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Motivation Predicts Self-Control of Racial Bias After Viewing Alcohol Advertisements

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Abstract

Exerting self-control shifts motivation toward rewarding cues (i.e., approach motivation) and impairs control of racial bias. However, whether approach motivation predicts deficits in control of racial bias is unknown. Exertion of self-control is also related to alcohol use, but whether exerting self-control shifts motivation toward alcohol-related cues is not established. Similar to exerting self-control, viewing alcohol-related cues shifts motivation and promotes racial bias. The current study examined the interaction between exerting self-control and viewing alcohol-related cues on approach motivation and its influence on racial bias. Participants ($N = 71$) exerted (or did not exert) self-control and then viewed neutral (e.g., water) and alcohol advertisements. To assess shifts toward rewarding cues, neurophysiological indices of approach motivation (LPP, cortical asymmetries) were assessed while participants viewed advertisements. Participants then completed a measure of racial bias assessing behavioral and neurophysiological indices of self-control (ERN, N2). No differences in approach motivation emerged between those who exerted or did not exert self-control. However, alcohol-related individual differences (alcohol identity, coping drinking motives, and alcohol sensitivity) predicted greater approach motivation (i.e., cortical asymmetries) while viewing alcohol advertisements among those who exerted self-control. Participants who exerted self-control also exhibited lower behavioral control of racial bias and impaired error detection (i.e., ERN). Greater approach motivation predicted lower behavioral control of racial bias and error detection, suggesting approach motivation is a mechanism for impaired self-control. Results support motivational theories on self-control and provide insight on the relations among alcohol advertising, self-control, and racial bias.

Motivation Predicts Self-Control of Racial Bias After Viewing Alcohol Advertisements

Self-control is limited in capacity, resulting in the inability to successfully regulate behavior after exerting self-control. Exerting self-control may shift motivation away from cues related to controlling behavior and toward cues related to rewarding behavior (i.e., approach motivation; Inzlicht, Schmeichel, & Macrae, 2014). Approach motivation increases after exerting self-control (Schmeichel, Harmon-Jones, Harmon-Jones, 2010). However, shifts in approach motivation seem to depend on individual differences (Schmeichel, Crowell, & Harmon-Jones, 2015). Among people who drink alcohol, alcohol-related cues are known to elicit greater motivational reactivity compared to neutral cues (Bartholow, Lust, & Tragesser, 2010). Exerting self-control is related to greater alcohol consumption (Muraven, Collins, & Neinhans, 2002), but whether exerting self-control is related to greater motivation toward alcohol-related cues is not reported in the literature. Further, whether shifts in motivation toward alcohol-related cues after exerting self-control depend on individual differences, such as trait approach motivation, implicit alcohol identity, alcohol motivations, alcohol sensitivity, and alcohol preference, is not established.

Exerting self-control and viewing alcohol-related cues also promote racial bias (Govorun & Payne, 2006; Stepanova, Bartholow, Saults, & Friedman, 2012). Whether regulation of racial bias is impaired after viewing alcohol-related cues (e.g., advertisements) following exertion of self-control has not been tested. Further, whether approach motivation is related to subsequent self-control of racial bias is yet to be established. The purpose of this study is to examine the interaction between self-control (not exerted, exerted) and viewing advertisements (neutral, alcohol) on approach

motivation and its subsequent influence on racial bias. To provide background and context for this study, the following sections will review key areas in the literatures on measurement and theories of self-control, motivation, alcohol-related cues, individual difference variables including trait approach motivation, implicit alcohol identity, alcohol motivations, alcohol sensitivity, and alcohol preference, and racial bias.

Self-Control

Self-control is the capacity to change one's own behavior and is used daily (e.g., delayed gratification, aligning with social norms). Whereas most researchers have examined self-control as the ability to suppress impulses (Vohs & Baumeister, 2004), other researchers argue self-control is influenced by long-term goals and motivations (Fujita, 2011). Impaired self-control is responsible for many harmful behaviors and is non-domain specific (Cohen & Lieberman, 2010), suggesting deficits in self-control may impact control in other domains. Lower trait self-control is linked to crime (Gottfredson & Hirschi, 1990), impulsive behaviors (Vohs & Faber, 2007), poor academic performance (Tangney, Baumeister, & Boone, 2004), poor social outcomes (e.g., interpersonal relationships; Tangney et al., 2004), and alcohol use (Muraven et al., 2002). The ability to control behavior is also limited in capacity, resulting in an inability to regulate behavior after excessive exertion of self-control (Baumeister, Heatherton, & Tice, 1994; Inzlicht et al., 2014). After exerting self-control, individuals demonstrate deficits in working memory (Schmeichel & Zell, 2007), academic performance (Vohs, Lasaleta, & Fennis, 2009; Finkel et al., 2006; Wright et al., 2008), executive functioning (Gailliot & Baumeister, 2007), racial bias (Govorun & Payne, 2006), and subsequent self-control (Inzlicht & Gutsell, 2007). Despite evidence linking exerting self-control to many

negative social and health outcomes, the mechanism underlying poor self-control is unclear.

Neural Indices of Self-Control

Self-control is composed of two main functions, response monitoring and response selection (Amodio, 2014). Response monitoring is composed of conflict monitoring, the ability to detect competing responses in behavior prior to responding, and error detection, detecting errors in behavior after responding (Amodio, 2014). Response selection is the ability to adjust or inhibit behavior based on detection of conflict and errors (Amodio, 2014). The anterior cingulate cortex (ACC) is engaged during response monitoring, whereas the dorsolateral prefrontal cortex (dlPFC) is associated with response selection, and the inferior frontal gyrus (IFG) is associated with inhibition, all of which comprise the self-control network (Amodio, 2014). During the Stroop task, which is a color categorization task known to engage self-control, presentation of incongruent trials (“*blue*” written in red text) activates the ACC to monitor conflict among competing behavioral responses and detect errors in behavior after responding (i.e., inhibit automatic responses to read the word; Inzlicht & Gutsell, 2007; Zysset, Müller, Lohmann, & von Cramon, 2001). However, during the Stroop task, the dlPFC and IFG are signaled by the ACC to adjust and inhibit behavior (i.e., examine the text color rather than reading the word; Botvinick, Cohen, & Carter, 2004; Vanderhasselt, De Raedt, Baeken, Leyman, & D’haenen, 2006).

Impaired self-control after exerting control is typically thought to originate from deficits in the ACC (Zysset et al., 2001). However, prior research is unclear as to which function related to the ACC is responsible for successful self-control (Inzlicht & Gutsell,

2007; Wang & Yang, 2014). Whereas initial conflict monitoring prior to responding is a potential mechanism for impaired self-control (Inzlicht & Gutsell, 2007), studies have only established impaired neurophysiological indices of error detection after responding following self-control exertion (i.e., error detection; Inzlicht & Gutsell, 2007; Wang & Yang, 2014). While activation of the ACC is an established predictor of successful self-control (Zysset et al., 2001), the exact process underlying successful control of behavior, such as conflict monitoring or error detection, remains unclear. Studies utilizing electroencephalography (EEG) have identified event-related potential (ERP) components, such as the error-related negativity (ERN) and N2, related to both processes associated with activation of the ACC during self-control.

Error-related negativity. The ERN is an ERP component associated with error detection, thought to originate from the ACC (Dehaene et al., 1994; Falkenstein, Hohnsbein, Hoorman, & Blanke, 1990). The ERN is a response-locked ERP component characterized by a sharp, negative voltage deflection occurring between 50-80 milliseconds after a response and is most pronounced at fronto-central scalp sites (Dehaene, Posner, & Tucker, 1994; van Veen & Carter, 2002). Higher amplitudes of the ERN represent greater detection of errors in behavior (Yeung, Botvinic, & Cohen, 2004) or distress related to the behavioral error (Nash, Inzlicht, & McGregor, 2012). Incorrect responses during tasks requiring self-control demonstrate greater ERN amplitudes compared to correct responses, suggesting greater error detection or error-related distress (Inzlicht & Gutsell, 2007; West, 2004). The ERN is a marker of unsuccessful self-control. After exerting self-control, incorrect responses do not elicit increased amplitudes of the ERN (Inzlicht & Gutsell, 2007), suggesting previous exertion of self-control may

attenuate detection or distress of errors. Greater amplitude of the ERN also predicts slower responding in subsequent trials (Gehring, Goss, Coles, Meyer, & Donchin, 1993), suggesting detection of errors by the ACC leads to a more conservative style of responding to reduce future errors in behavior.

N2. The stimulus-locked N2 is an established marker of conflict monitoring during tasks of self-control (Donkers & van Boxtel, 2004; Fillmore, Rush, & Hays, 2006; Yeung & Cohen, 2006). The N2 is a negative voltage deflection elicited prior to responding approximately 300ms after stimulus onset and is most pronounced at fronto-central scalp sites (Kopp, Rist, & Mattler, 1996). Similar to the ERN, the N2 component originates from the ACC (Nieuwenhuis, Yeung, van den Wildenberg, & Ridderinkhof, 2003) and greater amplitudes predict successful self-control of behavior (Folstein & Van Petten, 2008). N2 amplitudes are greater during trials in which participants respond correctly, successfully controlling behavior, compared to trials where self-control is not successful (i.e., incorrect responses; Nieuwenhuis et al., 2003). After unsuccessful self-control (i.e., acute experiences of self-control failure), such as incorrectly responding to a trial during a task of self-control, N2 amplitudes are greater in subsequent trials (Bailey, Bartholow, Saults, & Lust, 2014), suggesting greater conflict monitoring following incorrect responses. While increased N2 amplitudes following acute self-control failure are established (Bailey et al., 2014), to our knowledge, no published research has examined the effects of prior self-control exertion on conflict monitoring (i.e., N2).

Models of Self-Control

Although self-control and its neurophysiological indices are established, the mechanism underlying deficits in self-control is not well understood. The strength model

of self-control posits self-control relies on a finite amount of cognitive resources that are depleted after engaging in excessive or prolonged self-control (Baumeister, Vohs, & Tice, 2007). However, despite previous claims (i.e., glucose; Gailliot et al., 2007), the precise cognitive resources described in the strength model are unknown. Alternatively, the process model of self-control argues exerting self-control does not deplete cognitive resources, but reallocates them (Inzlicht & Schmeichel, 2012). The process model posits exerting self-control shifts motivation away from regulating future behavior and toward immediately rewarding behavior (Inzlicht & Schmeichel, 2012). However, whereas most research examining self-control after previous exertion focuses on the strength model (Hagger, Wood, Stiff, & Chatzisarantis, 2010), little research has examined the role of motivation in self-control.

Strength model. The strength model of self-control was developed by Baumeister, Heatherton, and Tice (1994), which stated self-control seems to diminish after prolonged regulation of behavior, like a muscle after excessive exertion, suggesting self-control capacity is limited. This limited capacity is primarily tested using a sequential task paradigm in which participants engage in a task requiring self-control (or not) followed by a subsequent task requiring self-control. For example, Baumeister, Bratslavsky, Muraven, and Tice (1998) required participants to either eat radishes (requiring self-control) or eat chocolate chip cookies (requiring no self-control) in a room filled with the aroma of fresh baked cookies. Participants required to use self-control demonstrated poor problem solving compared to those in the no self-control condition (Baumeister et al., 1998). Similarly, suppressing emotions during an upsetting film clip predicted lower physical stamina as measured by the length of time squeezing a handgrip

(Muraven, Tice, & Baumeister, 1998). These studies initially demonstrated engaging in self-control impairs self-control in subsequent tasks.

Research also has examined how to strengthen self-control capacity. Muraven, Baumeister, and Tice (1999) found consistently engaging in self-control exercises (e.g., monitoring posture, regulating mood) improves self-control in other domains (e.g., longer handgrip time). Similarly, engaging in repeated physical exercise results in similar increases in other tasks requiring self-control (e.g., emotional control, study habits, alcohol consumption; Oaten & Cheng, 2004). Further supporting the strength model of self-control, exerting self-control is reported to reduce blood glucose levels (Gailliot et al., 2007) and administering a sucrose beverage restores self-control capacity after engaging in excessive self-control (Gailliot & Baumeister, 2007). This suggests self-control may rely on finite resources, such as glucose. However, attempts to replicate these findings are mixed (Kurzban, 2010; Molden et al., 2012). Research using positron emission tomography, which directly measures changes in brain glucose, has demonstrated exertion of mental effort (e.g., self-control) results in little change in glucose metabolism in the brain (< 1%; Raichle & Mintun, 2006). Whereas glucose as a resource of self-control is not supported, sucrose administration seems to increase control of aggression (Denson, von Hippel, Kemp, & Teo, 2010), working memory (Owen, Scholey, Finnegan, Hu, & Sünram-Lea, 2012), and racial bias (Gailliot, Peruche, Plant, & Baumeister, 2008), suggesting sucrose may influence other aspects of self-control.

Process model. Inzlicht and Schmeichel (2012) argue self-control may not rely on finite resources. According to the process model, resources are not depleted after exerting self-control, rather reallocated toward other processes (Inzlicht & Schmeichel,

2012). After engaging in prolonged self-control, motivation may be directed away from cues related to self-control and shifted toward rewarding cues (Inzlicht & Schmeichel, 2012). In other words, motivation is shifted from “have-to” tasks toward “want-to” tasks, especially those that are immediately satisfying (Inzlicht et al., 2014). This reallocation of resources accounts for previous findings after exertion of self-control in addition to inconsistent findings within self-control research, which cannot be accounted for solely by the strength model (e.g., monetary incentives diminishing effects of self-control exertion; Muraven & Slessareva, 2003).

One potential issue with previous self-control research is the use of sequential task paradigms (Inzlicht, Berkman, & Elkins-Brown, 2015). Unsuccessful self-control following exertion of self-control may not be due to resource depletion, but other mechanisms occurring between tasks (Inzlicht et al., 2014). One mechanism that may influence self-control is shifts in motivation. Providing motivationally salient rewards for participation (e.g., money) prolongs participants’ ability to exert behavioral control, diminishing typical effects of previous exertion of self-control (Muraven & Slessareva, 2003). After instructing participants they will receive payment based on their task performance, participants do not demonstrate deficits in subsequent self-control (Moller, Deci, & Ryan, 2006). Engaging in rewarding behavior between tasks also reduces deficits in self-control. Smoking cigarettes (Heckman, Ditte, & Brandon, 2012), positive moods (Tice, Baumeister, Shmueli, & Muraven, 2007), positive self-affirmation (Schmeichel & Vohs, 2009), drinking a sugary beverage (i.e., sucrose; Gailliot & Baumeister, 2007), and watching television (Egan, Hirt, & Karpen, 2012) seem to replenish self-control capacity. This suggests exerting self-control may increase sensitivity toward rewarding behaviors.

Consistent with this assertion, participants show greater self-reported (Schmeichel, Harmon-Jones, & Harmon-Jones, 2010) and neurophysiological (Schmeichel et al., 2015) approach motivation, or orientation toward rewards and incentives (Elliot & Dweck, 2013), after exerting self-control. Providing rewards may counteract the effects of exerting self-control and exerting self-control may increase sensitivity toward rewards. However, little research has examined how approach motivation predicts subsequent self-control. If shifts in motivation account for deficits in self-control, greater approach motivation after exerting self-control should be related to subsequent self-control.

Self-Control and Motivation

Generally, motivational models focus on two major systems, an approach system that guides behavior toward positive outcomes, increasing sensitivity to rewards, and an avoidance system that guides behavior away from negative outcomes, increasing sensitivity to punishment (Elliot, 2006; 2008). These sensitivities are assessed using the Behavioral Approach System (BAS) and Behavioral Inhibition System (BIS) self-report measures developed by Carver and White (1994). Higher BAS, or approach motivation, is associated with risk-taking (Voigt et al., 2009), aggression (Smits & Kuppens, 2005), mania (Meyer, Johnson, & Winters, 2001), and positive affect (Updegraff, Gable, & Taylor, 2004). Higher BIS, or avoidance motivation, is associated with greater nervousness (Carver & White, 1994), anxiety (Gray & McNaughton, 2000), depression (Meyer et al., 2001), and negative affect (Updegraff et al., 2004). In addition to self-report measures of these motivational systems, neurophysiological indices have been validated as markers of approach and avoidance motivation.

Cortical asymmetries. Functional differences in left versus right hemispheres of the prefrontal cortex (PFC) are well established (for review, see Harmon-Jones, Gable, & Peterson, 2010). Research using EEG have utilized the alpha frequency band, an inverse measure of activation (i.e., cortical inactivation), to examine asymmetrical activation of the PFC (Tomarken, Davidson, Wheeler, & Doss, 1992). Greater right activation of the PFC is associated with depressive symptoms and negative affect (Jacobs & Snyder, 1996), whereas greater left activation is associated with mania and positive affect (Harmon-Jones & Allen, 1998; Tomarken et al., 1992). Relatedly, greater left over right activation of the PFC is associated with greater approach motivation, as assessed by the BAS (Harmon-Jones & Allen, 1997), whereas greater right over left activation is associated with greater avoidance or withdrawal motivation, as assessed by the BIS (Sutton & Davidson, 1997). However, subsequent studies have failed to replicate asymmetrical activations associated with avoidance motivations (Coan & Allen, 2003; Harmon-Jones & Allen, 1997). It is suggested greater right activation of the PFC is associated with lower approach motivation, whereas avoidance motivation (i.e., BIS) is associated with amplitudes of ERP components linked to self-control (e.g., ERN; Amodio et al., 2008). Another neurophysiological measure related to approach motivation is the late positive potential (LPP).

