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DIFFERENTIAL EFFECTS OF MODERATE ALCOHOL CONSUMPTION ON PERFORMANCE AMONG OLDER AND YOUNGER ADULTS

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Abstract

Background—Studies exploring differential effects of acute alcohol consumption on younger and older adults are lacking within the field of alcohol research, especially those using moderate doses. Previous studies addressing this question have tended to use complex behavioral tasks too broad to isolate specific neurocognitive processes affected by both alcohol and aging. Compromises in cognitive efficiency (i.e. the ability to respond both quickly and accurately) have previously been identified in both elderly and acutely intoxicated individuals.

Methods—The present study employed a visual-spatial, two-choice reaction time task to evaluate the interactive effects of aging and alcohol on cognitive efficiency. Our primary outcome measure was an efficiency ratio derived from each participant's response accuracy (ACC) and mean reaction time (RT) (%correct/RT). Younger (25 – 35; n=22) and older (55 – 74; n=37) participants were randomly assigned to receive either a placebo or moderate alcohol dose intended to produce a peak BrAC of 0.04%. Participants performed the task at peak alcohol levels.

Results: A significant interaction between age group and dose assignment was observed ($F_{3,55}$=4.86, p=.03) for the efficiency ratio. Younger participants who received alcohol performed significantly better than did their older counterparts regardless of alcohol condition and despite no differences in performance between the two age groups in the placebo condition. Additional correlation analyses between ACC and RT suggested that moderately intoxicated older adults become more accurate as response times increase. This relationship was not observed in older adults in the placebo condition.

Conclusions—These data suggest that healthy individuals exhibit a differential susceptibility to the effects of alcohol depending on their age. Unfortunately, due to the presumed safety of moderate alcohol doses and a lack of studies investigating the interactive effects of acute alcohol consumption and aging, most individuals are unlikely to be aware of this relationship between alcohol consumption and age.

Keywords

Alcohol; aging; cognition; speed-accuracy trade-off

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Introduction

Recent evidence indicates that the portion of adults endorsing moderate drinking behaviors (~ 1 drink/day for women; ~ 2 drinks/day for men) has increased over the past two decades (King et al., 2009). Studies examining trends in moderate drinking also suggest that, although the total number of drinks consumed per day decreases with age, the frequency of drinking increases (Molander et al, 2010). In light of demographic projections indicating a rapidly aging U.S. population (U.S. Census Bureau, 2011, Table 8), these data emphasize the importance of determining how the consumption of moderate alcohol doses might acutely affect younger and older individuals differently. It is particularly important to investigate the differential effects on neurocognitive performance given the increased susceptibility of older individuals to cognitive decline.

Although the interaction between aging and alcohol effects on neurocognitive and neuroanatomical indices has received a great deal of attention among alcoholic populations (see Oscar-Berman and Marinkovic, 2003 for a review), it has not been adequately addressed in studies of acute administration among non-problem drinkers. Earlier attempts to address this question examined performance on ecologically valid tasks with diverse behavioral demands, often resulting in conflicting conclusions. For example, Collins and Mertens (1988) found that older airline pilots were significantly more susceptible to the impairing effects of alcohol than younger pilots on a flight simulator, a finding replicated by Morrow et al (1991). This interaction between alcohol and aging effects, however, was not observed in a later study using a similar simulated flying task (Yesavage et al., 1994) or in one testing simulated driving performance (Quillian et al, 1999).

Alternatively, some studies have focused on traditional neurocognitive tasks with predefined end-point measures rather than complex behavioral assessments (Gilbertson et al., 2009; Tupler et al., 1995). At least within the domain of psychomotor functioning, however, this approach has also produced an inconsistent pattern of results. Using various tests of psychomotor performance, some studies have reported that older adults display a greater sensitivity to alcohol induced impairments (Gilbertson et al., 2009) while others have failed to observe such an interaction (Tupler et al., 1995).

