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Motivation Matters: The Interaction of Approach and Avoidance Alcohol Motivation and Self-Control Demands in College Drinkers

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Motivation Matters: The Interaction of Approach and Avoidance Alcohol
Motivation and Self-Control Demands in College Drinkers

by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
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ABSTRACT

Failure in self-control has long been identified as a risk factor for problematic alcohol use among college students, as individuals who are less equipped or less able to regulate their thoughts, emotions, and behaviors use alcohol more frequently and are at greater risk for binge drinking. Recent findings suggest self-control depletion and motivation interact to determine performance on subsequent tasks that require self-control. The purpose of the present study was to investigate the ways self-control exertion and desires to use alcohol (approach inclinations) and desires to avoid using alcohol (avoidance inclinations) impact subsequent alcohol use behavior. Using ecological momentary assessment, the interaction of self-control exertion and alcohol motivation in the prediction of alcohol use behaviors was assessed in a sample of college drinkers. Daily monitoring assessments contained brief measures of alcohol-related behaviors, alcohol motivation, and self-control exertion and were administered five times daily for fourteen days. Results indicated that although self-control exertion interacted with alcohol motivation to predict drinking (controlling for drinking history, affect, and day of week), the relationship was not in the expected direction; *higher* self-control exertion among those high on both approach and avoidance motivation was associated with *fewer* number of drinks at the next measurement occasion. Findings highlight the need for consideration of the unique effects of both alcohol use motivation and self-control demand in the prediction of alcohol consumption, and draw attention to the need for further investigation into the complex interplay of these processes in daily life.

INTRODUCTION

Despite potential negative consequences (e.g., hangover, drop in academic performance), heavy episodic drinking occurs at alarming rates among college students. Recent estimates report 35% of college students have consumed five or more drinks in a single occasion in the last two weeks (Johnston, O'Malley, Bachman, Schulenberg, & Miech, 2016). Failure in self-control has long been identified as a risk factor for problematic alcohol use among college students (Gibson, Schreck, & Miller, 2004; Hull & Slone, 2004; Werch & Gorman, 1988), as individuals who are less equipped or less able to regulate their thoughts, emotions, and behaviors drink more frequently and are at greater risk for binge drinking (DeHart, Longua Peterson, Richeson, & Hamilton, 2014; Hustad, Carey, Carey, & Maisto, 2009; Quinn & Fromme, 2010). The Strength Model of Self-Control (Baumeister, Heatherton, & Tice, 1994; Baumeister, Vohs, & Tice, 2007) posits that self-control relies on finite cognitive resources that are vulnerable to depletion and that once depleted, subsequent attempts at self-control are more likely to fail. Although this model has received support in predicting a range of behaviors, including the violation of self-imposed drinking limits (Muraven, Collins, Morsheimer, Shiffman, & Paty, 2005b; Muraven, Collins, Shiffman, & Paty, 2005) and riskier decision making (Freeman & Muraven, 2010), it is not without controversy. Of particular note, replication of these effects have been mixed (Muraven & Shmueli, 2006; Muraven & Slessareva, 2003), leading some researchers to posit that motivation to exert self-control may in part explain some of the variance in self-control performance. As such, a limitation of many past investigations is the lack of consideration for individual differences in motivational factors that may play an important role in self-control.

Expanding upon previous literature, the present study sought to investigate the ways self-control exertion and desires to use (approach inclinations) and desires to avoid using alcohol (avoidance inclinations) impact subsequent alcohol use behavior.

Strength Control Model of Self-Control

Self-control, broadly defined, is the process of inhibiting or altering urges, thoughts, emotions, or behavior that interfere with greater goals and desirable long-term outcomes (Baumeister et al., 1994; Kanfer & Karoly, 1972; Mischel, Ebbesen, & Raskoff Zeiss, 1972; Muraven, Collins, & Neinhans, 2002). According to the Strength Model of Self-Control (Baumeister et al., 1994; Baumeister et al., 2007), self-control is a limited and renewable cognitive resource that can be depleted through acts of volition (e.g., Baumeister, Bratslavsky, Muraven, & Tice, 1998). Specifically, repeated acts of self-control decrease the probability of successful future self-control until restorative actions are taken to renew these cognitive resources (e.g., rest, experience of positive emotional states, etc.). For example, a heavy-drinking college student with a strong desire to drink would require self-control to remain sober while at a party the night before for an exam. However, cognitive resources that are required to inhibit drinking may become “depleted” by acts of self-control throughout the day, resulting in a failure to regulate future drinking behaviors. Research examining the effect of self-regulation on task performance across a variety of paradigms, including emotion suppression, thought suppression, and initiation of consummatory behaviors, suggest that even minor acts of self-control can erode self-regulatory processes across a variety of behaviors, including alcohol consumption (Baumeister et al., 1998; Muraven & Shmueli, 2006; Muraven, Shmueli, & Burkley, 2006; Muraven & Slessareva, 2003; Muraven, Tice, & Baumeister, 1998).

Despite initial support for the Strength Model of Self-Control, including meta-analytic findings suggesting a moderate effect of self-control depletion on varied behaviors (Hagger, Wood, Stiff, & Chatzisarantis, 2010), failed replications challenged the initial strong evidence for the theory. Specifically, additional analyses adjusting for small-study samples and publication bias effects suggest the evidence for the limited resource and depletion effects are much less promising than previously proposed (Carter, Kofler, Forster, & McCullough, 2015; Carter & McCullough, 2014). However, this work too has been criticized, including choice of study selection criteria (e.g., over-emphasis on non-published reports and failure to include a large portion of published literature), failure to examine potential moderators, and questionable assumptions regarding replicability in psychology (see Cunningham & Baumeister, 2016 for review). Nevertheless, one consistent finding is evident; there is a large range of obtained effect sizes across studies, suggesting either methodological (e.g., type of depletion task) or additional theoretical considerations (e.g., individual differences) may in part explain the heterogeneity of effects.

A review of the literature suggests several conditions that may moderate depletion effects. Specifically, depletion appears to be attenuated when a) desirable incentives are provided (e.g., Muraven & Slessareva, 2003), b) progress is closely monitored (i.e., self-awareness) (Alberts, Martijn, & De Vries, 2011; Wan & Sternthal, 2008), c) positive mood or self-efficacy is induced (Tice, Baumeister, Shmueli, & Muraven, 2007), d) there is an explicit expectation or perception that the task will not be depleting (Clarkson, Hirt, Jia, & Alexander, 2010; Martijn, Tenbült, Merckelbach, Dreezens, & de Vries, 2002), and e) there is a belief that self-control is unlimited (Job, Dweck, & Walton, 2010). Together, common themes of anticipatory, affective, and attentional processes emerge, suggesting that it is not only a state of depletion that determine

the extent to which self-control is exerted, but also overall motivation to effortfully control one's behavior, thoughts, and emotions.

Lurguin and Miyake (2017) also suggest that the controversies go beyond simple replication issues and should be more focused on the potential conceptual shortcomings of the Strength Model of Self-Control. These include difficulties with the operational definitions within the model (e.g., what is self-control within and across models), limited validity and research on self-control tasks themselves (e.g., do task A and task B tap similar resources, including domain specific areas such as attention and working memory that may be responsible for such effects), and more broadly the lack of well-specified models (i.e., lack of specific predictions to test). Consequently, perhaps the most problematic limitation is the lack of clearly defined concepts and mechanistic processes that open the door for alternative explanations for the observed depletion effect. For example, both shifts in motivation, fatigue, and affect have been identified as potential alternative explanations (e.g., Lurguin & Miyake, 2017; Hagger et al., 2010). Further, within the neurocognitive literature, constraints on attention and working memory have been identified as potential mechanisms of self-control failure (Mann & Ward, 2007), which are also likely to be influenced by individual differences in task performance motivation. Despite these findings, the impact of motivational and affective processes on self-control depletion are often 1) assessed in isolation of one another, 2) dismissed as an issue to be addressed by future research, or 3) ignored all together. As such, possible alternative explanations that the depletion effect is simply the result of a change in affect or a shift in motivation cannot be ruled out, requiring future research to carefully consider such processes when studying depletion effects.

