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Identifying Component-Processes of Executive Functioning That Serve as Risk Factors for the Alcohol-Aggression Relation

Peter R. Giancola and Aaron J. Godlaski
University of Kentucky

Robert M. Roth
Dartmouth Medical School

The present investigation determined how different component-processes of executive functioning (EF) served as risk factors for intoxicated aggression. Participants were 512 (246 males and 266 females) healthy social drinkers between 21 and 35 years of age. EF was measured using the *Behavior Rating Inventory of Executive Function–Adult Version (BRIEF-A)* that assesses nine EF components. After the consumption of either an alcohol or a placebo beverage, participants were tested on a modified version of the *Taylor Aggression Paradigm* in which mild electric shocks were received from, and administered to, a fictitious opponent. Aggressive behavior was operationalized as the shock intensities and durations administered to the opponent. Although a general *BRIEF-A* EF construct consisting of all nine components predicted intoxicated aggression, the best predictor involved one termed the *Behavioral Regulation Index* that comprises component processes such as inhibition, emotional control, flexible thinking, and self-monitoring.

Keywords: alcohol, aggression, executive functioning, *BRIEF-A*, behavioral regulation

O God, that men should put an enemy in their mouths to steal away their brains! that we should, with joy, pleasance, revel, and applause, transform ourselves into beasts!

~*William Shakespeare, Othello*

The loss of cognitive, emotional, and behavioral control under the influence of alcohol clearly drives some individuals to commit thoughtless and damaging acts. Alcohol intoxication is involved in 55 to 60% of violent crimes (U.S. Department of Justice, 2005). Alcohol is implicated in the majority of perpetrators of sexual assaults and is involved in a higher percentage of aggravated versus simple assaults in the general population (Maston, 2010). Similar relations are also observed in alcohol-related crime among college students (Baum & Klaus, 2005).

It is well accepted that alcohol increases the propensity for aggression in some, but not all persons, and that the process by which this occurs is driven largely by what trait factors place a person at heightened risk for such behavior (Collins, 1988; Fishbein, 2003). Findings from several meta-analytic studies show that alcohol has a "medium" effect size (d = 0.49 to 0.61) on aggression (Bushman & Cooper, 1990; Hull & Bond, 1986; Ito, Miller, & Pollock, 1996). However, it has also been hypothesized that alcohol's true effect on aggression may be obfuscated by a failure to in take into account key moderating trait risk factors (Giancola, Josephs, Parrott, & Duke, 2010).

Executive Functioning

While a number of variables have been found to moderate the alcohol-aggression relation (e.g., Berman, Bradley, Fanning, & McCloskey, 2009; Giancola, 2004), the lack of consensus in defining and conceptualizing executive function (EF), has made it a risk factor of special interest. Most theorists would agree that EF is a complex cognitive construct involved in planning, initiation, and self-regulation of goal-directed behavior (Goldberg, 2001; Mesulam, 2002); in other words, the conscious control of thought and action. Abilities that fall under the rubric of EF include strategic planning, abstract reasoning, set-shifting (i.e., flexible thinking), organization and manipulation of information in working memory, decision-making, problem-solving, behavioral inhibition, emotional regulation, as well as self- and task-monitoring (Alexander & Stuss, 2006; Bechara & Van Der Linden, 2005).

The empirical structure of the skills that comprise EF, and how they relate to one another, varies depending on one's conceptualization of the construct, which then dictates how it will be measured. Conceptually, EF can be appreciated as a relatively unified whole (Duncan et al., 2000; Zelazo, Carter, Reznick, & Frye, 1997) or as a set of distinct components (Baddeley & Logie, 1999; Shallice, 2002). Accordingly, some empirical studies have found EF to be best understood as a unitary general construct (Giancola, 2004; Giancola, Mezzich, & Tarter, 1998) while others have found that it better conforms to a set of fractionated components that still share a significant underlying commonality (Lehto, Juujarvi, Kooistra, & Pullkinen, 2003; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000).

While fully appreciating the aforementioned issues, Bates (2000) argued that viewing EF as a set of related component-processes could improve our understanding of the construct. Such

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Peter R. Giancola and Aaron J. Godlaski, Department of Psychology, University of Kentucky; Robert M. Roth, Neuropsychology Program and Brain Imaging Laboratory, Department of Psychiatry, Dartmouth Medical School.

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Correspondence concerning this article should be addressed to Peter R. Giancola, Department of Psychology, University of Kentucky, 115 Kastle Hall, Lexington, KY 40506-0044. E-mail: giancola.uky@gmail.com

a view would allow for the advancement of theoretically supported predictions regarding how particular EF components might differentially relate to, or predict, specific behavioral outcomes. Related to this line of thinking, a recent conceptualization of EF divided the construct into two categories termed "cool" and "hot" (Séguin, Arseneault, & Tremblay, 2007; Zelazo & Müller, 2002). Cool EF skills are considered to be more "cerebral" or metacognitive in nature, are more likely to be utilized in abstract decontextualized reasoning, and have been argued to be governed by the dorsolateral prefrontal cortex (Metcalfe & Mischel, 1999; Zelazo & Müller, 2002). More specifically, cool EFs include problem-solving abilities that require the capacity to represent a dilemma, maintain and organize related information in working memory, strategically plan and execute a response, evaluate the efficacy of the solution, and make necessary changes based on the outcome (Séguin et al., 2007; Zelazo et al., 1997). In contrast, hot EF has been described as being primarily governed by the ventromedial prefrontal cortex, which is closely connected to the limbic system, and is more strongly involved with the regulation of affective and motivational processes (Zelazo & Müller, 2002). Furthermore, hot EF is associated with an increased sensitivity to environmental cues of punishment as well as quick visceral responses pursuant to oncoming danger such as a hostile provocation (Séguin et al., 2007). Deficits in hot EF have also been reported to be more closely related to impairments in social and emotional functioning than cool EF (Hongwanishkul, Happaney, Lee, & Zelazo, 2005). Impaired hot EF may contribute to aggression by reducing one's ability to monitor the self and the situation for what are considered to be acceptable social behaviors, regulate emotional responses, and inhibit impulsive reactions.

Increasingly complex social-information processing related to behavioral responses requires time and progressively more elaborate decontextualized problem-solving abilities that are attributed to cool EF (Zelazo & Cunningham, 2007). However, before these and other related cognitive skills can begin to be enacted, the ability to control emotional reactions and inhibit basic behavioral impulses is required first (Barkley, 1997; Sonuga-Barke, Dalen, Daley, & Remington, 2002). Accordingly, hot EF components such as inhibitory control and emotional self-regulation may be considered to be temporally antecedent to cool components such as strategic planning and abstract problem-solving. If hot regulation represents the first-line of defense in controlled responding to aggression-eliciting provocation; then, understanding the role of behavioral and emotional regulation in alcohol-related aggression becomes of particular importance in predicting who will become aggressive under the influence of alcohol.

EF and Aggression

The relation between poor EF and increased aggression are documented in a wealth of studies (reviewed in Giancola, 1995; Hawkins & Trobst, 2000; Moffitt, 1993; Morgan & Lilienfeld, 2000). A number of these reports implicate emotional and behavioral regulation deficits in aggressive behavior in varied populations from healthy children (Ellis, Weiss, & Lochman, 2009; Raaijmakers et al., 2008) to violent offenders (Hoaken, Allaby, & Earle, 2007; Raine & Yang, 2006). In this sense, hot EF functions as a "gate-keeper," controlling emotional and behavioral reactions to the environment and is considered a moderator of, or risk factor for, violence. Accordingly, when exposed to hostile provocation, an individual with intact EF is capable of fully appraising their situation, inhibiting the immediate emotional responses to retaliate, and then behaving in a socially adaptive manner (unless violence is necessary for valid reasons of defense). However, if this same person possesses limited EF capacities, s/he will have difficulty controlling their emotional responses and inhibiting their impulses to retaliate in an aggressive manner that will then make it significantly less likely that they will engage in the more cool abstract reasoning/problem-solving aspects of EF.