A potential problem with previous work is that cognitive aging and alcohol consumption may interact at a component process level, affecting specific neurocognitive processes which underlie performance. Therefore, elaborate real-world simulations and traditional neuropsychological tasks employing gross performance indices may not be sufficiently sensitive to isolate individual processes affected by both alcohol and cognitive aging. Cognitive efficiency, which can be conceptualized as the ability to perform both quickly and accurately, may provide an example of such a process. There is evidence within the aging literature suggesting that older adults place a greater emphasis on maintaining accurate responding at the expense of speed, leading to efficiency decrements (Salthouse, 1979; Carriere et al., 2010). A similar speed-accuracy trade-off has also been observed among recovering alcoholics (Glenn and Parsons, 1991; Sullivan et al., 2002). Acute administration protocols also have found impairments in cognitive efficiency following alcohol consumption, although reported trade-offs tend to favor speed over accuracy (Acons et al., 2006; Jennings et al., 1976). Taken together, these studies suggest that aging and alcohol may affect similar neurocognitive processes. Thus, it is possible that the simultaneous manipulation of age and alcohol may result in an interactive effect on performance.

The current study was therefore designed to test the effects of age and acute alcohol consumption on a measure of cognitive efficiency using a 2 (age group) by 2 (dose group) randomized, double-blind factorial design. The alcohol dose administered was consistent

with episodes of moderate drinking. An efficiency ratio derived from accuracy and reaction time scores recorded during a visual-spatial attention task was used as a reflection of cognitive efficiency. Although results from previous studies are mixed, we posed a working hypothesis that alcohol's acute effect on cognitive efficiency would be compounded by advanced age and that older participants would therefore exhibit greater alcohol-related decrements in efficiency scores than would younger participants.

Materials and Methods

Participants

Participants between the ages of 25 – 35 (Younger; n=22; 14 female) or 55 – 74 (Older, n=37; 20 female) with 12 – 18 years of education were recruited via newspaper ads, flyers, radio ads and word-of-mouth. These age ranges were chosen to allow comparison with existing literature on acute alcohol consumption and cognitive aging. This sample partially overlapped with a sample used in a previous study conducted in our laboratory (Gilbertson et al., 2009). Interested individuals contacted the laboratory for a general description of the study and review of basic inclusionary/exclusionary criteria. Persons remaining interested were scheduled for a screening session during which demographic information, medication use and health status, smoking status, and substance use history were assessed via self-report. Individuals also completed a packet containing questionnaires to assess quantity and frequency of typical alcohol consumption over the previous six months (Quantity Frequency Index (QFI) [Cahalan et al., 1969]), state anxiety (Spielberger State-Trait Anxiety Inventory (STAI) [Spielberger, 1983]), and level of education. Separate age-appropriate measures were used to assess depressive symptomatology (Beck Depression Inventory-II (BDI-II) [Beck et al., 1996]; Geriatric Depression Scale [Yesavage et al., 1982]) and problematic drinking behaviors (Michigan Alcoholism Screening Test (MAST) [Selzer, 1971]; Michigan Alcoholism Screening Test-Geriatric Version (MAST-G) [Blow, 1991]). Individuals continuing to meet criteria for inclusion in the study were scheduled for a computerized clinical research interview based on DSM-IV criteria to test for the presence of Axis I psychiatric disorders including substance use disorders (computerized Diagnostic Interview Schedule (cDIS); [Robins et al., 1995]).

Exclusionary criteria included a) current or lifetime diagnosis of a major Axis I disorder including psychoses or substance use disorders, b) current nicotine dependence, c) significant medical history which might compromise neurocognitive function or which was incompatible with acute alcohol administration (e.g., epilepsy, history of stroke, untreated hypertension, etc.), d) a positive urine drug test (tetrahydrocannabinol, cocaine, benzodiazepines, morphine, and methamphetamine) or a breath alcohol concentration (BrAC) greater than 0.0% on the morning of testing, or e) positive result on a urine pregnancy test. Given our interest in the effects of moderate alcohol doses on social drinkers, participants who did not consume at least one alcoholic beverage per month were also excluded. Participants provided written informed consent prior to both the screening and laboratory sessions and were compensated for their time. All procedures were approved by the University of Kentucky Medical Institutional Review Board.