Theoretical Convergence: Motivation matters

Recent findings overwhelmingly suggest self-control depletion and motivation interact to determine performance (e.g., Berkman, Hutcherson, Livingston, Kahn, & Inzlicht, 2017; Inzlicht & Schmeichel, 2012; Milyavskaya & Inzlicht, 2017; Milyavskaya, Inzlicht, Hope, & Koestner, 2015; Muraven, Collins, Shiffman, et al., 2005; Muraven & Slessareva, 2003; Osgood & Muraven, 2015). For example, Muraven and Slessareva (2003) conducted a series of experiments demonstrating that motivational incentives to exert self-control mitigates the effect of self-control depletion. Specifically, participants who believed their efforts would help others (extrinsic motivation) or help themselves (intrinsic motivation) performed better after depletion than those without the incentivized motivation (i.e., depleted and unmotivated). Further, results from several studies also suggest that poorer performance after depletion was only on tasks that required self-control when compared to tasks that are deemed difficult but do not require self-control (e.g., solving arithmetic problems; Muraven et al., 2002; Muraven & Slessareva, 2003; Muraven et al., 1998).

As such, the Strength Model of Self-Control was updated to include motivational factors (Baumeister & Vohs, 2007; Baumeister et al., 2007; Muraven & Slessareva, 2003) and other models highlighting the importance of motivation in self-regulation have emerged (e.g., Motivated Effort-Allocation Model: Molden, Hui, & Scholer, 2016; Process Model of Ego Depletion: Inzlicht & Schmeichel, 2012). For example, the Motivated Effort-Allocation Model (Molden, Hui, & Scholer, 2016) proposes that regulated behavior is the product of 1) available cognitive resources to achieve a desired goal (via inhibition), 2) appraisal of the value of using the cognitive resources (motivation), and 3) evaluation of the consequences of previous self-control exertion attempts (monitoring). Applying this model to problematic alcohol use, when

attempting to abstain from drinking an individual would require 1) the ability to inhibit urges to drink (cognitive resources/self-control strength), 2) desire to inhibit urges to drink (avoidant alcohol motivation), and 3) belief that they can successfully inhibit the urges based on the success or consequences of previous attempts (monitoring).

Similarly, the Process Model of Ego-Depletion (Inzlicht & Schmeichel, 2012) posits that self-control requires intention to inhibit responses in conflict with long-term goals (motivation) and monitoring of discrepancies between responses in line with immediate rewards and long-term goals (attention). Thus, failure in drinking-related self-control is a consequence of motivational and attentional shifts from a desired long-term goal (“I don’t want to drink because I have an exam tomorrow”) toward immediate rewards in conflict with long-term goal (“I’ll feel less stressed about my exam if I drink”), resulting in failure to inhibit drinking. Motivation to adhere to responses consistent with long-term goals may be disregarded when there is a belief that doing so might lead to decrease in negative affect or increase in positive affect (Tice, Bratslavsky, & Baumeister, 2001). In other words, the well-learned rewards of drinking may become more salient (through shifting of attention toward rewarding alcohol cues) as the goal changes from intent not to drink because of an exam (distal reward contingency) to decreasing unpleasant feelings of stress (proximal reward contingency). Importantly, self-control resources may have the strongest influence on drinking behaviors during this state of motivational conflict (i.e., ambivalence). Thus, to fully understand the relationship between self-control depletion and alcohol use behaviors, researchers must integrate models of alcohol use that incorporate the full motivational spectrum.

Ambivalence Model of Craving: A motivational model of alcohol use

When desire to drink is present, restraining from drinking is an ongoing conflict between urge to drink and motivation to abstain. Considering the great deal of inhibition required to abstain from drinking, self-control is a critical factor in regulating alcohol intake (Brown, 1998; Marlatt, Demming, & Reid, 1973; Muraven & Shmueli, 2006). In an unfortunate paradox, effortfully inhibiting drinking urges requires self-control strength, resulting in a depletion of self-control resources. However, when individuals experience desire to drink, they may also simultaneously experience desire *not* to drink. This state of motivational ambivalence may be especially pertinent to college students who must weigh the immediate rewards of alcohol consumption against the longer-term consequences (e.g., “I want to drink but I have class in the morning”). Urge not to drink may alter the influence of urge to drink on self-control depletion. Extrapolating these concepts and applying them to college drinking, self-control demand throughout the day may interact with alcohol motivation (desire to drink and not to drink) to produce later drinking.

Reflecting the complexity of alcohol use motivation (desire to drink and not to drink), the Ambivalence Model of Craving (AMC; Breiner, Stritzke, & Lang, 1999; Stritzke, McEvoy, Wheat, Dyer, & French, 2007) defines craving as a motivational process with both approach and avoidance inclinations (the desire to use a substance and the desire not to use a substance, respectively). These inclinations (i.e., motivational states) are best represented as independent dimensions ranging from low to high levels of magnitude (Breiner et al., 1999; McEvoy, Stritzke, French, Lang, & Ketterman, 2004; Stritzke et al., 2007). Thus, the scope of the craving experience can be represented in a four quadrant model: approach (high approach, low

avoidance), avoidant (low approach, high avoidance), ambivalent (high approach, high avoidance), or indifferent (low approach, low avoidance) (see Figure 1).

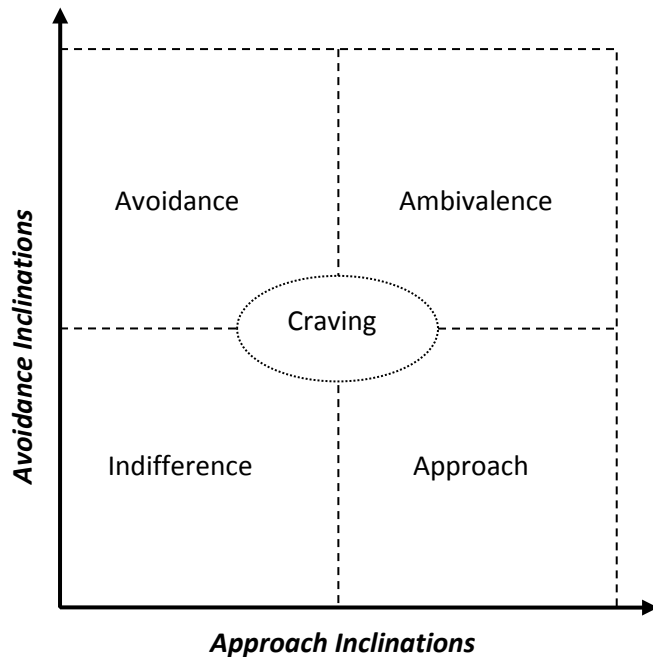


Figure 1. Ambivalence Model of Craving (adapted from Briener et al., 1999)

The inclusion of avoidance inclinations in the study of drinking related motivation is increasingly common. For example, approach and avoidance can be independently measured as separate dimensions of cue reactivity (e.g., Curtin, Barnett, Colby, Rohsenow, & Monti, 2005; Schlauch, Breiner, Stasiewicz, Christensen, & Lang, 2013; Schlauch, Rice, Connors, & Lang, 2015; Stritzke, Breiner, Curtin, & Lang, 2004). Further, avoidance has been shown to attenuate the effect of approach on drinking behaviors (Schlauch et al., under review; Schlauch et al., 2015; Schlauch, Levitt, et al., 2013), are incrementally related to taking steps to make a change (Klein, Stasiewicz, Koutsky, Bradizza, & Coffey, 2007; Schlauch, Breiner, et al., 2013; Schlauch, Levitt, et al., 2013; Schlauch et al., 2012), and may be more predictive of relapse among individuals with alcohol use disorder than increases in approach inclinations (Stritzke et

al., 2007). Together these findings suggest that not every experience of craving (approach inclination) will be followed by use, but rather is dependent on levels of avoidance inclinations and self-control.