Measuring EF With the *BRIEF-A*

The *Behavior Rating Inventory of Executive Function–Adult Version (BRIEF-A*; Roth, Isquith, & Gioia, 2005) is a self-report inventory that assesses a variety of EFs utilized in everyday life. The measure provides a global score reflecting an individual's overall level of EF, termed the *Global Executive Composite* (GEC), as well as two factors reflecting higher-order cognitive regulation (i.e., *Metacognition Index*; *MI*) and behavioral-emotional regulation (i.e., *Behavioral Regulation Index*; *BRI*). Although the latter two indices are moderately correlated with one another, they are better understood as two distinct, yet related, components of EF (Gioia, Isquith, Retzlaff, & Espy, 2002; Roth et al., 2005).

The MI appears to reflect largely what has been described as cool EF; assessing one's ability to independently initiate tasks, organize, and manipulate information in working memory, monitor task performance for accuracy, as well as engage in strategic planning and problem-solving (Roth et al., 2005). In contrast, the BRI comprises skills that generally fall under the rubric of hot EF such as the ability to properly regulate behavioral and emotional impulses, inhibit inappropriate thoughts and actions, actively shift/alter maladaptive problem-solving strategies (i.e., flexible thinking), and monitor the effects of one's behaviors on others (Hongwanishkul et al., 2005; Séguin, Arseneault, Boulerice, Harden, & Tremblay, 2002; Zelazo & Cunningham, 2007). Without the ability to emotionally regulate behavior (i.e., poor hot EF), the enactment of cool EF propensities such as strategic planning and abstract problem-solving become significantly less accessible (Zelazo & Cunningham, 2007), and may be less predictive of aggression than hot EF. As the BRI reflects aspects of hot EF while the MI reflects aspects of cool EF, the *BRIEF-A* has the potential to be a highly useful tool to understand the relation between different component-processes of EF in relation to aggression; an endeavor never attempted before this investigation.

EF, Alcohol, and Aggression

EF governs the same cognitive, emotional, and behavioral regulatory capacities that alcohol is purported to disrupt (reviewed in Giancola, 2000). Hence, possessing limited EF coupled with alcohol's disinhibitory effects should engender greater aggression. Giancola (2004) supported this hypothesis by demonstrating that EF, measured by an array of performance-based neuropsychological tests, was a risk factor for intoxicated aggression in a laboratory setting. Specifically, alcohol intoxication was significantly more likely to increase aggression in persons with lower, rather than higher, EF. However, Giancola's battery was not designed to examine more refined cognitive components of EF.

Thus, the purpose of the present investigation is to build upon Giancola's (2004) research. Unlike Giancola's previous experiment, we will use the *BRIEF-A* as our measure of EF because it is capable of assessing a variety of EFs. As noted above, this will afford us the advantage of testing the role of separate EF components in relation to intoxicated aggression in a way never done before. Consistent with Giancola's first experiment, we too hypothesize that a general EF score (i.e., the GEC index) will moderate the alcohol-aggression relation. While the GEC is a broad measure of EF, it simply represents a composite of the *BRIEF-A*s two major indices: the BRI and MI. As such, solely using the GEC would cloud, and limit, the potential explanatory power of our results by reducing our ability to differentiate between the theoretically important components of behavioral/emotional regulation (i.e., BRI) and metacognition (i.e., MI) in the prediction of intoxicated aggression. Consequently, we will advance Giancola's findings by making the more significant prediction that the alcohol-aggression relation will be moderated by hot EF, as reflected by the *BRIEF-A* BRI, but *not* by cool EF, as reflected by the MI. These predictions are based on our theoretical conceptualizations of hot and cool EF in addition to the fact that intoxicated persons with deficits in hot EF will have less access to EFs aggression-inhibiting components, such as behavioral and emotional regulation that are required to inhibit an immediate violent reaction to provocation.

Method

Participants

Participants were 512 (246 males and 266 females) healthy social drinkers between 21 and 35 years of age ($M = 23.08$; $SD = 2.93$) recruited from the greater Lexington, KY, area through newspaper advertisements and fliers. This is an entirely different sample than that used in Giancola (2004) and Godlaski and Giancola (2009) that utilized performance-based neuropsychological tests and not the self-report *BRIEF-A* instrument. Moreover, the present investigation did not utilize any neuropsychological measures. Social drinking was defined as consuming at least 3–4 drinks per occasion at least twice per month. The racial composition of the sample was 87% White, 10% African American, 1% Hispanic, and 2% Other. Most participants (92%) had never married, had an average of 16 years of education, and had an average household income of $61,000.

Inclusion and Exclusion Criteria

Respondents were initially screened by telephone. However, during the laboratory session, individuals reporting any past or present drug- or alcohol-related problems, contraindications to alcohol consumption, serious head injuries, learning disabilities, or serious psychiatric symptoms were excluded from participation. Regarding drinking problems, persons scoring an "8" or more on the *Short Michigan Alcoholism Screening Test* (Selzer, Vinokur, & van Rooijen, 1975) were also excluded. Less than 1.5% of respondents had to be excluded because of self-reported drug or alcohol-related problems. Anyone with a positive breath alcohol concentration (BrAC) test or with a positive urine pregnancy/drug test result (i.e., cocaine, marijuana, morphine, amphetamines, benzodiazepines, and barbiturates) upon arrival at the laboratory were not allowed to participate (less than 1%). Women were not tested between 1 week before menstruation and the beginning of menstruation because hormonal variations associated with menstruation can affect aggressive responding (Volavka, 1995). Participants abstained from alcohol for 24 hr, from caffeinated beverages the day of the study, and from food for 4 hr before consuming beverages.

Assessment of EF

Demographic data were then collected. Participants completed the *BRIEF-A* (Roth et al., 2005) in addition to a number of other self-report inventories not pertinent to this experiment. The *BRIEF-A* is a 75-item questionnaire designed to gauge the integrity of EF component processes that are utilized in everyday life (Roth et al., 2005). As indicated above, the inventory yields an overall score (*GEC*), that is a composite of two index scores (the *BRI* and the *MI*). The BRI is comprised of four scales (i.e., *Inhibit*, *Shift*, *Emotional Control*, and *Self Monitor*) and the MI is comprised of five scales (i.e., *Initiate*, *Working Memory*, *Plan/Organize*, *Task Monitor*, and *Organization of Materials*) reflecting a variety of processes commonly considered to be key components of EF. Higher scores reflect greater difficulty with EF. Three validity scales are also included and referred to as Negativity, Infrequency and Inconsistency. No participants had to be excluded because of deviations on these scales. The *BRIEF-A* was standardized on 1,050 adults sampled to approximate the 2002 U.S. census proportions with respect to sociodemographic characteristics. The measure has excellent internal consistency (Cronbach's alpha coefficients ranging from .93 to .96 for the three major indices) and 1-month test–retest reliabilities (ranging from $r = .93$ to .94 for the three major indices) (Roth et al., 2005). Support for the convergent and discriminant validity of the *BRIEF-A* has been reported (Roth et al., 2005). In the current sample, α coefficients for the nine individual subscales ranged from .69 to .89 with a mean of .77, which are consistent with the standardization sample. In our sample, the BRI, MI, and GEC had α coefficients of .89, .94, and .95, respectively. Table 1 presents the means and the standard deviations separated by men and women. Table 2 summarizes the correlations between the *BRIEF-A*s individual subscales and composite indices for this specific experimental sample.