Alcohol Administration and Breath Alcohol Concentration Measures

Eligible participants within each age group were randomly assigned to receive either a placebo or moderate dose of alcohol in a double-blind fashion. Each participant assigned to the active dose group was administered an amount of 100%, medical-grade ethanol sufficient to achieve a peak BrAC of 0.04%. Determination of this dose was based on calculations using a modified version of the Widmark Equation including a determination of total body water based on height and weight for women and height and age for men (Watson

et al., 1981). Alcoholic beverages consisted of vehicle (sugar-free, non-caffeinated lemon-lime soda) and ethanol in a 3:1 ratio. Placebo beverages contained only vehicle and were misted with a negligible amount of ethanol to control for an alcohol expectancy effect between the two dose groups. The total beverage volume was split into two drinks and the participants were given 5 minutes to consume both. Participants were told that they had been randomly assigned to either a placebo or active dose condition and had a "one-in-two chance of receiving alcohol". A booster beverage was also administered to all participants 30 minutes after consumption of the original beverage to ensure that participants in the active dose group maintained a peak BrAC of ~0.04% during neurocognitive assessment. The booster beverage consisted of half of the original vehicle dose for the placebo group and either half of the original active dose beverage or half of a vehicle dose for the active dose group depending on BrAC level. Breath samples were taken at 25, 45, 55, 65, 75 and 85 min. following beverage consumption to measure BrACs using a standard device (Intoxilyzer, Model 400; CMI, Inc., Owensboro, KY). Following task completion, participants were asked whether they believed they had or had not received alcohol. The effectiveness of our placebo manipulation did not differ between younger (π=64%) and older (π=69%) adults. All participants received a standardized lunch (~500kcal) prior to beverage administration.

Posner Task

Participants sat 70 cm. from the computer monitor with their chins in a chin rest to minimize head movements. An adaptation of the Posner paradigm (Luck et al., 1994) was used due to the demonstrated sensitivity of efficiency to the effects of aging (Salthouse, 1979) and alcohol (Tiplady et al., 2001) on attentional choice reaction time tasks. Each trial began with a fixation display consisting of 4 empty boxes (1.2″×1.2″) centered around (6.1″) a fixation dot (Fig. 1). After 1400 ms, a central cue appeared in the middle of the display, pointing to either one (valid and invalid trials) or all (neutral trials) of the boxes. The cue arrow(s) remained on the display until the offset of the post-cue mask. A target appeared 500 – 800 ms after the onset of the cue in 50% of the trials and was immediately replaced by the post-cue mask. Half of the participants were asked to respond via button press using their right index finger if the target had been presented and their left if the target had not been presented. Button assignment was reversed for the other half. Participants were instructed to respond as quickly and accurately as possible and were told that both their speed and accuracy would be recorded. Responses occurring over 1000 ms following presentation of the post-cue mask were not recorded. A valid cue was presented on 60% of trials, an invalid cue on 20% and a neutral cue on the remaining 20%.

Participants performed the Posner task 40 min. after administration of the initial beverage. The task was divided into 4 blocks, each lasting 7 min. with a 2 min. break in between each (34 min. total). This design was chosen to allow participants to complete the task at peak BrAC levels. Participants also performed a brief practice trial prior to beverage consumption to ensure task proficiency. Accuracy (ACC) and reaction time (RT) were automatically recorded by the stimulus presentation software (STIM^2 Compumedic Neuroscan, Charlotte, NC) for each trial type. An efficiency ratio (%correct/average RT) was also derived using these variables. By taking into account both ACC and RT this measure allows us examine speed-accuracy tradeoffs, which is a measure of efficient processing. This process approach has been shown to be more sensitive to subtle alterations than traditional end-point measures such as overall accuracy or reaction time (see Kaplan, 1988).

Data Analysis

Statistical analyses were conducted using SAS Version 9.1 (SAS Institute, Inc., Cary, NC). Demographic variables of interest were compared between the two age groups and the two

dose assignments using t-tests. Correlations were performed between potentially confounding factors and our dependent variables of interest. To test the interactive effects of age and alcohol on cognitive efficiency, separate 2 (Age: Older vs. Younger) X 2 (Dose: Active vs. Placebo) analyses of variance (ANOVA) were conducted on the three behavioral outcome measures of interest: the efficiency ratio, RT and ACC. Because the same pattern of significance was observed for all trial types, composite averages for the efficiency ratio, RT and ACC were derived from all responses and used in subsequent analyses. When appropriate, post-hoc comparisons using the least square means of the dependent variables were performed. Correlation analyses were also conducted between ACC and RT within each experimental condition to assess speed-accuracy trade-off strategies. Regression diagnostics were used to identify outliers (Studentized residuals > |2| and HATDIAG leverage values > 2(k+1)/n)) and highly influential observations (DFFITS values > 2(k+1/n)^1/2 and DFBETAS values > 2/(n)^1/2) (Eyduran et al, 2005; Belsley et al, 1980). A repeated measures ANOVA was used to test for differences between the BrACs of older and younger participants.