Motivational salience. The LPP is an ERP component defined as the positive deflection in the ERP starting approximately 300 milliseconds after stimulus onset and is prominent at centro-parietal scalp sites (Cacioppo, Crites, Gardner, & Berntson, 1994; Hajcak, MacNamara, & Olvet, 2010). Subcomponents of the LPP, such as the P3, index working memory updating (Friedman & Johnson, 2000) and processing of novel

information (Friedman, Cyrowicz, & Gaeta, 2001). Particularly, the LPP and its components (e.g., P3) are evoked after seeing motivationally significant stimuli, particularly when they are emotionally or personally relevant (Johnston, Miller, & Burleson, 1986; Keil et al., 2002; Piasecki, Fleming, Trela, & Bartholow, 2017; Warren & McDonough, 1999). Amplitudes of the LPP are also associated with approach motivation, such that greater approach motivation, as measured by the BAS, predicts larger amplitudes of the LPP in response to motivational stimuli (Poole & Gable, 2014). This suggests larger LPP amplitudes may reflect orientation or sensitivity toward rewarding behaviors as well as motivational salience and emotional relevance. Greater LPP amplitudes are also known to be elicited after viewing aversive stimuli, suggesting the LPP may also reflect greater avoidance motivation (Schupp, Flaish, Stockburger, & Junghöfer, 2006). However, in response to motivational stimuli, the LPP demonstrates concurrent validity with left over right activation of the PFC, an index of approach, but not avoidance, motivation (Poole & Gable, 2014). This suggests that individuals with greater approach motivation may exhibit greater LPP amplitudes while viewing appetitive, but not aversive, stimuli compared to individuals with lower approach motivation (Poole & Gable, 2014). According to the process model, impaired self-control may be the result of shifts in motivation toward rewarding cues (Inzlicht & Schmeichel, 2012). If this model is correct, individuals should demonstrate greater LPP amplitudes toward appetitive, or motivationally relevant, stimuli after exerting self-control. Further, whether cortical activation and LPP amplitudes demonstrate similar predictive validity in subsequent self-control is not reported in the literature. The current study examines the concurrent validity of cortical activation and LPP amplitudes on approach motivation.

Motivation after self-control. Consistent with the process model (Inzlicht & Schmeichel, 2012), exerting self-control increases approach motivation. Self-reported approach motivation, as measured by the BAS, is greater among those who exert self-control compared to those who do not (Schmeichel et al., 2010). Engaging in self-control also seemingly increases greater left over right activation of the PFC, consistent with approach motivation (Schmeichel et al., 2015). However, no published research has examined the influence of exerting self-control on the LPP. While exerting self-control may increase approach motivation, these motivational shifts may depend on individual differences. Schmeichel and colleagues (2015) suggest only individuals higher in trait approach motivation demonstrate shifts toward approach motivation after exerting self-control, whereas individuals lower in trait approach motivation demonstrate opposite effects (e.g., shifts away from approach motivation). Based on the process model of self-control, it is expected greater approach motivation, as measured by cortical asymmetries and the LPP, will be related to deficits in self-control (Inzlicht & Schmeichel, 2012). However, these shifts in motivation may be moderated by individual differences.

Self-Control and Alcohol

After exerting self-control, individuals are sensitive to motivational incentives (Muraven & Slessareva, 2003). Individuals are generally motivated to avoid effortful self-control (Kool, McGuire, Rosen, & Botvinick, 2010). However, providing incentives that are personally rewarding (e.g., money) can shift motivation towards effortful self-control (Kool et al., 2010). Providing motivational incentives after exerting self-control can also replenish self-control capacity after previously exerting self-control (Muraven & Slessareva, 2003). However, this effect is only evident for mild forms of depletion and

providing rewards and incentives may further impair self-control after severe exertion of self-control (Vohs, Baumeister, & Schmeichel, 2012). Among people who drink alcohol, alcohol is typically a motivational incentive that may be perceived as rewarding, particularly among those sensitive to rewards after exerting self-control. Although alcohol consumption is linked to deficits in self-control (Bartholow, Dickter, & Sestir, 2006), no reports in the literature have examined the role of motivation toward alcohol-related cues after exerting self-control and its influence on subsequent self-control.

Lower trait self-control is related to taking greater alcohol-related risks (e.g., driving under the influence of alcohol; Keane, Maxim, & Teevan, 1993) and greater alcohol consumption (Oei & Morawska, 2004). Self-control capacity also is a consistent predictor of patterns of alcohol-related behaviors (e.g., binge drinking; Costello, Anderson, & Stein, 2014; Gibson, Schreck, & Miller, 2004; Glassman, Werch, & Jobli, 2007). Exerting self-control leads to greater acute consumption of alcohol (Muraven et al., 2002; Otten et al., 2014). Individuals who experience greater demands on self-control over the course of a day also are more likely to exceed self-imposed expected drinking limits (Muraven, Collins, Shiffman, & Paty, 2005), suggesting daily exertion of self-control may mimic the effects of acute self-control exertion. While the behavioral outcomes related to alcohol (e.g., consumption) after deficits in self-control are established, the mechanism underlying these behaviors is unknown.

According to the process model of self-control, greater alcohol consumption might be the result of shifts in motivation away from cues for controlling behavior and toward cues for rewarding behavior (e.g., alcohol-related cues; Inzlicht & Schmeichel, 2012). Alcohol is a motivational incentive that is personally relevant among drinkers,

indicated by enhanced neurophysiological indices of motivation (e.g., P3 amplitudes) while viewing alcohol-related cues compared to neutral cues (Bartholow et al., 2010). Whereas motivational salience while viewing alcohol-related cues has been studied as a function of trait factors (e.g., alcohol dependence; Namkoong, Lee, Lee, Lee, & An, 2004), research has yet to examine how acute factors (e.g., exerting self-control) impact motivation toward alcohol-related cues. However, shifts in motivation toward alcohol-related cues after exerting self-control may depend on individual differences (Schmeichel et al., 2015).

Alcohol-Related Individual Differences

There are individual differences that may influence motivational reactivity to alcohol-related cues. Risky alcohol use is prevalent, particularly among college students (Johnston, O'Malley, Bachman, & Schulenberg, 2016), and is associated with poorer academic (Singleton & Wolfson 2009), health (Blanco et al., 2008; Hingson, Zha, & Weitzman, 2009), and social (Presley & Pimentel, 2006) outcomes. Although alcohol consumption alone is not a risk-factor for problematic alcohol use and development of an alcohol use disorder (AUD) among college students, there are alcohol-related individual differences that predict hazardous alcohol-related behaviors and may be associated with reactivity to alcohol cues, such as alcohol identity, motivations, sensitivity, and preference.

Implicit alcohol identity. Implicit measures of alcohol (e.g., attitudes, motivation, identity) predict risky alcohol use and development of an AUD (Lindgren et al., 2016). Implicit measures assess quick, impulsive, or automatic associations in implicit memory (Greenwald, McGhee, & Schwartz, 1998). Implicit alcohol measures,

particularly using the Implicit Association Test (IAT), may be useful for populations who may not honestly self-report their alcohol-related attitudes or identity due to social desirability concerns, particularly when assessing alcohol use among individuals with potentially embarrassing, illegal, or problematic drinking (Gray et al., 2011; Greenwald, Poehlman, Uhlmann, & Banaji, 2009). In addition, individuals may not be aware of their associations with alcohol (Nosek, Hawkins, & Frazier, 2011), thus explicit, or self-report, measures related to alcohol may not capture these associations. Researchers have used the IAT to examine implicit associations between alcohol and excitement, reward, motivation, and identity (Lindgren et al., 2013). Implicit measures of alcohol are validated predictors of alcohol use (Lindgren et al., 2013). However, alcohol identity, or how important alcohol is to one's self-concept, is the most consistent and longitudinally reliable predictor of alcohol use and related behaviors (Lindgren et al., 2016).

Alcohol identity is a well-studied predictor of alcohol consumption, cravings, problematic drinking, and development of an AUD, particularly among college students (Foster, Yeung, & Neighbors, 2014; Lindgren et al., 2016; Petzel & Casad, 2018). In addition to explicit alcohol identity, implicit alcohol identity (Foster et al., 2014; Reed et al., 2007) predicts the likelihood of engaging in risky alcohol-related behaviors (e.g., pre-gaming, casual sex; Gray, LaPlante, Bannon, Ambady, & Shaffer, 2011; Lindgren et al., 2016) and alcohol consumption (Lindgren et al., 2016; Petzel & Casad, 2018). Despite its robust relationship with alcohol-related outcomes, alcohol identity has not been examined in relation to motivation while viewing alcohol-related cues. The current study examines implicit alcohol identity as a moderator of motivational responses to alcohol-related cues after exerting self-control.

Alcohol motivations. Among drinkers, 4 primary motivations to drink alcohol (coping, enhancement, social, and conformity) are established factors that predict alcohol related behaviors (e.g., consumption; Cooper, 1994). Coping motives, or drinking to alleviate negative emotions, and enhancement motives, or drinking to promote positive emotions, are associated with problematic alcohol use (Read et al., 2003). Social motives, or drinking to be sociable with others, and conformity motives, or drinking to fit in, are less associated with problematic drinking (MacLean & Lecci, 2000) and are not associated with emotional motivations for drinking (Cooper, 1994). Coping motives for drinking do not reliably predict alcohol consumption (Merrill & Read, 2010; Patrick, Lee, & Larimer, 2011), however; coping motives do predict greater alcohol-related consequences (e.g., poorer academic outcomes, decreased self-care, increased risk-taking; Merrill & Read, 2010). Enhancement motives consistently predict greater alcohol use (Read et al., 2003); however, this motive only indirectly predicts alcohol-related consequences through increased alcohol consumption (Merrill & Read, 2010). Like alcohol identity, to our knowledge, no research has examined how drinking motives influence motivation toward alcohol-related cues, particularly after exerting self-control. Based on past research (Cooper, 1994) individuals higher in coping and enhancement alcohol motivations should demonstrate greater motivational reactivity toward alcohol advertisements. The present study examines alcohol motivations as moderators of motivational responses to alcohol-related cues after exerting self-control.

Alcohol sensitivity. Individuals differ in their experiences of acute alcohol consumption (Sher, Wood, Richardson, & Jackson, 2005) and this variability is known as alcohol sensitivity, or the intensity of response to alcohol consumption (Schuckit, 1994).

Low sensitivity to alcohol (i.e., high tolerance to the effects of alcohol) is a risk factor for greater alcohol use and the development of an AUD (Schuckit, Smith, Anderson, & Brown, 2004). Individuals reporting the need to consume more alcohol to experience its effects are more likely to engage in risky alcohol use (Schuckit & Smith, 2000). Although low alcohol sensitivity may be genetic (Schuckit et al., 1999), research suggests social and environmental factors (e.g., peer alcohol use, drinking motives) influence alcohol sensitivity (Radel & Goldman, 2001; Schuckit et al., 2011).

Alcohol sensitivity is a validated moderator of responses to alcohol-related cues, such that people lower in alcohol sensitivity demonstrate greater motivational salience toward alcohol-related cues (i.e., greater P3 amplitudes) compared to those higher in alcohol sensitivity (Bartholow, Henry, & Lust, 2007). These findings parallel individuals with an AUD demonstrating greater motivational salience toward alcohol-related cues compared to social drinkers (Namkoong et al., 2004). Further, individuals lower in alcohol sensitivity show deficits in regulating automatic responses to alcohol-related stimuli, demonstrating difficulty inhibiting behavior related to alcohol-related cues (Fleming & Bartholow, 2014), suggesting alcohol sensitivity may identify those at-risk of failing to control alcohol-related behavior. While alcohol sensitivity is a moderator of motivational reactivity to alcohol cues (i.e., P3; Bartholow et al., 2007), research has not examined alcohol sensitivity's role in cortical asymmetries while viewing alcohol-related cues, particularly after exerting self-control. The current study examines alcohol sensitivity as a moderator of motivational responses to alcohol-related cues after exerting self-control.

Alcohol preference. Another risk factor for hazardous alcohol use is individual alcohol preferences. Alcohol preferences are associated with risky drinking habits and alcohol-related consequences (e.g., unprotected sex, police involvement, drunk driving; Dey, Gmel, Studer, Dermota, & Mohler-Kuo, 2013). Preferences for beer and liquor (i.e., hard alcohol) are associated with hazardous drinking patterns such as greater frequency of binge drinking (Naimi, Brewer & Miller, 2007), volume of alcohol consumption (Jensen et al., 2002), and likelihood of developing an AUD (Flensburg-Madsen et al., 2008). Preferences for wine and mixed drinks (i.e., cocktails) are less predictive of risky drinking behaviors (Naimi et al., 2007). Further, men tend to prefer beer and liquor whereas women tend to prefer wine and cocktails (Klatsky, Armstrong, & Kipp, 1990; Lindgren et al., 2012), which may contribute to men's higher rates of developing an AUD (Mann et al., 2005). However, research has largely relied on standardized sets of alcohol-related images for priming (Pedersen et al., 2014; Stepanova et al., 2012) and IATs (Gray et al., 2011; Lindgren et al., 2013), ignoring individuals' personal preferences. While accounting for individual differences in alcohol-related measures has shown no differences in content validity (i.e., no mean differences between alcohol preference groups; Lindgren et al., 2012; Petzel & Casad, 2018), the predictive validity, or the relation between alcohol-related measures and use, differ in magnitude depending on alcohol preference (Petzel & Casad, 2018). No research has examined how alcohol preference may interact with motivation toward alcohol-related cues after exerting self-control. The present study examines hazardous alcohol preference as a moderator of motivational responses to alcohol-related cues after exerting self-control.

Racial Bias

Brief exposure to stimuli activates related concepts, known as semantic priming (Lucas, 2000; Perea & Rosa, 2002), which automatically influences behavior (Bargh, 1992). The model of spreading activation posits semantic information is stored and linked based on similarities between concepts (Collins & Loftus, 1975; Fodor, 1983). For example, the concept of red is semantically related to the concept of apple, due to their shared characteristics (i.e., color). After exposure to red, individuals are quicker to identify apple compared to unrelated concepts (e.g., chair; Collins & Loftus, 1975). Brief exposure to weapons predicts greater aggressive thoughts and behaviors (Anderson, Benjamin, & Bartholow, 1998; Bartholow, Anderson, Carnagey, & Benjamin, 2005; Berkowitz & LePage, 1967), demonstrating priming also influences behavior, activating related, behavioral concepts (e.g., aggression). Priming's influence on behavior is explained through utilizing prime-related information, which is easily accessible due to spreading activation, to inform decisions and judgments (Loersch & Payne, 2011). The use of prime-related information to inform decisions has been demonstrated in the application of stereotypes (Payne, 2001).

Primes related to stereotyped groups (e.g., Black Americans) facilitates responding to related, negatively valenced stimuli (Fazio, Jackson, Dunton, & Williams, 1995; Gaertner & McLaughlin, 1983). For example, priming a Black face facilitates faster reaction times to negative words, whereas White face primes facilitate faster reaction times to positive words (Payne, 2001). Under normal circumstances, prime-related information is overridden, allowing for attentive, controlled processing to determine correct responses (Draine & Greenwald, 1998). However, when participants

are encouraged to quickly complete a task (i.e., minimize reaction times), attentive processes are diminished, and prime-related information is promoted. Under time constraints, participants rely on stereotypical congruent information (e.g., prime-related), leading to greater errors in responses (Draine & Greenwald, 1998). This research suggests stereotyping is composed of controlled and automatic components, which influence the use of stereotypes and racial bias (Plant & Devine, 1998; Payne, 2001). Controlled processes of stereotyping require attention and cognitive control, similar to self-control (Govorun & Payne, 2006), whereas automatic processes rely on semantically linked information related to the initial primes (Payne, 2001). The process dissociation procedure has been used to separate automatic versus controlled responding during tasks assessing racial bias (Payne, 2001). The current study assesses automatic and controlled indices of racial bias after exerting self-control and viewing alcohol-related cues.

Self-control. Generally, deficits in self-control (attenuated ERN amplitudes) predict greater racial bias (Amodio et al., 2004). After exerting self-control, controlled processes are impaired, which is thought to force participants to rely on automatic processing or semantically related information in responding during tasks assessing racial bias (Govorun & Payne, 2006). While experiencing acute exertion of self-control leads to greater errors in overall responding during tasks assessing racial bias (i.e., following both Black and White primes), suggesting impaired control, it does not lead to greater bias against Blacks (Govorun & Payne, 2006). However, exerting self-control does lead to greater racial bias (e.g., relying on prime-related information) among those higher in automatic racial bias, while no relationship is present among those lower in automatic racial bias (Govorun & Payne, 2006). This suggests exerting self-control only promotes

greater racial bias when automatic or semantic associations between stereotypical information is high. If greater approach motivation is related to deficits in self-control, those higher in automatic racial bias who also are higher in approach motivation should demonstrate deficits in controlling their use of stereotypes, resulting in greater racial bias.

Alcohol priming. The pharmacological effects of alcohol (e.g., depressing the central nervous system) impair executive control, leading to greater expressions of racial bias and aggression (Bartholow et al., 2006; Field, Wiers, Christiansen, Fillmore, & Verster, 2010; Parrot, Gallagher, Vincent, & Bakeman, 2010; Reeves & Nagoshi, 1993; Ridderinkhof et al., 2002). However, after consumption of placebo (i.e., non-alcoholic) beverages, participants' behaviors parallel alcohol consumption (e.g., aggression; Chermack & Taylor 1995). This suggests priming alcohol may alter behavior beyond the pharmacological effects of alcohol consumption. Exposure to alcohol primes, such as advertisements, similarly predicts changes in behavior (Bartholow et al., 2006; Bartholow & Heinz, 2006).

