Trait and state versions of the Multidimensional Assessment of Self-Control (MASC; Papova & Corbin, manuscript submitted for publication), both consisting of 15 items, were used to measure internal motivation, external motivation, and perceived capacity (e.g., self-efficacy) for self-control. Each item is rated on a 5-point Likert scale. Cronbach's alpha coefficients for the trait MASC in the current study were as follows: $\alpha = .842$ (5 items) for perceived capacity, $\alpha = .849$ (5 items) for internal motivation, and $\alpha = .900$ (5 items) for external motivation. The trait MASC also

demonstrates strong evidence of reliability and construct validity. For example, in the measurement development study, individual subscales were uniquely correlated with different behavioral outcomes. The trait MASC was related to, but relatively distinct from associated concepts such as conscientiousness, and preliminary longitudinal analyses showed that the MASC (internal motivation in particular) predicted change in alcohol use frequency over time (Papova & Corbin, manuscript submitted for publication). The reliability and validity of the state MASC was examined for the first time in the current study. Cronbach's alpha coefficients for the state MASC ranged from $\alpha = .874 - .915$ (5 items) for perceived capacity, $\alpha = .874 - .927$ (5 items) for internal motivation, and $\alpha = .929 - .963$ (5 items) for external motivation at three timepoints.

Impulsivity. Bottom-up influences that interfere with successful self-control were measured using the 59-item UPPS-P Impulsive Behavior Scale (UPPS-P; Lynam, Smith, Whiteside, & Cyders, 2006). The UPPS-P captures 5 aspects of impulsive behavior (premeditation, sensation seeking, positive urgency, negative urgency, and perseverance) with each item scored on a 4-point Likert scale. Internal consistency reliabilities of the subscale scores in the current study were as follows: negative urgency $\alpha = .802$ (12 items), positive urgency $\alpha = .943$ (14 items), perseverance $\alpha = .756$ (10 items), sensation seeking $\alpha = .825$ (12 items), premeditation $\alpha = .801$ (11 items).

Alcohol use and problems. Alcohol consumption was assessed using the three-item set recommended by the National Institute on Alcohol Abuse and Alcoholism (NIAAA). These questions ask about number of drinking days in a typical week (frequency), number of drinks on a typical drinking day (quantity), and number of binge drinking episodes in a typical month (binge). Alcohol-related problems were assessed

using the 24-item Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; Kahler, Strong, & Read, 2005), which assesses the experience of various alcohol-related problems within the past month using a dichotomous "yes/no" scale. Internal consistency reliability of scores on the BYAACQ in the current study was $\alpha = .826$.

Preference. Participants were asked one question about how much they enjoy mixed alcoholic beverages with vodka on a 1-10 Likert scale. This variable was used as a covariate in analyses predicting ad libitum consumption in the lab.

Estimated BAC. Participants were asked one question immediately after ad lib consumption that asked them to estimate their current blood alcohol content (BAC) on a 0.00 – 0.12 scale. This question was added to the protocol later and collected on 76 participants in the final sample, whose mean estimated BAC was .032 (SD = .022).

ECF. Response inhibition, or the ability to override an impulse, was assessed using the brief computerized version of the Cued Go/No Go task (Fillmore & Weafer, 2004), which requires participants to learn, then inhibit a dominant response. Participants learn to associate a go cue with a go target and a no-go cue with a no-go target, which are congruent 80% of the time. Participants' accuracy on no-go trials and reaction time on go trials were used as covariates in analyses which aimed to demonstrate effects above and beyond the predictive power of ECF. Updating, or the ability to use and modify information in one's working memory, was assessed using a shortened computerized version of the Operation Span Task (OSPAN; Turner & Engle, 1989; Foster et al., 2015), which requires participants to complete simple arithmetic problems while remembering an ordered string of letters presented between problems. The length of the string of letters varies to challenge participants' concentration. The OSPAN partial score was used,

which is calculated as the number of trials in which all letters were recalled correctly and in the correct order. This score gives partial credit for correct trials regardless of whether or not the entire set of trials is correct. Switching, or the cognitive flexibility required to move fluently between cognitive processes, was assessed using a modified paper-and-pencil version of the Trail Making Test (Reitan & Wolfson, 1985), which requires participants to connect numbers or alternate between connecting numbers and letters in sequence. Participants' score on the Trails A, which measures processing speed when connecting numbers only, was subtracted from their score on Trails B, which measures speed when switching between numbers and letters, to give a measure of switching that was less dependent on overall processing speed. While these tasks are not presumed to be entirely process-pure and contain some overlap, they have also been used in the literature to assess unique variability in the aforementioned domains of executive function. Therefore, they are intended to provide broad information about a person's overall cognitive functioning, as well as discrete information about the unique processes that comprise it. See Table 1 for means and standard deviations of ECF variables in the current sample. Overall, participants performed well on CGNG with few inhibition failures, which is typical for college samples (Corbin & Cronce, 2017). Scores on the OSPAN in the current study were similar to those reported in previous studies using this task (Foster et al., 2015; Unsworth, Heitz, Schrock, & Engle, 2005). Trails A and Trails B mean scores in all three conditions were within the average range for age (Mitrushina, Boone, Razani, & D'Elia, 2005). Therefore, ECF means suggested no ceiling or floor effects in the current sample.

Procedures

Participants attended a 1-2 hour individual laboratory session by appointment. Upon arrival in the laboratory, they first completed written informed consent. They were then taken to the simulated bar to complete baseline surveys, which assessed various constructs including trait and state self-control and alcohol use. The surveys took approximately 10 minutes to complete. Participants then completed a series of computer and paper ECF tasks, which included measures of inhibition, switching, and updating according to the Miyake et al. (2000) model of executive function. These tasks took approximately 30 minutes to complete. Immediately following the ECF tasks, participants completed a second state MASC survey asking about their self-control motivation and capacity at the current moment, which took approximately 3 minutes. Next, participants were randomly assigned to one of three conditions and received either a motivation manipulation, self-efficacy manipulation, or no manipulation (control), after which they completed an ad libitum consumption task where they tasted two drinks they believed contained alcohol. See Figure 1 for a visual overview of the protocol.

The motivation manipulation is based on a paradigm for impaired control of alcohol use developed by Leeman et al. (2013). Participants were told that they would complete one of the ECF tasks again after the ad libitum consumption period, that alcohol may impair their performance on this task, and that they may lose part or all of a bonus payment if they performed less well than the first time they completed the ECF task. Specifically, they were told that, following the repeat administration of the ECF task, they would either receive a $5 bonus (if they performed at a similar level) or the researcher would flip a coin and the participant would only have a 50% chance of getting a $5 bonus payment (if they performed worse than the first time they completed the task).

This manipulation was designed to simulate real-world uncertain consequences of alcohol use and motivate self-control over ad lib consumption.

In the self-efficacy manipulation condition, participants were given false feedback (Bandura, 1997; Hutchinson et al., 2008) about their ECF task performance and how that translates to their unusually high ability to control their behavior. After looking over a printout that looked like a task performance report, the researcher told the participant, "Oh wow, you did really well on these. This is one of the best scores I've seen from somebody in our study. You must be really good at controlling yourself." Control participants were simply taken to the next task with no feedback. The manipulations took negligible time (3 minutes for self-efficacy, 1 minute for motivation).

The ad libitum consumption task followed, under the premise that we were testing out two new drink mixers for a future study and we wanted participants' feedback about the palatability of these drinks. Flat tonic water was poured in view of the participant from a vodka bottle into 2 glasses with 2 different-colored mixers. Glasses were rimmed with alcohol to provide an olfactory cue. One mixer consisted of cranberry juice, citrus soda, and lime juice, and the other consisted of orange juice, citrus soda, and lime juice. Participants were led to believe that they were consuming alcohol, although the beverages only contained trace amounts of alcohol in the form of vodka floated on top of the drink from a lime juice bottle. They were instructed to drink as much or as little as they wanted to in order to rate the drinks on a variety of attributes such as taste and smell, which they recorded on 2 taste rating forms. These instructions were meant to encourage the participants to consume at least some volume of the beverages. A TV show was

played in the background while the researcher left the room and observed the participant discreetly to monitor safety.