The accumulating evidence suggests that ambivalence (high approach and high avoidance) may represent a crucial point in decision-making where motivation to use and not use a substance are particularly susceptible to influence from other factors such as self-control. For example, cognitive resources available in the moments leading up to the decision to drink may be sufficient to tip the decisional scale during states of motivational conflict. Supporting this link between alcohol motivation and self-control, Schlauch, Christensen, Derrick, Crane, & Collins (2015) found that those experiencing greater levels of ambivalence (i.e., high approach and avoidance inclinations) consumed more alcohol following a self-control depletion task when compared to other motivational profiles. Consequently, one potential link between avoidance motivations and drinking behavior is self-control, as avoidance inclinations may activate control processes to alter behavior. In other words, when desire to *not* consume alcohol is high, relevant cognitive processes (i.e., self-control) may aid in the inhibition of alcohol approach behaviors. Further, ambivalence likely creates a state that inherently requires self-control, which can be depleting in of itself. Thus, the cognitive resources required in alcohol-related decision-making likely interact with approach and avoidance inclinations to predict behavior.

Strength Model of Self-Control and Drinking

Self-control depletion has been associated with future alcohol consumption in numerous studies (Ampel, O'Malley, & Muraven, 2016; Muraven, Collins, Morsheimer, Shiffman, & Paty, 2005a; Muraven et al., 2002; Muraven & Shmueli, 2006 but see Christiansen, Cole, & Field, 2012). For example, male social drinkers randomly assigned to a high self-control depletion

condition consumed more alcohol during ad lib drinking task when compared to those in the low depletion condition, despite being told they would complete a driving simulation after to earn prizes for good driving performance (Muraven et al., 2002). Further, this effect has been shown to be greater for those higher on temptation to drink, suggesting alcohol intake is a product of alcohol approach motivations and self-control (Muraven et al., 2002; Muraven & Shmueli, 2006). While study methods included a tactic to induce motivation to limit alcohol consumption (i.e., simulated driving test with chance to win a prize), the extent to which such the manipulation increased motivation to not drink is unclear as neither momentary assessments of motivation to limit alcohol intake (avoidance motivation) nor to use alcohol (approach motivation) were explicitly assessed at any point in the study. This is noteworthy for two reasons; a) just as self-control strength is an event-reactive time-dynamic phenomenon, approach and avoidant alcohol motivations are also susceptible to short-term fluctuations in intensity, and b) because motivational conflict lies at the heart of all self-control demands (Inzlicht & Schmeichel, 2012; Milyavskaya & Inzlicht, 2017; Milyavskaya et al., 2015), assessment of both desire to use and not use alcohol is crucial.

Motivation, like self-control, is subject to fluctuation over time. Intent not to drink (i.e., avoidance motivation) may be stronger earlier in the day or in the beginning of the week and decrease as a new goal is developed that might take precedence over the originally specified goal (e.g., to regulate drinking), resulting in a change in goal commitment (motivation to adhere to the original goal of regulated drinking). Put another way, a college student may plan on staying home to study but change plans when invited to go out to celebrate a friend's birthday at a party. Failure to meet the original goal (i.e., staying home and not drinking) was not necessarily due to a lack of self-control, but instead due to a change in motivation to adhere to a predetermined goal

(i.e., studying), demonstrating that the interaction between self-control strength and motivation jointly determine future behavior. Further, since the relationship between self-control depletion and substance craving has been found to be bidirectional (i.e., depletion increases craving, craving increases depletion; Heckman et al., 2017; Muraven & Shmueli, 2006), assessing alcohol approach and avoidance motivation as well as self-control demand at multiple time points throughout the day may elucidate the relationship between motivation and self-control depletion related to alcohol use behaviors.

In one study utilizing experience sampling, Hofmann, Vohs, and Baumeister (2012) found an accumulative effect of self-control depletion such that the frequency and temporal recency of self-control demand was associated with success at exerting self-control later in the same day. Specifically, self-control was measured by assessing a) the presence of a desire or urge (yes/no) in the last half hour, b) the strength of the desire, c) if the desire conflicted with long-term goals, d) the nature of the desire (e.g., selecting from a list of 15 domains that included sex, eating, alcohol, and sleep), and e) the extent to which the desire was resisted. Participants completed the items up to seven times a day for one week. Although the study assessed *if* the desire conflicted with long-term goals, *state motivation to pursue the goal* was not assessed. As such, it is unclear how motivation to resist a desire might impact the reported accumulation effect. The accumulation effect might explain why individuals with ambivalent motivational profiles (strong avoidance and strong approach motivations) earlier in the day might fall into an approach-oriented motivational state (i.e., low avoidance, high approach) later in the day as acts of self-control over time accumulates and intent to abstain from drinking becomes weaker. In other words, avoidance engages self-control throughout the day as drinking urges are inhibited, resulting in a depletion of self-control.

With regard to alcohol use, to date only one published report has examined self-control depletion and drinking behaviors using experience sampling. In this study, researchers found that among underage college social drinkers greater self-control depletion (acts of self-control throughout the day not related to alcohol use) predicted violation of self-imposed drinking limits and greater intoxication that night, even after controlling for mood and urge to drink (Muraven, Collins, Shiffman, et al., 2005). Trait self-control moderated the relationship between self-control demands and alcohol intake suggesting that individuals with a smaller pool of cognitive resources (i.e., lower trait self-control) were more affected by depletion and reported greater alcohol intake later in the day than those with greater trait-self-control. Interestingly, state self-control demands were not related to urge to drink or intention to limit drinking. This may be an artifact of how and when urge was measured; *urge not to drink* was implied by low scores on the *urge to drink* scale assessed in a scheduled evening assessment, which fails to capture the nature of alcohol motivation that consists of two independent dimensions (i.e., approach and avoidant) that may fluctuate throughout the day, thus directly influencing intention to limit drinking. As such, assessing self-control in real time by use of experience sampling techniques may yield support for the external validity of motivational models of self-control.

Proposed Study

Mixed findings of previous self-control literature may be due to the failure to assess motivational profiles associated with self-control failure and subsequent alcohol use behaviors. To fully understand the influences of self-control on alcohol use behaviors, motivational factors must be incorporated along with self-control factors to elucidate the breakdown of goal-directed behavior. Further, while there is some evidence for the effect of self-control depletion on subsequent behavior in real-world applications, no studies to date assess the influence of in-vivo

self-control exertion and approach and avoidance alcohol motivation throughout the day on subsequent drinking behaviors. Specifically, the role of ambivalent (i.e., high approach and high avoidance) motivational states in the context of alcohol self-control has been largely neglected. The ecological validity of many experimental paradigms that induce motivation to self-control via incentives based on performance likely limit the generalization to real world settings. Using ecological momentary assessment (EMA; Shiffman, 2009; Shiffman, Stone, & Hufford, 2008) the current study sought to assess whether the interaction of self-control exertion and alcohol motivation predicts drinking behavior in college drinkers. Based on previous research and hypotheses generated from both the AMC and self-control theories, we hypothesized that self-control exertion will significantly and positively predict drinking (i.e., simple slope) among those higher on both approach and avoidance inclinations (i.e., ambivalent motivation).