Results

Demographics

Demographic data for the four groups are presented in Table 1. Alcohol dose groups did not differ on any variable of interest (p's>.09). 8 participants reported current smoking but did not meet diagnostic criteria for nicotine dependence. As a conservative measure, we performed a correlation between the average number of cigarettes smoked per day and our dependent measures. This analysis failed to indicate a significant relationship. Depressive symptomatology (BDI-II and GDS) and problematic drinking behaviors (MAST and MAST-G) were not compared statistically between older and younger participants since different, age-appropriate measures were used to evaluate the two groups. None of the participants' scores on these measures, however, suggested the presence of significant depressive symptoms or a potential alcohol use disorder. Differences in education level (t_{57}=2.73, p=.009) were detected between younger and older participants. However, years of education did not correlate with the efficiency ratio (p>.5), reaction time (p>.7) or accuracy (p>.8). Older and younger participants did not differ on any other demographic variable of interest or on a baseline measure of simple reaction time (all p's>.2).

Breath Alcohol Concentration Measures

Peak BrACs for both younger (M=0.052%; SD=0.01%) and older (M=.056%; SD=0.01%) participants occurred at the 45 minute time point (Figure 2). There was no effect of age group on BrAC measures (p>.8) or interaction between age group and measurement time-point (p>.2). BrACs also did not differ between older and younger participants across testing session (p's>.3).

Efficiency Ratio

There was a significant interaction between age group and dose group ($F_{3,55}$=4.86, p=.03) on cognitive efficiency. Post-hoc comparisons using least square means revealed that older and younger participants performed nearly identically when administered a placebo dose (p's>.9), but within the active alcohol condition younger adults performed significantly more efficiently than older adults (p=.003, Cohen's d=1.39 (Cohen's d: large effect~0.8; medium effect~0.5; small effect~0.2)) (Figure 3A). The efficiency of younger subjects receiving alcohol was also better than those receiving a placebo beverage (p=.05, d=1.13). A similar alcohol effect was not observed for older subjects (p>.9). A significant main effect of age ($F_{3,55}$=8.75, p=.005, d=0.79) was observed with older participants (M=1.27, SD=0.4) performing less efficiently than younger participants (M=1.62, SD=0.6) regardless of dose

assignment. An effect of dose ($F_{3,55}$=3.95, p=.05, d=0.52) was also observed such that alcohol improved efficiency (M=1.46, SD=0.5) compared to placebo (M=1.35, SD=0.5) regardless of age group.

Reaction Time

Overall, there was a significant effect of age on RT ($F_{3,55}$=12.17, p=.001, d=0.94). Older participants responded more slowly (M=0.563 sec, SD=0.09) compared to younger participants (M=0.487 sec, SD=0.07). There was no significant effect of alcohol dose (p>.8) or an interaction between age and dose on RT (p>.2).

Accuracy

Neither dose (p>.1), nor age (p>.08), nor their interaction (p>.3) had a significant effect on ACC.

Speed-Accuracy Trade-Off

ACC and RT were not correlated among younger participants who received a placebo dose (r=.53, p=.09) (Figure 4A). The association remained non-significant after removal of outliers (Studentized residuals > |2| and HATDIAG leverage values > 2(k+1)/n)) and highly influential observations (DFFITS values > 2(k+1/n)^1/2 and DFBETAS values > 2/(n)^1/2) (p>.1). ACC and RT were negatively correlated among younger participants who received an active alcohol dose (r=-.81, p=.002) (Fig. 4A). No extreme observations were observed in this group. The two behavioral measures were not correlated among older participants in the placebo condition prior to (p>.2) or after (p>.6) the removal of extreme observations. A positive correlation was observed between ACC and RT among older participants receiving an active dose (r=.46, p=.03) (Figure 4B). This association was strengthened after extreme observations were removed from this analysis (r=.64, p=.003).