After 10 minutes, the remaining volume of the drinks was subtracted from the initial volume to determine the number of milliliters consumed. Immediately following the ad libitum consumption task, participants completed a state MASC survey asking about their self-control motivation and capacity at the current moment, as well as their estimated BAC, which took approximately 3 minutes. To preserve expectations about a bonus payment being contingent on post ad lib performance for those in the motivation condition and to keep the protocol length similar for all participants, all participants were administered the Cued Go/No Go task (Fillmore & Weafer, 2004) again, which took approximately 10 minutes. After this, participants completed a quick debriefing survey that asked if they believed they were deceived in any way to check for demand characteristics. Then, participants were debriefed and received compensation. Task performance was not actually compared and all participants in the motivation condition received the $5 bonus.

Data Analytic Plan

Preliminary Analyses

The proposed analyses were carried out in SPSS version 23. Prior to conducting the primary analyses, the distributions of all variables were examined for non-normality. Outliers were removed or winsorized. ANOVA was used to check for any baseline differences on study variables by experimental condition (i.e., motivation, self-efficacy, or control) to ensure that random assignment was effective in creating comparable groups. Variables that differed by condition at baseline were included as covariates in all

subsequent analyses. Additionally, preference (i.e., how much participants reported liking mixed drinks such as those used in the study) was used as a covariate in all analyses involving ad lib consumption. Task order was included as a covariate in all analyses. Gender was used as a covariate in all analyses given well-established differences in both self-control and alcohol use between men and women. Semester of study completion was included as a covariate in analyses because data collection started later in the fall semester than in the spring semester, and participants who expressed interest in the study may have differed in trait self-control depending on when during the semester they preferred to complete their required research credits.

Manipulation Check of the State MASC

The effect of the two experimental manipulations (motivation and self-efficacy) on the corresponding aspects of perceived self-control was examined via ANCOVA using pairwise comparisons. It was expected that the self-efficacy manipulation would significantly increase perceived self-control capacity. It was also expected that the motivation manipulation would significantly increase external motivation for self-control.

Effects of the Experimental Manipulations on Ad Libitum Consumption

There were no sufficiently similar studies in the literature upon which to base power calculations, but prior studies examining the effects of similar manipulations on executive cognitive function were typically in the medium range. Therefore, initial power analyses were based on medium effect sizes.

ANCOVA analyses and planned pairwise comparisons were used to examine between-group differences in ad libitum consumption. In addition to the covariates mentioned above, performance on baseline ECF tasks were included as covariates to

assess the effects of the experimental manipulations on ad lib consumption above and beyond the predictive power of trait ECF. First, the two experimental manipulation groups (motivation and self-efficacy combined; n=63) were compared to the control group (n=30). For this analysis, the power to detect a medium effect (*d*=.50) was estimated to be .723. Next, the motivation condition (n=30) was compared to the control condition (n=30), and the self-efficacy condition (n=33) was compared to the control condition (n=30). It was also expected that the motivation manipulation would be stronger than the self-efficacy manipulation, so the motivation condition (n=30) was compared to the self-efficacy condition (n=33). For these analyses, the power to detect a medium effect (*d*=.50) was estimated to be .624.

Validation of the State MASC

The construct validity of the state version of the MASC was examined via correlations between changes in aspects of state self-control and ad lib drinking, and the extent to which these correlations differed by experimental condition. It was hypothesized that only the aspect of state self-control that was manipulated would be significantly correlated with ad lib consumption. Specifically, change in external motivation on the MASC was expected to be significantly associated with ad libitum consumption only for participants in the motivation condition. Similarly, change in perceived capacity on the MASC was expected to be significantly correlated with ad lib consumption only for those in the self-efficacy condition. Differences in the statistical significance of correlation coefficients across experimental groups were assessed using the Steiger (1980) method using an online calculator (Preacher, 2002). In addition, test-retest reliability on the state MASC was examined within the control group (n=29) to

determine the extent to which state self-control varied across time in the absence of an explicit manipulation. Significant changes in MASC scores were not anticipated within the control group.

Results

Preliminary Analyses

The proposed analyses were carried out in SPSS version 23. Prior to conducting the primary analyses, distributions of all variables were examined for non-normality. Two cases with more than 10 math errors were removed on the OSPAN, which normalized the rest of the distribution. Two outliers greater than 3 standard deviations away from the mean on the Trails difference (Trails B – Trails A) variable were winsorized. Three outliers on the NIAAA binge drinking question, three outliers on the CGNG No-Go trial accuracy, and 3 outliers on age were winsorized using the same standard deviation cutoff. This normalized the skew of all study variables (skew < 2). Lastly, homogeneity of variance was examined prior to all ANOVA and ANCOVA analyses using an ANOVA with interaction terms between condition and the covariates. No interaction terms were significant; therefore, this assumption was satisfied.

ANOVA was used to check for baseline differences on study variables by experimental condition to ensure that random assignment was effective in creating comparable groups (see Table 1). A cutoff value of p <= .10 was used for inclusion of covariates given the modest sample size for detecting effects of continuous covariates. The following variables had *p* values <= .10 at baseline and were included as covariates in all subsequent analyses: NIAAA drinking quantity, NIAAA binge drinking, UPPS-P premeditation, CGNG no-go accuracy, and Trails difference. Alcohol use quantity and

binge were highest in the motivation group, while premeditation was lowest. CGNG no-go accuracy was lowest in the motivation group and Trails difference was highest in the self-efficacy group. Additionally, preference (i.e., how much participants reported liking mixed drinks such as those used in the study) was used as a covariate in all analyses involving ad lib consumption, and task order, gender, and semester of study completion were used as covariates in all analyses regardless of statistical differences at baseline.

Manipulation Check of the State MASC

The effect of the two experimental manipulations (motivation and self-efficacy) on the corresponding aspects of perceived self-control was examined via ANCOVA pairwise comparisons. Because two MASC assessments were completed before the manipulations, we examined scores across these two baseline assessments. Plots of these scores suggested potential reactivity (see Figures 2, 3, 4), whereby MASC scores (particularly in the two manipulation conditions) appeared to increase between baseline 1 and baseline 2 in the absence of an experimental manipulation. Thus, averaged MASC scores across the two baseline assessments were used as covariates when looking at effects of condition on post-manipulation MASC scores. When analyses were repeated using only the second of the two baseline measures as a covariate, the results did not substantively change.

For MASC capacity, the only significant covariate was baseline MASC capacity, with higher perceived capacity at baseline associated with higher perceived capacity following the manipulation ($p < .001$). The self-efficacy manipulation significantly increased perceived self-control capacity by 1.922 points on a 0-25 scale compared to the control group, $p = .013$ (Cohen's $d = 0.291$, small effect) (see Figure 5). For MASC

external motivation, the only significant covariate was MASC external motivation, with greater baseline external motivation associated with greater external motivation following the manipulation. The motivation manipulation did not significantly impact external motivation for self-control, mean difference = .543, p = .483 (Cohen's d = 0.041) (see Figure 6).

Effects of the Experimental Manipulations on Ad Libitum Consumption

ANCOVA analyses and planned pairwise comparisons were used to examine between-group differences in ad libitum consumption. Performance on baseline ECF tasks were included as additional covariates to assess the effects of the experimental manipulations on ad libitum consumption above and beyond the predictive power of trait ECF. First, the two experimental manipulation groups (motivation and self-efficacy combined; n=63) were compared to the control group (n=30) (see Figure 7). Here, only the covariates of gender (p < .001) and preference (p = .029) were significantly predictive of ad lib consumption. Specifically, men and those who more strongly liked vodka drinks consumed more of the drinks during ad lib. There was no main effect of condition on ad lib consumption (F(1,80) = 2.031, p = .158). Next, the motivation condition (n=30) was compared to the control condition (n=30) (see Figure 8). The mean difference of -54.739 ml (SE = 45.090) (lower in the control group) was not significant, p = .228. Next, the self-efficacy condition (n=33) was compared to the control condition (n=30). The mean difference of -51.427 ml (SE = 42.202) (lower in control group) was not significant, p = .227. Finally, the motivation condition (n=30) was compared to the self-efficacy condition (n=33). The mean difference of 3.312 ml (SE = 44.942) (lower in self-efficacy condition) was not significant, p = .941.