METHOD

Participants

Undergraduate students enrolled in psychology courses at the University of South Florida were recruited from a psychology research pool (SONA Systems) to participate in an online EMA survey study. Inclusion criteria were: a) experience a binge drinking episode at least one occasion per week on average (i.e., 4 or more drinks for females, 5 or more drinks for males on a single occasion), b) have a personal smartphone with text messaging capabilities and access to the internet, c) be English speaking, and d) be at least 18 years of age. Exclusion criteria were: a) current participation in other experience sampling SONA research studies. A total of 174 students began the brief 6 item screening survey, however, 29 did not finish the survey. Of the 145 students who completed the inclusion/exclusion screening survey, 21 participants were excluded for failing to meet the alcohol consumption inclusion criteria, 10 participants were excluded for reporting participation in another EMA study, and 12 participants were excluded for failing to meet both criteria (alcohol consumption and participation in another EMA study). Finally, one participant failed to meet the smart phone criteria, and one participant declined to participate following screening. Of the 100 participants enrolled into the study, one participant was excluded from analyses for failing to meet validity check requirements (i.e., inappropriately responding to an embedded attention check item in the baseline assessment and providing significantly different responses on two similar items with slightly different wording) and two participants enrolled in the study twice and data from their second participation was excluded, bringing the final sample size to 97 participants.

Participants were 87.6% female with a mean age of 22.02 years (SD = 4.77), 47.4% were White (non-Hispanic), 21.6% were Hispanic, and 10.3% were African American, and 73.2% were of junior or senior college standing. The majority of participants were employed full- (15.5%) or part-time (48.5%), although 59.8% reported an average annual income of <\$10,000. Most participants were single (73.2%) and either living in campus dorms (20.6%), off campus with roommates (35.1%), or off campus with family (19.6%) (see Table 1 for summary).

Measures – EMA

AAAQ-6 (state-based alcohol motivation). The Brief Approach and Avoidance Alcohol Questionnaire (Levine et al., 2019; AAAQ; McEvoy et al., 2004) is an abbreviated 6-item self-report measure that assesses approach inclinations and avoidance inclinations specific to alcohol use. Each item is rated on a 9-point Likert scale from 0 (not at all) to 8 (very strongly) indicating the extent to which the respondent agrees with each statement since the last prompt completed. Reliability analyses in the current study yielded good internal consistency for the approach ($\alpha = 0.869$) and avoidance scale ($\alpha = 0.856$).

Self-Control Exertion. Self-reported self-control exertion was assessed at each EMA time point (Effortful Behavior Items; Derrick, Leonard, Houston, Lucke, & Muraven, 2015). Each item is rated on a 5-point Likert scale from 0 (not at all) to 4 (very strongly) indicating the extent to which the respondent agrees with each statement. Reliability analyses in the current study yielded acceptable internal consistency ($\alpha = 0.774$).

Since the last survey I completed...

1. I stopped myself from doing something.
2. I controlled my feelings.

3. I kept my thoughts focused.
4. I experienced stress.
5. I was interrupted or distracted.
6. I made myself do something I didn't feel like doing.

PANAS (state-based affect). The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) is a brief 20-item self-report measure that assesses positive and negative affect. Each item is rated on a 5-point Likert scale ranging from 0 (very slightly or not at all) to 4 (extremely) indicating the extent to which the respondent has experienced different feelings and emotions since the last prompt. The PANAS was used to statistically control for the potential influence of affect in the relationship between self-control demand and alcohol motivation.

Alcohol and drug use. Alcohol and drug use was assessed at each daily monitoring assessment using four questions;

1. How many STANDARD DRINKS have you consumed since the last survey you completed?
 - a. How long ago did you have your first drink?
2. Since the last survey you completed, how difficult would it have been to get alcohol if you wanted to drink?
3. Do you plan on consuming alcohol between now and the end of today?
4. Which of these substances have you used since the last survey completed? (check all that apply; response options included tobacco cannabis, and nonprescription medication)

Table 1. Summary of Participant Demographics (n=97)

Variable	Frequency (Percent)
Sex/Gender	
Female	85 (87.6%)
Male	12 (12.4%)
(Transgender)	2 (2.1%)
Age, Mean (SD)	22.02 (4.77)
Race/Ethnicity	
White (non-Hispanic)	46 (47.4%)
Hispanic	21 (21.6%)
Black/African American	10 (10.3%)
Asian or Asian/American	5 (5.2%)
Native Hawaiian or Pacific Islander	1 (1%)
Multiracial	11 (11.3%)
Other or Unknown	3 (3.1%)
College Standing	
Freshman	11 (11.3%)
Sophomore	14 (14.4%)
Junior	30 (30.9%)
Senior	41 (42.3%)
Other	1 (1%)
Member of Fraternity or Sorority	15 (15.5%)
Employment Status	
Employed Full Time	15 (15.5%)
Employed Part Time	47 (48.5%)
Unemployed, Looking for work	19 (19.6%)
Unemployed, Not looking for work	15 (15.5%)
Disabled	1 (1%)
Residence	
Campus Residence Hall/Dorm	20 (20.6%)
Fraternity/Sorority House	2 (2.1%)
Off-Campus, Student Housing	8 (8.2%)
Off-Campus, with roommates	34 (35.1%)
Off-Campus, with significant other	5 (5.2%)
Off-Campus, with family	19 (19.6)
Off-Campus, alone	8 (8.2%)
Relationship Status	
Single/Never Married	71 (73.2%)
Partnered, not living with partner	17 (17.5%)
Partnered, living with partner	3 (3.1%)
Married	6 (6.2%)
Income	
0 to \$10,000	58 (59.8%)
\$10,101 to \$20,000	17 (17.5%)
\$20,001 to \$40,000	16 (16.5%)
Over \$40,000	6 (6.2%)

Table 2. Descriptive Statistics for EMA Variables

Variable	Mean (SD)	Minimum-Maximum
Self-Control Exertion	1.454 (.690)	0-4
AAAQ-6		
Approach	1.202 (1.727)	0-8
Avoidance	.499 (1.090)	0-8
PANAS		
Negative Affect	.391 (.529)	0-4
Positive Affect	1.077 (.874)	0-3.6
Number Drinking Days	4.055 (3.237)	0-14
Number of Drinks per Drinking Day	3.76 (3.08)	1-18

Measures - other

Demographics. Demographic information including gender, age, race, ethnicity, employment status, income, education/year in school, residential status, current psychotropic medications, and affiliation with a fraternity or sorority was collected using a self-report questionnaire.

DHQ. The Drinking History Questionnaire is a 10-item self-report measure that assesses an individual's quantity and frequency of current and past alcohol use and their subjective experiences and beliefs related to their own use. This questionnaire was used to categorize general drinking behavior of participants based on quantity and frequency, which was statistically controlled for in the main analyses of the current study.

Self-Control Scale (trait-based self-control). The Self-Control Scale (Tangney, Baumeister, & Boone, 2004) is a 36-item self-report measure that assesses trait self-control with higher scores indicating better self-control (e.g., "I am good at resisting temptation", "I am able to work effectively toward long-term goals"). Prior research has found strong associations between the Self-Control Scale and behavioral measures of self-control (Schmeichel & Zell, 2007), yielding support for the Self-Control Scale as a valid measure of trait self-control.