The *BRIEF-A* was selected as our measure of EF based on a number of considerations: (1) It contains a number of subscales that correspond well with established EF component processes that have been argued should be examined in relation to aggressive behavior (Bates, 2000); (2) it assesses the subjective integrity of EF that has been argued to potentially offer greater ecological validity than, or at least complement, traditional performance-based neuropsychological measures of EF (Gioia & Isquith, 2004); and (3) it is also very time-efficient to complete (10–15 min to complete) compared with a full neuropsychological battery.

Procedure

Participants were told that the investigation concerned the effects of alcohol and personality on reaction time in a competitive situation and that they were about to compete against a person of the same gender in an adjacent room on a reaction time task. Instructions for the task were given as participants began drinking their beverages. Men and women were randomly assigned into alcohol and placebo beverage groups. Regardless of beverage group assignment, all participants were informed that their opponent was intoxicated. This was done to ensure that the "drinking status" of the opponent would not confound any potential beverage group differences in aggression. Because of gender differences in body fat composition and alcohol metabolism (Watson, Watson, & Batt, 1981), men and women were given different alcohol doses. Men received 1 g/kg of 95% alcohol USP mixed at a 1:5 ratio with Tropicana orange juice, whereas women received 0.90 g/kg of alcohol. The placebo beverages contained 4 ml of alcohol in the juice and 4 ml layered on top of the juice. In addition, the rims of the glasses were sprayed with alcohol just before being served. All participants were told that they would consume the equivalent of 3–4 mixed drinks. Participants were given 20 min to consume their beverages. No participant experienced any adverse effects because of alcohol consumption.

Next, participants' pain tolerances to electric shock were assessed with electrodes attached to two fingertips with Velcro straps. The experimenter gradually increased the level of shock until participants reported it became "painful." Shocks ranged from "Level 1" to "Level 10." Level 10 was described as "painful," Level 9 was 95% of the "painful" level, Level 8 was 90% of the "painful" level, and so on. Levels 1, 5, and 10 were labeled as "Low," "Medium," and "High" shock, respectively.

To measure aggression, participants competed against a fictitious opponent of the same gender on an ostensible reaction time task to determine who could respond more quickly on a computer keyboard prompted by messages on the computer screen; with the winner delivering an electric shock to the loser (Taylor, 1967). Winners were able to control the losers' suffering by varying the intensity and duration of the selected shocks. The task consisted of 34 trials. After each trial, shock intensities set by the participant and the "opponent" were displayed on the computer screen. Participants won half of the trials (randomly determined). The aggression score was calculated by transforming each corresponding shock intensity and duration value into z-scores and then summing them across the 17 winning trials. This was done to increase the reliability of both indices as a meta-analytic investigation demonstrated that shock intensity and duration are significantly related to one another and are considered to be part of a more general construct of aggression (Carlson, Marcus-Newhall, & Miller, 1989). Basically, within the ethical limits of the laboratory, participants controlled a weapon that could be used to give their partner electrical shocks. As such, this task has excellent validity, on a number of different levels, and has been used for decades as a laboratory measure of aggression for men and women (for review see Giancola & Chermack, 1998). To ensure safety and to protect the integrity of the study, the experimenter secretly viewed and heard the participants through a hidden video camera and microphone.

BrAC levels were measured using the Alco-Sensor IV breath analyzer (Intoximeters Inc., St. Louis, MO), at baseline, immediately before, and immediately after the aggression task. The aggression task began at a BrAC as close as possible to 0.09% on the ascending limb of the BrAC curve as research has shown that aggression is more likely to be observed at this time, when persons are feeling more energized and impulsive rather than when blood alcohol levels are falling which is when feelings of sedation, fatigue, and confusion tend to predominate (Giancola & Zeichner, 1997; Martin, Earleywine, Musty, Perrine, & Swift, 1993). We chose a rising BrAC of 0.09% because both field (e.g., Graham, Osgood, Wells, & Stockwell, 2006; Phillips et al., 2007) and laboratory studies (reviewed in Duke, Giancola, Morris, Holt, & Gunn, 2011) clearly indicate a close relation between higher BrACs and increased aggression.

To enhance the effectiveness of the placebo manipulation, participants in the placebo group began the aggression task approximately 2 min after beverage consumption (e.g., Martin & Sayette, 1993). Given that our alcohol dose produces BrACs around 0.11%, a double-blind procedure would not have been feasible. When attempts are made at disguising a beverage's alcoholic content (using the alcohol dose proposed in this study), participants typically know that they have consumed alcohol (reviewed in Martin & Sayette, 1993) thus uncovering the attempt to keep them blind. Further, given alcohol's distinct odor, the highly visible effects of alcohol intoxication, and participants' frequent comments that they are "drunk," the experimenter would also be aware of the participant's drinking status. For these reasons, double-blind procedures are typically not used in alcohol and aggression research (Bushman & Cooper, 1990).

Immediately before and after the aggression task, participants rated how drunk they were (0 = *not drunk at all* to 11 = *more drunk than I have ever been*) and after the aggression task they also rated how impaired they were (0 = *no impairment* to 10 = *strong impairment*). Participants were also asked whether they believed they had consumed alcohol (No or Yes). Finally, they were debriefed. Individuals who received alcohol remained in the laboratory until their BrAC dropped to 0.04%. Although discharging participants at a BrAC of 0.04% might be considered somewhat high, we followed NIAAA (2005) guidelines that state that participants can be discharged from a laboratory if the risk of danger is determined to not be physically hazardous. In our case, discharge was clearly nonhazardous especially because participants had to be transported home in a prepaid taxi or they had to arrange for someone to drive them home (the experimenter visually confirmed this event) and they had to pass a field sobriety test and report feeling "comfortable" and "in control." Regarding the field sobriety test, all participants were given this test upon entering the laboratory in the sober state. They were then given the same test when they reach a descending BrAC of 0.04%. Participants only "passed" the test if their score was better or the same as when they entered the laboratory. Finally, before exiting the laboratory, participants also had to sign a form attesting to the fact that they would not drive a motor vehicle nor operate any heavy machinery until the next morning.

Results

Manipulation Checks

Aggression task checks. To verify the success of the aggression task deception, participants were administered a posttask interview in which they were asked a number of questions about their subjective perceptions about their opponent, such as whether he or she tried hard to win, whether they thought the task was a good measure of reaction time, and how well they believed they performed on the task. The deception manipulation appeared successful. Many participants called their opponent vulgar and profane names, or gave their opponent the middle finger, during the task. Ultimately, participants were asked if their believed that they were competing against a real person. Less than 1% of participants provided responses indicating that they should be removed from the investigation. Previous research has shown that this task provides a valid and reliable laboratory measure of aggression (e.g., Giancola & Parrott, 2008). In approximately 20 years of conducting such research, including this investigation, the lead author has found that it was extremely rare ($<1\%$) that participants admitted to being aware of the underlying purpose of his experiments. This statement is supported by empirical data from a recent meta-analytic analysis demonstrating that people are generally incapable of correctly judging deception in research studies (Bond & DePaulo, 2008). Moreover, a seminal article by Berkowitz and Donnerstein (1982) noted that "*there is not as much awareness of the research hypothesis in many experiments as the critics have claimed*" (p. 250).