Validation of the State MASC

The construct validity of the state version of the MASC was examined via correlations between changes in aspects of state self-control and ad lib drinking, and the extent to which these correlations differed by experimental condition. Differences in the statistical significance of dependent correlation coefficients across experimental groups were assessed using the Steiger (1980) method via the Preacher (2002) online calculator for the test of the difference between two independent correlation coefficients. Within the motivation manipulation condition, change in external motivation on the MASC was not significantly associated with ad libitum consumption (r = -.002, p = .99). When compared to the corresponding correlation in the control condition (r = .15, p = .46), the two correlations did not significantly differ (z = -.53, p = .59). Within the self-efficacy manipulation condition, change in perceived capacity on the MASC was not significantly correlated with ad lib consumption (r = -.04, p = .83). When compared to the corresponding correlation in the control condition (r = -.04, p = .86), the two correlations did not significantly differ (z = -.02, p = .98).

Additionally, the post-test state MASC was not significantly related to ad libitum consumption in any condition (r values ranged between -.003 and -.31). When all conditions were examined together, only post-test state MASC internal motivation was significantly related to ad libitum consumption (r = -.21, p = .04). Within the motivation manipulation condition, external motivation on the post-test state MASC was not significantly associated with ad libitum consumption (r = -.195, p = .303). When compared to the corresponding correlation in the control condition (r = .155, p = .431), the two correlations did not significantly differ (z = -1.28, p = .20). Within the self-

efficacy manipulation condition, perceived capacity on the post-test state MASC was not significantly correlated with ad lib consumption (r = -.312, p = .082). When compared to the corresponding correlation in the control condition (r = -.070, p = .713), the two correlations did not significantly differ (z = -.95, p = .34).

Test-retest reliability of the state MASC was examined within the control group (n=28-30) at baselines 1 and 2 to determine the extent to which state self-control varies across time in the absence of an explicit manipulation. Perceived capacity subscale scores were significantly correlated at .811, $p < .001$, internal motivation subscale scores were significantly correlated at .657, $p < .001$, and external motivation subscale scores were significantly correlated at .884, $p < .001$.

Supplementary Analyses

To determine if the results were consistent with more restrictive exclusion criteria, several different sensitivity analyses were conducted. First, models were re-estimated with the exclusion of an additional 11 participants who questioned whether or not the drinks contained alcohol on the debriefing survey but provided a non-zero BAC (ranging from .01 to .05) after ad lib drinking. The sample size for these analyses was 83. None of the findings substantively changed with the exclusion of these participants.

Next, models were estimated with the exclusion of 26 participants who consumed the entire 600 ml of beverages that they were given during the ad lib drinking period, as there was a ceiling effect for these individuals and their drinking may have been driven by factors other than study manipulations. These analyses included the 7 (of 11) participants in the prior analysis who did not consume the entire 600 ml. Most results were similar, though there was one notable difference. Correlations between MASC

change scores and ad lib drinking were stronger within the manipulation conditions. Within the motivation manipulation condition, the inverse correlation between change in external motivation on the MASC and ad lib consumption was stronger, but not statistically significant (r = -.18, p = .45) and this correlation was not stronger than the correlation in the control condition (r = -.08, p = .73) (z = -.33, p = .74). Similarly, within the self-efficacy manipulation condition, the inverse correlation between change in perceived capacity on the MASC and ad lib consumption was stronger, but not statistically significant (r = -.29, p = .18), and the correlation was not significantly stronger within the self-efficacy condition relative to the control condition (r = -.07, p = .74) (z = -.747, p = .46).

Discussion

The current study tested the effects of two experimental manipulations of self-control on consumptive behavior in a laboratory setting, as well as the validity and reliability of a novel survey measure of state self-control. Two experimental manipulations were used, and one produced a significant effect on the corresponding aspect of self-reported self-control, while the other one did not. The self-efficacy manipulation produced a small, but significant increase in perceived self-control capacity. However, the motivation manipulation did not significantly increase external motivation for self-control.

Between-group differences in ad libitum consumption were examined with performance on baseline ECF tasks as additional covariates to assess the effects of the experimental manipulations on ad libitum consumption above and beyond the predictive power of trait ECF. When the two experimental manipulation groups were compared to

the control group, there was no main effect of condition on ad lib consumption. There were also no significant differences between any two of the three conditions in pairwise comparisons. These results suggest that neither the motivation nor the self-efficacy manipulation affected consumptive behavior in the current sample. These results were also not due to ECF, as ECF did not significantly predict ad lib consumption either.

Furthermore, within the motivation manipulation condition, change in external motivation on the MASC was not significantly associated with ad lib consumption, and this correlation did not significantly differ from the corresponding correlation in the control condition. Likewise, within the self-efficacy manipulation condition, change in perceived capacity on the MASC was not significantly correlated with ad lib consumption, and this correlation did not significantly differ from the corresponding correlation in the control condition either. This calls into question the construct validity of the state MASC and the validity of measuring self-control behavior via ad lib consumption. However, when the post-test state MASC was used for comparison instead of change in the state MASC, results showed stronger evidence for the construct validity of the MASC, despite lack of statistical significance in the relatively small sample. Taken together, this portion of the study found that while the self-efficacy manipulation increased perceived self-control capacity, this effect did not translate to a reduction in ad lib consumption. The motivation manipulation neither increased motivation for self-control nor decreased consumption.

There are several potential explanations for the failure of the motivation manipulation to impact either external motivation or drinking behavior. First, despite random assignment, there were baseline differences between experimental groups. Most

notably, the motivation manipulation condition contained participants who typically consumed a greater quantity of alcohol, binge drank more often, and were lower in premeditation. Taken together, these differences could point to the motivation condition being comprised of higher-risk individuals overall. While baseline differences in drinking behavior were controlled for in the analyses, there may have been other variables not assessed in the current study that differed by group and could have affected the results.

Second, the motivation manipulation in the current study differed in several ways from similar manipulations that have been successful in changing motivation for behavioral control. The manipulation was briefer and less intensive than those typically used in alcohol ad lib consumption paradigms (Leeman et al., 2013). Because of this, it may not have been sufficiently strong to motivate participants to refrain from consuming the beverages. In fact, in the current study, 11 participants in the motivation condition consumed the full volume of the beverages they were offered, consistent with the idea that the $5 incentive may not have been enough to deter consumption for some people. The value of a potential $5 bonus may have been outweighed by the value of two free alcoholic drinks due to their ready availability and potentially higher cost at a local bar or restaurant. The motivation manipulation in the current study was designed cautiously, so as not to provide such a strong incentive that there was a floor effect with participants not consuming any of the beverages. However, the monetary value of the incentive may need to be higher in future studies.

The way in which the incentive/cost was presented may also have impacted the strength of the manipulation. In the current study, although participants knew that they might lose the $5 if they did not perform well on the task, it was presented as an

opportunity to earn an additional $5. In contrast, previous studies that have employed a motivation manipulation have phrased instructions as willingness to pay (i.e., potential loss of payment). The way that the bonus payment is presented to participants can affect results via a phenomenon known as loss aversion (Tversky & Kahneman, 1981; Kahneman, Knetsch, & Thaler, 1990). According to research on loss aversion, participants assign greater value to the potential to lose $5 than gain $5 (Carmon & Ariely, 2000; Hossain & List, 2012), which may have made the incentive in the current study less salient than in previous studies (Leeman et al., 2013). Therefore, it may boost the effectiveness of the motivation manipulation to phrase the incentive more clearly in a willingness to pay framework.