Viewing alcohol-related cues (e.g., advertisements) predicts greater bias against racial (Stepanova et al., 2012) and sexual minorities (Greitemeyer & Nierula, 2016). Further, brief alcohol primes during unrelated tasks predict similar behavioral changes compared to non-alcohol related primes (Friedman, McCarty, Bartholow, & Hicks, 2007), suggesting effects from alcohol priming do not require prolonged attention. Despite the robust effects of alcohol primes, the behavioral effects of alcohol priming diminish linearly within 15 minutes, suggesting alcohol primes do not have the same, long-lasting pharmacological effects from alcohol consumption (Pedersen, Vasquez, Bartholow, Grosvenor, & Truong, 2014). Viewing alcohol-related cues promotes

automatic racial bias, while not affecting control of racial bias (Stepanova et al., 2012). This suggests viewing alcohol-related cues (e.g., advertisements) primes related information (e.g., stereotypes), increasing automatic responding during tasks of racial bias, and may not impair self-control like alcohol consumption. However, whether the promotion of racial stereotypes after viewing alcohol-related cues following self-control exertion is related to deficits in controlled racial bias is not established in the literature.

Present Study

The current research aims to examine whether participants required to exert self-control demonstrate greater approach motivation compared to those not required to exert self-control. The current study also will examine whether approach motivation differs between viewing alcohol or non-alcohol advertisements, particularly after exerting self-control. Individual differences also will be examined to determine their relation to approach motivation, particularly while viewing alcohol advertisements. Further, the current study will test the process model of self-control (Inzlicht & Schmeichel, 2012) by examining whether approach motivation while viewing alcohol advertisements predicts subsequent self-control of racial bias.

Self-control. It is expected that participants who exert self-control will demonstrate greater approach motivation, as measured by (H1a) greater left over right frontal cortical activation, and (H1b) LPP amplitudes compared to those who did not exert self-control. However, it is expected participants will demonstrate greater (H2a) left over right frontal cortical activation and (H2b) LPP amplitudes while viewing alcohol advertisements compared to non-alcohol advertisements. Since prior research demonstrates shifts in motivation after exerting self-control may depend on individual

differences (Schmeichel et al., 2015), it is hypothesized that after exerting self-control, individuals higher in (H3a-b) trait approach motivation, (H4a-b) implicit alcohol identity, (H5a-b) coping drinking motives, and (H6a-b) enhancement motives will demonstrate greater motivational indices (cortical asymmetries, LPP) while viewing alcohol advertisements compared to those who did not exert self-control. Further, individuals who exert self-control (H7a-b) lower in alcohol sensitivity and (H8a-b) who report preference for alcohol associated with hazardous drinking (i.e., beer and liquor) will exhibit greater motivational indices (cortical asymmetries, LPP) while viewing alcohol advertisements compared to those who did not exert self-control.

Racial bias. After viewing alcohol advertisements, (H9) participants who exert self-control, are expected to demonstrate less controlled racial bias compared to those who did not exert self-control. However, (H10) no differences are expected in automatic racial bias between individuals who exert self-control and those who do not exert self-control, suggesting viewing alcohol advertisements promoted automatic racial bias equally between conditions. After exerting self-control, (H11a) ERN amplitudes will be attenuated after incorrect responses and (H11b) N2 amplitudes will be attenuated prior to responding during the task assessing racial bias compared to those who did not exert self-control, suggesting impaired self-control capacity (Inzlicht & Gutsell, 2007). Greater approach motivation, as measured by greater left over right frontal cortical activation and LPP amplitudes while viewing alcohol advertisements, will be related to (H12a-b) impaired controlled racial bias, (H13a-b) lower ERN amplitudes, and (H13c-d) lower N2 amplitudes, suggesting orientation toward rewarding cues (e.g., alcohol advertisements)

predicts subsequent deficits in self-control, supporting the process model of self-control (Inzlicht & Schmeichel, 2012).

Motivation as a mechanism. Based on the process model of self-control (Inzlicht & Schmeichel, 2012), mediational models are predicted. Exerting self-control will be related to deficits in self-control (i.e., controlled racial bias, ERN amplitudes, N2 amplitudes) compared to those who do not exert self-control. Exerting self-control also is expected to predict greater approach motivation (cortical asymmetries, LPP) compared to not exerting self-control. Finally, greater approach motivation (cortical asymmetries, LPP) is expected to predict deficits in self-control (i.e., controlled racial bias, ERN amplitudes, N2 amplitudes). It is hypothesized approach motivation (cortical asymmetries, LPP) will account for the relationship between self-control (required, not required) and deficits in (H14a-b) controlled racial bias, (H15a-b) ERN amplitudes, and (H16a-b) N2 amplitudes, demonstrating shifts in approach motivation toward rewarding cues (i.e., alcohol advertisements) after exerting self-control impairs subsequent self-control. Further, (H17-22a-b) moderated-mediational models are predicted and individual differences (i.e., trait approach motivation, implicit alcohol identity, coping and enhancement drinking motivations, alcohol sensitivity, and alcohol preference) will be examined as moderators of the relationship between self-control (required, not required) and approach motivation (cortical asymmetries, LPP; see Figure 1).

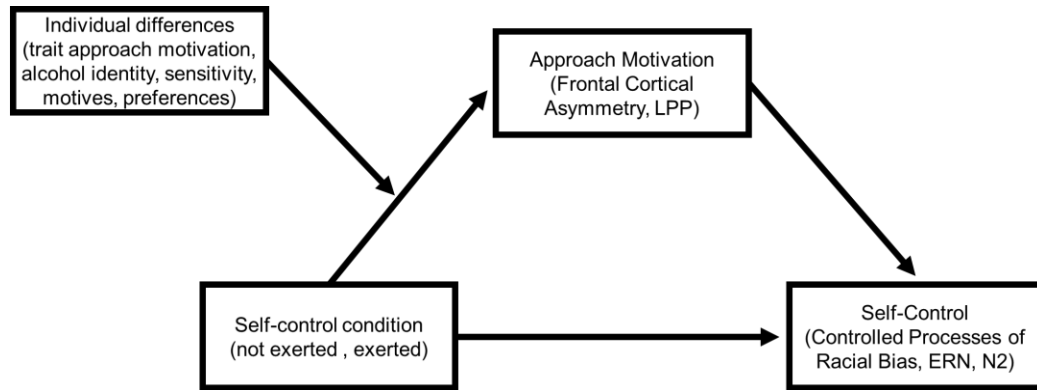


Figure 1. Hypothesized moderated-mediational model of approach motivation accounting for the relationship between self-control condition and self-control outcomes.

Method

Participants

Seventy-two participants were recruited to take part in a study described as opinions of advertisements and social issues. Participants were recruited through the University of Missouri – St. Louis using advertisements on campus (e.g., postings on bulletin boards, classroom announcements) and through the Department of Psychological Sciences’ Sona research subject pool. Individuals from the community were also recruited from ResearchMatch.org. Participants were compensated with \$10 per hour (\$20 total) or 2 Sona credits. Participants were 18 years of age or older, active alcohol drinkers (i.e., at least 1 alcoholic drink in the past year), right-handed, had no history of a traumatic brain injury, were not currently taking any psychotropic medications, and had normal or corrected vision. One participant was excluded from analyses due to computer error, resulting in a total sample of 71 participants (71.8% female) ranging from 18 to 29 years of age ($M_{age} = 22.66$, $SD_{age} = 2.94$). Participants self-reported their race/ethnicity as Caucasian/White (67.6%), African American/Black (11.3%), Asian/Pacific Islander

(8.5%), Latino(a) (7.0%), and Multiracial (5.6%). A sensitivity power analysis indicated an approximately medium effect size ($\eta^2 = .08$) would provide 80% power to detect significant interaction effects with the recruited sample.

Measures

Approach and avoidance motivation. Trait approach motivation was assessed using the BAS scale developed by Carver and White (1994). Twenty-four items ($\alpha = .80$) were rated on a 4-point scale, from 1 (*Very true for me*) to 4 (*Very false for me*). The BAS contains 3 subscales including drive (e.g., “I go out of my way to get things I want), fun-seeking (e.g., “I crave excitement and new sensations”), and reward responsiveness (e.g., “It would excite me to win a contest”). All BAS items were averaged together to assess approach motivation with higher values indicating greater approach motivation or greater sensitivity to rewards.

Alcohol preference. Participants were asked to rank order alcohol preferences using a list of alcohol types with descriptions, including beer, wine, mixed drinks (i.e., cocktails), malt liquor (e.g., Smirnoff Ice), and liquor. Participants were grouped into 2 categories reflecting either non-hazardous drinking preferences (i.e., mixed drinks, wine) and hazardous drinking preferences (i.e., beer, liquor) based off their first ranked alcohol preference.

Alcohol identity. An alcohol identity IAT was used to measure implicit alcohol identity (Gray et al., 2011). The IAT used standard procedures developed by Greenwald et al. (1998). The categories were “alcohol” and “water” and the attributes were “me” and “not me”, a common method to assess implicit identity (Gray et al., 2011; Greenwald & Farnham, 2000). Stimuli included alcohol and water images, in addition to me- (e.g.,

“me,” “my,” “myself”) or not me- (e.g., “their,” “them,” “others”) relevant words. Only alcohol images reflecting individuals’ self-reported alcohol preference (beer, wine, mixed drinks, or liquor) were presented, while a standardized set of water images was used for all participants (see Measures Appendix). Congruent trials required participants to pair images of alcohol with me-relevant words while pairing images of water with not me-relevant words. In incongruent trials, these pairings were switched. Scores for the alcohol identity IAT were calculated using the D score algorithm developed by Greenwald, Nosek, and Banaji (2003), which accounts for excessive errors and response latency.

Alcohol sensitivity. Sensitivity to the effects of alcohol consumption was assessed using the alcohol sensitivity questionnaire developed by Fleming and colleagues (2016). Fifteen items ($\alpha = .92$) were rated on a 6-point scale from 1 (*Almost never*) to 6 (*Almost always*). Example items included, “Do you ever pass out after drinking alcohol?” and, “Do you ever feel more relaxed after drinking alcohol?” Items were averaged such that higher values indicated greater sensitivity to the effects of alcohol.

Drinking motives. Motivations to use alcohol were assessed using the drinking motives questionnaire developed by Cooper (1994). Twenty items were rated on a 6-point scale, from 1 (*Almost never*) to 6 (*Almost always*). The drinking motives questionnaire measures 4 factors of motivation including social (e.g., “Because it helps you enjoy a party”; $\alpha = .85$), coping (e.g., “To forget your worries”; $\alpha = .84$), enhancement (e.g., “Because it is exciting”; $\alpha = .88$), and conformity (e.g., “So you won’t feel left out”; $\alpha = .85$; Cooper, 1994). Items were averaged within coping and enhancement motive factors, such that higher values indicated higher motivation to drink due to that factor.

Self-control manipulation. Participants completed a free writing task where they were instructed to write a short story describing a recent trip they had taken (adapted from Schmeichel, 2007). Participants required to exert self-control were instructed to not use the letters *a* or *n* during the task, previously established to increase task difficulty (Schmeichel, 2007). This restriction on writing requires participants to exert self-control by inhibiting the use of two frequent letters. Participants not required to exert self-control completed the writing task with no restriction of letters. Participants were instructed to write continuously until the researcher instructed them to stop after 6 minutes of writing. Those required to exert self-control were given the following instructions prior to the task (adapted from Lewandowski, Ciarocco, & Pettanato, 2012):

“Please write a story about a recent trip you have taken. It may be a trip to the store, to another state, or to another country – wherever! Please write until the researcher asks you to stop. Very important! Please do not use the letters A or N anywhere in your story (For example, use ‘plus’ instead of ‘and’).”

Participants not required to exert self-control were given the following instructions:

“Please write a story about a recent trip you have taken. It may be a trip to the store, to another state, or to another country – wherever! Please write until the researcher asks you to stop.”

Advertisement viewing task. Participants completed an advertisement viewing task adapted from Schmeichel and colleagues (2015) in which they were presented a set of 60 images consisting of 30 alcoholic beverage advertisements and 30 non-alcoholic beverage advertisements (e.g., water). Thirty images per advertisement type were chosen to ensure high ERP reliability for the LPP (Huffmeijer, Bakermans-Kranenburg, Alink, &

IJzendoorn, 2014). Non-alcoholic advertisements were included as comparison stimuli since both are similarly consumed beverages (i.e., drinking), but only alcoholic beverages are associated with pharmacological effects of intoxication. Further, since images containing people elicit larger ERPs, no advertisements contained people (Weinberg & Hajack, 2010). Images were presented in randomized order. During the task, a fixation cross appeared on the screen for 2-3s (randomly determined), followed by the advertisement for 6s. After the advertisement was displayed, participants were asked to rate the advertisement (e.g., “How appealing was this advertisement?”) using a 6-point scale ranging from 1 (*Not at all*) to 6 (*Very*). The question remained on the screen until the participant responded, followed by an inter-trial interval between 8-12s (randomly determined) and another fixation cross, advertisement, and rating.

Weapons identification task. Participants completed the weapons identification task (WIT) adapted from Payne (2001). Participants were instructed to sort images of either weapons (i.e., guns) or tools (e.g., hammer) using buttons labeled as “weapon” or “tool.” Prior to each weapon/tool image, participants were shown a male Black or White face. Each trial started with a pattern mask (1s), a Black or White face (200ms), an inter-stimulus interval (0-200ms), a weapon or tool (200ms), and an additional pattern mask that remained on the screen until response or until 2s elapsed (see Measures Appendix; Amodio, Devine, & Harmon-Jones, 2008). An inter-trial interval of 2-4s (which is randomly determined) was displayed between trials. Participants first completed 16 practice trials, in which a warning stating, “Respond more quickly!” appeared 500ms after the onset of the second pattern mask. After the practice block, participants completed 2 blocks of 144 trials without the warning statement (Amodio et al., 2008).

Similar to past research using the WIT, process dissociation procedure analyses were conducted on percentages of correct responses and error rates to trial types, which provided indices of automatic versus controlled responding (Payne, 2001). Indices of automatic and controlled responses were computed separately for Black faces and White faces (Stepanova et al., 2012). Controlled processing (C) were derived by subtracting the percentage of errors to stereotypic incongruent trials (e.g., Black face prime followed by tool) from the correct percentage of responses to stereotype congruent trials (e.g., Black face prime followed by a gun). Automatic processing (A) was estimated by dividing the percentage of errors for stereotypically incongruent trials by the inverse of the controlled processing estimate.

$$C = \%(\text{correct} \mid \text{congruent trials}) - \%(\text{stereotypic error} \mid \text{incongruent trials})$$

$$A = \%(\text{stereotypic error} \mid \text{incongruent trials}) / (1 - C)$$

Electrophysiological recording. EEG recordings were acquired using a 16-channel amplifier and data acquisition software (ActiveTwo System, BioSemi, Amsterdam, The Netherlands). Sixteen Ag/AgCl active electrodes were placed on the scalp according to the 10–20 International System (O1, Oz, O2, P3, Pz, P4, T7, T8, C3, Cz, C4, F3, Fz, F4, Fp1, Fp2) using a nylon electrode cap (BioSemi). Vertical electrooculogram (VEOG) and horizontal electrooculogram (HEOG) were recorded by attaching electrodes (UltraFlat Active electrodes, BioSemi) below the left eye and outside of the right eye. Two electrodes were attached to the left and right mastoids (M1/2) and an additional electrode was placed on the left side of the nose. All voltages were digitized with a sample rate of 512 Hz and recorded relative to a common mode voltage derived from the Active Two's Common Mode Sense/Driven Right Leg feedback loop.

Procedure

Participants first completed an online prescreening questionnaire prior to the lab session to determine eligibility (e.g., handedness, normal or corrected vision, etc.). Eligible participants then completed an online questionnaire using Qualtrics (Provo, UT) measuring trait approach motivation, drinking motives, alcohol sensitivity, alcohol preference, and demographics. Participants then were redirected to an online Inquisit task hosted by Millisecond (Seattle, WA) where they completed a measure of implicit alcohol identity (30 minutes). Participants then made an appointment for the lab portion of the study via an online calendar (i.e., Doodle). Upon arrival to the lab, participants had an EEG cap attached to their scalp for continuous measure of electrophysiological data during the study (30 minutes). Following setup, participants completed a 4-minute baseline period with eyes open in a sitting position to record resting frontal cortical alpha asymmetries. During the baseline period, participants were instructed to stare at a fixation cross on a computer screen to reduce eye movements. After baseline, participants were randomly assigned to self-control condition (not exerted, exerted), completed the self-control manipulation (10 minutes), followed by the advertisement viewing and rating task (20 minutes). After completion of these tasks, participants completed the WIT (20 minutes). Finally, participants were debriefed, compensated, and dismissed (see Figure 2 for timeline).

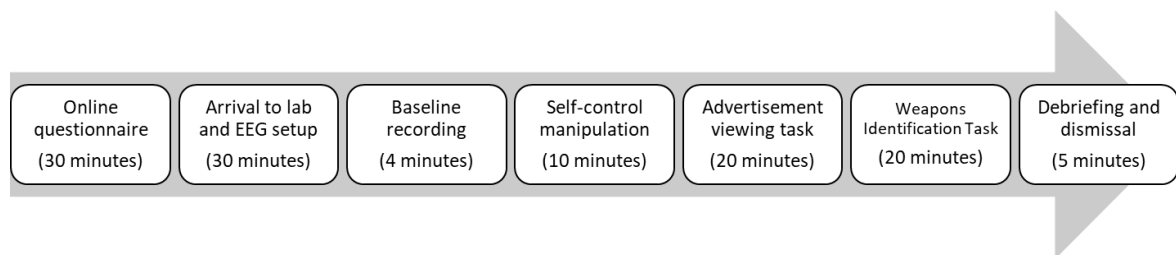


Figure 2. Timeline of study measures and procedures.