Placebo checks. All participants in the placebo group indicated that they believed that they drank alcohol. With regard to the question regarding how drunk they felt, persons in the alcohol group reported mean pre- and posttask ratings of 4.7 and 5.1 (scale range: 0 to 11) and those in the placebo group reported mean pre- and posttask ratings of 1.8 and 1.9, respectively, [pretask ratings: $t(508) = -20.5$, $p < .05$; posttask ratings: $t(510) = -19.9$, $p < .05$]. With regard to the question about whether the alcohol they drank caused any impairment, persons in the alcohol group reported an average rating of 5.6 and those in the placebo group reported an average rating of 2.1, $t(510) = -19.56$, $p < .05$, (scale range: 0 to 10) indicating that persons in the placebo group did in fact believe that they consumed alcohol. Given the alcohol dose used in this investigation, it is impossible to expect that subjective feelings of intoxication can be equated between the alcohol and placebo groups, especially when dealing with experienced drinkers. As such, it has been pointed out by Martin and Sayette (1993), in an authoritative review on the topic of placebo manipulations, that the success of a placebo manipulation is reflected by the fact that persons believed that they consumed alcohol that is considered, in and of itself, to be enough to activate any behavioral effects that alcohol has been consumed (Vogel-Sprott & Fillmore, 1999). Thus, according to this well accepted guideline in the alcohol administration research literature, our placebo manipulation is considered valid and effective.

BrAC levels. All participants tested in this study had BrACs of 0% upon entering the laboratory. Individuals in the alcohol group had a mean BrAC of 0.095% ($SD = 0.011$) just before beginning the aggression task and a mean BrAC of 0.105% ($SD = 0.015$) immediately after the task. Persons given the placebo had a mean BrAC of 0.015% ($SD = 0.011$) just before the aggression task and a mean BrAC of 0.007% ($SD = 0.007$) immediately after the task. There were no gender differences in mean BrACs either before (men = .094%; women = .096%) or after (men = .103%; women = .106%) the task.

Gender Differences

There were no significant gender differences on the demographic variables of age, years of education, and yearly salary. Gender differences for the *BRIEF-A* are presented in Table 1. Gender was associated with the Emotional Control and Working Memory scales, but not with any other scale, index score, or the GEC. These findings are consistent with the original *BRIEF-A* standardization sample that showed minimal gender differences (Roth et al., 2005).

Table 1
Gender Differences for the BRIEF-A Scales

	Males		Females	
Measure	*M*	*SD*	*M*	*SD*
Inhibit	1.64	0.34	1.59	0.36
Shift	1.38	0.34	1.43	0.34
Emotional Control	1.35	0.38	1.47	0.40*
Self-Monitor	1.48	0.37	1.45	0.36
Initiate	1.52	0.35	1.49	0.34
Working Memory	1.43	0.36	1.51	0.37*
Plan/Organize	1.46	0.35	1.43	0.32
Task Monitor	1.54	0.36	1.54	0.36
Organization of Materials	1.57	0.46	1.63	0.52
Behavioral Regulation Index	1.46	0.29	1.49	0.26
Metacognition Index	1.51	0.31	1.52	0.31
Global Executive Component	1.49	0.28	1.51	0.26

Note. *Behavioral Regulation Index* represents a combination of the following subscales: Inhibit, Shift, Emotional Control, and Self-Monitor; the *Metacognition Index* represents a combination of the following subscales: Initiate, Working Memory, Plan/Organize, Task Monitor, and Organization of Materials; and the *Global Executive Component* represents a total combination of all subscales.
* $p < .05$.

Regression Analyses

The principal aim of this investigation was to determine whether specific components of EF, as measured by the *BRIEF-A*, would moderate the alcohol-aggression relation. Given that the *BRIEF-A* scores were continuous in nature, regression analyses were indicated. Values from the EF variable were first converted into *z*-scores therefore centering them as recommended by Aiken and West (1991). Beverage and gender groups were dummy-coded following the procedures outlined in Cohen, Cohen, West, and Aiken (2003). Interaction terms were calculated by obtaining the cross-products of pertinent first-order variables. It is important to create interaction terms using *z*-scores rather than raw scores inasmuch as standardizing cross-products after they have already been created does not yield the same regression coefficients as multiplying standardized values (Aiken & West, 1991; Friedrich, 1982). Standardizing the first-order variables also automatically centers the values (i.e., deviation scores with a mean of zero) that reduces multicollinearity between interaction terms and their constituent lower-order terms (Aiken & West, 1991). When using this procedure, it is important to interpret the unstandardized, and not the standardized, regression solution. Traditional standardized solutions should not be interpreted because they are not scale invariant for multiplicative terms and will thus yield incorrect regression coefficients for these effects. Thus, readers should be aware that the parameter estimates for the regression equations are reported as unstandardized *b*s. Variables were entered into the regression models in a hierarchical fashion. According to the procedures put forth in Aiken and West (1991), significant interaction terms were interpreted by plotting the effect and testing to determine whether the slopes of the simple regression lines (1 *SD* above and 1 *SD* below the overall mean) differed significantly from zero.

Table 2
Correlation Matrix of the BRIEF-A Scales

	1	2	3	4	5	6	7	8	9	10	11	12
1. BRF Inhibit		.34	.41	.56	.43	.62	.48	.53	.36	.58	.75	.72
2. BRF Shift			.50	.41	.50	.50	.50	.47	.25	.53	.73	.67
3. BRF Emotional Control				.44	.34	.43	.35	.33	.26	.42	.78	.63
4. BRF Self-Monitor					.36	.43	.50	.48	.20	.46	.79	.65
5. BRF Initiate						.61	.69	.66	.46	.82	.53	.77
6. BRF Working Memory							.66	.66	.42	.80	.64	.81
7. BRF Plan/Organize								.72	.57	.88	.59	.83
8. BRF Task Monitor									.49	.85	.59	.81
9. BRF Organization of Materials										.76	.35	.65
10. BRF MI Composite											.67	.94
11. BRF BRI Composite												.87
12. BRF GEC Composite												

Note. All correlations are significant at $p < .001$ with a sample size of 512.

Aggression Analyses

***BRIEF-A* GEC.** As summarized in Table 3, the first step of the model containing only the main effects was significant, $F(3, 508) = 23.45$, $p < .001$; $R^2 = .12$. These analyses revealed that alcohol significantly increased aggression compared with placebo ($b = -.49$, $p < .001$), that men were significantly more aggressive than women ($b = -.73$, $p < .001$), and that the GEC variable was related to aggression ($b = .11$, $p = .05$). The second step of model was also significant, $F(6, 505) = 14.10$, $p < .001$; $R^2 = .14$. Here, the GEC × Beverage ($b = -.29$, $p < .02$) and Beverage × Gender ($b = .47$, $p < .03$) interactions were the only two significant two-way effects. The increment in R^2 from Step 1 was .02, $p < .01$. When the GEC × Beverage interaction was probed, it revealed a positive relation between GEC and aggression in the alcohol group (simple slope $b = .21$; $t = 2.24$, $p < .05$), but not in the placebo group (simple slope $b = .02$; $t = 0.34$, $p = .74$). Decomposition of the Beverage × Gender interaction indicated that alcohol significantly increased aggression for both genders, but to a greater extent in men, $t(244) = -3.90$, $p < .01$ than in women, $t(264) = -2.39$, $p < .01$ (see Giancola et al., 2009). The three-way interaction in the three-step model was not significant and was thus not probed. Given that these data are derived from a larger dataset, a more complete description of these gender differences is presented in Giancola et al. (2009).

Table 3
Regression Equations Relating Beverage, Gender, and BRIEF-A GEC Variables With Responses on the Physical Aggression Task

Step and measure	R^2	ΔR^2	F for Δ in R^2	Final *b*s
Step 1				
Beverage	0.12	0.12	23.45***	−0.49***
Gender				−0.73***
GEC				0.11
Step 2				
Beverage	0.14	0.02	4.30**	−0.75***
Gender				−1.00***
GEC				0.39***
Gender × Beverage				0.47*
Beverage × GEC				−0.29*
Gender × GEC				−0.20

Note. Step 3: No significant three-way effect. ΔR^2 = change in R^2.
* $p < .05$. ** $p < .01$. *** $p < .001$.