Prior studies have also framed potential losses as both probabilistic and delayed compared to immediate rewards. Although the reward in the current study was probabilistic (participants were told that they had a 50% chance of receiving a bonus payment), reward was not delayed. Although this is an important difference from prior studies, delaying the reward would have presumably made the reward less, rather than more, salient. This would have further weakened the motivation manipulation in the current study. To strengthen the motivation manipulation, it may be helpful to add in successful elements of various other motivation manipulations from prior research (not necessarily with ad lib consumption of alcohol). For example, creating competition with other participants may be particularly effective for men if instructions are phrased to induce social comparison (e.g., "You will receive a $5 bonus if you outperform at least 50% of other participants in this study so far") (Niederle & Vesterlund, 2007; Croson & Gneezy, 2009).

Third, efforts to increase external motivation may be met with defensiveness, particularly when focused on reducing a behavior that is seen as normative within the population. For example, efforts by universities to set up external motivators to reduce risk for heavy drinking, such as emphasizing harsh institutional consequences for alcohol use, may be met with strong resistance. In contrast, efforts to increase internal motivation through motivational interviewing approaches have shown considerable promise with this population (e.g., BASICS; Dimeff, 1999; Borsari & Carey, 2000). Thus, efforts to manipulate motivation to control drinking behavior in college students may have greater success if they focus on increasing internal versus external motivation. This is an important empirical question that could be addressed in future studies.

Lower ad lib consumption was not observed within the motivation condition, relative to other conditions, and this may have resulted from a failure of the manipulation. However, a manipulation failure cannot explain the same ad lib results in the self-efficacy condition, as the self-efficacy manipulation significantly increased perceived capacity for self-control. There could be several reasons for the lack of correspondence between changes in self-control and ad lib consumption. First, the current sample may have had little motivation to control their alcohol consumption, despite the perceived ability to do so. Undergraduate college students who participated in this study were told that they would remain in the laboratory for at least two hours until their blood alcohol level was low enough for them to safely leave. Having set aside this time, they may not have perceived a risk from alcohol consumption and may therefore have had no reason not to consume the beverages offered. Moreover, increased self-efficacy may have contributed to self-licensing effects (De Witt Huberts, Evers, & De Ridder, 2012), whereby

participants who felt better able to control themselves may have then permitted themselves to consume more alcohol.

In general, self-efficacy alone may be unlikely to reduce alcohol consumption in a college population because students may have little motivation/incentive to control their drinking in an environment in which the behavior is common and perceived as normative. Efforts focused exclusively on self-efficacy may have more utility in clinical populations where impaired control over alcohol use is a driving factor in addiction. For college students, it may be important to target both motivation and self-efficacy to reduce drinking (Dimeff, 1999; Vasilaki, Hosier, & Cox, 2006). Consistent with this idea, current interventions for alcohol use on college campuses frequently contain a motivational component (Dimeff, 1999; Borsari & Carey, 2000). As indicated previously, these approaches typically focus on increasing internal versus external motivation to moderate alcohol consumption. Variations of values affirmation exercises (Steele, 1988; Burson, Crocker, & Mischkowski, 2012) and motivational interviewing techniques (Miller & Rollnick, 2012; Rollnick & Miller, 1995) may boost motivation to control oneself without creating reactance to outside influences. The principles of motivational interviewing emphasize readiness to change, ambivalence, and resistance, in addition to fostering autonomy and self-efficacy (Miller & Rollnick, 2012; Rollnick & Miller, 1995). Individuals are encouraged to set their own goals for behavior change rather than having goals imposed upon them. The success of these approaches suggests that future lab-based studies that manipulate both internal motivation and self-efficacy may have the greatest potential to reduce ad lib consumption, at least within a college population.

Although there may be unique explanations for the lack of impact of the two manipulations on ad lib consumption (i.e., failure of the manipulation vs. low motivation to control behavior), there may have also been a shared influence across groups. In prior studies that have effectively impacted ad lib consumption with a motivational manipulation (e.g., Leeman et al., 2013), participants were told that they would have to stay in the laboratory for at least 8 hours, regardless of consumption. In contrast, participants in the current study were told that they may have to stay for up to 2 hours until their blood alcohol level came down. This shorter time window and introduction of a relation between amount consumed and length of the study may have motivated participants to get through the protocol more quickly and be released earlier by consuming less during ad lib administration. Alternatively, participants who wanted to gain more credit for their time may have been motivated to drink more and remain in the lab longer. Either way, this approach would introduce a source of error, as participants' life circumstances and goals may have affected ad lib consumption independently of experimental manipulations. Although one would expect this source of error to be distributed similarly across groups, given the relatively small sample size, it is possible that the impact of this source of error could have differed across groups.

The potential reasons for a lack of group differences in ad lib consumption discussed thus far may also help explain the lack of correspondence between changes in self-control and ad lib consumption within the motivation and self-efficacy manipulations. In fact, sensitivity analyses suggested that ceiling effects in ad lib consumption may have played some role in these null findings. When removing the people who drank all 600 milliliters available during ad lib consumption, there was more

evidence of an inverse correlation between change in perceived self-efficacy/external motivation and consumption following the manipulations. Correlations between ad lib consumption and changes in perceived self-efficacy/motivation, as measured by subtracting the averaged state MASC baseline from the post-test state MASC within the two manipulation conditions, ranged from -.002 to -.04 in the full sample, and from -.18 to -.29 in the sample with participants who drank the entire volume removed. These correlations provide support for the idea that people who maxed out on ad lib consumption may have limited the ability to detect relations between ad lib drinking and the state MASC. For participants who consumed the entirety of both drinks, ad lib consumption may have been driven by variables other than perceived self-efficacy/motivation. For example, if they arrived at the study determined to consume all available alcohol, experimental manipulations may not have affected their decisions to drink. These choices may have been made ahead of time and deliberately, based on individual goal prioritization and incentive evaluation.

Within the control condition, analyses provided strong support for the test-retest reliability of the state MASC. All subscales of the MASC were highly correlated (correlations ranging from .657 to .884). At the same time, the correlations allowed room for variability in capturing natural fluctuations in perceived self-control. Moreover, the correlations between trait and state self-control, as measured by the trait MASC and averaged baseline state MASC, ranged between .608 and .735 for corresponding subscales. The weaker correlations between trait and state measures (relative to correlations between state measures within person), suggest that trait and state self-control are distinct constructs. Overall, the state MASC appears to be reliable and

sensitive to fluctuations in perceived self-control capacity following a manipulation. Thus, this self-report measure may offer a quick and efficient way to capture multiple subcomponents of state self-control. Given its brevity, this measure is also well suited to assessing state self-control in the real world using ecological momentary assessment.

In the context of interpreting the findings, several limitations of the current study have been discussed (e.g., small sample size, potentially weak manipulation of motivation, baseline differences between groups, ceiling effects, correlation between ad lib and time spent in the lab as a source of error). A final limitation worth noting is that the nature of the current sample limits generalizability. The sample comprised 94 undergraduate students at a large university who were predominantly white and male. Therefore, results from the current study may not be generalizable to the broader population of college students or young adults not in college.

Although the current study has a number of limitations, the results yield important information about multiple aspects of state self-control. First, perceived state self-control capacity was successfully increased by a self-efficacy manipulation, even though this effect did not translate to a significant reduction in ad lib consumption. The motivation manipulation did not increase motivation or decrease ad lib consumption. Therefore, future studies may benefit from strengthening the motivation manipulation in several ways, including increasing the monetary value of the bonus payment and framing the incentive more clearly in a willingness to pay framework. Additionally, results of the current study supported the test-retest reliability of the state MASC and its distinction from the trait MASC, endorsing this brief measure's utility in detecting fluctuations in multiple subcomponents of perceived self-control. By elucidating the relationships

between specific mechanisms of self-control, laboratory-based tasks and manipulations, and real-world consumptive behaviors, prevention and intervention efforts for problems such as alcohol abuse can be made more impactful and cost-effective.