Reliability analyses in the current study yielded excellent internal consistency for the total scale ($\alpha = 0.902$). This questionnaire was used to conduct post-hoc exploratory analyses.

SURPS. The Substance Use Risk Profile Scale (SURPS; Woicik, Stewart, Pihl, & Conrod, 2009) is a 23-item self-report measure that assesses personality risk for substance use and dependence across four dimensions; Sensation Seeking, Impulsivity, Anxiety, and Hopelessness. Each item is rated on a 5-point Likert scale from 0 (strongly disagree) to 4 (strongly agree) indicating the extent to which the responded agrees with each statement. Reliability analyses in the current study yielded nearly acceptable internal consistency for the Impulsivity subscale ($\alpha = 0.662$). The SURPS was used to conduct post-hoc exploratory analyses.

UPPSP. The UPPS-P Impulsive Behavior Scale (Cyders et al., 2007; Lynam, Smith, Whiteside, & Cyders, 2006), a revision to the original UPPS (Whiteside & Lynam, 2001), is a 59-item measure assessing impulsivity across 5 subscales: Positive Urgency, Negative Urgency, Premeditation (lack of), Perseverance (lack of) and Sensation Seeking. The UPPSP provides two composite scores; Emotion-Based Rash Action and Lack of Conscientiousness. Reliability analyses in the current study yielded good internal consistency for the Total ($\alpha = 0.925$), Emotion-Based Rash Action ($\alpha = 0.802$), and Lack of Conscientiousness ($\alpha = 0.768$) subscales. The UPPSP was used to conduct post-hoc exploratory analyses.

Procedure

Initial assessment. Eligible participants were recruited for the study through SONA. Participants viewing studies listed on SONA were provided with a brief description of the study as follows “Participate in a two-week brief daily survey study looking at day-to-day behavior of college drinkers”. Participants clicked on a link to a full description of the study, including

estimated time, points (class credit) awarded, and eligibility requirements. Participants provided informed consent and completed a series of online self-report surveys assessing demographics, alcohol-related behaviors, personality, and mood and anxiety symptomology. Participants received online instruction of the use of the EMA survey website Qualtrics. The Qualtrics instruction included a review of the EMA sampling protocol (i.e., time frame of random assessments) and education on a “standard” drink using the NIAAA standard drink guideline. All measures were presented with their full instructions.

Two-week EMA monitoring period. Self-control exertion, alcohol-related behavior, and alcohol motivation was assessed on an interval-contingent schedule (Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009). Beginning the following day, participants received text message prompts with a hyperlink directing them to the Qualtrics website where the survey was completed five times daily for the next fourteen days. The text message assessments occurred at randomized times within each of five predetermined time frame intervals (9:00am-12:00pm, 12:01pm -3:00pm, 3:01pm-6:00pm, 6:01pm-9:00pm, and 9:01pm-12:00am). Survey completion was timestamped. Brief or single item measures were administered where appropriate to reduce participant burden and facilitate compliance.

Compensation. Participants received class credit for their participation (30 minutes = 0.5 points), awarded to them through SONA. Baseline questionnaires and education on the monitoring portion of the study took an average of about an hour to complete ($M = 54.7$ minutes, $SD = 27.33$). The EMA survey took an average of 2 minutes to complete ($M = 123.2455$ seconds, $SD = 34.07$). To encourage survey compliance, compensation for survey completion was based on total number of surveys completed (see Figure 2 for compensation schedule), allowing a maximum of 8 credits for participation in the baseline assessment and two-week

monitoring period. The procedures for the EMA protocol are similar to those used in studies of self-control and substance use (e.g., Hepp et al., 2017; Shiffman, 2009; Trull et al., 2008).

<u>Study Compensation Schedule</u>	
Initial Assessment (what you are completing now):	1.5 SONA points
Daily Surveys: Based on the percentage of completed surveys, you will earn an additional...	
100% - 80%	= 6.5 SONA points
80% - 60%	= 5 SONA points
60% - 40%	= 3.5 SONA points
40% - 20%	= 2 SONA points
20% - 1%	= .5 SONA points

Figure 2. Study Compensation Schedule provided to participants

Data Analytic Strategy

Within person data are best analyzed using multilevel regression models (Kenny, Kashy, & Bolger, 1998; Schwartz & Stone, 1998) that estimate both within person (variability of self-control demand and alcohol motivations around person-centered means) and between person (individual differences such as drinking history) data simultaneously. Multilevel regression meets assumptions of such data (e.g., data dependency) that other analytic methods (e.g., repeated measures analysis of variance) fail to meet. In addition, multilevel regression allows for statistical control of potential covariates (e.g., affect, day of week) that would otherwise lead to biased estimates. There are two levels of nesting in the present study; time points (level 1) nested within individuals (level 2), thus, multilevel regression was the appropriate statistical technique for the current study.

Self-control indices were obtained by calculating the mean of the six effortful behavior items, with higher scores indicating greater self-control exertion. Approach and avoidance were calculated as average scores (three approach items, three avoidance items) with higher scores indicating greater approach/avoidance inclinations. All level 1 predictors and control variables

(i.e., affect, day of week) were entered as random effects and estimated using restricted maximum-likelihood estimation (REML; for continuous variables) with robust standard errors. REML was chosen over FML (full maximum likelihood) because it provides less biased variance estimates, particularly with smaller sample sizes (e.g., Hox, 2010). All level 2 variables (i.e., drinking history) were entered as fixed effects and estimated using REML with robust standard errors. Consistent with centering recommendations (Enders & Tofighi, 2007), and due to our interest in examining within-person variability, all level 1 time-varying predictors (i.e., self-control exertion, approach, avoidance, affect) were person-mean centered. Day of week was dummy coded (entered as fixed effects) as 0 for Sunday-Wednesday and 1 for Thursday-Saturday (representing days college students are most likely to drink) as previous literature indicates alcohol consumption among college students regularly varies as a function of day of the week (Del Boca, Darkes, Greenbaum, & Goldman, 2004). For all analyses, normality, homoscedascity, and other multilevel regression assumptions were assessed by visual examination of residual plots and significant testing of residuals and predicted residuals.

To investigate the moderating role of alcohol motivation on self-control in the prediction of alcohol use behaviors in heavy college drinkers (primary aim), a time-lagged multilevel regression model was estimated using Hierarchical Linear Modeling (HLM 7.0; Raudenbush, Bryk, Cheong, Congdon, & Du Toit, 2011). Specifically, we examined whether self-control exertion leads to greater likelihood of drinking among individuals with high approach and high avoidance alcohol motivation (ambivalence). Indices of self-control exertion, approach, avoidance and all two-way and the three-way interaction were entered as level 1 predictors of drinking quantity (number of drinks consumed; time-lagged/leaded where appropriate), controlling for positive and negative affect and day of the week. Because of the nature of typical

alcohol use throughout the two week monitoring period (i.e., not daily or almost daily), drinking quantity was skewed with a high proportion of zeros, and an overdispersed Poisson distribution was used (Snijders and Bosker, 1999).

Power analysis. To date there is no consensus for estimating power to examine within person effects in MLM. However, the general rule of thumb for sample size consideration (based on simulation studies) is a 50/20 (level 2/level 1) ratio (Hox, 2010). Further, Hox (2010) notes that as the n for level 2 increases the number of observations can decrease. With a total of 70 level-2 assessment opportunities, a sample size of 100 meets these recommendations and is consistent with previous studies (Dvorak, Pearson, & Day, 2014; Dvorak, Pearson, Sargent, Stevenson, & Mfon, 2016; Peacock, Cash, Bruno, & Ferguson, 2015; Simons, Wills, & Neal, 2014).

