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

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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 Functioning–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.

Executive Functioning

While a number of variables have been found to moderate the alcohol-aggression relation (e.g., Berman, Bradley, Fanning, & McCloskey, 2000; 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, & Pullikainen, 2003; Miyake, Friedman, Emerson, Witzki, & Howarter, 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 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,
violence is necessary for valid reasons of defense). However, if
ate, and then behaving in a socially adaptive manner (unless
situation, inhibiting the immediate emotional responses to retali-
for, violence. Accordingly, when exposed to hostile provocation,
Raaijmakers et al., 2008) to violent offenders (Hoaken, Allaby, &
Hawkins & Trobst, 2000; Moffitt, 1993; Morgan & Lilienfeld,
documented in a wealth of studies (reviewed in Giancola, 1995;
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 (Metcalf & Mischel, 1999; Zelazo & Müller,
2002). More specifically, cool EFs include problem-solving abili-
ties 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 as-
associated with an increased sensitivity to environmental cues of
punishment as well as quick visceral responses pursuant to on-
coming 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). Im-
paired 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 elabo-
rate 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 behav-
ioral regulation deficits in aggressive behavior in varied popula-
tions from healthy children (Ellis, Weiss, & Lochman, 2009;
Raaijmakers et al., 2008) to violent offenders (Hoeken, 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 retal-
iate, 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 Ver-
sion (BRIEF-A; Roth, Isquith, & Gioia, 2005) is a self-report inven-
tory 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., Meta-
cognition Index; MI) and behavioral-emotional regulation (i.e., Be-
vioral Regulation Index; BRI). Although the latter two indices are
merely moderately correlated with one another, they are better understood as
two distinct, yet related, components of EF (Gioia, Isquith, Reitzel, &
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, moni-
tor 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 (Hong-
wanishkul et al., 2005; Séguiu, Arseneault, Boulerice, Harden, &
Tremblay, 2002; Zelazo & Cunningham, 2007). Without the abil-
ity to emotionally regulate behavior (i.e., poor hot EF), the enact-
ment of cool EF propensities such as strategic planning and ab-
stract 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 regu-
laratory capacities that alcohol is purported to disrupt (reviewed in
Giancola, 2000). Hence, possessing limited EF coupled with alco-
hol’s disinhibitory effects should engender greater aggression.
Giancola (2004) supported this hypothesis by demonstrating that
EF, measured by an array of performance-based neuropsychologi-
cal tests, was a risk factor for intoxicated aggression in a labora-
tory 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 experi-
ment, 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 compo-
ments 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-As 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, $\alpha$ 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 $\alpha$ coefficients of .89, .94, and .95, respectively. Table 2 summarizes the correlations between the BRIEF-A 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 & Cermack, 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).

**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 bs. 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.

### 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; R² = .12. These analyses revealed that alcohol significantly increased aggression compared with placebo (b = −.49, p < .001), that men were significantly more aggressive...
than women \((b = -0.73, p < .001)\), 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 \(\times\) Beverage \((b = -0.29, p < .02)\) and Beverage \(\times\) 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 \(\times\) Beverage interaction was probed, it revealed a positive relation between GEC and aggression in the alcohol group \((b = .21; t = 2.24, p < .05)\), but not in the placebo group \((b = .02; t = 0.34, p = .74)\). Decomposition of the Beverage \(\times\) Gender interaction indicated that alcohol significantly increased aggression for both genders, but to a greater extent in men, \(n(244) = -3.90, p < .01\) than in women, \(n(264) = -2.39, p < .01\) (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).

**BRIEF-A BRI and MI.** Following analyzing the total BRIEF-A score \(\text{GEC}\) 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 complementary four-way model that includes gender and beverage.

### 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,

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**Table 2**

**Correlation Matrix of the BRIEF-A Scales**

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<td>1. BRF Inhibit</td>
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<td>2. BRF Shift</td>
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<td>3. BRF Emotional Control</td>
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<td>4. BRF Self-Monitor</td>
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<td>5. BRF Initiate</td>
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<td>6. BRF Working Memory</td>
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<td>7. BRF Plan/Organize</td>
<td>.72</td>
<td>.57</td>
<td>.88</td>
<td>.59</td>
<td>.83</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8. BRF Task Monitor</td>
<td>.49</td>
<td>.85</td>
<td>.59</td>
<td>.81</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. BRF Organization of Materials</td>
<td>.76</td>
<td>.35</td>
<td>.65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. BRF MI Composite</td>
<td>.67</td>
<td>.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. BRF BRI Composite</td>
<td>.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>12. BRF GEC Composite</td>
<td>.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Note.** All correlations are significant at \(p < .001\) with a sample size of 512.

---

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 its constituent parts.
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 significantly add to those of Giancola (2004) by clearly demonstrating that utilizing a component-process approach revealed 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).

**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 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).

**Table 4**

<table>
<thead>
<tr>
<th>Step and measure</th>
<th>$R^2$</th>
<th>$\Delta R^2$</th>
<th>$F$ for $\Delta$ in $R^2$</th>
<th>Final $b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage</td>
<td>0.136</td>
<td>0.136</td>
<td>19.97***</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>-0.74***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRI</td>
<td></td>
<td>.24**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td></td>
<td>-0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage</td>
<td>0.161</td>
<td>0.024</td>
<td>2.43*</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>-0.71***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRI</td>
<td></td>
<td>.42**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td></td>
<td>0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender $\times$ Beverage</td>
<td></td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage $\times$ BRI</td>
<td></td>
<td>-0.28*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage $\times$ MI</td>
<td></td>
<td>-0.02</td>
<td></td>
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<tr>
<td>Gender $\times$ BRI</td>
<td></td>
<td>-0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender $\times$ MI</td>
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<td>-0.15</td>
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<td></td>
</tr>
<tr>
<td>BRI $\times$ MI</td>
<td></td>
<td>-0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No significant three-way effects</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Step 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No significant four-way effect</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note. $\Delta R^2 = \text{change in } R^2$.

*p < .05. **p < .01. ***p < .001.
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, 2000), smoking (Kassel & Unrod, 2000), as well as poor overall self-control (Mann & Ward, 2007) (for review see Giancola, Jossephs, 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; Kawada et al., 2009; 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 over-look 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, Stirner, & 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


EXECUTIVE FUNCTIONING, ALCOHOL, AND AGGRESSION

9


AUTHOR PLEASE ANSWER ALL QUERIES

AQ1: Author: Journal style is to cite Tables in numerical order. Table 2 has been cited before Table 1. Please renumber your tables. In addition, please cite Table 4 in the text.

AQ2: Author: Please add Duke et al. (2011) to the reference list. Thank you.

AQ3: Author: Please verify if this is meant to be Fillmore & Vogel-Sprott (1999) and if not, add Vogel-Sprott & Fillmore (1999) to the reference list.

AQ4: Author: Please add MacDonald, Zanna, & Fong (1995) to the reference list.

AQ5: Author: Please provide a legend for Figure 1.