***BRIEF-A* BRI and MI.** Following analyzing the total *BRIEF-A* score (GEC) above, the theory upon which this article rests, by definition, *requires* that we test a theoretically based component-process model whereby the BRI and MI scores are examined in a comprehensive four-way model that includes gender and beverage. As can be seen in Table 4, the first step of the model containing only the main effects was significant, $F(4, 507) = 19.97$, $p < .001$; $R^2 = .136$. These analyses revealed that alcohol significantly increased aggression compared with placebo ($b = -.50$, $p < .001$), men were significantly more aggressive than women ($b = -.74$, $p < .001$), greater BRI scores were significantly related to increased aggression, ($b = .24$, $p < .002$), and, as expected, the MI scores were *not* significantly related to aggression (in fact, the relation was even in the wrong direction) ($b = -.11$, $p = ns$). The second step of the model was also significant, $F(10, 501) = 9.60$, $p < .001$; $R^2 = .16$. The increment in R^2 from Step 1 was .024, $p < .05$). However, here, the BRI × Beverage was the only significant two-way effect ($b = -.26$, $p < .05$). This indicates that our hypotheses were confirmed such that when all component-processes are considered together, the BRI is the most important risk factor for intoxicated aggression across both men and women. When the BRI × Beverage interaction was probed, it revealed a clearly significant positive relation between BRI and aggression in the alcohol group, (simple slope $b = .31$, $p < .001$) but not in the placebo group (simple slope $b = .05$, $p = .52$) (see Figure 1). The three- and four-way interactions in the model were not significant and thus were not further probed (see Aiken & West, 1991; Friedrich, 1982).[1]

[1] Given that we predicted that the BRI, and not the MI, would moderate the alcohol-aggression relation, we thought it valuable to attempt to isolate any components of the BRI that are most predictive of the observed effect (i.e., intoxicated aggression). Thus, we carried out a hierarchical multiple regression model including the four BRI subscales and beverage as the main effect variables in the first step and, more importantly, all subsequent two-way effects involving these variables in the second step. None of the two-way interactions were significant indicating that it is the BRI construct as whole that is the optimal risk factor for intoxicated violence, rather than any of it constituent parts.

Table 4
Regression Equations Relating Beverage, Gender, and BRIEF-A MI and BRI Variables With Responses on the Physical Aggression Task

Step and measure	R^2	ΔR^2	F for Δ in R^2	Final *b*s
Step 1				
Beverage	0.136	0.136	19.97***	−0.50***
Gender				−0.74***
BRI				.24**
MI				−0.11
Step 2				
Beverage	0.161	0.024	2.43*	−0.71***
Gender				−0.98***
BRI				0.42**
MI				0.03
Gender × Beverage				0.41
Beverage × BRI				−0.28*
Beverage × MI				−0.02
Gender × BRI				−0.06
Gender × MI				−0.15
BRI × MI				−0.06
Step 3				
No significant three-way effects				
Step 4				
No significant four-way effect				

Note. ΔR^2 = change in R^2.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

The primary goal of this investigation was to explore the premise put forth by Bates (2000) that identifying component-processes of EF will advance our understanding of the role of EF in the expression of alcohol-related aggression. To begin this process, we chose the *BRIEF-A*, a multifaceted self-report inventory to explore EFs component-processes. By taking a "top-down" approach, we found a specific EF component (i.e., the BRI) to be a key moderator of the alcohol-aggression relation. We found that an overall measure of EF integrity, the GEC, was only mildly predictive of *intoxicated* aggression. Although we found the GEC to be a relatively weak predictor of intoxicated aggression, our results significantly add to those of Giancola (2004) by clearly demonstrating that utilizing a component-process approach revealed more detailed and theoretically important findings regarding the relations between specific EF elements and intoxicated aggression.

When simultaneously evaluating the MI and BRI of the *BRIEF-A*, the value of the component-process analysis in assessing EFs moderating qualities began to emerge. Specifically, the BRI was a significantly better risk factor for intoxicated aggression than the GEC, while the MI turned out to be neither a risk factor at all for either alcohol-related, or overall, aggression. This clearly indicates that the GECs status as a "mild" risk factor for intoxicated aggression was actually driven by the BRI. The BRI is representative of an individual's capacity to regulate their behavioral and emotional responses, while the MI involves components of working memory, strategic planning, and organization (Roth et al., 2005). Following our line of reasoning discussed earlier, we believe that in a hostile situation, the role of the cognitive components assessed by the BRI is temporally antecedent to that of the components assessed by the MI in the moderation of alcohol-related aggression. Specifically, the inhibition of basic emotional and behavioral reactions occurs before more elaborate and time-consuming abstract problem-solving functions described by the MI (Barkley, 1997; Sonuga-Barke et al., 2002).

Our initial differentiation of EF component-processes was couched within the theoretical framework of hot and cool EFs described by Zelazo and Müller (2002) and Séguin et al. (2007). The hot-cool distinction provides a heuristic for understanding how specific EFs are related to behavioral outcomes depending, in part, on environmental contingencies, and are proposed to have at least a partially distinct neuroanatomical basis. However, it should be noted that while we have argued that the BRI and MI scales of the *BRIEF-A* map onto the theoretical conceptions of hot and cool EF, respectively, they do so imperfectly as the *BRIEF-A* was not specifically designed to assess the hot-cool distinction. On balance, we chose to utilize the hot–cool distinction because it provides a theoretically intuitive means of understanding the BRI and the MI and how they may differentially predict, and provide the next "stepping stone" in understanding and explaining, the underlying etiology of the association between alcohol intoxication and aggression. Finally, in the context of this article, the BRI findings are also important in that they are consistent with the "disinhibition model" of alcohol-related aggression (Collins, 1988; Graham, 1980) that states that alcohol is a general dysregulator of EF, and acts as a proxy for symptoms of organic EF deficits (Hoaken, Assaad, & Pihl, 1998; Lyvers & Maltzman, 1991). However, before concluding, as is delineated in the footnote, it is important to note that it was the BRI (i.e., hot EF) as a whole, and not any of its constituent subcomponents, that best predicted the alcohol-aggression relation. These data suggest that a component-process approach to studying EF is absolutely worthwhile, however, it is equally important to understand that EF is a complex and multifaceted construct who's whole is greater than its individual parts (Perecman, 1987; Zelazo et al., 1997); or in other words, its constituent parts are not wholly independent from one another, but instead, they share an underlying commonality (Miyake, 2000).

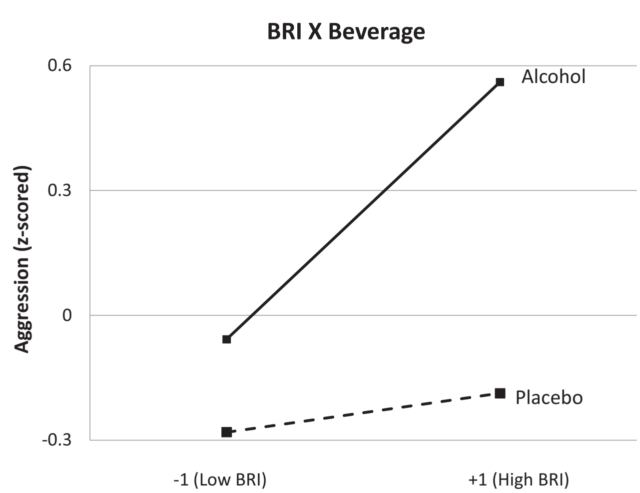

Figure 1. The relation between the behavioral regulation index (BRI) and aggression under alcohol and placebo conditions.

