McNair Scholars Research Journal

Volume 11 Article 7

2018

Cognitive Functioning Outomes after Binge Drinking and Cigarette Smoking Among a National Sample of U.S. Older Adults

Courtni M. Montgomery
cmontg11@emich.edu

Cognitive Functioning Outcomes After Binge Drinking and Cigarette Smoking Among a National Sample of U.S. Older Adults

Courtni M. Montgomery
Dr. Karen Saules, Mentor

ABSTRACT

Although the effects of chronic substance use on both improvements and impairments in cognitive functioning have been widely studied, less is known about the interactive effect that two or more substances can have on different domains of cognitive functioning in aging adults. As the number of older adults continues to grow in the U.S., along with concomitant increases in substance use in this age group, it will be crucial to better understand the impact of their substance use over time. Information processing speed will be an imperative component to consider when studying substance use in this group because of the role it plays in reasoning, working memory, and cognitive aging. To explore this, we used processing speed and substance use data on older adults (60 years and older) from the 1999--2002 National Health and Nutrition Examination Surveys. A 2 (smoke now; yes/no) by 2 (ever binge drink; yes/no) ANOVA revealed a significant main effect for alcohol on processing speed, a trend for smoking on processing speed, but a non-significant interaction term. Processing speed among non-alcohol users was significantly higher than for alcohol users. Future research should study more complex interactions between substances on the processing speed of older adults.

INTRODUCTION

Older Adults in the United States

In recent years, there has been increased interest in topics pertaining to aging adults, including declines in their cognitive ability and increases in their substance use prevalence. Public health interest in this group will continue to rise as the number of older adults sustains growth in the United States. The U.S. Census Bureau has reported that by 2050, adults aged 65 and older will become 22% of the overall U.S. population due to many factors, including the aging of the “Baby Boomers,” a decrease in fertility rates in younger generations, and a general increase in life expectancy (as cited in He, Goodkind, & Kowal, 2016). Due to this growth, it will become increasingly important to consider the physical and psychological health of this group, and, of relevance to the current study, to learn more about how certain factors affect their cognitive functioning.

The processing speed theory of cognitive aging.

Processing speed can be defined as the rate or pace at which a person interprets and responds to stimuli in their daily environment. One measure of processing speed is the Digit Symbol Substitution Test (DSST), or Digit Symbol Coding Test (DSCT), from the Wechsler Adult Intelligence Scale (WAIS). Whether processing speed is optimal at a younger age or impaired in later life, it is said to have a role in working memory and reasoning (Nettelbeck & Burns, 2010). Impaired, or slower processing speed, is partially accounted for by the degradation of cerebral white matter integrity (WMI), which is common with aging (Albinet, Boucard, Bouquet, & Audiffren, 2012). White matter pathways aid in the communication and integration of information within the brain (Turken et al., 2008). The processing speed theory of cognitive aging cites slower processing speed as an imperative factor in cognitive aging and a link to many deficits in the fluid ability/cognition (e.g., problem solving and memory) of mature adults (Riddle, 2007). When describing this theory, Salthouse (1996) suggested that delayed processing speed has deteriorating effects on certain aspects of aging adults' cognitive performance. Upon further elaboration, Salthouse (1996) explained that, when certain cognitive functions are performed too slowly, over time, specific information that is needed to complete those functions is lost or misplaced, causing those functions to be carried out in an ineffective manner. The slowed and impaired completion of different cognitive tasks is particularly notable when cognitive processes are attempted under a time limit (Salthouse, 1996).

Since this theory was proposed, much research has been done to support and maintain its validity (Albinet et al., 2012). One study controlled for crystalized ability/cognition (i.e., knowledge acquired through different environmental experiences and learning),by assessing the processing speed of middle aged and older adult twins (ages ranging from 55 to 88 years) who were separated before the age of eleven. The investigators found that slower processing speed was associated with impaired memory and spatial ability, which are components of fluid ability/cognition, or knowledge and skills that are not dependent on experience (Finkel, Reynolds, McArdle, & Pedersen, 2007). Thus, changes in processing speed that are linked to cognitive aging may also affect factors independent of learning and experience.

Protective factors of processing speed.

Slower processing speed can have an impact on many elements of the lives of aging adults, including *activities of daily living* (ADLs; e.g., grooming) and other *instrumental activities of daily living* (IADLs; e.g., shopping). Slower processing speed has been linked to the cessation of driving in this group (Edwards, Bart, O'Connor & Cissell, 2010), highlighting the impact that impaired processing speed can have on necessary, routine tasks. Recognizing different risk and protective factors, or understanding ways to improve impaired processing speed in older adults, is critical in helping this population enjoy daily life and may aid in maintaining their independence. An Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) clinical trial assessed three different cognitive interventions (or trainings), including a processing speed training, hypothesizing that this could potentially advance older adults' cognitive functioning and their performance in ADL and/or IADL functioning (Jobe et al., 2001). Trial participants were adults with a mean age of 74 years. Participants underwent approximately six weeks of 10 processing speed group trainings, which aimed to refine visual search speed through four tasks of varying difficulties (described further in Jobe et al., 2001). Booster trainings, similar to the first training, were also randomly given to participants 11 and 35 months after the initial training. Speed training provided the largest improvements, and all three trainings produced statistically significant cognitive improvement after a five-year follow-up. The booster training produced additionally increased improvements in processing speed (Tennstedt & Unverzagt, 2013). After a 10-year follow-up, those who received the speed training exhibited better processing speed abilities and IADL functioning (Rebok, Ball, & Guey, 2014).