Data Analysis Plan

EEG Data Cleaning

All scalp electrodes were referenced to an averaged mastoid reference and independent components analysis was conducted on all scalp electrode data utilizing recorded VEOG and HEOG signals to correct for ocular artifacts using BrainVision Analyzer 2 (Brain Vision LLC; Morrisville, NC). All segments were baseline-corrected by subtracting the average voltage during the 100ms before stimulus presentation or response. Segments were rejected based on a maximum allowed voltage gradient of 50 μV and a maximum absolute difference threshold of 70 μV (Inzlicht & Gutsell, 2007).

Cortical asymmetries. For the advertisement viewing task, data were filtered using a 1-15 Hz band-pass filter and segmented into 2s epochs after presentation of each image for the duration of the image (6s). A Fast Fourier Transformation was then applied to each remaining segment after artifact rejection to determine the power of the alpha frequency band (8-13 Hz) and was then averaged over all segments within each stimuli type during the advertisement viewing task (neutral, alcohol). Values at all sites were log transformed to reduce positive skew (Harmon-Jones & Allen, 1998). Hemispheric asymmetry was computed by subtracting left alpha power from right alpha power (F4-F3) such that positive values represent greater left frontal cortical activation and negative values indicate greater right frontal cortical activation (Harmon-Jones & Allen, 1998).

ERPs. EEG signals were stimulus (LPP and N2) or response-locked (ERN) and were then segmented into individual trials per participant. For the LPP, data were filtered using a 0.1-15 Hz band-pass filter and segments were created from 100ms before stimulus onset to 6000ms after onset (i.e., duration of stimulus presentation) for each trial

of the advertisement viewing task and then averaged together based on advertisement type (neutral, alcohol) within each participant to account for variability between trials. The LPP was defined as the average EEG activity within the 300-6000ms range after stimulus presentation (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Langeslag, Jansma, Franken, & Van Strien, 2007). Greater positive amplitudes of the LPP was interpreted as greater motivational salience or emotional significance toward presented stimuli (Warren & McDonough, 1999). The LPP was examined at the midline parietal electrode (i.e., Pz; Huffmeijer et al., 2014)

To assess self-control during the WIT, data were filtered using a 1-15 Hz band-pass filter and ERPs were averaged based on response (correct, incorrect) within each participant. Peaks of the averaged waveforms were then labelled on all scalp locations for amplitudes within respective time windows for the N2 (200-500ms after presentation; Kopp et al., 1996) and ERN (50-80ms after response; Dehaene et al., 1994). Greater negative amplitudes of the N2 were interpreted as greater conflict monitoring (Yeung & Cohen, 2006) and greater negative amplitudes of the ERN were interpreted as greater error detection (Yeung & Cohen, 2006), whereas lower amplitudes of the N2 and ERN, particularly for incorrect responses, were interpreted as depleted or impaired self-control (Inzlicht & Gutsell, 2007). The ERN amplitude was assessed at the central midline electrode (i.e., Cz; Inzlicht & Gutsell, 2007) and the N2 amplitude was assessed at the frontal midline electrode (i.e., Fz; Kopp et al., 1996).

Results

Approach Motivation

Frontal cortical asymmetry and the LPP were analyzed using a 2 (self-control: not exerted, exerted) X 2 (advertisement: neutral, alcohol) mixed analysis of variance (ANOVA) using SPSS 25, with the last factor repeated. Results indicated no main effect of self-control, $F(1, 69) = 0.51, p = .476, \eta_p^2 = .007$, or advertisement, $F(1,69) = 0.002, p = .962, \eta_p^2 < .001$, on frontal cortical asymmetry, contrary to hypothesis 1a. There was also no main effect of self-control, $F(1, 69) = 0.40, p = .531, \eta_p^2 = .006$, for the LPP, contrary to hypothesis 1b. However, LPP amplitudes were significantly different between advertisement conditions, $F(1,69) = 5.38, p = .023, \eta_p^2 = .072$, suggesting alcohol advertisement elicited a larger LPP ($M = 5.48, SD = 11.08$) compared to neutral advertisements ($M = -2.17, SD = 28.45$) regardless of self-control condition (see Figure 3). The interaction between self-control and advertisement condition was not significant for frontal cortical asymmetry, $F(1,69) = 0.07, p = .796, \eta_p^2 = .001$, contrary to hypothesis 2a, or the LPP, $F(1,69) = 0.18, p = .672, \eta_p^2 = .003$, contrary to hypothesis 2b.

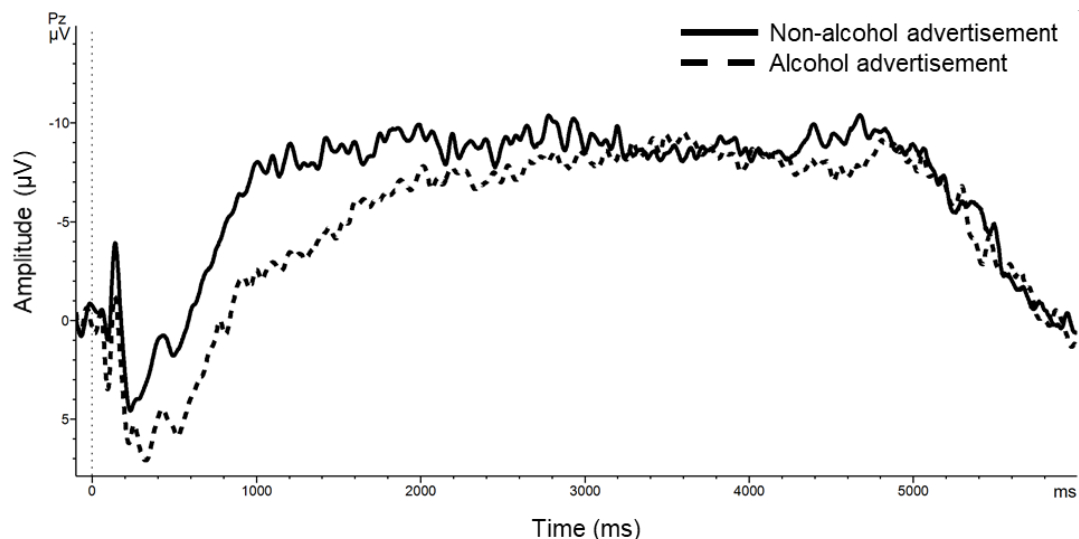


Figure 3. Averaged response-locked ERPs at Pz electrode displaying non-alcohol and alcohol advertisements (zero represents time of stimulus onset). The LPP is the averaged voltage from 300-6000ms.

Individual Differences in Approach Motivation

The PROCESS macro for SPSS 25 (model 1; Hayes, 2012) was used to test for moderating effects of individual differences on approach motivation while viewing alcohol advertisements between self-control conditions. Self-control condition was entered as a dichotomous independent variable and individual difference variables (trait approach motivation, alcohol identity, sensitivity, motives, preference) were individually entered as continuous moderators of differences in approach motivation (frontal cortical asymmetry, LPP) between self-control conditions. For each analysis, indices of approach motivation while viewing neutral advertisements was entered as a covariate.

Trait approach motivation. The interaction between self-control condition and self-reported trait approach motivation was not significant in predicting frontal cortical asymmetry, $F(1,66) = 0.68, p = .412, b = -0.07, \Delta R^2 = .006, 95\% \text{ CI} [-0.2234, 0.0928]$, contrary to hypothesis 3a, or the LPP, $F(1,66) = 0.43, p = .513, b = 5.03, \Delta R^2 = .006, 95\% \text{ CI} [-10.2226, 20.2685]$, contrary to hypothesis 3b.

Implicit alcohol identity. The interaction between self-control condition and implicit alcohol identity was significant in predicting frontal cortical asymmetry while viewing alcohol advertisements, $F(1,66) = 9.02, p = .004, b = 0.22, \Delta R^2 = .071, 95\% \text{ CI} [0.3693, 0.6823]$. Conditional effects revealed greater implicit alcohol identification predicted greater approach motivation, as indicated by greater left over right frontal

cortical activation, among participants who exerted self-control ($n = 36$), $t(66) = 3.56$, $p < .001$, $b = 0.19$, 95% CI [0.0845, 0.3003], supporting hypothesis 4a. No significant relation between implicit alcohol identity and frontal cortical asymmetry emerged among those who did not exert self-control ($n = 35$), $t(66) = -0.53$, $p = .560$, $b = -0.03$, 95% CI [-0.1219, 0.0710] (see Figure 4). The interaction between self-control condition and implicit alcohol identity was not significant in predicting the LPP, $F(1,66) = 0.001$, $p = .974$, $b = 0.24$, $\Delta R^2 < .001$, 95% CI [-14.9506, 15.4405], contrary to hypothesis 4b.

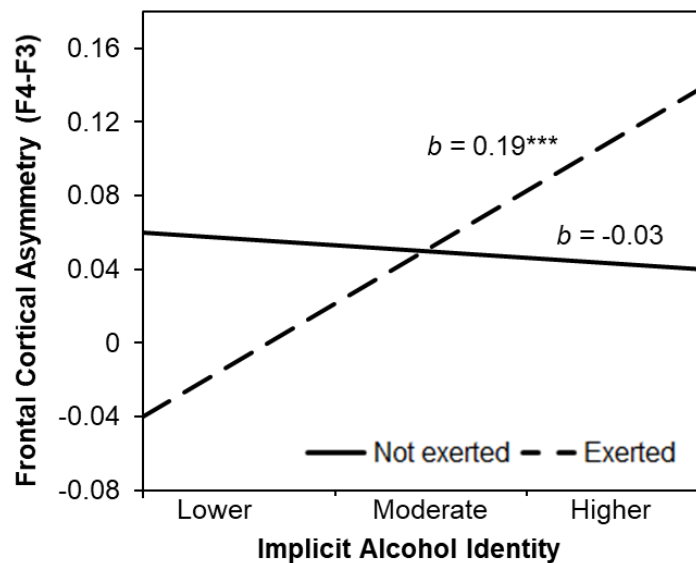


Figure 4. Interaction between implicit alcohol identity and self-control condition predicting frontal cortical asymmetry while viewing alcohol advertisements, controlling for frontal cortical asymmetry while viewing neutral advertisements. Higher, positive values on the y-axis indicate greater left over right frontal cortical activation, indicating approach motivation. Implicit alcohol identity is graphed at -1SD (lower), at the mean (moderate) and +1SD (higher). *** $p < .001$.

Drinking motives. The interaction between self-control condition and coping motives was significant in predicting frontal cortical asymmetry while viewing alcohol advertisements, $F(1,66) = 5.70$, $p = .020$, $b = 0.06$, $\Delta R^2 = .048$, 95% CI [0.0094, 0.1054]. Conditional effects revealed greater coping drinking motives predicted greater left over right frontal cortical activation among participants who exerted self-control, $t(66) = 2.73$, $p = .008$, $b = 0.05$, 95% CI [0.0124, 0.0798], supporting hypothesis 5a. Coping motives did not significantly predict frontal cortical asymmetry among those who did not exert self-control, $t(66) = 0.66$, $p = .511$, $b = 0.01$, 95% CI [-0.0229, 0.0455] (see Figure 5).

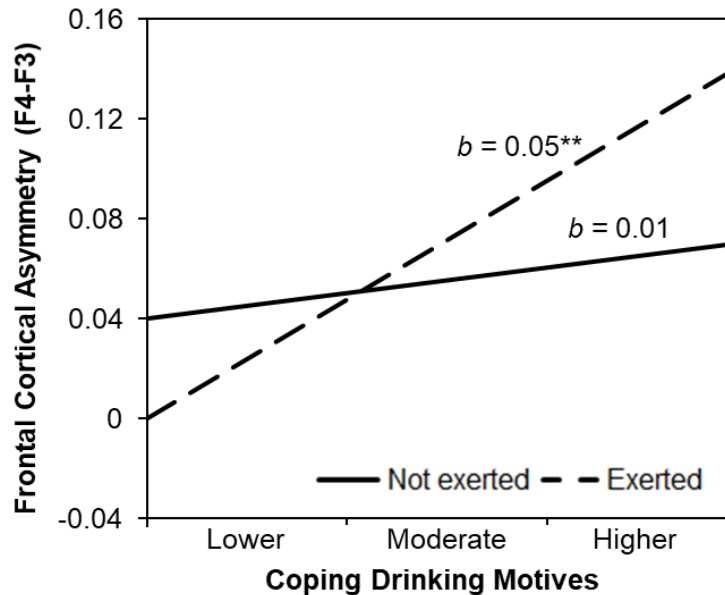


Figure 5. Interaction between coping drinking motives and self-control condition predicting frontal cortical asymmetry while viewing alcohol advertisements, controlling for frontal cortical asymmetry while viewing neutral advertisements. Higher, positive values on the y-axis indicate greater left over right frontal cortical activation, indicating approach motivation. Coping drinking motives are graphed at -1SD (lower), at the mean (moderate) and +1SD (higher). ** $p < .01$.

The interaction between self-control condition and coping motives was not significant in predicting the LPP, $F(1,66) = 0.72, p = .789, b = 0.79, \Delta R^2 = .001, 95\% \text{ CI} [-5.1132, 6.7027]$, contrary to hypothesis 5b. The interaction between self-control condition and enhancement motives was not significant in predicting either frontal cortical asymmetry, $F(1,66) = 0.58, p = .447, b = -0.04, \Delta R^2 = .002, 95\% \text{ CI} [-0.5028, 0.224]$, contrary to hypothesis 6a, or the LPP, $F(1,66) = 0.51, p = .477, b = 1.78, \Delta R^2 = .007, 95\% \text{ CI} [-3.1939, 6.7602]$, contrary to hypothesis 6b.

Alcohol sensitivity. The interaction between self-control condition and alcohol sensitivity was significant in predicting frontal cortical asymmetry while viewing alcohol advertisements, $F(1,66) = 11.17, p = .001, b = -0.09, \Delta R^2 = .086, 95\% \text{ CI} [-0.1357, -0.0342]$. Conditional effects indicated lower sensitivity to the effects of alcohol predicted greater left over right frontal cortical activation among participants who exerted self-control, $t(66) = -3.69, p < .001, b = -0.07, 95\% \text{ CI} [-0.1050, -0.0313]$, supporting hypothesis 7a. Alcohol sensitivity did not predict frontal cortical asymmetry among those who did not exert self-control, $t(66) = 0.95, p = .346, b = 0.02, 95\% \text{ CI} [-0.0186, 0.0522]$ (see Figure 6). The interaction between self-control condition and alcohol sensitivity was not significant in predicting the LPP, $F(1,66) = 0.69, p = .411, b = 2.24, \Delta R^2 = .009, 95\% \text{ CI} [-3.1690, 7.6580]$, contrary to hypothesis 7b.

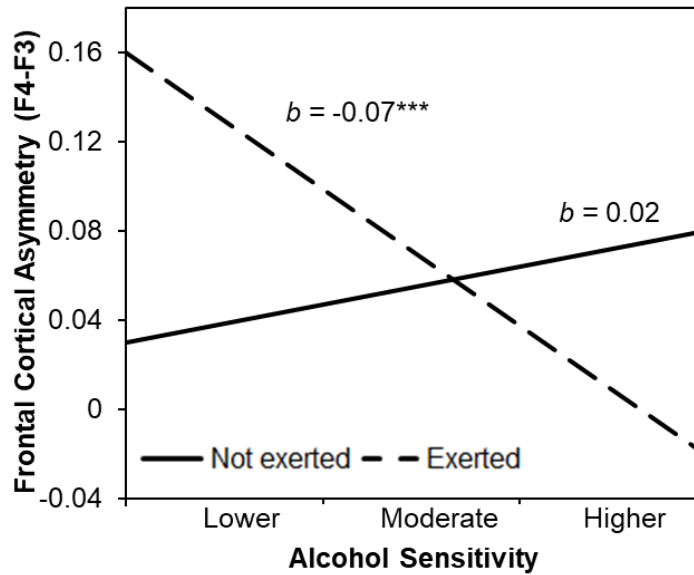


Figure 6. Interaction between alcohol sensitivity and self-control condition predicting frontal cortical asymmetry while viewing alcohol advertisements, controlling for frontal cortical asymmetry while viewing neutral advertisements. Higher, positive values on the y-axis indicate greater left over right frontal cortical activation, indicating approach motivation. Alcohol sensitivity is graphed at -1SD (lower), at the mean (moderate) and +1SD (higher). *** $p < .001$.

Alcohol preference. The interaction between self-control condition and alcohol preference (non-hazardous [$n = 54$], hazardous [$n = 17$]) was not significant in predicting frontal cortical asymmetry while viewing alcohol advertisements, $F(1,66) = 1.17$, $p = .284$, $b = -0.09$, $\Delta R^2 = .011$, 95% CI [-0.2476, 0.0737], contrary to hypothesis 8a. The interaction between self-control condition and alcohol preference was also not significant in predicting the LPP, $F(1,66) = 0.03$, $p = .871$, $b = 0.58$, $\Delta R^2 < .001$, 95% CI [-6.5646, 7.7275], contrary to hypothesis 8b.