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Table 1

Means and Standard Deviations of Study Variables by Experimental Condition

	Control	Motivation	Self-Efficacy
Age	23.31 (3.85)	23.59 (3.59)	23.06 (3.22)
Preference	6.53 (2.47)	6.32 (2.80)	6.36 (2.38)
NIAAA Frequency	1.53 (1.14)	2.06 (1.36)	1.55 (0.90)
NIAAA Quantity*	2.63 (1.59)	3.90 (2.30)	3.00 (2.05)
NIAAA Binge*	2.97 (3.07)	4.84 (4.46)	2.61 (3.00)
BYAACQ Alcohol Problems	4.97 (3.99)	6.16 (4.63)	6.15 (4.26)
UPPS-P Negative Urgency	2.22 (0.44)	2.14 (0.55)	2.21 (0.50)
UPPS-P Premeditation*	1.80 (0.32)	1.68 (0.41)	1.98 (0.49)
UPPS-P Perseverance	1.91 (0.41)	1.75 (0.38)	1.92 (0.44)
UPPS-P Sensation Seeking	2.85 (0.57)	2.93 (0.63)	3.00 (0.52)
UPPS-P Positive Urgency	1.94 (0.61)	2.00 (0.71)	1.95 (0.66)
Trails Difference (B - A)*	35.20 (18.38)	38.77 (18.78)	46.49 (22.73)
CGNG Go Reaction Time	284.25 (27.66)	279.02 (19.40)	278.19 (24.78)
CGNG No-Go Accuracy*	0.99 (0.01)	0.98 (0.02)	0.99 (0.02)
OSPAN Partial Score	15.20 (4.82)	13.80 (4.54)	13.76 (4.37)

Mean (Standard Deviation)

*. Significant difference between groups at baseline at the 0.10 level.

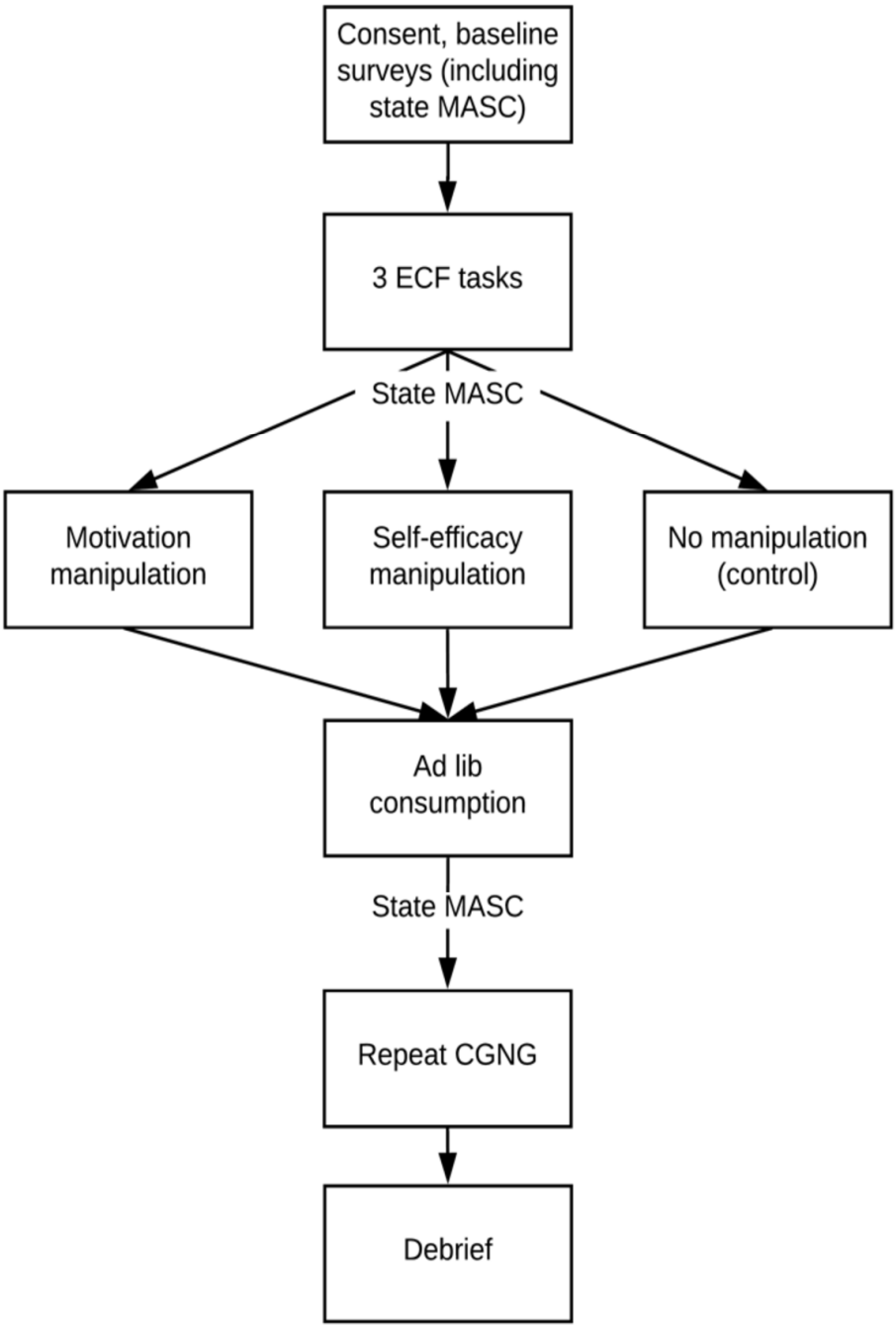

Figure 1. Visual Map of the Protocol

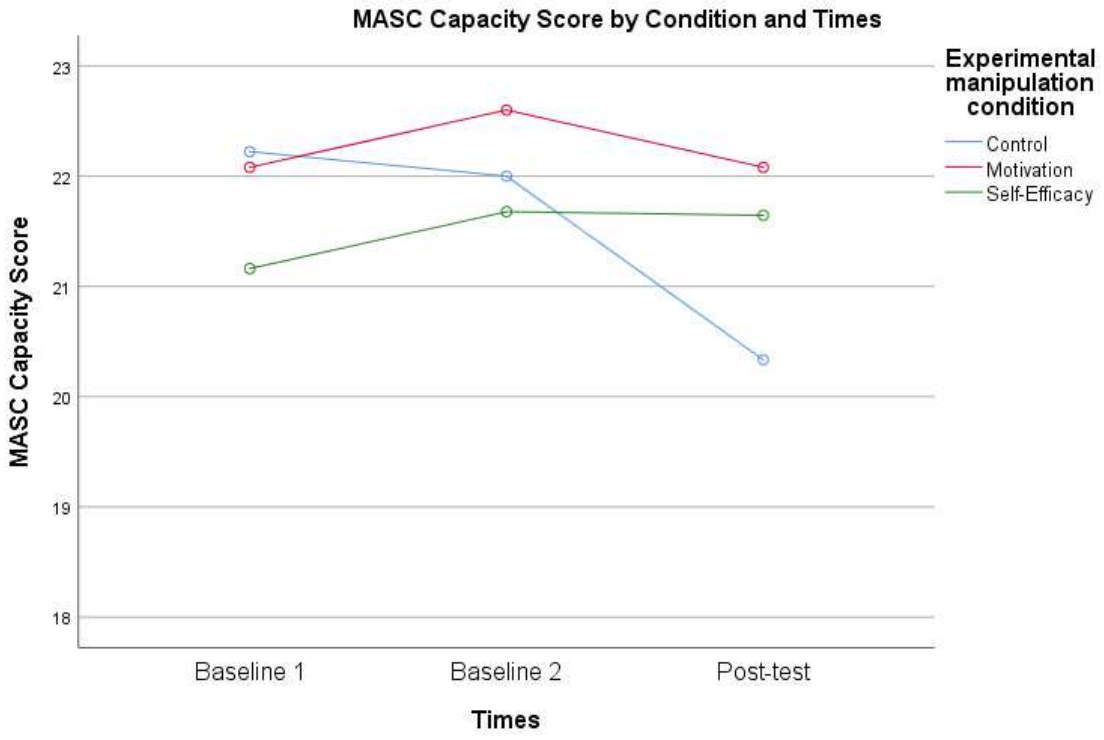

Figure 2. Estimated Marginal Means of State MASC Capacity Score by Condition and Times