RESULTS

Descriptive and Compliance Statistics

A total of 3736 EMA assessments were completed (55.02% of total possible surveys). As expected, this overall compliance rate is lower than those reported in previous studies using similar methods (ranging from 69-75%; see Jones et al., 2019) given the 80% survey compliance benchmark and limitations of awarding class credit within the SONA system. Specially, participants in the current study were required to complete 80% of total surveys to earn full compensation and no additional incentives was offered for providing more than 80% of surveys. Using the 80% benchmark (i.e., completing at least 80% of total surveys), compliance rates were comparable to compliance rates reported in similar studies (Jones et al., 2019). Compliance rates for prompts throughout the day were fairly consistent; 52.1% for prompt #1 (9a-12p), 58.0% for prompt #2 (12p-3p), 56.4% for prompt #3 (3p-6p), 55.5% for prompt #4 (6p-9p), and 53.1% for prompt #5 (9p-12a). There was little variability in compliance rates by day of the week; of all surveys completed, 13.5% was on Sunday, 14.9% on Monday, 14.2% on Tuesday, 14.2% on Wednesday, 15.0% on Thursday, 14.3% on Friday, and 13.9% on Saturday. During the 14 day monitoring period, participants reported 357 drinking days (36.1% of reported days) and of those days, participants consumed an average of 3.76 ($SD = 3.15$) drinks per day.

Unconditional Models and Intraclass Correlations

To examine the proportion of variance accounted for due to clustering (i.e., correlation among observations within person), an unconditional model for the outcome was conducted (drink quantity) yielding an ICC of .1308, indicating 13.08% of the variance in outcome

measures are accounted for the grouping structure of the data. Further, all random intercepts were significant, p 's $<.001$.

Primary Aim Results

Our hypothesis that approach and avoidance would interact with daily self-control demands to predict alcohol use was partially supported. A significant three-way interaction was found ($b = -.243$, $SE = .1003$, $p = .018$; Event Rate Ratio = .785, CI = .643, .958). Inspection of the plotted estimated means for high (85th percentile) and low values (15th percentile) of self-control, approach, and avoidance indicated ambivalent alcohol motivation was predictive of *fewer* number of drinks per occasion at high levels of self-control exertion, and *higher* number of drinks per occasion at low levels of self-control exertion (see table 2 for full model results and figure 3 for visual representation of interaction).

To further examine this interaction, several follow-up analyses were conducted. A significant Approach X Avoidance interaction was found among those with high self-control ($b = -.321$, $SE = .107$, $p = .003$). At high levels of self-control exertion, a significant simple slope for approach was observed at both high ($b = .366$, $SE = .067$, $p < .001$) and low ($b = .510$, $SE = .091$, $p < .001$) levels of avoidance. Further, at high levels of self-control exertion, a significant simple slope for avoidance was observed at high ($b = -.448$, $SE = .182$, $p = .016$), but not low ($b = .155$, $SE = .141$, $p = .275$) levels of approach. The Approach X Avoidance interaction at low levels of self-control exertion was nonsignificant.

Table 3. Summary of Results (full model)

Effect	Fixed Effects					Random Effects			
	Coefficient	SE	p	ERR	CI	Parameter	Variance	χ^2	p
Intercept	-2.588	0.185	<.0001	.075	(0.052,0.109)	r0	1.697	102.749	<.001
Drinking History	.071	.014	<.0001	1.073	(1.044,1.103)				
Positive Affect	-.016	.150	.913	.984	(0.730,1.326)	r1	.893	76.692	<.001
Negative Affect	-.386	.209	.068	.680	(0.448,1.030)	r2	1.098	58.925	.002
Day of Week	.975	.203	<.0001	2.65	(1.771,3.965)	r3	1.914	111.049	<.001
Approach (AP)	.456	.053	<.0001	1.58	(1.419,1.755)	r4	.091	43.142	.072
Avoidance (AV)	-.151	.100	.136	.860	(0.705,1.050)	r5	.207	15.728	>.500
APxAV	-.179	.064	.006	.836	(0.736,0.950)	r6	.118	25.951	>.500
Self-Control (SC)	-.184	.161	.257	.832	(0.604,1.147)	r7	.901	32.846	.376
APxSC	-.058	.086	.501	.944	(0.796,1.119)	r8	.185	30.361	>.500
AVxSC	-.011	.123	.928	.989	(0.774,1.264)	r9	.301	21.287	>.500
APxAVxSC	-.243	.100	.018	.785	(0.643,0.958)	r10	.250	26.407	>.500
						Level-1 e	1.042		

Note: SE = standard error; ERR = event rate ratio; CI = Confidence Interval; Drinking History = baseline quantity/frequency composite; Day of Week = Sunday through Wednesday dummy coded as 0, Thursday through Saturday dummy coded as 1. AP = approach, AV = avoidance, SC = self-control exertion.

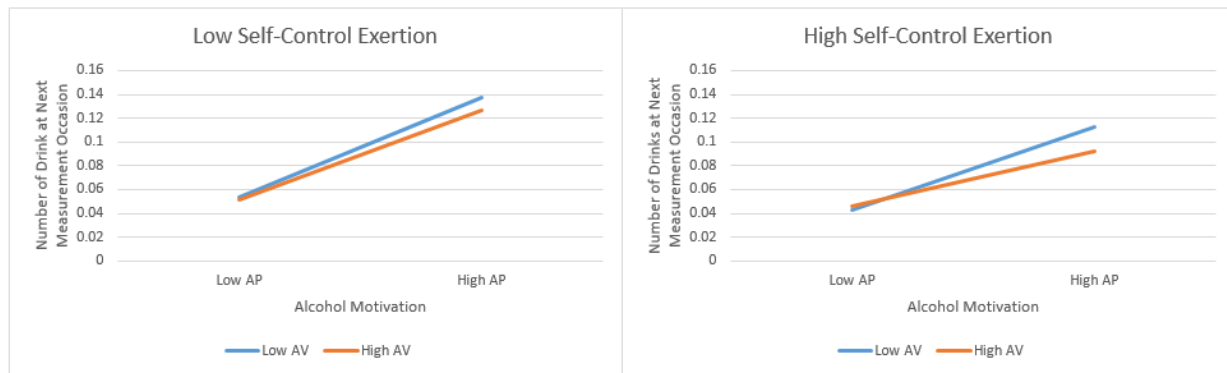


Figure 3. Graph of 3-way interaction. AV = avoidance motivation. AP = approach motivation.

To further explore the relationship between the self-control measure and related constructs (i.e., trait self-control, trait impulsivity), a series of exploratory analyses were conducted. Self-control exertion (mean of SC EMA measure) was significantly negatively correlated with a baseline measure of trait self-control (e.g., “I have trouble saying no”, “I am good at resisting temptation”) ($r = -.256, p < .001$), indicating that participants who self-rate themselves as having better self-control in general report exerting self-control to a lesser extent on the daily level. Further, self-control exertion (mean of SC EMA measure) was also significantly positively correlated with baseline measures of trait impulsivity (SURPS Impulsivity subscale: $r = .198, p < .001$; UPPSP Total Score: $r = .091, p < .001$; UPPSP Emotion-Based Rash Action Composite Score: $r = .149, p < .001$), whereas the correlation with an index of deficits in conscientiousness was nonsignificant (UPPSP: $r = .017, p = .175$) (see Table 3). Further, exploratory analyses assessing the influence of self-control exertion on alcohol consumption controlling for drinking history, affect, and day of week (i.e., excluding alcohol motivation from the model) revealed a significant negative association ($b = -.265, SE = .131, p = .047$) such that greater self-control exertion was associated with less alcohol consumption.