Racial Bias

Preliminary analysis of racial bias during the WIT focused on error rates in tool categorization following Black compared to White face primes (Amodio et al., 2004; Payne, 2006; Stepanova et al., 2012). Error rates of categorizing tools were analyzed using a 2 (self-control: not exerted, exerted) X (race of face prime: Black, White) mixed ANOVA, with the last factor repeated. Results indicated a significant main effect of face prime, $F(1,69) = 6.29$, $p = .014$, $\eta_p^2 = .084$, suggesting greater errors following Black face primes ($M = 0.17$, $SD = 0.16$) compared to White face primes ($M = 0.13$, $SD = 0.13$). A significant interaction emerged between self-control and face prime, $F(1,69) = 5.65$, $p = .020$, $\eta_p^2 = .076$. Simple effects indicated participants who exerted self-control exhibited significantly greater errors following Black face primes ($M = 0.21$, $SD = 0.18$) compared to those who did not exert self-control, ($M = 0.13$, $SD = 0.14$), $F(1,69) = 4.35$, $p = .041$, $\eta_p^2 = .059$ (see Figure 7).

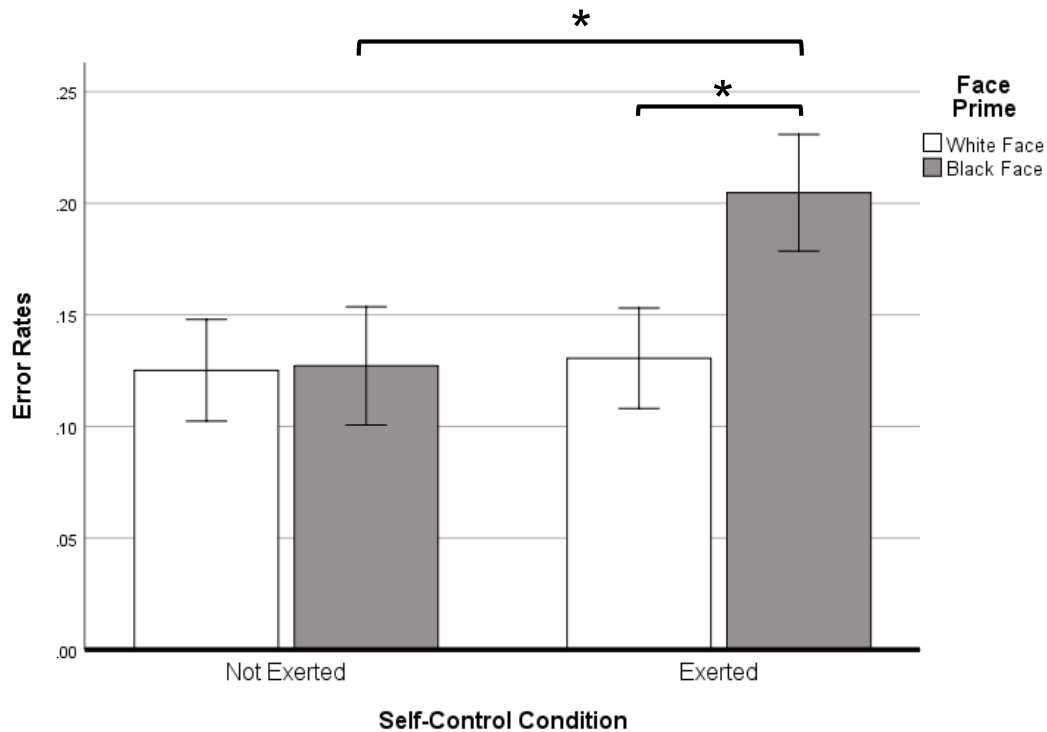


Figure 7. Error rates during WIT following Black and White face primes as a function of self-control (not exerted, exerted). Error bars represent standard error. $*p < .05$

Controlled process of racial bias. Estimates of controlled processes during the WIT were analyzed using a 2 (self-control: not exerted, exerted) X 2 (race of face prime: Black, White) mixed ANOVA, with the last factor repeated. Results indicated no main effect of face primes on controlled processes, $F(1,69) = 0.03$, $p = .866$, $\eta_p^2 < .001$. A significant interaction emerged between self-control and face prime on controlled processes, $F(1,69) = 7.92$, $p = .006$, $\eta_p^2 = .103$, supporting hypothesis 9. Participants who exerted self-control exhibited significantly lower controlled processes following Black face primes ($M = 0.65$, $SD = 0.33$) compared to those who did not exert self-control, ($M = 0.73$, $SD = 0.26$), $F(1,69) = 5.81$, $p = .019$, $\eta_p^2 = .078$ (see Figure 8).

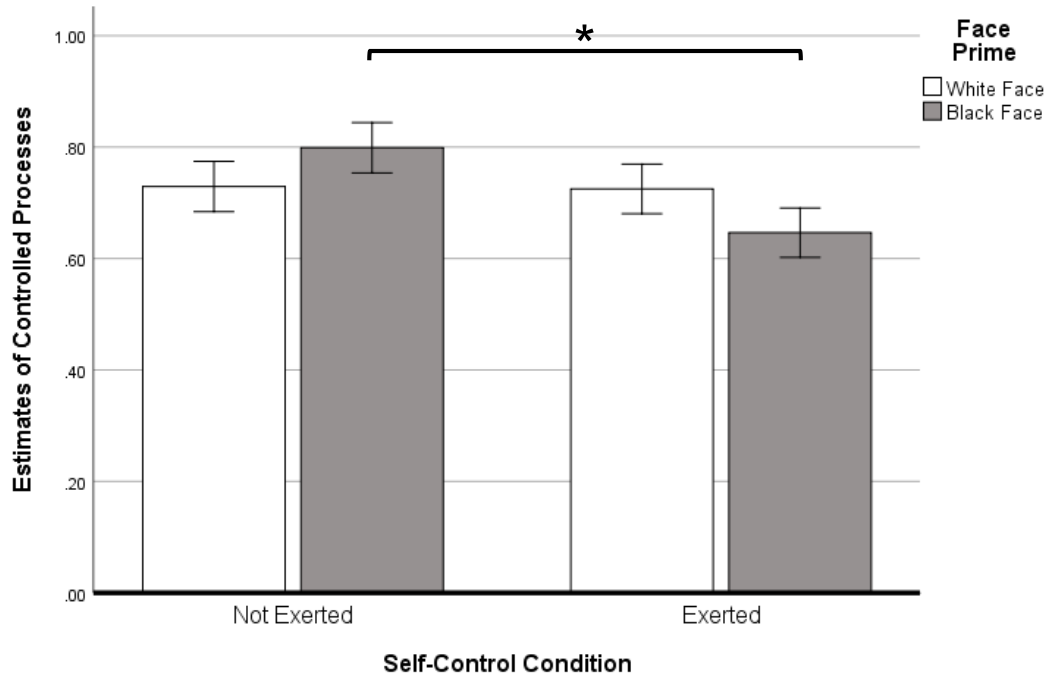


Figure 8. Estimates of controlled processes following Black and White face primes as a function of self-control (not exerted, exerted). Error bars represent standard error. $*p < .05$

Automatic processes of racial bias. Estimates of automatic processes during the WIT were analyzed using a 2 (self-control: not exerted, exerted) X 2 (race of face prime: Black, White) mixed ANOVA, with the last factor repeated. Results indicated a main effect of faces primes on automatic processes, $F(1,69) = 8.77, p = .004, \eta_p^2 = .113$, indicating participants exhibited greater automatic processes following Black face primes ($M = 0.57, SD = 0.27$) compared to White face primes ($M = 0.46, SD = 0.20$). Supporting hypothesis 10, the interaction between self-control and face prime on automatic processes was not significant, $F(1,69) = 0.001, p = .975, \eta_p^2 < .001$, suggesting exerting self-control did not impact automatic processes of racial bias (see Figure 9).

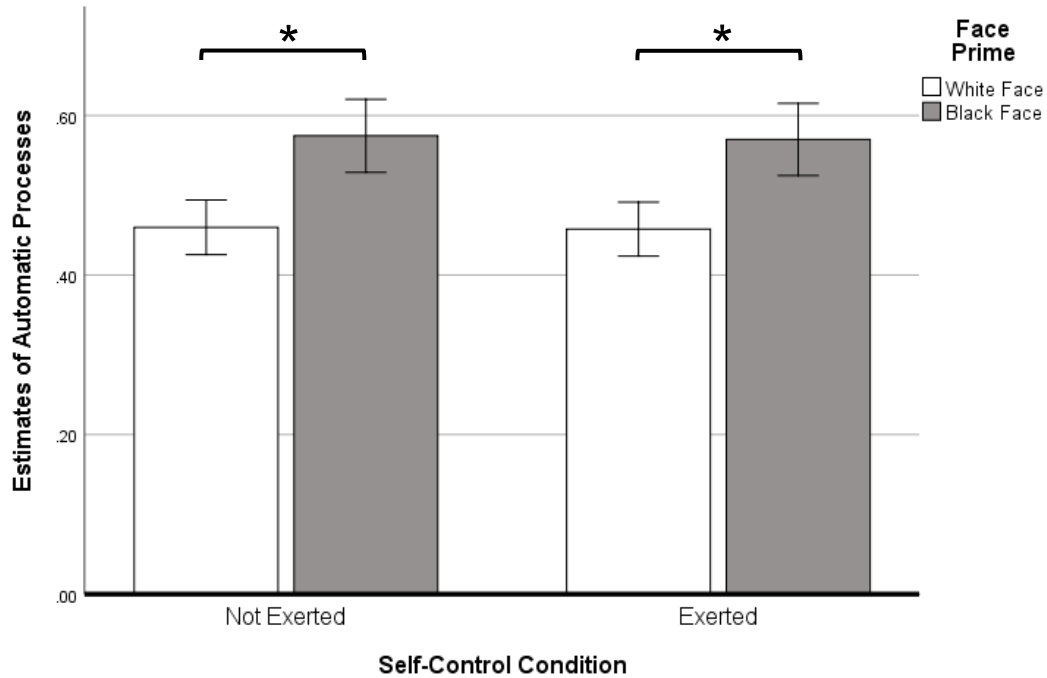


Figure 9. Estimates of automatic processes following Black and White face primes as a function of self-control (not exerted, exerted). Error bars represent standard error. $*p < .05$

Neural indices of self-control. ERN amplitudes during the WIT were analyzed using a 2 (self-control: not exerted, exerted) X 2 (response: correct, error) mixed ANOVA, with the last factor repeated. Results indicated a main effect of response, $F(1,69) = 87.60, p < .001, \eta_p^2 = .559$, indicating ERN amplitudes were greater following incorrect responses ($M = -4.94, SD = 4.12$) compared to correct responses ($M = -0.79, SD = 1.53$). A significant interaction emerged between self-control and response, $F(1,69) = 6.89, p = .011, \eta_p^2 = .091$. Supporting hypothesis 11a, participants who exerted self-control exhibited significantly lower ERN amplitudes following incorrect responses ($M = -3.89, SD = 2.89$) compared to those who did not exert self-control, ($M = -6.03, SD = 4.89$), $F(1,69) = 5.09, p = .027, \eta_p^2 = .069$ (see Figure 10). No significant differences

emerged between self-control conditions for ERN amplitudes following correct responses, $F(1,69) = 0.29, p = .594, \eta_p^2 = .004$.

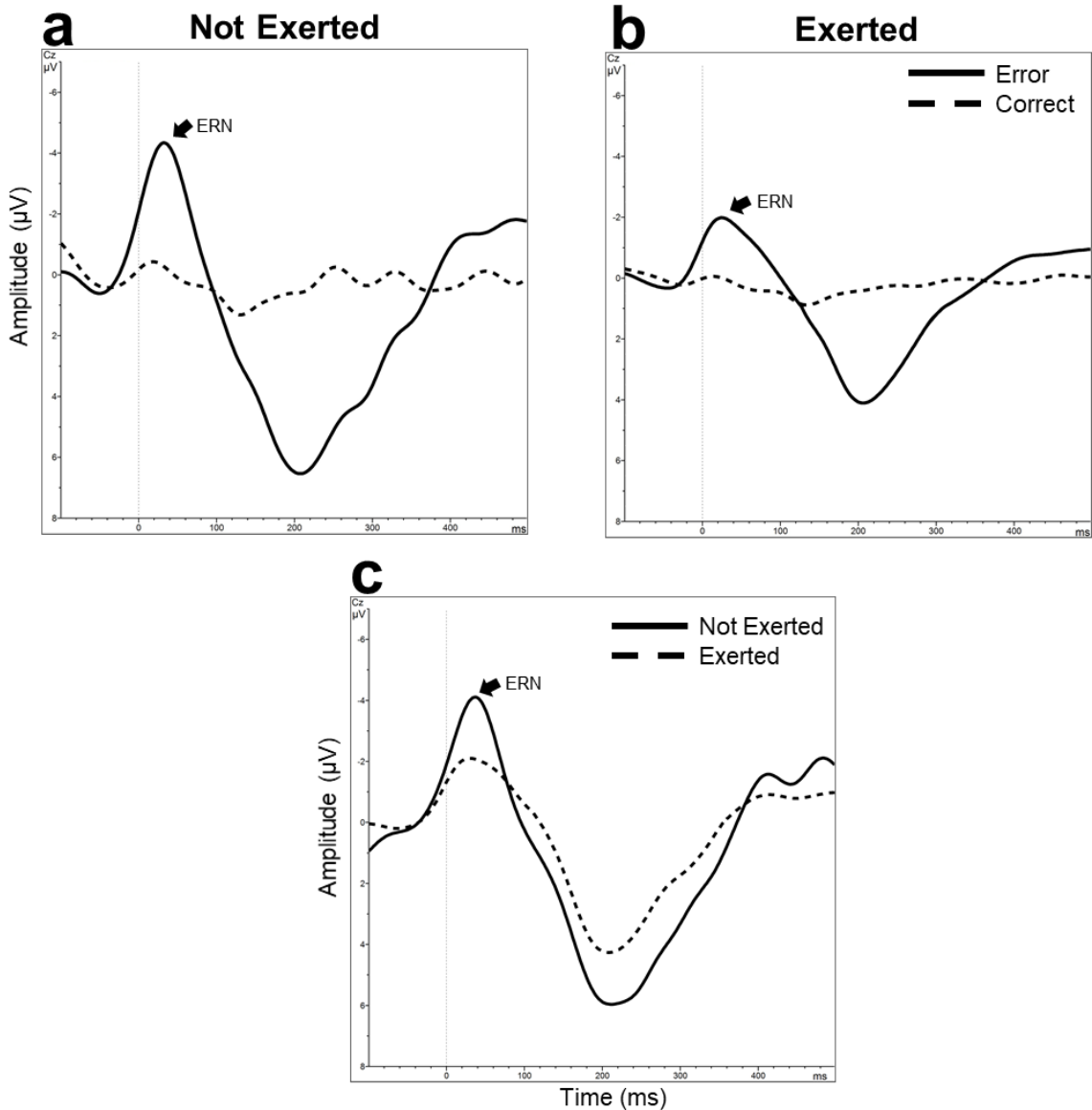


Figure 10. Averaged response-locked ERPs at Cz electrode displaying (a) not exerted and (b) exerted self-control conditions following error and correct responses (zero represents time of response). Average difference waveforms (error minus correct response) for both conditions are also displayed (c). The ERN is the negative most amplitude peaking at approximately 50ms.

N2 amplitudes during the WIT were also analyzed using a 2 (self-control: not exerted, exerted) X 2 (response: correct, error) mixed ANOVA, with the last factor repeated. Results indicated a main effect of response, $F(1,69) = 87.60, p < .001, \eta_p^2 = .559$, indicating N2 amplitudes were lower prior to incorrect responses ($M = -2.36, SD = 1.90$) compared to correct responses ($M = -3.70, SD = 2.99$; see Figure 11). Contrary to hypothesis 11b, the interaction between self-control and response was not significant, $F(1,69) = 0.03, p = .854, \eta_p^2 < .001$, suggesting self-control did not impact the N2.

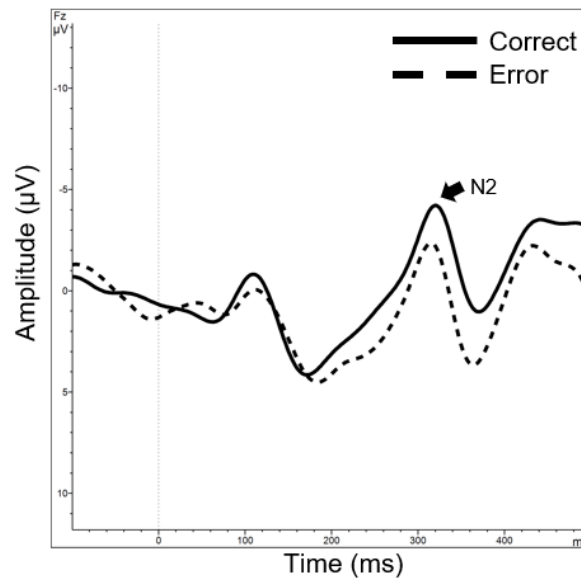


Figure 11. Averaged stimulus-locked ERPs at Fz electrode displaying showing correct and incorrect responses (zero represents time of stimulus presentation). The N2 is the negative most amplitude peaking at approximately 300ms.

Approach Motivation as a Mechanism

The PROCESS macro for SPSS 25 (model 4; Hayes, 2012) was used to examine approach motivation while viewing alcohol advertisements (frontal cortical asymmetry, LPP) as a mediator between self-control condition and indices of self-control (controlled

processes of racial bias, ERN after error responses, N2 before error responses). Self-control condition was entered as a dichotomous independent variable and indices of approach motivation were individually entered as mediator variables, while indices of self-control were individually entered as dependent variables in each model. Confidence intervals of indirect effects were computed using 1,000 bootstrapped samples for each analysis. Consistent with hypothesis 12a, frontal cortical asymmetry significantly predicted controlled processes of racial bias, $t(69) = -2.54, p = .013, b = -0.56, 95\% \text{ CI} [-0.9957, -0.1195]$, suggesting greater left over right frontal cortical activation is related to lower controlled processes during the WIT following Black faces. However, the LPP did not predict controlled processes, $t(69) = 1.43, p = .156, b = -0.01, 95\% \text{ CI} [-0.0081, 0.0498]$, inconsistent with hypothesis 12b.