Limitations and Issues for Further Consideration

The cultural idea that aggression is a hot behavior, because of its relation to being "red with anger" or "hot-headed" rather than "calm, cool, and collected," and therefore more closely tied to hot EF processes (i.e., emotional control, inhibition), makes sense semantically. However, the extent to which this metaphor is used, or accepted, should be tempered. As noted by Zelazo and colleagues (Zelazo & Cunningham, 2007; Zelazo & Müller, 2002), specific EFs do not necessarily fall into mutually exclusive hot or cool categories; but rather, the extent to which they are hot or cool depends, in part, on situational circumstances and demands. For example, inhibitory control may be considered hot when engaged in more emotionally laden contexts such as those involving the potential for reward or punishment but would be seen as more cool in situations that require problem solving with little or no emotionally laden content (see Huijbregts, Warren, de Sonneville, & Swaab-Barneveld, 2008). More specifically, describing EFs components as hot or cool simply allows scientists a means of theoretical classification to determine the components that are the most salient risk factors for alcohol-related aggression, as well as other destructive behaviors in related areas such as substance abuse (Tarter et al., 2003), risky sex (MacDonald, Fong, Zanna, & Martineau, 2000), drinking and driving (MacDonald, Zanna, & Fong, 1995), suicide (Hufford, 2001), disinhibited eating (Mann & Ward, 2004), smoking (Kassel & Unrod, 2000), as well as poor overall self-control (Mann & Ward, 2007) (for review see Giancola, Josesphs, Parrott, & Duke, 2010). Finally, readers must always be aware of the perils and pitfalls of reification. Simply because we apply appealing labels such as hot and cool to cognitive functions *does not make them real.* Readers must always be keenly aware that as more is understood about the nature of EF, many different models and conceptualizations will come and go (Platt, 1964).

Findings from the current investigation are consistent with prior work demonstrating that EF, assessed with performance-based neuropsychological tests, moderates the alcohol-aggression relation (Giancola, 2004). While interpretation of our present findings must take into account the subjective nature of the *BRIEF-A*, prior work using this measure has indicated good ecological validity as reflected by its association with a variety of outcome measures (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Vriezen & Pigott, 2002; Weber, Gerber, Turcios, Wagner, & Forbes, 2006), as well as correlations with neuroimaging measures of frontal lobe integrity (Garlinghouse et al., 2010; Mahone, Martin, Kates, Hay, & Horska, 2009). Furthermore, performance-based EF measures have been reported to be limited in their sensitivity to real-world functional problems (Cripe, 1999; Denckla, 2002). Neuropsychological measures alone may overlook important information about how EF deficits can negatively affect daily life (Damasio & Anderson, 1993; Lezak, 1995). This assertion is supported by data showing that, compared with neuropsychological measures alone, self-report tools appear to be better at predicting real-life problems associated with executive dysfunction such as previously noted risky behaviors and aggression (Ready, Stierman, & Paulson, 2001). Thus, self-report measures of EF can provide a valuable and time-efficient means by which to gauge the integrity of EF and its component processes. Nevertheless, despite extending the results of Giancola's (2004) previous experiment that used a broad neuropsychological battery to measure EF, we unfortunately did not incorporate any performance-based tests in the present investigation and therefore cannot compare the relative nature of subjective versus objective measures of EF in relation to alcohol-related aggression. Future studies would benefit by directly contrasting how a full performance-based neuropsychological battery assessing EF relates to a self-report tool such as the *BRIEF-A*, and how they both moderate the alcohol-aggression relation from a component-processes perspective. Moreover, as noted in the Method section, we did not utilize a double-blind alcohol administration procedure for the reasons described. However, despite these mitigating factors, it is still a limitation of the study that such a procedure could not be implemented to improve the integrity of the data.

The ecology of alcohol-related violence is that a person is often placed in an emotionally charged situation where the modulation of behavior requires an immediate response to either engage in retaliatory violence or to inhibit such a response. When EF does not function normally, either because of a cognitive deficit or when coupled with the disinhibitory effects of alcohol intoxication, the propensity for a violent response is heightened by the collapse of cognitively controlled behavioral and emotional regulation; which is what may be considered to be hot EF. When behavioral and emotional regulation "give way," the ability to engage metacognitive skills to diffuse a hostile situation is significantly mitigated. Our data support the theoretical position that, EFs ability to control intoxicated violence through the use of abstract problem-solving, as well as other metacognitive skills, represents a highly compromised set of abilities that make behavioral regulation the first and most powerful line of defense in dealing with immediate behavioral and emotional responses to provocation, especially when under the influence of alcohol.

References

Aiken, L., & West, S. (1991). *Multiple regression: Testing and interpreting interactions.* Thousand Oaks, CA: Sage.

Alexander, M., & Stuss, D. (2006). Frontal injury: Impairment of fundamental processes leads to functional consequences. *Journal of the International Neuropsychological Society, 12,* 192–193. doi:10.1017/S1355617706060292

Baddeley, A., & Logie, R. (1999). Working memory: The multiple-component model. In A. Miyake & P. Shah (Eds.), *Models of working memory* (pp. 28–61). New York, NY: Cambridge University Press.

Barkley, R. (1997). Attention deficit/hyperactivity disorder, self-regulation, and time: Towards a more comprehensive theory. *Journal of Developmental and Behavioral Pediatrics, 18,* 271–279.

Bates, M. (2000). Utility of component-process approaches for understanding complex alcohol-related behavior within an executive functioning framework: Comment on Giancola (2000). *Experimental and Clinical Psychopharmacology, 8,* 598–600. doi:10.1037/1064-1297.8.4.598

Baum, K., & Klaus, P. (2005). *Violent victimization of college students, 1995–2002. Bureau of Justice Statistics.* Retrieved from http://bjs.ojp.usdoj.gov/index.cfm?ty=pbdetail&iid=593

Bechara, A., & Van Der Linden, M. (2005). Decision-making and impulsive control after frontal lobe injuries. *Current Opinion in Neurology, 18,* 734–739. doi:10.1097/01.wco.0000194141.56429.3c

Berkowitz, L., & Donnerstein, E. (1982). External validity is more than skin deep. *American Psychologist, 37,* 245–257. doi:10.1037/0003-066X.37.3.245

Berman, M., Bradley, T., Fanning, J., & McCloskey, M. (2009). Self-focused attention reduces self-injurious behavior in alcohol-intoxicated men. *Substance Use & Misuse, 44,* 1280–1297. doi:10.1080/10826080902961328

Bond, C. F., & DePaulo, B. M. (2008). Individual differences in judging deception: Accuracy and bias. *Psychological Bulletin, 134,* 477–492. doi:10.1037/0033-2909.134.4.477

Bushman, B., & Cooper, H. (1990). Effects of alcohol on human aggression: An integrative research review. *Psychological Bulletin, 107,* 341–354. doi:10.1037/0033-2909.107.3.341

Carlson, M., Marcus-Newhall, A., & Miller, N. (1989). Evidence for a general construct of aggression. *Personality and Social Psychology Bulletin, 15,* 377–389. doi:10.1177/0146167289153008

Cohen, J., Cohen, P., West, S., & Aiken, L. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Erlbaum.

Collins, J. (1988). Suggested explanatory frameworks to clarify the alcohol use/violence relationship. *Contemporary Drug Problems, Spring,* 107–121.

Cripe, L. (1999). *Use of the MMPI with mild closed head injury.* The evaluation and treatment of mild traumatic brain injury (pp. 291–314). Mahwah, NJ: Erlbaum Publishers.

Damasio, A., & Anderson, S. (1993). *The frontal lobes. Clinical neuropsychology* (3rd ed., pp. 409–460). New York, NY: Oxford University Press.