Table 4. Descriptive statistics and correlations for self-control related measures

	<i>M</i>	<i>SD</i>	1.	2.	3.	4.	5.
1. Self-Control Exertion (EMA Mean)	1.454	.690	-				
2. Self-Control Scale	85.295	20.364	-.256*	-			
3. SURPS Impulsivity	.979	.578	.198*	-.575*	-		
4. UPPSP Total Score	127.255	25.660	.091*	-.638*	.571*	-	
5. UPPSP Emotion-Based Rash	52.670	14.727	.149*	-.569*	.537*	.916*	-
6. UPPSP Deficits in Conscientiousness	42.213	9.775	.017	-.539*	.463*	.765*	.550*

To examine whether measures of alcohol motivation were functioning as expected in the current study, a 2-way approach by avoidance interaction model predicting drinking was

conducted (again controlling for affect, day of week, and drinking history). As expected, a significant 2-way interaction ($b = -.135$, $SE = .059$, $p = .025$; Event Rate Ratio = .874, CI = .776, .983) was found indicating that high avoidance motivation was associated with drinking at high, but not low, levels of approach motivation. Further, a significant simple slope for avoidance was observed at high ($b = .739$, $SE = .052$, $p < .001$) and low ($b = -.174$, $SE = .066$, $p = .009$) levels of approach.

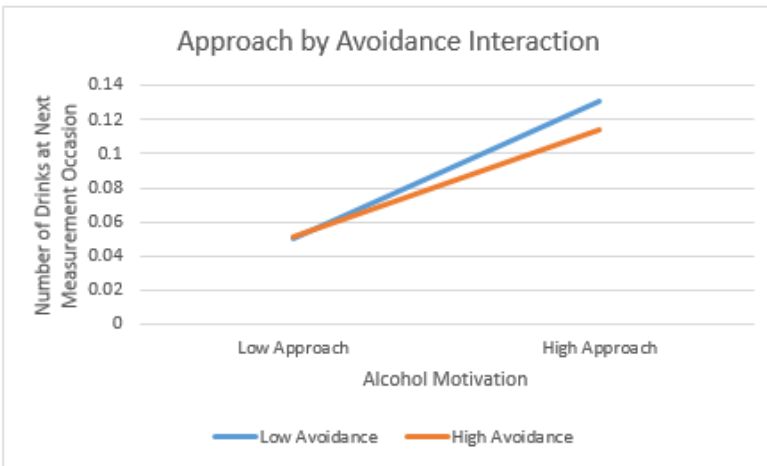


Figure 4. Graph of 2-way Approach by Avoidance interaction.

DISCUSSION

The current study investigated the interaction of self-control exertion and alcohol motivation in the prediction of alcohol consumption in heavy college drinkers. Ambivalence (high approach and high avoidance motivation) may represent a crucial point in decision-making where motivation to use and not use alcohol are particularly susceptible to influence from factors such as self-control. According to the Strength Model of Self-Control (Baumeister et al., 2007), exerting self-control results in diminished capacity to regulate behavior, and it was expected that self-control exertion leading up to the decision to drink may be sufficient to tip the decisional scale during states of motivational conflict (i.e., ambivalence). Accordingly, it was predicted that self-control exertion would interact with alcohol motivation to predict drinking (controlling for drinking history, affect, and day of week). Specifically, we expected high approach and high avoidance (i.e., ambivalence) would be more strongly associated with drinking at higher levels of self-control exertion compared to lower levels of self-control exertion. Although results indicated a significant interaction, the relationship was not in the expected direction; *higher* self-control exertion among those with high approach and high avoidance motivation was associated with *fewer* number of drinks per occasion. In other words, competing desires to drink and not to drink were associated with less drinking when self-control demands were high.

Although a significant interaction was found, findings must be considered in context of restricted range in reported self-control exertion at the between person level ($M=1.454$, $SD=.690$, $Min=0$, $Max=4$) and somewhat diminished variability at the within person level. Specifically, the unconditional intraclass correlation of self-control exertion was .54, indicating 57% of the

variance in self-control exertion was due to person mean differences (between-person) and 43% was due to within person variation across time (Hoffman, 2015). Although the observed high ICC was expected given the longitudinal nature of the data, the restricted range at the between person level have implications on the interpretation and generalizability of study findings, especially to samples with higher levels of daily self-control exertion. Likewise, although rates of alcohol consumption and reports of alcohol motivation were largely consistent with previous literature, it will be important to examine these relationships in other samples with varying drinking patterns (e.g., light/social drinkers, individuals with alcohol use disorder). Examining other drinking samples will be particularly important given the typical drinking patterns of college students as observed in the current sample. Specifically, alcohol consumption among college students tends to occur on specific days of the week and although day of week for typical college student drinking was statistically controlled for in the current study (i.e., Thursday, Friday, Saturday; Reich, Cummings, Greenbaum, Moltisanti, & Goldman, 2015), the relationship between self-control exertion and alcohol motivation may vary across different drinking patterns in different samples of drinking severity. Thus it is unclear how the current findings may have been impacted by this limited variability in drinking.

Several potential explanations for the surprising findings exist. Although the self-control measure used in the current study was chosen to assess broad indices of self-control exertion that were hypothesized to contribute to self-control depletion, it is possible that the measure did not capture the aspects of self-control demand it was theorized to capture. Specifically, the measure may have captured self-control “successes” rather than total attempts at self-control. Indeed, four out of the six items used in previous studies imply successful self-control (i.e., I stopped myself from doing something, I controlled my feelings, I kept my thoughts focused, and I made myself

do something I didn't feel like doing). According to the Strength Model of Self-Control, any attempts at self-regulation, whether successful or unsuccessful, tax cognitive resources, highlighting the necessity to assess total self-control exertion that includes both successful and failed attempts.

Other EMA studies assessing alcohol use and self-control demands have used measures with very similar items to those used in the current study. Specifically, Muraven, Collins, Shiffman, et al. (2005) used 6 items that assessed the extent to which participants regulated their mood, experienced stress, felt overwhelmed, and controlled their thoughts among a heavy drinking college sample (alcohol consumption reported on 35.1% of study days, mean number of drinks = 5.45, SD = 3.10). Walters et al. (2018) expanded this measure to include two items assessing the extent to which participants forced themselves to do something they didn't want to and forced themselves not to do something they wanted to among a sample of much lighter drinkers (alcohol consumption reported on 13.9% of study days, mean number of drinks = .73, SD = 2.39). Analyses in the current study revealed findings consistent with Walters et al. (2018) in which greater self-control exertion was *negatively* associated with alcohol consumption, while Muraven, Collins, Shiffman, et al. (2005) found that greater self-control exertion was *positively* associated with alcohol consumption. Notably, our sample was more similar to the heavy drinking sample used in Muraven, Collins, Shiffman, et al. (2005) (current study alcohol consumption reported on 36.1% of study days, mean number of drinks = 3.76, SD = 3.15). However, the items used in current study were more similar to Walters et al. (2018) in that we also included the two additional items (i.e., doing something they didn't want to not to do something they wanted to) when assessing self-control exertion. To investigate the impact of

these two additional items, follow up analyses were conducted without these items, however, the relationships and significant interactions remained the same.