Supporting hypothesis 13a, frontal cortical asymmetry significantly predicted ERN amplitudes following errors during the WIT, $t(69) = 2.29, p = .025, b = 5.74, 95\% \text{ CI} [0.7438, 10.7312]$, indicating greater left over right frontal cortical activation predicts lower ERN amplitudes. Contrary to hypothesis 13b, the LPP was not related to ERN amplitudes, $t(69) = -1.49, p = .141, b = -0.03, 95\% \text{ CI} [-0.7599, 0.1103]$. Further, frontal cortical asymmetry, $t(69) = 0.23, p = .819, b = 0.79, 95\% \text{ CI} [-6.0943, 7.6759]$, and the LPP, $t(69) = -0.11, p = .910, b = -0.04, 95\% \text{ CI} [-0.3515, 0.3138]$, were unrelated to N2 amplitudes prior to incorrect responses, contrary to hypotheses 13c and 13d, respectively.

Controlled processes of racial bias. A mediation analysis examined frontal cortical asymmetry as a mediator between self-control condition and estimates of controlled processes (see Figure 12). Similar to findings reported previously, self-control condition did not predict frontal cortical asymmetry ($a = -0.02, p = .574$), but frontal

cortical asymmetry did significantly predict controlled processes ($b = -0.56, p = .013$). The direct effect of self-control condition on controlled processes was also significant ($c' = -0.16, p = .010$). However, this effect was largely unaffected when controlling for the indirect pathway through frontal cortical asymmetry ($c = -0.15, p = .019$). This assumption was supported by the estimated confidence intervals of the indirect effect containing zero, indicating the indirect effect was not significant, 95% CI [-0.0464, 0.0439], contrary to hypothesis 14a.

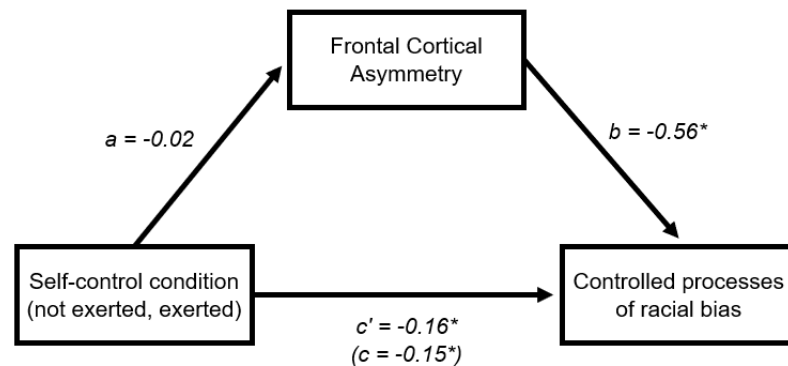


Figure 12. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and controlled processes of racial bias. $*p < .05$

A similar mediation analysis examined the LPP as a mediator between self-control condition and estimates of controlled processes of racial bias (see Figure 13). Similar to previous findings, self-control condition did not predict the LPP ($a = 1.08, p = .684$) and the LPP was not significantly related to controlled processes ($b = -0.01, p = .067$). The direct effect of self-control condition on controlled processes was significant ($c' = -0.16, p = .010$) and was unaffected when controlling for the indirect pathway through the LPP ($c = -0.15, p = .021$). This assumption was supported by estimated

confidence intervals of the indirect effect containing zero, indicating the indirect effect was not significant, 95% CI [-0.0368, 0.0257], contrary to hypothesis 14b.

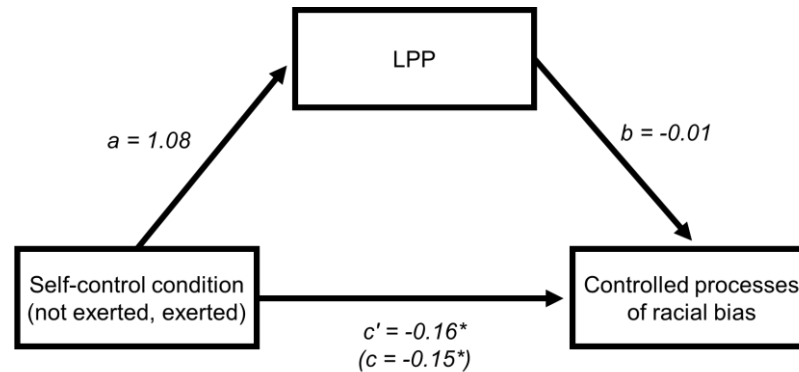


Figure 13. Model examining the LPP as a mediator between self-control (not exerted, exerted) and controlled processes of racial bias. * $p < .05$

Error-related negativity. A mediation analysis examined frontal cortical asymmetry as a mediator between self-control condition and ERN amplitudes following incorrect responses during the WIT (see Figure 14). Replicating previously reported findings, self-control condition did not predict frontal cortical asymmetry ($a = -0.02$, $p = .574$), but frontal cortical asymmetry did significantly predict ERN amplitudes ($b = 5.74$, $p = .025$). The direct effect of self-control condition on ERN amplitudes was also significant ($c' = 2.16$, $p = .027$), but was unaffected when controlling for the indirect pathway through frontal cortical asymmetry ($c = 2.15$, $p = .028$). This assumption was supported by the estimated confidence intervals of the indirect effect containing zero, indicating the indirect effect was not significant, 95% CI [-0.3219, 0.1544], contrary to hypothesis 15a.

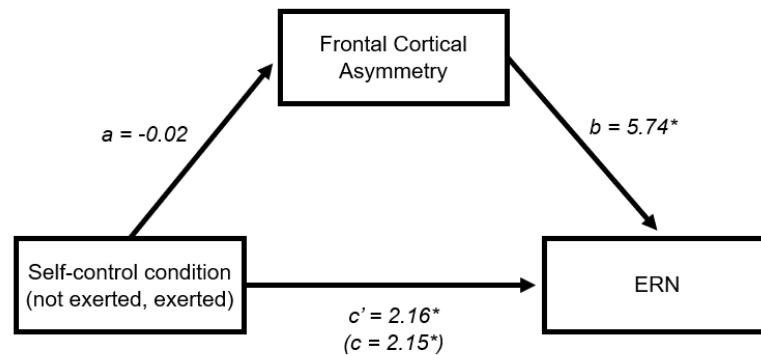


Figure 14. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and ERN amplitude following incorrect responses. $*p < .05$

A similar mediation analysis examined the LPP as a mediator between self-control condition and ERN amplitudes following errors (see Figure 15). Self-control condition did not predict the LPP ($a = 1.08, p = .684$) and the LPP was not significantly related to ERN amplitudes ($b = -0.03, p = .486$). The direct effect of self-control condition on controlled processes was significant ($c' = 2.16, p = .027$) and this relation was unaffected when controlling for the indirect pathway through the LPP ($c = -2.17, p = .026$). This assumption was supported by the estimated confidence intervals of the indirect effect containing zero, indicating the indirect effect was not significant, 95% CI [-0.4695, 0.1380], contrary to hypothesis 15b.

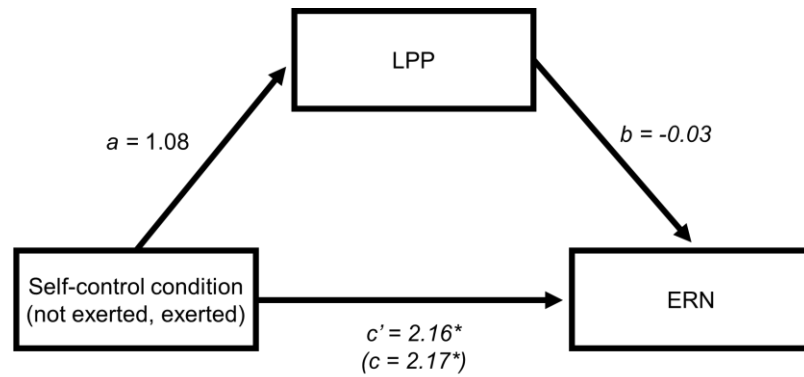


Figure 15. Model examining the LPP as a mediator between self-control (not exerted, exerted) and controlled processes of racial bias following incorrect responses. $*p < .05$

N2. A mediation analysis examined frontal cortical asymmetry as a mediator between self-control condition and ERN amplitudes following incorrect responses (see Figure 16). Self-control condition did not predict frontal cortical asymmetry ($a = -0.02$, $p = .574$) and frontal cortical asymmetry did not significantly predict N2 amplitudes ($b = 0.79$, $p = .819$). The direct effect of self-control condition on N2 amplitudes was not significant ($c' = -0.16$, $p = .723$) and was unaffected when controlling for the indirect pathway through frontal cortical asymmetry ($c = -0.21$, $p = .646$). This assumption was supported by the estimated confidence intervals of the indirect effect containing zero, indicating the indirect effect was not significant, 95% CI [-0.2654, 0.0700], contrary to hypothesis 16a.

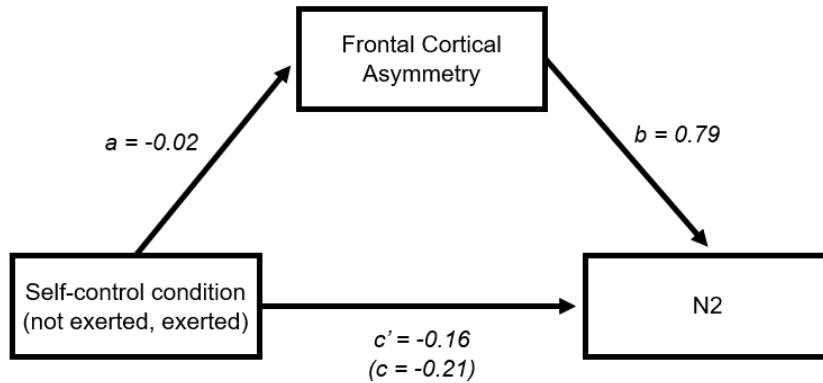


Figure 16. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and N2 amplitude prior to incorrect responses.

A similar mediation analysis examined the LPP as a mediator between self-control conditions and N2 amplitudes (see Figure 17). Self-control condition did not predict the LPP ($a = 1.08, p = .684$) and the LPP was not significantly related to N2 amplitudes ($b = -0.04, p = .194$). The direct effect of self-control condition on N2 was also non-significant ($c' = -0.16, p = .723$) and this relationship was again unaffected when controlling for the indirect pathway through the LPP ($c = -0.22, p = .923$). This assumption was supported by the estimated confidence intervals of the indirect effect containing zero, indicating the indirect effect was not significant, 95% CI [-0.3712, 0.2072], contrary to hypothesis 16b.

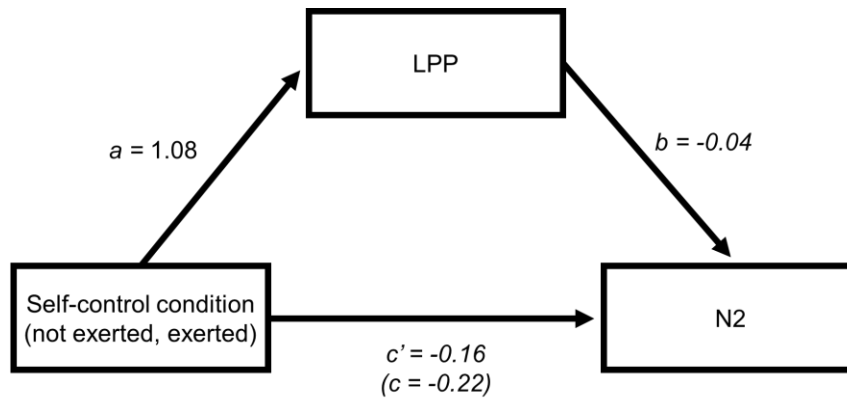


Figure 17. Model examining the LPP as a mediator between self-control (not exerted, exerted) and N2 amplitude prior to incorrect responses.

Individual differences in approach motivation. The PROCESS macro for SPSS 25 (model 7; Hayes, 2012) was used to examine the moderating effects of individual differences (trait approach motivation, alcohol identity, sensitivity, motives, preferences) on the pathway between self-control condition and indices of approach motivation (frontal cortical asymmetry, LPP) on the previously tested mediation models (see Figure 18). Similar to prior analyses, self-control condition was entered as a dichotomous independent variable and indices of approach motivation were individually entered as mediator variables, while indices of self-control (controlled processes, ERN, N2) were entered as dependent variables in each model. Confidence intervals of moderated indirect effects were computed using 1,000 bootstrapped samples for each analysis. If bootstrapped confidence intervals for the indirect effect estimates did not contain zero, the moderated-mediational model was interpreted as significant at $p < .05$.

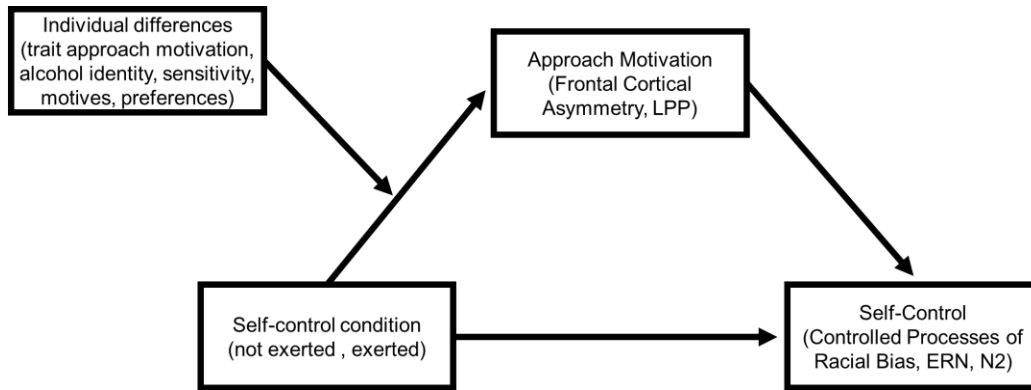


Figure 18. Proposed model for moderated-mediational analyses of approach motivation mediating the relation between self-control condition and self-control outcomes.

Trait approach motivation. The moderated-meditation models examining self-reported trait approach motivation as a moderating variable between self-control condition and frontal cortical asymmetry were not significant in explaining controlled processes, $b = 0.07$, 95% CI [-0.0154, 0.2596], ERN amplitudes, $b = -0.10$, 95% CI [-1.1860, 0.9059], and N2 amplitudes, $b = -0.74$, 95% CI [-2.0334, 0.0715], inconsistent with hypothesis 17. Similarly, analyses examining self-reported trait approach motivation moderating the relationship between self-control condition and the LPP were not significant in explaining controlled processes, $b = -0.04$, 95% CI [-0.1203, 0.0130], ERN amplitudes, $b = -0.20$, 95% CI [-0.9692, 0.6003], and N2 amplitudes, $b = -0.28$, 95% CI [-1.0617, 0.1482], further contrary to hypothesis 17.

Implicit alcohol identity. The moderated-meditation model examining implicit alcohol identity moderating the relationship between self-control condition and frontal cortical asymmetry was significant in explaining controlled processes of racial bias, indicating a significant moderated-mediated indirect effect on controlled processes through approach motivation, $b = -0.14$, 95% CI [-0.3773, -0.0081]. Specifically, only

individuals exhibiting stronger implicit alcohol identification demonstrated this indirect effect, $b = 0.06$, 95% CI [0.0063, 0.1510], such that greater alcohol identity predicted greater left over right frontal cortical activity among those exerting self-control, subsequently predicting lower controlled processes of racial bias (see Figure 19). Those exhibiting moderate, $b = 0.003$, 95% CI [-0.0532, 0.0332], or lower, $b = -0.03$, 95% CI [-0.1384, 0.0073], alcohol identity did not demonstrate this significant indirect effect.

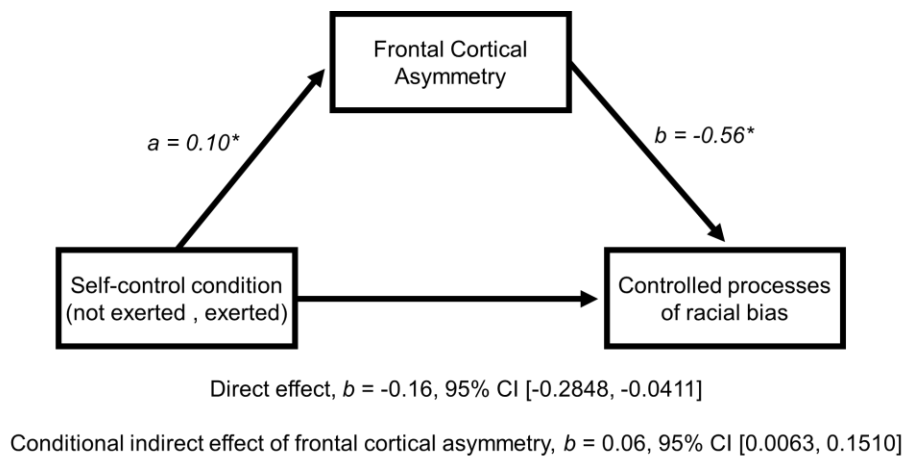


Figure 19. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and controlled processes of racial bias among participants with higher (+1SD) alcohol identity. $*p < .05$

A significant moderated-mediated indirect effect also emerged on ERN amplitudes following errors through approach motivation, $b = 1.43$, 95% CI [0.1285, 3.4624]. Similarly, only individuals exhibiting stronger implicit alcohol identity demonstrated this indirect effect, $b = 0.63$, 95% CI [0.0213, 1.5086], such that greater alcohol identity predicted greater left over right frontal cortical activity among those exerting self-control which then predicted lower ERN amplitudes following incorrect

responses (see Figure 20). Those exhibiting moderate, $b = -0.04$, 95% CI [-0.3497, 0.4147], or lower, $b = -0.35$, 95% CI [-1.1620, 0.0499], implicit alcohol identity did not demonstrate this significant indirect effect on ERN amplitudes.