Discussion

The present study was designed to investigate the differential age effect of moderate alcohol consumption on the neurocognitive process of efficiency. Older (55 - 74) and younger (25 - 35) adults were administered a dose of alcohol consistent with an episode of moderate drinking and performed a covert visual attention task at peak BrAC levels. RT and ACC on this task were recorded and used to derive a measure of cognitive efficiency (%correct/RT). Both the ability to respond efficiently (i.e. quickly and accurately) as well as the methods used to achieve efficiency (speed-accuracy trade-offs) were considered.

Although the predicted deficit in efficiency among older adults was observed, the statistically and conceptually more important result was the interaction between alcohol and aging. Interestingly, the efficiency ratios between younger and older adults did not differ within the placebo condition. This result cannot be explained by differences in the placebo effect or expectancy between age groups. Instead, the observed effect of age on efficiency seems to have been driven by the interaction between alcohol and aging. Because alcohol led to more efficient responding among younger participants but did not affect performance among older participants, younger adults as a group performed better than older adults accounting for the observed main effect of age. The effect of alcohol on efficiency in younger participants was also responsible for the main effect of dose on the efficiency ratio scores.

Although acute alcohol consumption has been shown to produce mixed effects on visual-spatial performance (Schulte et al., 2001), a significant portion of the literature suggests an impairment of visual-spatial processes (do Canto-Pereira et al., 2007; Leone and McCourt,

2010). Thus, the relatively better performance observed among the younger active dose group in the present study seems counterintuitive. However, it is important to consider that most of the acute studies used intoxicating alcohol doses (i.e. BACs > .08%) and much simpler visual-spatial attention tasks. A possible explanation for the high efficiency scores in the younger active dose group comes from the alcohol myopia model (Steele and Josephs, 1990). According to this model, intoxicated individuals tend to allocate greater attentional resources to target detection and become less susceptible to the influence of distracters (i.e. the central cue) while performing very challenging attention tasks such as the current adaptation of the Posner task. It is also important to keep in mind that the results suggest a higher level of efficiency among the younger participants in the active dose group rather than superior visual-spatial performance as measured by traditional end-point outcomes (i.e. ACC and RT). Post hoc analysis revealed that ACC did not differ between any of the four groups and that response times were only faster in younger participants in the active dose condition compared to their older counterparts. The latter result could be explained by the previously reported facilitation of psychomotor performance in younger, but not older adults by moderate alcohol consumption (Gilbertson et al., 2009). However, alcohol administration in the present study did not result in faster RTs among the younger participants suggesting that the neurocognitive process of efficiency rather than gross psychomotor or attentional performance was improved in this group.

Examination of the RT and ACC scores (Figure 3) suggests that older adults who received alcohol were able to maintain their level of efficiency by sacrificing speed to improve their accuracy. To further investigate this possibility, correlations between RT and ACC were performed within each condition. In spite of a lack of association between these variables among older participants who received placebo, slower responses were positively associated with more accurate responses in the active dose condition (Figure 4B). This finding is similar to previous results reported among older adults (Carriere et al., 2010; Salthouse, 1979) and alcoholics (Glenn and Parsons, 1991; Sullivan et al., 2002). Interestingly, a considerably stronger correlation was observed in the younger participants who received alcohol, although in the opposite direction (Figure 4A). This pattern is difficult to reconcile with our working model of cognitive efficiency, but worthy of further consideration given the strength of the negative association. It also suggests that alcohol affects speed-accuracy trade-off strategies differently in older and younger adults.

Due to the presumed safety of moderate alcohol doses and a lack of studies investigating the interactive effects of acute alcohol consumption and aging, light and moderate social drinkers may not expect alcohol to affect their performance differently over the course of their lifetime. The data from the present study, however, suggest a need to reconsider such expectations. Although the alcohol manipulation did not affect efficiency in older adults, their performance was impaired relative to their younger counterparts who received alcohol. In conjunction with a shift in speed-accuracy trade-off strategy, this result indicates that the relationship between alcohol and performance is not constant over the lifespan of healthy moderate drinkers. These data may have practical implications for the operation of motor vehicles by older adults who have consumed small amounts of alcohol given that, compared to sober adults, they may increase their reaction times (slow down) to enhance their accuracy or correct responding as was suggested by our correlation analysis. Current work in our laboratory using a simulated driving task will allow us to further explore this possibility.