An important consideration in the interpretation of the findings in the current study pertains to individual differences in self-control abilities that may govern how self-control demand is experienced in everyday life. Although seemingly counterintuitive, individuals who have greater capacity to control their cognitions and behaviors (i.e., trait-based self-control ability) may create and maintain an environment for themselves that places less demand on their self-control abilities (Galla & Duckworth, 2015; Gollwitzer & Sheeran, 2006), resulting in less reported self-control exertion at the daily level. Consistent with this, follow-up analyses in the current study indicated a small but significant negative correlation between the EMA measure of self-control exertion and baseline self-report measures of trait self-control indicating that those with greater trait self-control reported exerting self-control to a lesser extent on the daily level than those with poorer trait self-control. Also, small but significant positive correlations between the EMA measure of self-control exertion and baseline self-report measures of trait impulsivity were found, further suggesting individual differences in longstanding traits in self-control ability may govern how self-control demand is experienced in everyday life. However, if *greater self-control exertion* at the daily level is an indicator of *poorer trait self-control*, it does not explain why greater self-control exertion was associated with *less* drinking in the current study, especially given the existing literature linking poor self-control to dysregulated drinking. Additional research clarifying the relationship between trait self-control and self-control exertion in everyday life is necessary to resolve these issues particularly in regard to self-control exertion and drinking behavior.

Equally important to note is that the self-control exertion measure used in the current study was a modified version of a measure used in previous research examining self-control demand specific to romantic relationship interactions predicting tobacco use (Derrick et al., 2015). Two modifications were made. First, specification of self-control demand in context of romantic relationship interactions was removed from the instruction set to better capture a wider range of demands that may tax cognitive resources. The Strength Model of Self-Control posits any task that requires self-regulation leads to a depletion effect (for review see Baumeister, Gailliot, DeWall, & Oaten, 2006). As such, the modification was made to capture self-control depletion across a wide range of contexts in which self-control depletion may occur (e.g., interpersonal relationships, occupational or education responsibilities). The second modification was that responses to the measure of the current study were rated on a Likert scale rather than a dichotomous yes/no scale that was used in the original measure. To explore potential differences in self-control exertion rated on a dichotomous rather than a continuous scale, self-control exertion was recoded dichotomously and the three-way interaction was reanalyzed. All relationships remained the same and all significant interactions held, suggesting minimal impact from modification of the scale type. Although participant's responses may have differed if provided a dichotomous versus a continuous scale (i.e., a participant who selected a "1" on a given item may select "no/0" if presented with only two response options), previous research has found a cumulative effect of self-control depletion that emphasizes the importance of examining *intensity* in addition to frequency (yes/no) of self-control demands (Hofmann, Vohs, & Baumeister, 2012).

Although self-control exertion as measured in the current study intended to capture a wide range of self-control demands and was non-specific to any particular domain, it is possible

that two of the items in the measure may have captured attempts to regulate alcohol consumption (i.e., “I stopped myself from doing something” and “I made myself do something I didn’t feel like doing”). Further, as noted by Walters et al. (2018), these indices of self-control may be particularly sensitive to self-control demands that are incompatible with drinking, such as studying or having early morning classes. To explore the potential influence of these items on the measure of self-control exertion, the two items were removed and the three-way interaction was reanalyzed. All relationships remained the same and all significant interactions held, suggesting minimal impact from these two items in the relationship between self-control exertion and motivation predicting drinking. That being said, future research may want to consider specifying the self-control domain the participants should refer to in the instruction set of the measure, or rather the domains not to refer to (i.e., regulating alcohol consumption) to allow for more precise inferences to be drawn from studies using the self-control exertion measure.

All things considered, the current study adds to the existing literature by demonstrating the importance of considering the unique effects of both alcohol use motivation and self-control demand in the prediction of alcohol consumption, and draw attention to the need for further investigation into the complex interplay of these processes in daily life. Specifically, refinement of the measurement of self-control demand in everyday life is warranted to characterize meaningful patterns of self-control exertion and motivation that lead to alcohol use. Of particular importance would be to assess self-control successes *and* failures, given the potential for self-control failure to be especially taxing on cognitive resources. Further, to address the concerns of construct validity previously described, striking a balance between assessing self-control demand broadly enough to capture the many domains that tax cognitive resources, but also narrow enough to draw meaningful conclusions is necessary. As it stands, findings from the current

study suggest that greater self-control exertion leads to less drinking, which has important theoretical and clinical implications.

Implications

Replication efforts of the self-control depletion effect (“ego-depletion”) have yielded mixed findings, prompting the need to reexamine the fundamental concepts self-control depletion theories were based on (“conceptual crisis”; Lurquin & Miyake, 2017). Of particular importance is the role of motivational incentives in the self-control depletion effect (Lurquin & Miyake, 2017). Accumulating evidence suggests that self-control exertion results in diminished *willingness* to exert subsequent self-control, rather than diminished *ability* to exert subsequent self-control (Inzlicht & Schmeichel, 2012; Inzlicht, Schmeichel, & Macrae, 2014; Kool & Botvinick, 2014; Kurzban, Duckworth, Kable, & Myers, 2013). Based on these findings, self-control exertion may result in diminished willingness to regulate drinking (i.e., greater approach motivation and/or less avoidance motivation), which then leads to alcohol consumption. However, exploratory analyses in the current study indicated that self-control exertion was significantly associated with avoidance motivation (positive association), but not approach motivation. Future research experimentally manipulating depletion of self-control will be important in understanding how self-control depletion influences alcohol use motivation.

Additionally, continued research examining the interactions among self-control and alcohol motivation may provide guidance for the development of new approaches to the prevention of risky alcohol consumption and the treatment of alcohol use disorder. Specifically, a better understanding of the interplay between approach, avoidance, and self-control will be important in understanding who and when individuals are at greatest risk for problematic drinking behavior, such as binge drinking or alcohol lapses. Results of the current study

indicated that when individuals report greater-than-usual non-specific self-control exertion they drank less, suggesting that goal-directed behavior in general may be protective against alcohol consumption. Applying this to current alcohol intervention, it may be beneficial to encourage the active pursuit of goals broadly (i.e., beyond just goals that are incompatible with drinking), which may lead to increased avoidance motivation and behavior aimed at regulating alcohol consumption.

Limitations

The primary limitation of the current study is the lack of strong validation of the self-control exertion measure. Trait-based self-control measures are plentiful, however use of state-based measures validated for use in intensive EMA designs are limited. In addition, a theoretical account of self-control exertion and alcohol use motivation at the daily level is lacking. Together, these issues raise the concern of potential replicability concerns. Although the EMA study design allows for a better understanding of temporal relationships between self-control and motivational processes and alcohol consumption, the nonexperimental design prevents any causal inferences to be made. Further, the data were based on self-report, and actual alcohol consumption were not independently verified by objective measures such as blood alcohol concentration. There was somewhat limited variability in reports of alcohol use quantity, alcohol avoidance motivation, and self-control exertion which limits the generalizability of results. For example, the influence of alcohol motivation predicting drinking varies with level of alcohol use severity and whether or not they are actively trying to change their drinking, which limits the generalizability of these results to clinical samples with alcohol dependence, including individuals who are currently in treatment and individuals with alcohol use disorder who are non-treatment seeking.

Conclusions

The results of this study provided evidence that competing desires to drink and not to drink were associated with less drinking when greater-than-average self-control demands were high, above and beyond the influence of drinking history, current affect, and day of the week. Although the results were inconsistent with predictions based on the Strength Model of Self-Control, they are consistent with recent findings (Walters, Simons, & Simons, 2018). Our results highlight the need for consideration of the unique effects of both alcohol use motivation and self-control demand in the prediction of alcohol consumption, and draw attention to the need for further investigation into the complex interplay of these processes in daily life.

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