Denckla, M. (2002). The behavior rating inventory of executive function: Commentary. *Child Neuropsychology, 8,* 304–306. doi:10.1076/chin.8.4.304.13512

Duke, A. A., Giancola, P. R., Morris, D. H., Holt, J. C. D., & Gunn, R. L. (2011). Alcohol dose and aggression: Another reason why drinking more is a bad idea. *Journal of Studies on Alcohol and Drugs, 72,* 34–43.

Duncan, J., Seitz, R., Kolodny, J., Bor, D., Herzog, H., & Ahmed, A. (2000). A neural basis for general intelligence. *Science, 289,* 457–460. doi:10.1126/science.289.5478.457

Ellis, M., Weiss, B., & Lockman, J. (2009). Executive functioning in children: Associations with aggressive behavior and appraisal processing. *Journal of Abnormal Child Psychology, 37,* 945–956. doi:10.1007/s10802-009-9321-5

Fishbein, D. (2003). Differential susceptibility to comorbid drug abuse and violence. *Journal of Drug Issues, 28,* 859–891.

Friedrich, R. (1982). In defense of multiplicative terms in multiple regression equations. *American Journal of Political Science, 26,* 797–833. doi:10.2307/2110973

Garlinghouse, M., Roth, R., Isquith, P., Flashman, L., & Saykin, A. (2010). Subjective rating of working memory is associated with frontal lobe volume in schizophrenia. *Schizophrenia Research, 120,* 71–75. doi:10.1016/j.schres.2010.02.1067

Giancola, P. (1995). Evidence of dorsolateral and orbital prefrontal cortical involvement in the expression of aggressive behavior. *Aggressive Behavior, 21,* 431–450. doi:10.1002/1098-2337(1995)21:6<431::AID-AB2480210604>3.0.CO;2-Q

Giancola, P. (2000). Executive functioning: A conceptual framework for alcohol-related aggression. *Experimental and Clinical Psychopharmacology, 8,* 576–597. doi:10.1037/1064-1297.8.4.576

Giancola, P. (2004). Executive functioning and alcohol-related aggression. *Journal of Abnormal Psychology, 113,* 541–555. doi:10.1037/0021-843X.113.4.541

Giancola, P., & Chermack, S. (1998). Construct validity of laboratory aggression paradigms: A response to Tedeschi and Quigley (1996). *Aggression and Violent Behavior, 3,* 237–253. doi:10.1016/S1359-1789(97)00004-9

Giancola, P., Josephs, R., Parrott, D., & Duke, A. (2010). Alcohol myopia revisited: Clarifying aggression and other acts of disinhibition through a distorted lens. *Perspectives on Psychological Science, 5,* 265–278. doi:10.1177/1745691610369467

Giancola, P., Levinson, C., Corman, M., Godlaski, A., Morris, D., Phillips, J., & Holt, J. C. D. (2009). Men and women, alcohol and aggression. *Experimental and Clinical Psychopharmacology, 17,* 154–164. doi:10.1037/a0016385

Giancola, P., Mezzich, A., & Tartar, R. (1998). Executive cognitive functioning, temperament, and antisocial behavior in conduct disordered adolescent females. *Journal of Abnormal Psychology, 107,* 629–641. doi:10.1037/0021-843X.107.4.629

Giancola, P., & Parrott, D. (2008). Further evidence for the validity of the Taylor aggression paradigm. *Aggressive Behavior, 34,* 214–229. doi:10.1002/ab.20235

Giancola, P. R., & Zeichner, A. (1997). The biphasic effects of alcohol on human physical aggression. *Journal of Abnormal Psychology, 106,* 598–607. doi:10.1037/0021-843X.106.4.598

Gilotty, L., Kenworthy, L., Sirian, L., Black, D., & Wagner, A. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychology, 8,* 241–248. doi:10.1076/chin.8.4.241.13504

Gioia, G., & Isquith, P. (2004). Ecological assessment of executive function in traumatic brain injury. *Developmental Neuropsychology, 25,* 135–158. doi:10.1207/s15326942dn2501&2_8

Gioia, G., Isquith, P., Retzlaff, P., & Espy, K. (2002). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function (BRIEF) in a clinical sample. *Child Neuropsychology, 8,* 249–257. doi:10.1076/chin.8.4.249.13513

Godlaski, A., & Giancola, P. (2009). Executive functioning, irritability, and alcohol-related aggression. *Psychology of Addictive Behaviors, 23,* 391–403. doi:10.1037/a0016582

Goldberg, E. (2001). *The executive brain: Frontal lobes and the civilized mind.* New York, NY: Oxford University Press.

Graham, K. (1980). Theories of intoxicated aggression. *Canadian Journal of Behavioral Sciences, 12,* 141–158. doi:10.1037/h0081045

Graham, K., Osgood, D. W., Wells, S., & Stockwell, T. (2006). To what extent is intoxication associated with aggression in bars? A multilevel analysis. *Journal of Studies on Alcohol, 67,* 382–390.

Hawkins, K., & Trobst, K. (2000). Frontal lobe dysfunction and aggression: Conceptual issues and research findings. *Aggression and Violent Behavior: A Review Journal, 5,* 147–157.

Hoaken, P., Assaad, J., & Pihl, R. (1998). Cognitive functioning and the inhibition of alcohol-induced aggression. *Journal of Studies on Alcohol, 59,* 599–607.

Hoaken, P. N. S., Allaby, D., & Earle, J. (2007). Executive cognitive functioning and the recognition of facial expressions of emotion in incarcerated violent offenders, non-violent offenders, and controls. *Aggressive Behavior, 33,* 412–421. doi:10.1002/ab.20194

Hongwanishkul, D., Happaney, K., Lee, W., & Zelazo, P. (2005). Assessment of hot and cool executive function in young children: Age-related changes in individual differences. *Developmental Neuropsychology, 28,* 617–644. doi:10.1207/s15326942dn2802_4

Hufford, M. (2001). Alcohol and suicidal behavior. *Clinical Psychology Review, 21,* 797–811. doi:10.1016/S0272-7358(00)00070-2

Huijbregts, S., Warren, A., de Sonneville, L., & Swaab-Barneveld, H. (2008). Hot and cool forms of inhibitory control and externalizing behavior in children of mothers who smoked during pregnancy: An exploratory study. *Journal of Abnormal Child Psychology, 36,* 323–333. doi:10.1007/s10802-007-9180-x

Hull, J., & Bond, C. (1986). Social and behavioral consequences of alcohol consumption and expectancy: A meta-analysis. *Psychological Bulletin, 99,* 347–360. doi:10.1037/0033-2909.99.3.347

Ito, T., Miller, N., & Pollock, V. (1996). Alcohol and aggression: A meta-analysis of the moderating effects of inhibitory cues, triggering events, and self-focused attention. *Psychological Bulletin, 120,* 60–82. doi:10.1037/0033-2909.120.1.60

Kassel, J., & Unrod, M. (2000). Smoking, anxiety, and attention: Support for the role of nicotine in attentionally mediated anxiolysis. *Journal of*

Abnormal Psychology, 109, 161–166. doi:10.1037/0021-843X.109.1.161

Lehto, J., Juujarvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology, 21,* 59–80. doi:10.1348/026151003321164627

Lezak, M. (1995). *Neuropsychological assessment* (3rd ed.). New York, NY: Oxford University Press.

Lyvers, M., & Maltzman, I. (1991). Selective effects of alcohol on Wisconsin Card Sorting Test performance. *British Journal of Addiction, 86,* 399–407. doi:10.1111/j.1360-0443.1991.tb03417.x

MacDonald, T., Fong, G., Zanna, M., & Martineau, A. (2000). Alcohol myopia and condom use: Can alcohol intoxication be associated with more prudent behavior? *Journal of Personality and Social Psychology, 78,* 605–619. doi:10.1037/0022-3514.78.4.605

MacDonald, T., Zanna, M., & Fong, G. (1995). Decision making in altered states: Effects of alcohol on attitudes toward drinking and driving. *Journal of Personality and Social Psychology, 68,* 973–985.