Limitations

Unfortunately, the lack of a cross-over design tempers the conclusions that can be drawn from these results. Because participants were randomized to placebo and alcohol conditions rather than receiving both doses on separate days, the change in individual performance

resulting from our alcohol manipulation could not be measured. As a result, our data are suggestive of group differences rather than causal effects of alcohol on older and younger adults. Additionally, the considerable variability previously reported (Bennett et al., 1993; Tolentino et al., 2011) in individual tolerance to alcohol's effects among social drinkers should be considered when interpreting the data from any acute administration study. However, the concern that this individual variability might confound the results of the present study are minimized by the fact that all groups were well matched on drinking habits (see Table 1) and that dose assignment was randomized within each age group.

With current trends in moderate drinking behaviors among older adults (King et al., 2009) and the understudied nature of this question, further characterization of the effects of alcohol on cognitive efficiency in older adults is clearly needed. For example, the speed and accuracy of responding has been shown to be affected differently by alcohol depending on the limb of the BrAC curve (Schweizer and Vogel-Sprott, 2008). Investigation of cognitive and behavioral processes other than efficiency as well as the effects of additional alcohol doses is also needed as alcohol's interactions with cognitive aging are likely to be process and dose specific.

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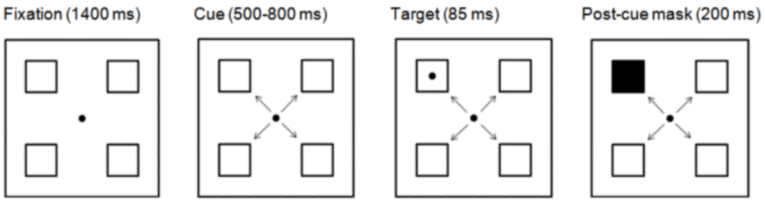

Figure 1.
Depiction of a neutral cue trial from the adaptation of the Posner Task (Luck et al, 1994). Participants were instructed to detect the presence of the target dot and indicate via button press if the target was present or not.

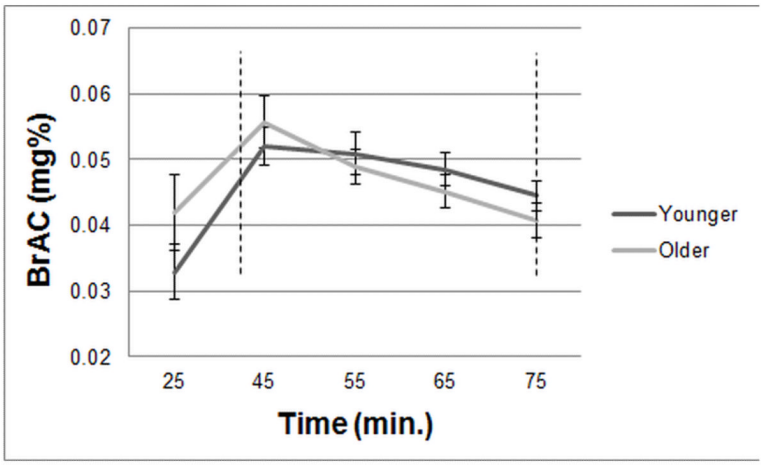

Figure 2.
Average breath alcohol concentration (BrAC) curves recorded from older and younger participants over the course of the experiment. Age group did not have an overall effect on BrAC measurements (p>.8). In addition, measurements did not differ between the two groups at any time-point (p's>.3). Dashed lines represent the start (40 min. post-administration) and end (74 min. post-administration) of the testing session.

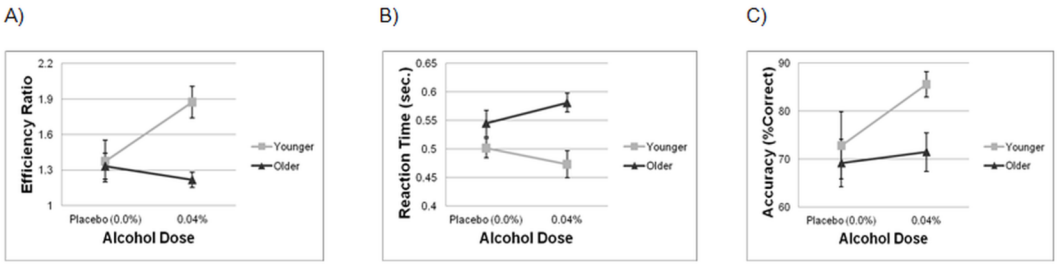

Figure 3.