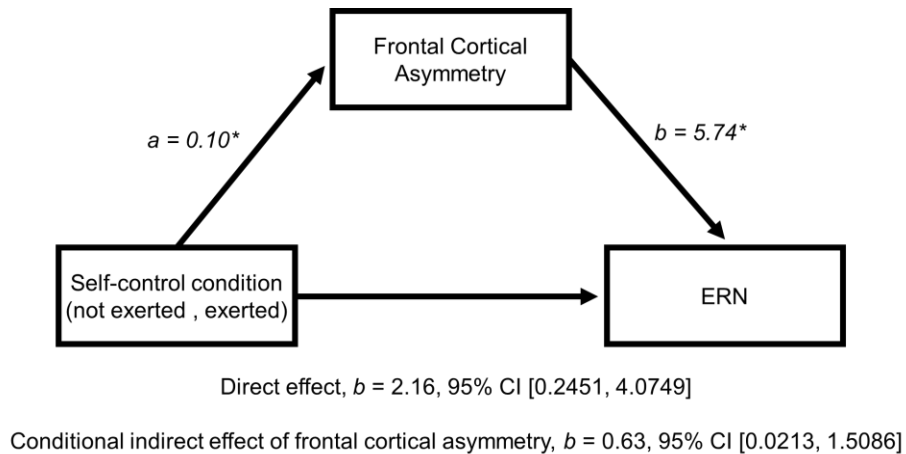


Figure 20. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and ERN amplitudes following incorrect responses among participants with higher (+1SD) alcohol identity. $*p < .05$

The moderated-meditation models examining implicit alcohol identity as a moderating variable between self-control condition and frontal cortical asymmetry was not significant in explaining N2 amplitudes, $b = 0.20$, 95% CI [-1.2096, 1.7907]. Similarly, the moderated-meditation models examining implicit alcohol identity as a moderating variable between self-control condition and the LPP were not significant in explaining controlled processes, $b = -0.01$, 95% CI [-0.0869, 0.1505], ERN amplitudes, $b = -0.05$, 95% CI [-1.5215, 0.6453], and N2 amplitudes, $b = -0.06$, 95% CI [-0.8849, 1.2750]. Overall, these findings demonstrate partial support for hypothesis 18.

Drinking motives. The moderated-mediation model examining coping drinking motives moderating the relationship between self-control condition and frontal cortical asymmetry was significant in explaining controlled processes, indicating a significant moderated-mediated indirect effect on controlled processes through approach motivation, $b = 0.03$, 95% CI [0.0149, 0.0770]. Specifically, individuals reporting higher coping motives demonstrated this indirect effect, $b = 0.04$, 95% CI [0.0382, 0.1098], with greater coping motives predicting greater left over right frontal cortical activity among those exerting self-control, which subsequently predicted lower controlled processes of racial bias (see Figure 21). Those exhibiting moderate, $b = 0.01$, 95% CI [-0.0495, 0.0388], or lower, $b = -0.02$, 95% CI [-0.0382, 0.1098], coping motives did not demonstrate this significant indirect effect.

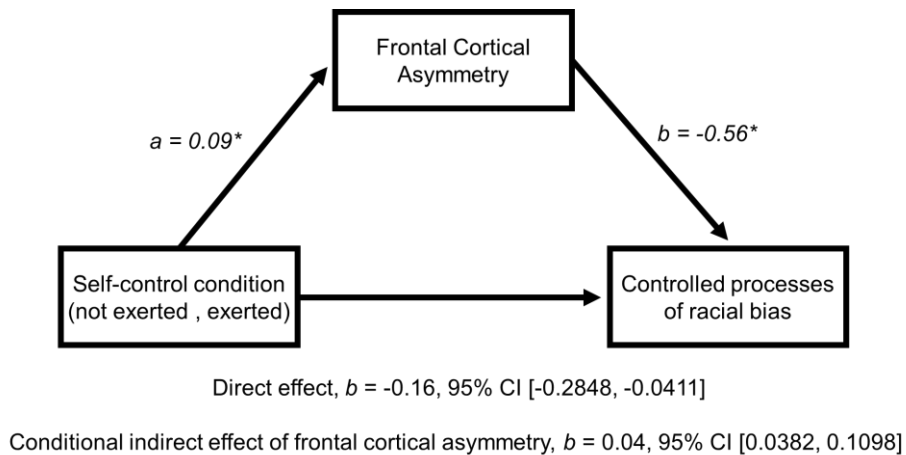


Figure 21. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and controlled processes of racial bias among participants with higher (+1SD) coping drinking motives. $*p < .05$

A significant moderated-mediated indirect effect also emerged on ERN amplitudes through approach motivation, $b = 0.29$, 95% CI [0.0784, 0.8598]. Only

individuals exhibiting stronger coping motives demonstrated this indirect effect, $b = 0.43$, 95% CI [0.2513, 1.3119], such that greater coping motives predicted greater left over right frontal cortical activity among those exerting self-control which then predicted lower ERN amplitudes following incorrect responses (see Figure 22). Those reporting moderate, $b = -0.05$, 95% CI [-0.3766, 0.3971], or lower, $b = -0.21$, 95% CI [-0.8648, 0.1700], coping motives did not demonstrate this significant indirect effect on ERN amplitudes.

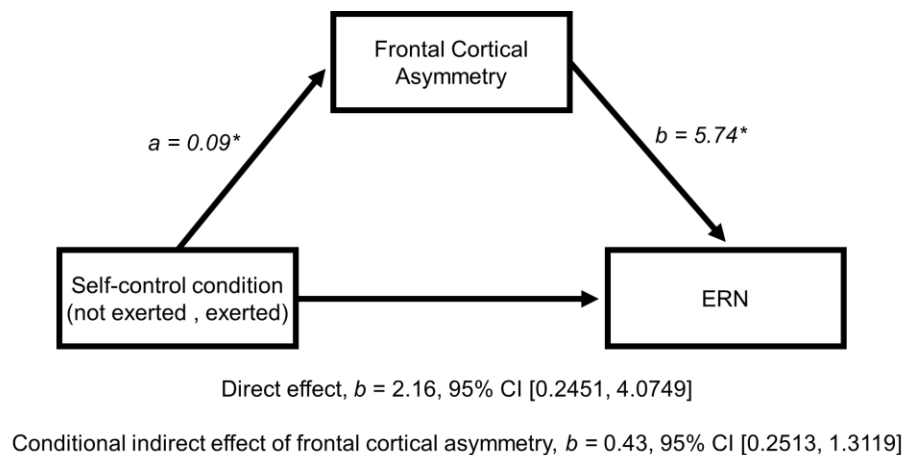


Figure 22. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and ERN amplitudes following incorrect responses among participants with higher (+1SD) coping drinking motives. $*p < .05$

The moderated-mediation models examining coping motives as a moderating variable between self-control condition and frontal cortical asymmetry was not significant in explaining N2 amplitudes, $b = -0.05$, 95% CI [-0.4758, 0.2461]. Similarly, the moderated-mediation models examining coping motives as a moderating variable between self-control condition and the LPP were not significant in explaining controlled processes, $b = -0.04$, 95% CI [-0.0984, 0.0042], ERN amplitudes, $b = -0.19$, 95% CI [-

0.9954, 0.4625], and N2 amplitudes, $b = -0.33$, 95% CI [-0.7538, 0.1042]. These findings demonstrate partial support for hypothesis 19.

The moderated-meditation models examining enhancement drinking motives as a moderating variable between self-control conditions and frontal cortical asymmetry were not significant in explaining controlled processes, $b = 0.003$, 95% CI [-0.0194, 0.0380], ERN amplitudes, $b = -0.03$, 95% CI [-0.4518, 0.1443], or N2 amplitudes, $b = -0.04$, 95% CI [-0.3665, 0.2129], inconsistent with hypothesis 20. Similarly, analyses examining enhancement motives moderating the relation between self-control condition and the LPP were not significant in explaining controlled processes, $b = -0.01$, 95% CI [-0.0513, 0.0039], ERN amplitudes, $b = -0.06$, 95% CI [-0.3034, 0.3274], or N2 amplitudes, $b = -0.11$, 95% CI [-0.4517, 0.0537], also inconsistent of hypothesis 20.

Alcohol sensitivity. The moderated-meditation model examining alcohol sensitivity moderating the relationship between self-control condition and frontal cortical asymmetry was significant in explaining controlled processes of racial bias, indicating a significant moderated-mediated indirect effect on controlled processes through approach motivation, $b = 0.04$, 95% CI [0.0146, 0.1225]. Only individuals exhibiting lower alcohol sensitivity demonstrated this indirect effect, $b = 0.06$, 95% CI [0.0216, 0.1447], such that lower alcohol sensitivity predicted greater left over right frontal cortical activity among those exerting self-control, subsequently predicting lower controlled processes of racial bias (see Figure 23). Those exhibiting moderate, $b = 0.009$, 95% CI [-0.0538, 0.0464], or higher, $b = -0.04$, 95% CI [-0.1811, 0.0326], alcohol sensitivity did not demonstrate this significant indirect effect.

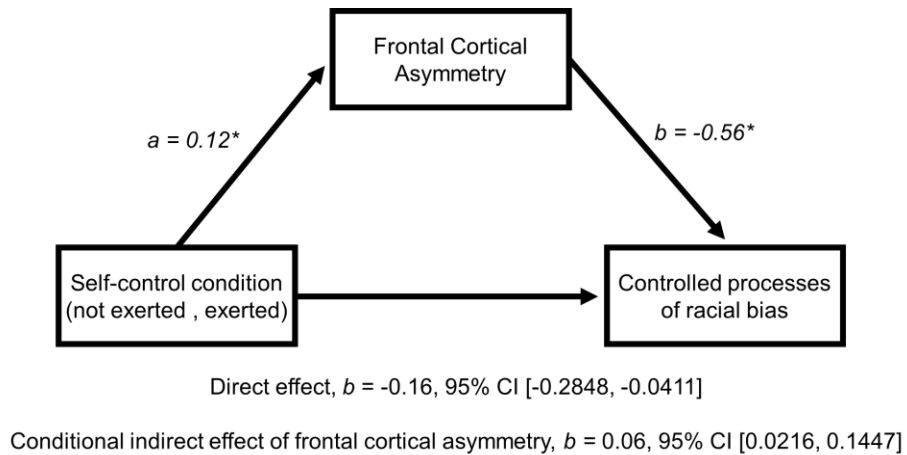


Figure 23. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and controlled processes of racial bias among participants with lower (-1SD) alcohol sensitivity. $*p < .05$

A significant moderated-mediated indirect effect also emerged on ERN amplitudes through approach motivation, $b = -0.06$, 95% CI [-0.6176, -0.3730]. Similarly, only individuals exhibiting lower alcohol sensitivity demonstrated this indirect effect, $b = -0.08$, 95% CI [-0.7464, -0.5539], such that lower alcohol sensitivity predicted greater left over right frontal cortical activity among those exerting self-control which then predicted lower ERN amplitudes following incorrect responses (see Figure 23). Those exhibiting moderate, $b = -0.01$, 95% CI [-0.2388, 0.2538], or higher, $b = 0.06$, 95% CI [-0.4618, 0.8280], alcohol sensitivity did not demonstrate this significant indirect effect on ERN amplitudes.

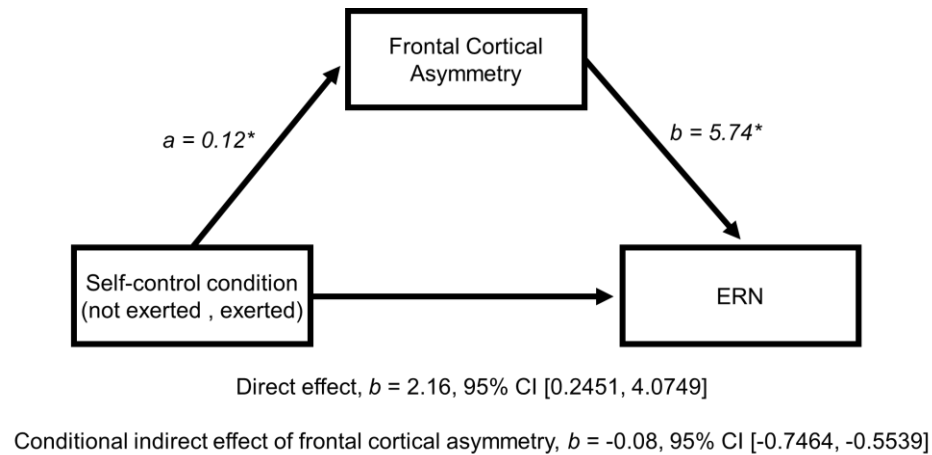


Figure 22. Model examining frontal cortical asymmetry as a mediator between self-control (not exerted, exerted) and ERN amplitudes following incorrect responses among participants with lower (-1SD) alcohol sensitivity. $*p < .05$

The moderated-mediation models examining alcohol sensitivity as a moderating variable between self-control condition and frontal cortical asymmetry was not significant in explaining N2 amplitudes, $b = -0.01$, 95% CI [-1.3959, 1.3817]. Similarly, the moderated-mediation models examining alcohol sensitivity as a moderating variable between self-control condition and the LPP were not significant in explaining controlled processes, $b = -0.01$, 95% CI [-0.0627, 0.0222], ERN amplitudes, $b = -0.08$, 95% CI [-0.4718, 0.3294], or N2 amplitudes, $b = -0.11$, 95% CI [-0.5355, 0.1957]. Overall, these findings demonstrate partial support hypothesis 21.

Alcohol preferences. The moderated-mediation models examining alcohol preferences as a moderating variable between self-control conditions and frontal cortical asymmetry were not significant in explaining controlled processes, $b = -0.12$, 95% CI [-0.3350, 0.0069], ERN amplitudes, $b = 0.16$, 95% CI [1.1912, 1.4178], or N2 amplitudes, $b = 0.19$, 95% CI [-0.1509, 2.4704], inconsistent with hypothesis 22. Similarly, analyses

examining alcohol preferences moderating the relationship between self-control condition and the LPP were not significant in explaining controlled processes, $b = -0.07$, 95% CI [-0.2234, 0.0274], ERN amplitudes, $b = -0.42$, 95% CI [-3.0236, 0.3612], or N2 amplitudes, $b = -0.58$, 95% CI [-1.7835, 0.4322], contrary to hypothesis 22.

Discussion

Results indicated approach motivation, as assessed by frontal cortical asymmetries and the LPP, were not significantly different between those who exerted self-control and those who did not exert self-control. Further, requiring participants to exert self-control (or not) did not significantly interact with advertisement type (neutral vs. alcohol) for levels of approach motivation, inconsistent with predictions. This finding suggests that exerting self-control may not promote approach motivation, even if participants are viewing emotionally relevant stimuli such as alcohol-related cues. These findings are inconsistent with prior research demonstrating approach motivation increases after exertion of self-control (Schmeichel et al., 2010), but consistent with prior research which suggests shifts in motivation after exerting self-control may rely on individual differences and may not be universally promoted after prior exertion of self-control (Schmeichel et al., 2015). However, results indicated the LPP was greater while viewing alcohol compared to neutral advertisements, regardless of exertion of self-control, suggesting alcohol advertisements may have been more emotionally relevant compared to neutral advertisements. This assumption is consistent with prior work examining similar neural indices of motivation while viewing alcohol-related cues (i.e., P3; Bartholow et al., 2010). Based on these findings, whether frontal cortical asymmetries demonstrate

concurrent validity with the LPP is unclear since no differences in cortical asymmetries emerged between advertisement types (Poole & Gable, 2014).

While research has established reactivity to alcohol-related cues differ due to trait factors, such as alcohol dependence (Namkoong et al., 2004) and alcohol sensitivity (Bartholow et al., 2010), this experiment reports the effects of acute experiences (i.e., exerting self-control) on motivation toward alcohol-related cues. However, exertion of self-control did not influence neurophysiological indices of motivation toward alcohol advertisements as hypothesized, suggesting exertion of self-control may not necessarily promote approach toward alcohol-related cues. While past work suggests self-control is related to greater alcohol consumption (Muraven et al., 2002), it remains unclear whether this greater consumption may be due to shifts in motivation toward alcohol-related cues after exerting self-control. These initial findings are inconsistent with the process model of self-control, which suggests exerting self-control increases motivation toward rewarding cues (Inzlicht & Schmeichel, 2012; Schmeichel et al., 2010), such as alcohol-related cues among drinkers. Currently, evidence supporting the process model is mixed, with studies reporting overall increases in approach motivation after engaging in self-control (Schmeichel et al., 2010), while others report this change is dependent on individual differences (Schmeichel et al., 2015).