Mahone, E., Martin, R., Kates, W., Hay, T., & Horska, A. (2009). Neuroimaging correlates of parent ratings of working memory in typically developing children. *Journal of the International Neuropsychological Society, 15,* 31–41. doi:10.1017/S1355617708090164

Mann, T., & Ward, A. (2004). To eat or not to eat: Implications of the attentional myopia model for restrained eaters. *Journal of Abnormal Psychology, 113,* 90–98. doi:10.1037/0021-843X.113.1.90

Mann, T., & Ward, A. (2007). Attention, self-control, and health behaviors. *Current Directions in Psychological Science, 16,* 280–283. doi:10.1111/j.1467-8721.2007.00520.x

Martin, C., Earleywine, M., Musty, R., Perrine, M., & Swift, R. (1993). Development and validation of the biphasic alcohol effects scale. *Alcoholism: Clinical and Experimental Research, 17,* 140–146. doi:10.1111/j.1530-0277.1993.tb00739.x

Martin, C., & Sayette, M. (1993). Experimental design in alcohol administration research: Limitations and alternatives in the manipulation of dosage-set. *Journal of Studies on Alcohol and Drugs, 54,* 750–761.

Maston, C. (2010). *Crime victimization in the United States: Statistical tables. Bureau of Justice Statistics.* Retrieved from http://bjs.ojp.usdoj.gov/index.cfm?ty=pbdetail&iid=2173

Mesulam, M. (2002). The human frontal lobes: Transcending the default mode through continent encoding. In D. Stuss & R. Knight (Eds.), *Principles of frontal lobe function* (pp. 8–30). New York, NY: Oxford University Press. doi:10.1093/acprof:oso/9780195134971.003.0002

Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of will power. *Psychological Review, 106,* 3–19. doi:10.1037/0033-295X.106.1.3

Miyake, A., Friedman, N., Emerson, M., Witzki, A., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology, 41,* 49–100. doi:10.1006/cogp.1999.0734

Moffitt, T. (1993). The neuropsychology of conduct disorder. *Development and Psychopathology, 5,* 133–151. doi:10.1017/S0954579400004302

Morgan, A., & Lilienfeld, S. (2000). A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. *Clinical Psychology Review, 20,* 113–136. doi:10.1016/S0272-7358(98)00096-8

NIAAA. (2005). *National advisory council on alcohol abuse and alcoholism: Recommended council guidelines on ethyl alcohol administration in human experimentation* (http://www.niaaa.nih.gov/Resources/ResearchResources/job22.htm).

Perecman, E. (1987). Consciousness and the meta-functions of the frontal lobes: Setting the Stage. In E. Perecman (Ed.), *The frontal lobes revisited* (pp. 1–10). Mahwah, NJ: Erlbaum.

Phillips, S., Matusko, J., & Tomasovic, E. (2007). Reconsidering the relationship between alcohol and lethal violence. *Journal of Interpersonal Violence, 22,* 66–84. doi:10.1177/0886260506294997

Platt, J. (1964). Strong inference. *Science, 146,* 347–353. doi:10.1126/science.146.3642.347

Raaijmakers, M., Smidts, D., Sergeant, J., Maassen, G., Posthumus, J., van Engeland, H., & Matthys, W. (2008). Executive functions in preschool children with aggressive behavior: Impairments in inhibitory control. *Journal of Abnormal Child Psychology, 36,* 1097–1107. doi:10.1007/s10802-008-9235-7

Raine, A., & Yang, Y. (2006). Neural foundations to moral reasoning and antisocial behavior. *Social Cognitive and Affective Neuroscience, 1,* 203–213. doi:10.1093/scan/nsl033

Ready, R., Stierman, L., & Paulsen, J. (2001). Ecological validity of neuropsychological and personality measures of executive functions. *The Clinical Neuropsychologist, 15,* 314–323. doi:10.1076/clin.15.3.314.10269

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A).* Lutz, FL: Psychological Assessment Resources.

Séguin, J., Arseneault, L., Boulerice, B., Harden, P., & Tremblay, R. (2002). Response perseveration in adolescent boys with stable and unstable histories of physical aggression. *Journal of Child Psychology and Psychiatry, 43,* 482–494. doi:10.1111/1469-7610.00039

Séguin, J., Arseneault, L., & Tremblay, R. (2007). The contribution of “hot” and “cool” components of decision-making in adolescence: Implications for developmental psychopathology. *Cognitive Development, 22,* 530–543. doi:10.1016/j.cogdev.2007.08.006

Selzer, M., Vinokur, A., & van Rooijen, L. (1975). A self-administered Short Michigan Alcoholism Screening Test (SMAST). *Journal of Studies on Alcohol, 36,* 117–126.

Shallice, T. (2002). Fractionation of the supervisory system. In D. Stuss & R. Knight (Eds.), *Principles of frontal lobe function* (pp. 261–277). New York, NY: Oxford University Press. doi:10.1093/acprof:oso/9780195134971.003.0017

Sonuga-Barke, E., Dalen, L., Daley, D., & Remington, B. (2002). Are planning, working memory, and inhibition associated with individual differences in preschool ADHD symptoms? *Developmental Neuropsychology, 21,* 255–272. doi:10.1207/S15326942DN2103_3

Tarter, R., Kirisci, L., Mezzich, A., Cornelius, J., Pajer, K., Vanyukov, M., . . . Clark, D. (2003). *American Journal of Psychiatry, 160,* 1078–1085. doi:10.1176/appi.ajp.160.6.1078

Taylor, S. (1967). Aggressive behavior and physiological arousal as a function of provocation and the tendency to inhibit aggression. *Journal of Personality, 35,* 297–310. doi:10.1111/j.1467-6494.1967.tb01430.x

United States Department of Justice. (2005). *Bureau of Justice Statistics: Crime characteristics.* Retrieved from http://www.ojp.usdoj.gov/bjs/cvict_c.htm#alcohol

Vogel-Sprott, M., & Fillmore, M. T. (1999). Learning theory and research. In K. E. Leonard & H. T. Blane (Eds.), *Psychological theories about drinking and alcoholism* (2nd ed., pp. 292–327). New York, NY: Guilford Press.

Volavka, J. (1995). *Neurobiology of violence.* Washington, DC: American Psychiatry Press.

Vriezen, E., & Pigott, S. (2002). The relationship between parental report on the BRIEF and performance-based measures of executive function in children with moderate to severe traumatic brain injury. *Child Neuropsychology, 8,* 296–303. doi:10.1076/chin.8.4.296.13505

Watson, P., Watson, I., & Batt, R. (1981). Prediction of blood alcohol concentration in human subjects: Updating the Widmark equation. *Journal of Studies on Alcohol, 42,* 547–556.

Weber, D., Gerber, E., Turcios, V., Wagner, E., & Forbes, P. (2006). Executive functioning and performance on high-stakes testing in children from urban schools. *Developmental Neuropsychology, 29,* 459–477. ;/Border doi:10.1207/s15326942dn2903_5

Zelazo, P., Carter, A., Reznick, S., & Frye, D. (1997). Early development of executive function: A problem-solving framework. *Review of General Psychology, 1,* 198–226. doi:10.1037/1089-2680.1.2.198

Zelazo, P., & Cunningham, W. (2007). Executive function: Mechanisms underlying emotion regulation. In J. Gross (Ed.), *Handbook of emotion regulation* (pp. 135–158). New York, NY: Guilford Press.

Zelazo, P., & Müller, U. (2002). Executive function in typical and atypical development. In U. Goswami (Ed.), *Handbook of childhood cognitive development* (pp. 445–469). Oxford, UK: Blackwell.

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