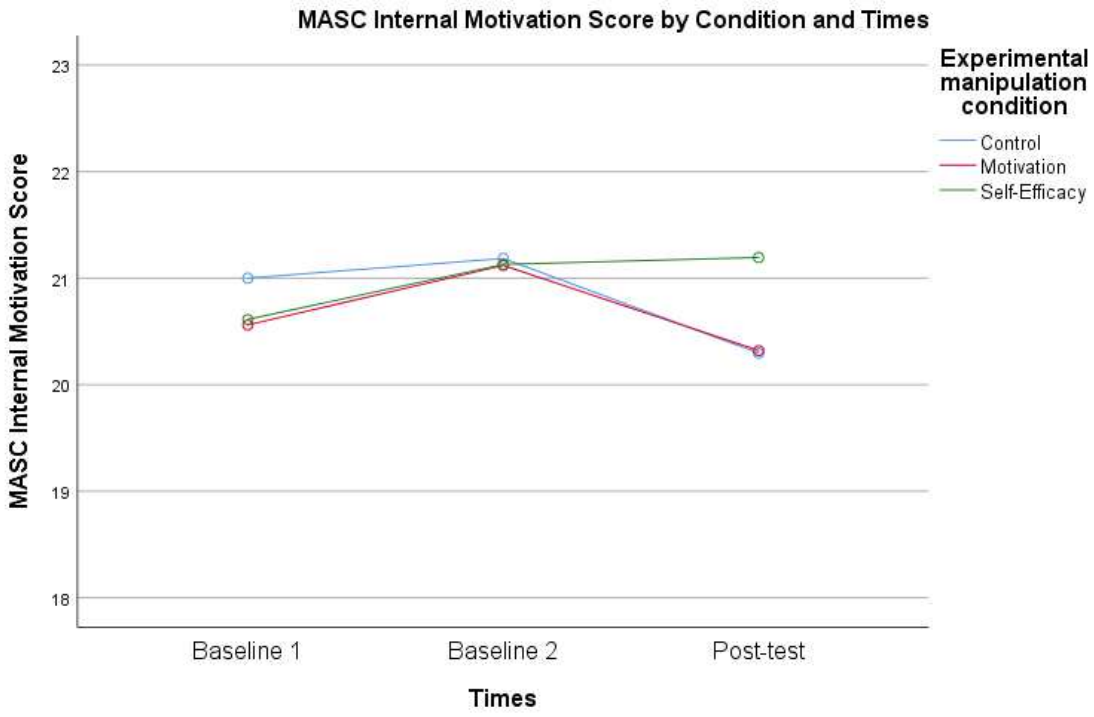

Figure 3. Estimated Marginal Means of State MASC Internal Motivation Score by Condition and Times

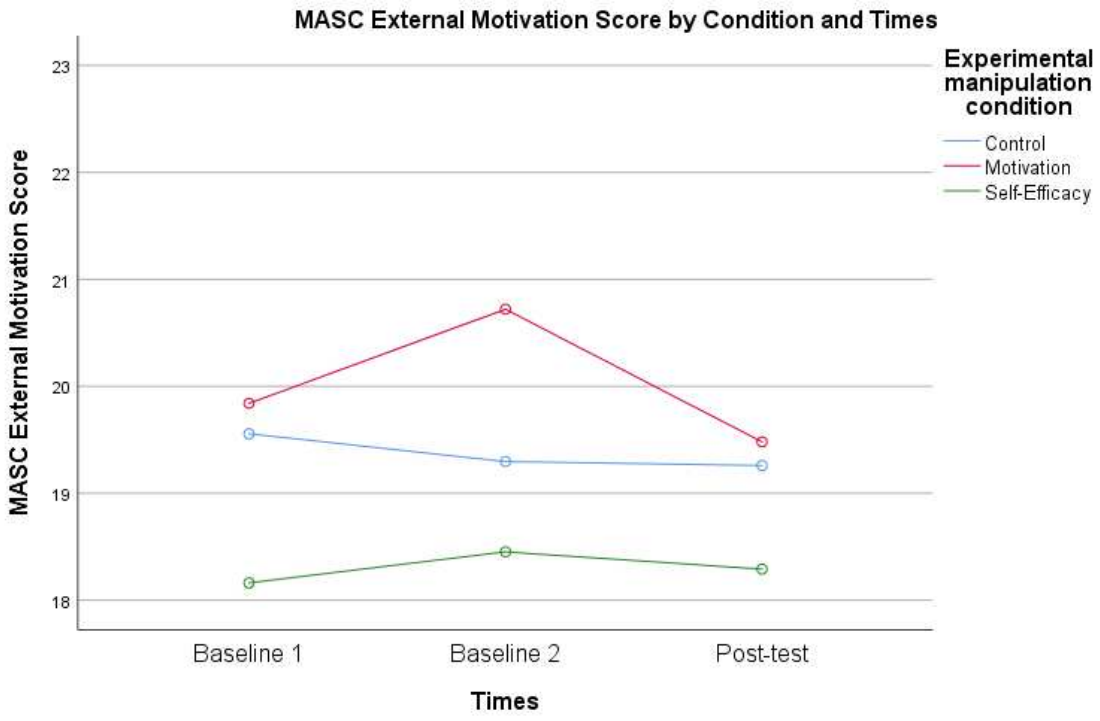

Figure 4. Estimated Marginal Means of State MASC External Motivation Score by Condition and Times

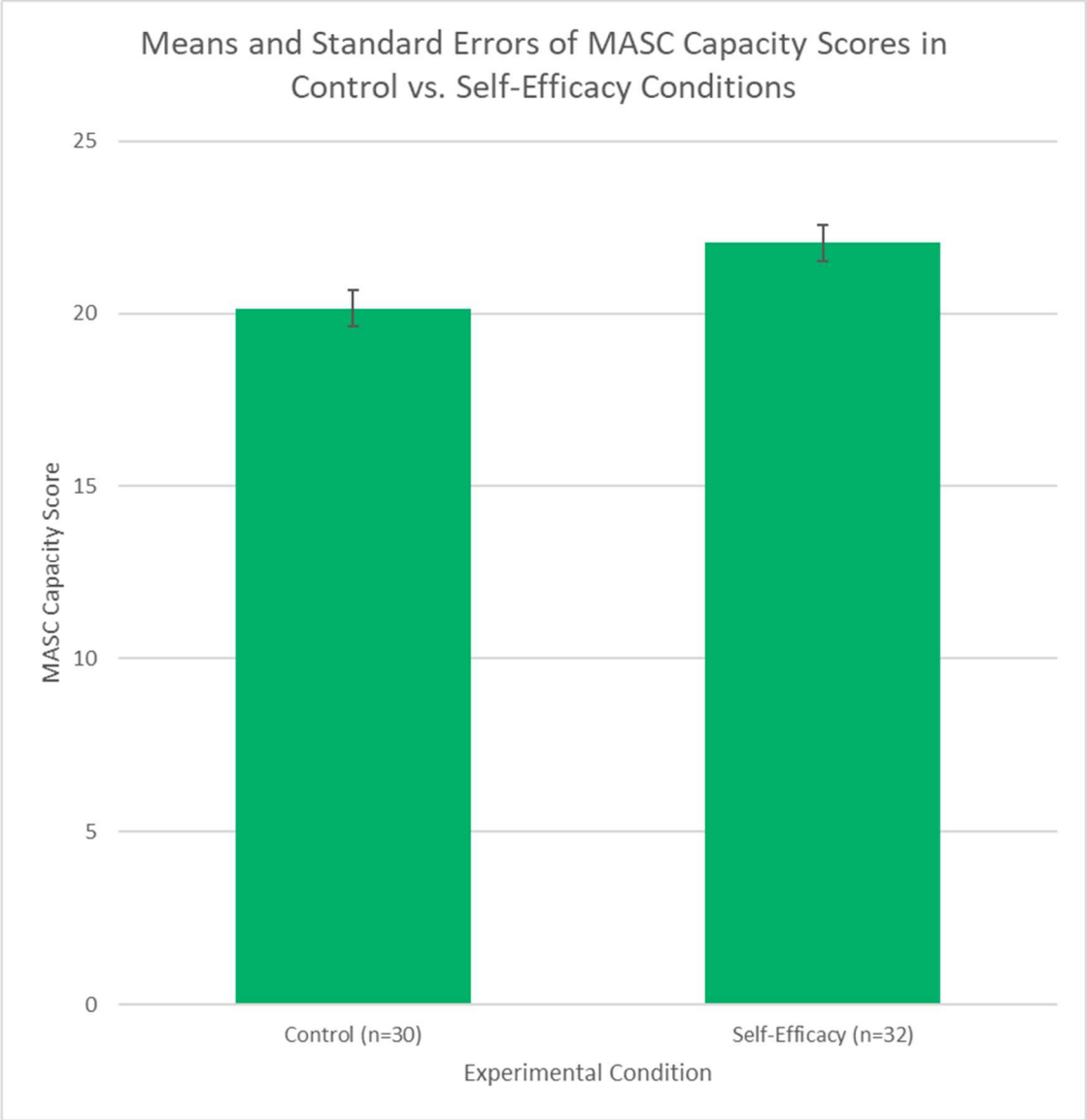

Figure 5. Estimated Marginal Means and Standard Errors of MASC Capacity Scores in Control vs. Self-Efficacy Conditions