Performance on the Posner Task depicted by age group and dose assignment. A) Efficiency ratios did not differ between older and younger participants in the placebo condition ($p>.9$), but the younger age group performed significantly better than the older age group in the active dose condition ($p<.01$). Alcohol also significantly increased efficiency scores among younger participants ($p=.05$). B) A significant main effect of age group was observed on RT ($p=.001$). C) Age had a trend level effect on ACC ($p=.08$).

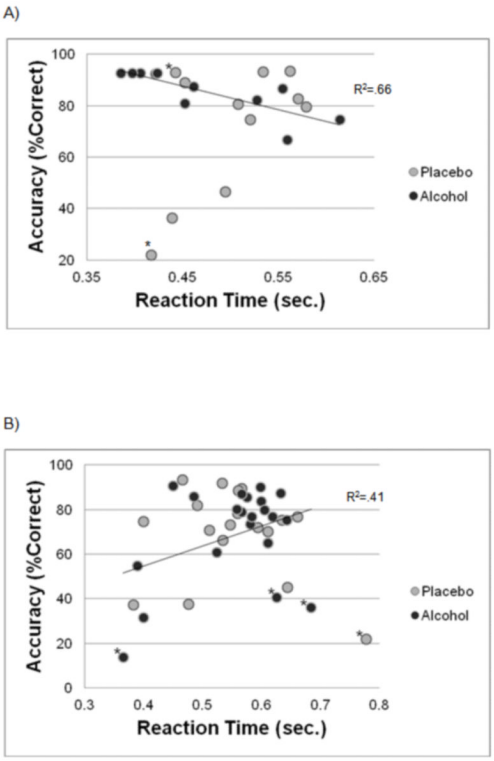

Figure 4.

Regression plots depicting the association between ACC and RT within the four experimental conditions. Asterisks (*) indicate outliers/highly influential observations which were excluded from the regression analysis depicted on the graphs (see Data Analysis). A) ACC and RT were not correlated among younger participants in the placebo condition (p>.1). ACC and RT, however, were negatively correlated in the active dose condition (p=.002). B) ACC and RT were not correlated among older participants who received a placebo dose (p>.6). However, these behavioral measures were significantly correlated in the active dose condition (p=.003).

Table 1
Demographic data by age and alcohol dose condition

	Younger		Older	
	Placebo (n=11) Mean (SD)	**Alcohol (n=11) Mean (SD)**	**Placebo (n=18) Mean (SD)**	**Alcohol (n=19) Mean (SD)**
Age*	27.82 (2.6)	29.09 (3.9)	57.17 (6.9)	56.47 (5.9)
Education*	17.36 (1.4)	18.27 (4.1)	15.28 (1.9)	16.26 (3.1)
Female, %	64	64	50	58
GDS/BDI-II[a,b]	3.73 (4.4)	5.27 (7.4)	3.94 (4.1)	4.28 (5.2)
STAI[c]	43.82 (3.9)	45.27 (7.1)	44.94 (9.8)	46.68 (6.1)
QFI[d]	0.32 (0.2)	0.72 (0.8)	0.97 (0.9)	0.50 (0.4)
MAST/G[e,f]	2.09 (2.1)	2.22 (1.7)	3.78 (3.8)	4.84 (3.1)
BMI	25.44 (3.3)	25.10 (5.1)	27.25 (4.6)	25.78 (2.6)
Avg Cig/Day[g]	0.45 (1.5)	2.64 (5.1)	0.06 (0.2)	1.09 (4.3)

*Significant differences between older and younger participants (p's<.01)

[a]Geriatric Depression Scale (Yesavage et al, 1982);

[b]Beck Depression Inventory-II (Beck et al, 1996);

[c]Spielberger State Anxiety Inventory (Spielberger, 1983);

[d]Quantity-frequency Index (Cahalan et al, 1969)

[e]Michigan Alcoholism Screening Test (Selzer, 1971)

[f]Michigan Alcoholism Screening Test-Geriatric Version (Blow, 1991)

[g]Average number of cigarettes smoked per day