Results indicated alcohol-related individual differences interacted with self-control conditions in predicting approach motivation while viewing alcohol advertisements. These findings are consistent with research suggesting shifts in motivation after exerting self-control may rely on individual differences (Schmeichel et al., 2015). However, inconsistent with Schmeichel et al. (2015), trait approach motivation

did not significantly interact with exertion of self-control in predicting neurophysiological indices of approach motivation. However, alcohol-related individual differences, such as alcohol identity, coping drinking motives, and alcohol sensitivity, significantly predicted left over right frontal cortical activation among those required to exert self-control. This suggests participants at risk for hazardous alcohol use, such as those exhibiting greater implicit alcohol identification, greater motives to drink to cope with negative emotions, or lower sensitivity to the effects of alcohol, may exhibit greater approach toward alcohol-related cues after exerting self-control. While prior research has demonstrated the predictive validity of alcohol identity (Lindgren et al., 2016; Petzel & Casad, 2018), drinking motives (MacLean & Lecci, 2000; Read et al., 2003), and sensitivity (Schuckit & Smith, 2000; Schuckit et al., 2004) on alcohol use, the present research contributes to these literatures by demonstrating how these constructs influence motivations toward alcohol-related cues after exerting self-control.

While coping motives predicted greater motivation toward alcohol-related cues following exertion of self-control, enhancement drinking motives did not demonstrate this relationship as hypothesized. This may be due to coping motives' specific link to greater alcohol approach following negatively valenced experiences (e.g., exerting self-control) whereas enhancement motives are predictive of alcohol approach following positively valenced experiences (Birch et al., 2008; Ostafin & Brooks, 2010). Further inconsistent with hypotheses, alcohol preference did not significantly predict greater approach motivation toward alcohol after exertion of self-control. However, this may be due to the underrepresentation of hazardous alcohol preferences (beer, hard liquor) found in the sample (23.9%). The underrepresentation of hazardous alcohol preferences may be

explained by the similar underrepresentation of males in the sample (28.2%), who tend to prefer beer and liquor compared to females (Lindgren et al., 2012). Lastly, no hypothesized individual difference variables interacted with exertion of self-control in predicting the LPP, suggesting the LPP was similar between conditions regardless of self-control exertion and was not predicted by alcohol-related individual differences assessed in this study. These incongruent findings between frontal cortical asymmetries and the LPP further suggest these neurophysiological indices assess different motivational constructs and likely do not share concurrent validity with approach motivation as hypothesized (Poole & Gable, 2014).

Consistent with predictions, viewing alcohol advertisements after exerting self-control predicted deficits in controlled processes of racial bias. Whereas exerting self-control leads to general deficits in controlled processes (Govorun & Payne, 2006; Inzlicht & Gutsell, 2007), racial differences in controlled processes only emerge among participants higher in automatic processes of racial bias (Govorun & Payne, 2006). However, Govorun and Payne (2006) examined trait levels of automatic racial bias and did not experimentally manipulate these levels as in the present study (i.e., viewing alcohol advertisements). The manipulation of promoting automatic processes of racial bias is supported by the present findings demonstrating participants exhibited greater automatic processes following Black compared to White face primes, regardless of self-control condition, suggesting viewing alcohol advertisements prior to completing the WIT equally promoted automatic processes of racial bias across all conditions (Stepanova et al., 2012). This suggests prime-related information was promoted after viewing alcohol advertisements, particularly while responding following Black face

primes. However, those who exerted self-control may have been unable to inhibit the application of these promoted automatic processes, resulting in unsuccessful inhibition of racially biased responding or lower controlled processes of racial bias.

Participants who exerted self-control also demonstrated lower amplitudes of the ERN following incorrect responses compared to those who did not exert self-control, suggesting lower error detection. These results replicate previous findings of attenuated error detection following exertion of self-control (Inzlicht & Gutsell, 2007). However, no differences in N2 amplitudes emerged between self-control conditions, suggesting exerting self-control may not reduce conflict monitoring prior to responding (i.e., N2 amplitudes). While impaired error detection is associated with exerting self-control (Inzlicht & Gutsell, 2007; Wang & Yang, 2014), it is unclear whether changes in error detection are solely responsible for deficits in self-control or if earlier components of self-control (i.e., conflict monitoring) are responsible. No published research has examined the effects of exerting self-control on N2 amplitudes. The current findings suggest only error-detection, as indicated by attenuated ERN amplitudes, may be impacted following exertion of self-control.

Lastly, this study examined mechanistic models for impaired self-control of racial bias through an indirect effect of approach motivation, assessed by frontal cortical asymmetry and the LPP. These models were derived from the theoretical account of deficits in self-control posited by the process model (Inzlicht & Schmeichel, 2012), which argues exerting self-control shifts motivation toward rewarding cues which impacts subsequent self-control. Consistent with predictions, greater approach motivation as assessed by frontal cortical asymmetry predicted lower controlled processes of racial

bias and ERN amplitudes. However, the LPP was not predictive of any self-control outcomes, further demonstrating differences in the constructs assessed between frontal cortical asymmetry and the LPP. Inconsistent with predictions, but in line with previous findings already discussed, neither approach motivation assessed by frontal cortical asymmetry or the LPP significantly mediated the relation between self-control conditions and related outcomes (controlled processes, ERN, N2).

However, among individuals with greater implicit alcohol identity, higher coping drinking motives, and lower alcohol sensitivity, moderated-mediation models indicated approach motivation assessed by frontal cortical asymmetries mediated the relationship between self-control conditions and deficits in controlled processes of racial bias and attenuated ERN amplitudes. Overall, this suggests exertion of self-control may not lead to greater approach motivation toward alcohol which would subsequently impair self-control. However, shifts toward alcohol approach following exertion of self-control and subsequent impairment of self-control may be more likely among individuals at greater risk for hazardous alcohol use. These findings suggest approach motivation, as measured by cortical asymmetry, may be a potential mechanism of subsequent deficits in self-control, but these shifts toward greater alcohol-related approach motivation are reliant on alcohol-related individual differences, consistent with prior research (Schmeichel et al., 2015).

Limitations

Although results provide novel contributions to the literatures on self-control, alcohol-related cues, and racial bias, there are several limitations in the design. The ecological validity is limited due to the manipulation of self-control (writing task) and

exposure to advertisements (structured advertisement viewing task). While participants are likely to exhibit impaired self-control capacity by other means (e.g., long day of work; Heatherton & Baumeister, 1996; Muraven et al., 2005), the current manipulation may not generalize to typical states of mental exhaustion. Further, exposure to advertisements in a controlled lab setting may not generalize to typical everyday viewing of advertisements (e.g., a billboard on the highway or television commercial). Another limitation is the lack of a control group that did not view alcohol advertisements. While it is assumed that automatic racial bias was equally promoted after viewing alcohol-related cues (Stepanova et al., 2012), the current design does not have a control group to ensure that automatic racial bias is greater among participants following the advertisement viewing task. Further, there was not an equal distribution of participants between non-hazardous (wine, mixed drinks) and hazardous (beer, hard liquor) alcohol preferences, which may have hindered analyses regarding the moderating effects of alcohol preference. Despite these limitations, the present study provides several novel contributions to science, advances theories of on self-control, and has implications for future research and interventions.

Implications

The results provide partial support for the process model of self-control (Inzlicht & Schmeichel, 2012) and a potential mechanism (i.e., approach motivation) for greater expressions of racial bias and impaired self-control, particularly among those at risk for hazardous alcohol use. While acute exertion of self-control is unlikely to be experienced in an ecologically valid setting, similar states of mental fatigue are commonly experienced due to extensive self-control throughout the day (Muraven et al., 2005).

Further, alcohol-related cues are prevalent and are viewed daily (e.g., billboards, magazine advertisements, television commercials). The present study demonstrates mere exposure to these advertisements during states of mental exhaustion (i.e., after exerting self-control) may lead to greater expressions of racial bias, particularly through deficits in controlled process and attenuated error detection (i.e., ERN amplitudes). Additionally, research suggests after severe depletion, motivationally relevant stimuli may further impair self-control (Vohs et al., 2012). Supporting this argument, the current findings suggest viewing motivationally relevant stimuli (i.e., alcohol advertisements) following exertion of self-control promotes approach motivation among those already at risk for greater alcohol use which then subsequently predicts impaired self-control.

These findings may inform interventions to reduce negative outcomes associated with deficits in self-control. For example, unimpaired self-control is an indicator of safe driving (Gwyther & Holland, 2012). The current study suggests viewing alcohol advertisements may subsequently impair self-control of behavior after prior exertion of self-control, which has implications for public policy regarding the use of alcohol advertisements near high traffic roads and highways. Further, results suggest viewing alcohol advertisements after exerting self-control impairs controlled processes of racial bias, which has implications for the influence of alcohol-related cues on intergroup relationships.

The findings regarding alcohol-related individual differences, particularly implicit alcohol identity, coping drinking motives, and alcohol sensitivity, may help identify individuals who are more susceptible to greater motivation toward alcohol-related cues after exerting self-control. Individuals higher in alcohol identity and lower in sensitivity

have a greater likelihood to develop an AUD and engage in risky alcohol use (Lindgren et al., 2016; Schuckit et al., 2004). Further, individuals higher in coping motives for drinking are more likely to engage in risky alcohol use compared to their socially motivated peers (Dey et al., 2013; Read et al., 2003). The current study extends this literature by demonstrating these risk factors contribute to greater shifts toward alcohol-related cues following exertion of self-control. These alcohol-related individual differences may help identify individuals who may be at risk for exhibiting greater approach toward alcohol-related cues during states of mental exhaustion.

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Measures Appendix

Behavioral Activation/Inhibition Scale

Adapted from:

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology*, 67, 319-333.

In this moment...

1. A person's family is the most important thing in life.
2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.
3. I go out of my way to get things I want.
4. When I'm doing well at something I love to keep at it.
5. I'm always willing to try something new if I think it will be fun.
6. How I dress is important to me.
7. When I get something I want, I feel excited and energized.
8. Criticism or scolding hurts me quite a bit.
9. When I want something I usually go all-out to get it.
10. I will often do things for no other reason than that they might be fun.

11. It's hard for me to find the time to do things such as get a haircut.
12. If I see a chance to get something I want I move on it right away.
13. I feel pretty worried or upset when I think or know somebody is angry at me.
14. When I see an opportunity for something I like I get excited right away.
15. I often act on the spur of the moment.
16. If I think something unpleasant is going to happen I usually get pretty "worked up."
17. I often wonder why people act the way they do.
18. When good things happen to me, it affects me strongly.
19. I feel worried when I think I have done poorly at something important.
20. I crave excitement and new sensations.

21. When I go after something I use a "no holds barred" approach.
22. I have very few fears compared to my friends.
23. It would excite me to win a contest.
24. I worry about making mistakes.

Implicit Alcohol Identity

Adapted from:

Lindgren, K. P., Neighbors, C., Teachman, B. A., Wiers, R. W., Westgate, E., & Greenwald, A. G. (2013). I drink therefore I am: Validating alcohol-related implicit association tests. *Psychology of Addictive Behaviors*, 27(1), 1-13.

Alcohol stimuli:



Task example:

Me
or
Alcohol

Others
or
Water



Alcohol Sensitivity Questionnaire

Adapted from:

Fleming, K. A., Bartholow, B. D., Hilgard, J., McCarthy, D. M., O'Neill, S. E., Steinley, D., & Sher, K. J. (2016). The alcohol sensitivity questionnaire: Evidence for

construct validity. *Alcoholism: Clinical and Experimental Research*, 40(4), 880-888.

1. Do you ever experience a hangover after drinking alcohol?
2. Do you ever pass out after drinking alcohol?
3. Do you ever throw up (vomit) after drinking alcohol?
4. Do you ever feel nauseated after drinking alcohol?
5. Do you ever forget part of an evening (i.e., blackouts) after drinking alcohol?
6. Do you ever feel dizzy or feel things spinning after drinking alcohol?
7. Do you ever become more talkative after drinking alcohol?
8. Do you ever become more flirtatious after drinking alcohol?
9. Do you ever feel high or “buzzed” after drinking alcohol?
10. Do you ever feel more socially at ease after drinking alcohol?
11. Do you ever feel more relaxed after drinking alcohol?
12. Do you ever feel sluggish after drinking alcohol?
13. Do you ever feel less inhibited after drinking alcohol?
14. Do you ever feel that your driving would be affected after drinking alcohol?
15. Do you ever feel sedated or sleepy after drinking alcohol?

Drinking Motives

Adapted from:

Cooper, M. L. (1994). Motivations for alcohol use among adolescents: Development and validation of a four-factor model. *Psychological Assessment*, 6(2), 117-128.

Listed below are 20 reasons people might be inclined to drink alcoholic beverages. Using the scale below, decide how frequently your own drinking is motivated by each of the reasons listed.

1. To forget your worries.
2. Because your friends pressure you to drink.
3. Because it helps you enjoy a party.
4. Because it helps you when you feel depressed or nervous.
5. To be sociable.
6. To cheer up when you are in a bad mood.
7. Because you like the feeling.
8. So that others won't kid you about not drinking
9. Because it's exciting.
10. To get high.
11. Because it makes social gatherings more fun.
12. To fit in with a group you like.
13. Because it gives you a pleasant feeling.
14. Because it improves parties and celebrations.
15. Because you feel more self confident and sure of yourself.
16. To celebrate a special occasion with friends.
17. To forget about your problems.

- 18. Because it's fun.
- 19. To be liked.
- 20. So you won't feel left out.

Advertisement Examples

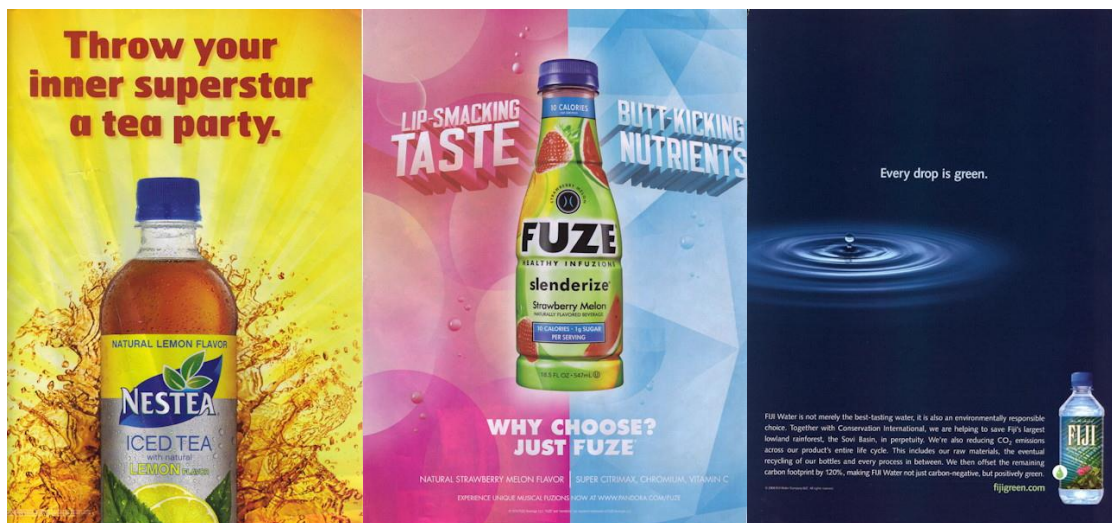
Adapted from:

Stepanova, E. V., Bartholow, B. D., Sauls, J. S., & Friedman, R. S. (2012). Alcohol-related cues promote automatic racial bias. *Journal of Experimental Social Psychology, 48*(4), 905-911.

Alcohol:



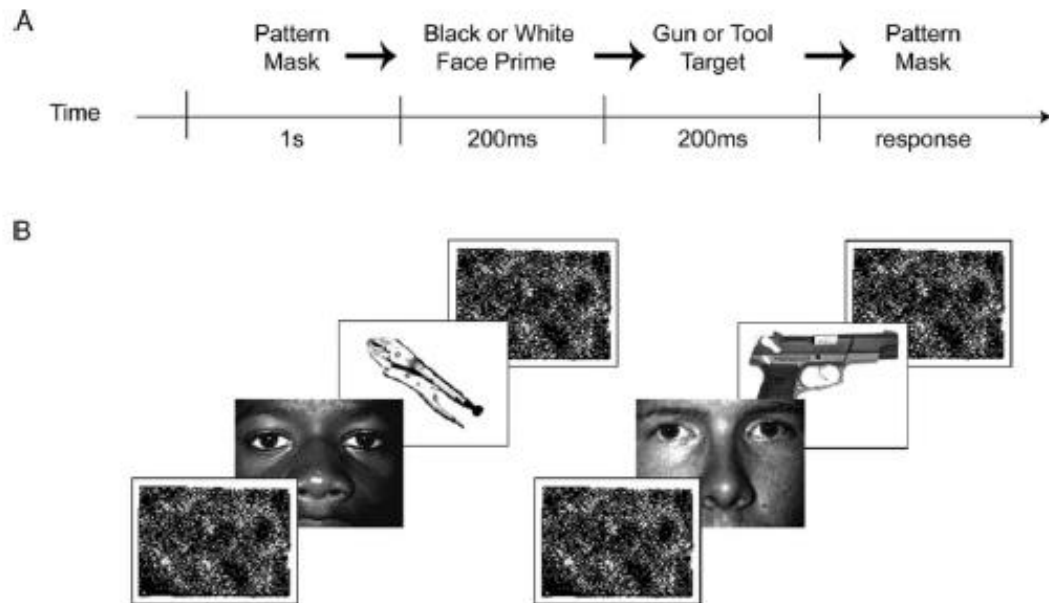
Non-Alcohol:



Weapon Identification Task

Adapted from:

Amodio, D. M., Kubota, J. T., Harmon-Jones, E., & Devine, P. G. (2006). Alternative mechanisms for regulating racial responses according to internal vs external cues. *Social Cognitive and Affective Neuroscience*, 1(1), 26-36.



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