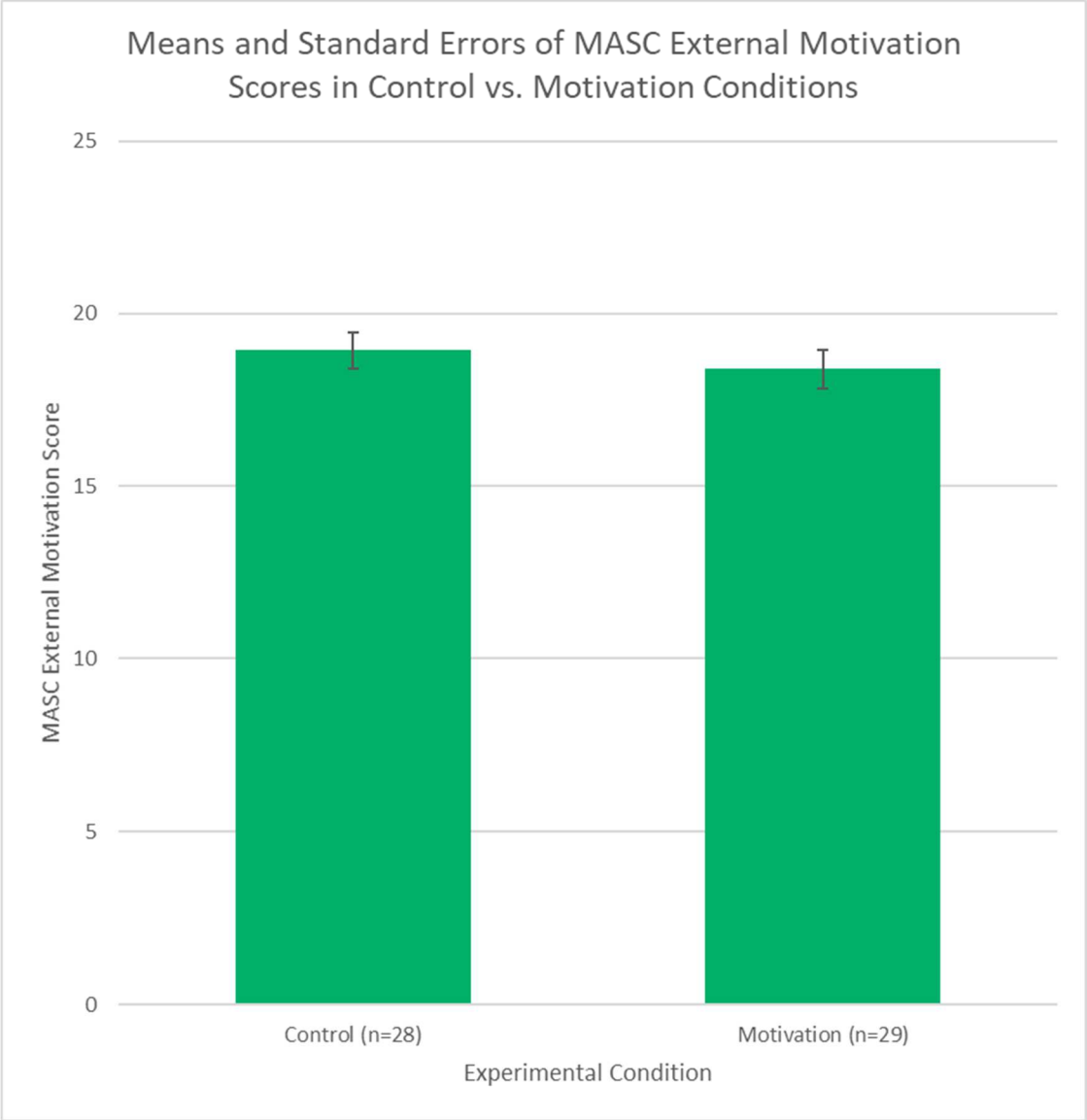

Figure 6. Estimated Marginal Means and Standard Errors of MASC External Motivation Scores in Control vs. Motivation Conditions

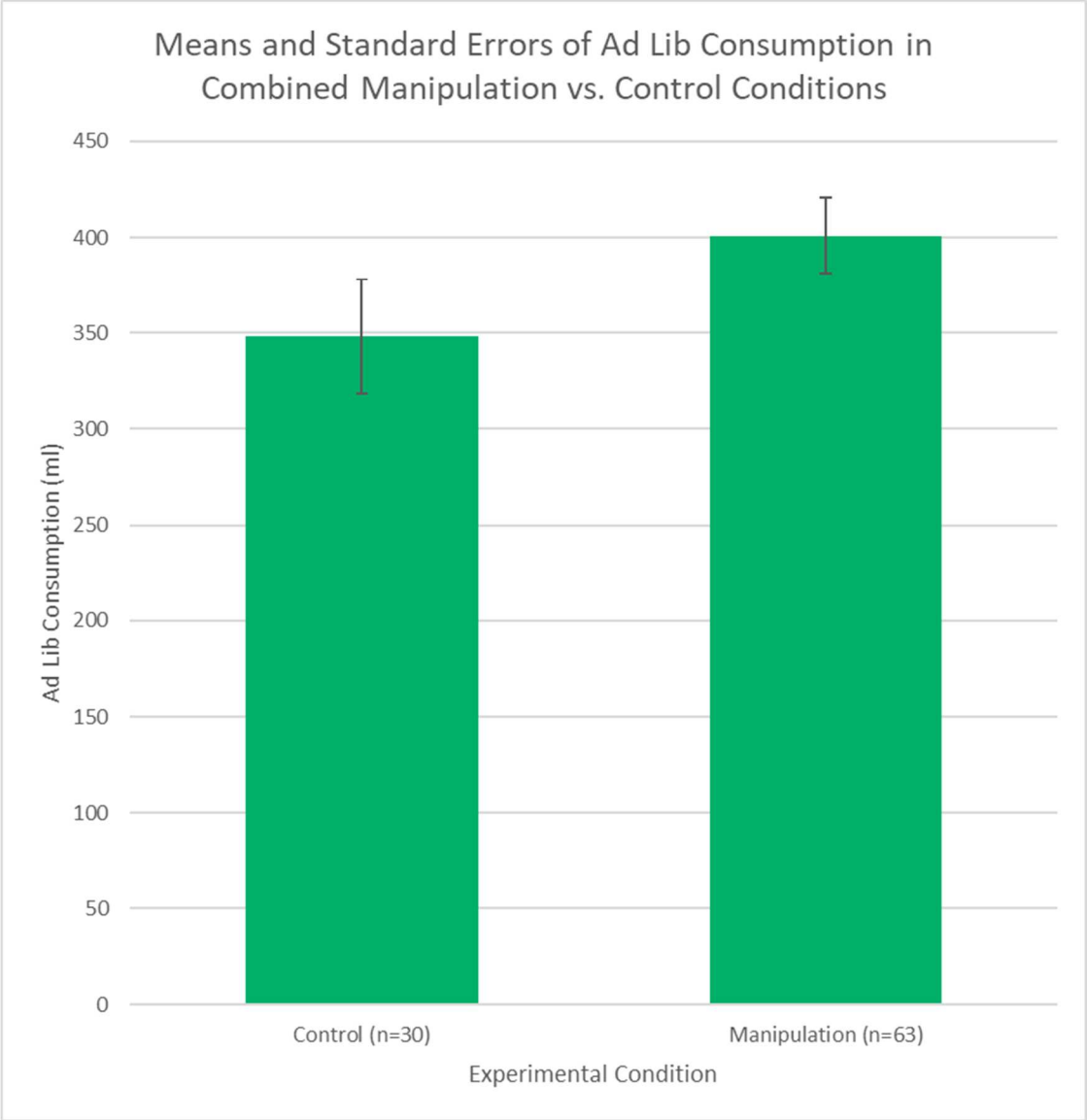

Figure 7. Estimated Marginal Means and Standard Errors of Ad Lib Consumption in Combined Manipulation vs. Control Conditions

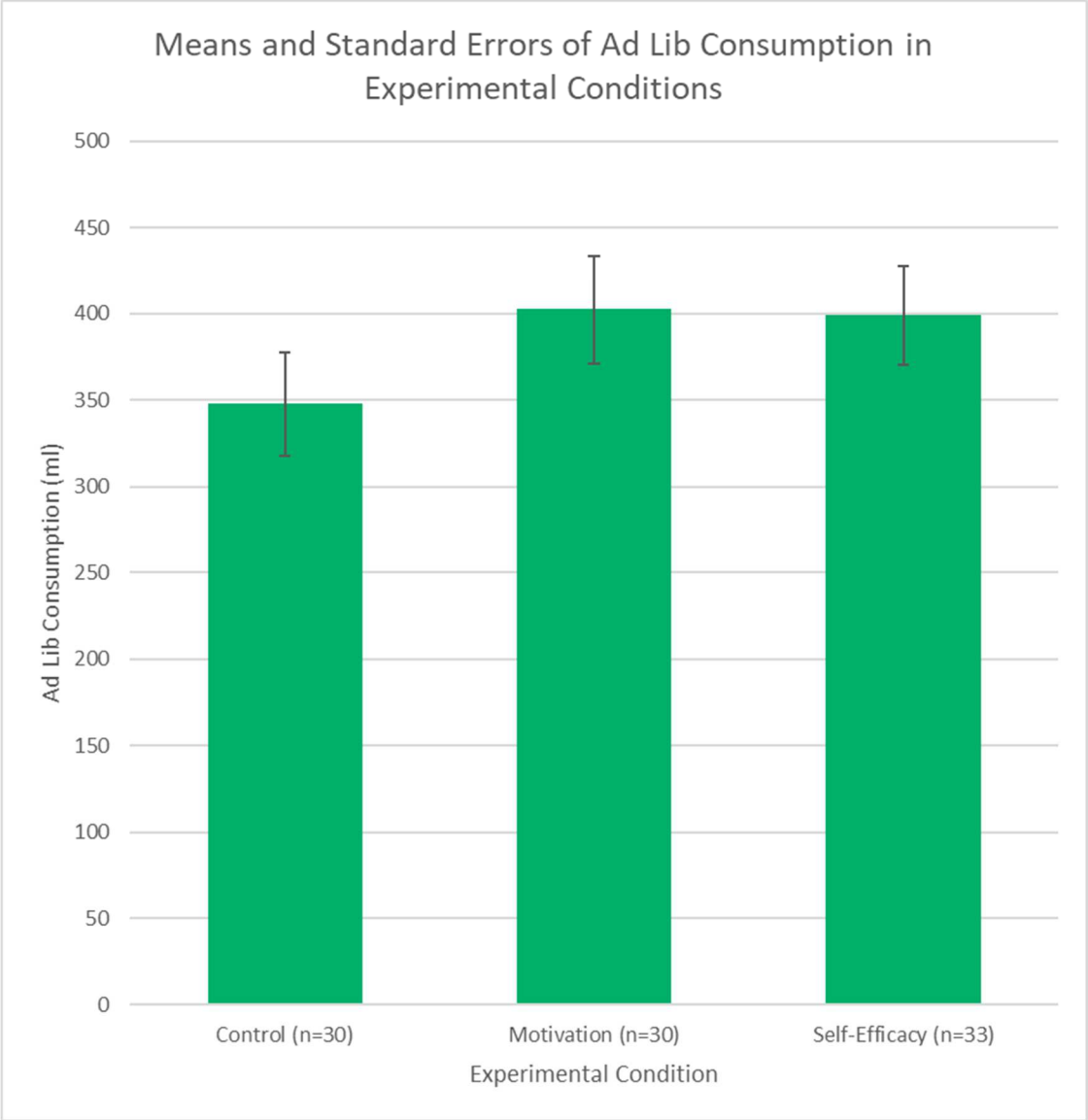

Figure 8. Estimated Marginal Means and Standard Errors of Ad Lib Consumption in Experimental Conditions

APPENDIX A

15-ITEM TRAIT MULTIDIMENSIONAL ASSESSMENT OF SELF-CONTROL ITEMS

Perceived Capacity
Using the scale provided, please indicate how easy or difficult the following tasks would be for you to complete if you were motivated to do them.

With much difficulty 1———2———3———4———5 Very easily

When I have the motivation, I'm able to…
1. … resist temptation.
2. … avoid doing certain things that are bad for me even though they are fun.
3. … refuse things that are bad for me.
4. … have self-discipline.
5. … stop myself from doing something if I know it is wrong.

Internal Motivation
Using the scale provided, please indicate the extent to which you are motivated to do each of the following because of your own personal values, identity, standards, etc.

Not at all 1———2———3———4———5 Very much

Because of my own personal values, identity, standards, etc. I am motivated to…
1. … resist temptation.
2. … avoid doing certain things that are bad for me even though they are fun.
3. … refuse things that are bad for me.
4. … have self-discipline.
5. … stop myself from doing something if I know it is wrong.

External Motivation
Using the scale provided, please indicate the extent to which you are motivated to do each of the following because of how you would be viewed by others (e.g. parents, friends, peers, society, etc.)

Not at all 1———2———3———4———5 Very much

Because of how I'd be viewed by others (e.g. parents, friends, peers, society, etc.), I am motivated to…
1. … resist temptation.
2. … avoid doing certain things that are bad for me even though they are fun.
3. … refuse things that are bad for me.
4. … have self-discipline.
5. … stop myself from doing something if I know it is wrong.

APPENDIX B

15-ITEM STATE MULTIDIMENSIONAL ASSESSMENT OF SELF-CONTROL ITEMS

Perceived Capacity
Using the scale provided, please indicate how easy or difficult the following tasks would be for you to complete *right now* if you were motivated to do them.

With much difficulty 1———2———3———4———5 Very easily

Right now, if I were motivated to, I feel like I'd be able to…
1. … resist temptation.
2. … avoid doing certain things that are bad for me even though they are fun.
3. … refuse things that are bad for me.
4. … have self-discipline.
5. … stop myself from doing something if I know it is wrong.

Internal Motivation
Using the scale provided, please indicate the extent to which you are motivated to do each of the following because of your own personal values, identity, standards, etc. *right now*

Not at all 1———2———3———4———5 Very much

Because of my own personal values, identity, standards, etc., right now, I am motivated to…
1. … resist temptation.
2. … avoid doing certain things that are bad for me even though they are fun.
3. … refuse things that are bad for me.
4. … have self-discipline.
5. … stop myself from doing something if I know it is wrong.

External Motivation
Using the scale provided, please indicate the extent to which you are motivated to do each of the following because of how you would be viewed by others (e.g. parents, friends, peers, society, etc.) *right now*

Not at all 1———2———3———4———5 Very much

Because of how I'd be viewed by others (e.g. parents, friends, peers, society, etc.), right now, I am motivated to…
1. … resist temptation.
2. … avoid doing certain things that are bad for me even though they are fun.
3. … refuse things that are bad for me.
4. … have self-discipline.
5. … stop myself from doing something if I know it is wrong.