Subsequent studies using the processing speed intervention from the ACTIVE trials have resulted in imperative findings as well. Wolinsky et al. (2010) showed that, after undergoing ten sessions of an ACTIVE speed of processing intervention, older adult participants (mean age 74) reported significant improvements in rates of self-described health compared to those in the no-contact control group after two, three, and five-year follow-ups. The investigators in this study suggested that higher perceived health rates in this population may be predictors of increased health overall. Regarding risk and protective factors for processing speed impairments, Rexroth et al. (2013) examined the effect that age, race, gender, education, and previous health conditions may have on processing speed performance, using participant data from the ACTIVE trial. This team discovered that participants of a younger age, a higher education level, and of European descent had better performance. Those with diabetes and other physical health discrepancies presented worse performance overall. The ACTIVE trial, as well as the subsequent studies described above, showcases the potential protective factors and overall improvement in processing speed that may be possible in this age group.

Substance Use among Older Adults

Alcohol use trends among older adults.

Alcohol has long been the most consistently and commonly used substance among older adults (Kuerbis, Sacco, Blazer, & Moore, 2014). Although it may be assumed that most adults decrease their alcohol intake as they age, new data suggests that there have been significant increases in alcohol consumption among older adults. A recent study (Grant et al., 2017) evaluated data from the 2001-2002 and 2012-2013 cycles of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) to track alcohol use in America among many demographics (e.g., race, age, gender) over a 10-year timeline. Adults aged 65 and older had the biggest increase (107%) in Alcohol Use Disorders (AUD) of all groups over the timespan, with 3% of aging adults meeting the AUD criteria delineated by the DSM-IV in the 2012-2013 cycle. In addition, there was a 22% increase in 12-month alcohol use and a 65% increase in high-risk 12-month alcohol use in older adults, with 55% reporting 12-month alcohol use and 4% reporting 12-month high-risk drinking.

Such large increases in alcohol use in older adults present a public health and safety issue, as alcohol use could lead to a heightened risk of falls, mortality, and comorbid alcohol and prescription medication consumption (Sacco, Bucholz, & Spitznagel, 2009; Schuckit, 2017). One cohort of older adults self-reported that their experiences with high-risk drinking are often a financial burden, cause feelings of intoxication, leave them feeling confused, and cause them to miss their meals (Gilson, Bryant, & Judd, 2017). According to Kuerbis et al. (2014), aging adults have larger susceptibility to the adverse physiological effects of alcohol because they attain higher blood-alcohol concentrations than younger ages when drinking, which, in some ways, is a result of the liver's inability to process alcohol quickly, and a greater rate of blood-brain barrier permeability (increased ability for alcohol to reach the brain) in older age. Moreover, older women may experience more negative health effects associated with alcohol intake than men for various gender-related differences. Women's overall reduction in the alcohol metabolizing enzyme known as *alcohol dehydrogenase* may expose them to enhanced effects of drinking, even with conservative portions of alcohol (Choi & DiNitto, 2011). These mechanisms could also contribute to a possible decline in the cognitive functioning of older adults. Processing speed, in particular, could be more sensitive to the effects of chronic and excessive alcohol use, due to the deteriorating effects that it may have on cerebral WMI (Sorg et al., 2015).

Effects of alcohol use on older adults' processing speed.

Normal cognitive changes associated with increased age are said to account for white matter atrophy (Harada, Natelson Love, & Triebel, 2013). As stated above, slow processing speed is also linked to a decline in WMI (Albinet et al., 2012). Kerchner et al. (2012) used seven choice response time visuospatial tests and diffusion tensor imaging (DTI) on both cognitively normal adults and older adults (mean age 70 years) to measure the relationship between slow processing speed and degenerated WMI. In this case, DTI measured WMI, and the visuospatial tests measured processing speed (described further in Kerchner et al., 2012). Degenerated WMI was found to mediate the relationship between processing speed and older age; more specifically, cognitive aging impaired WMI, which then delayed processing speed. Thus, slower processing speed can be a result of normal cognitive aging. Certain factors, however, may increase the rate at which WMI reduces in mature adults. As stated in Durazzo et al. (2014), as individuals experience normal cognitive aging, the added effects of chronic and high-risk alcohol use, known as Excessive Alcohol Disorder (AUD), are associated with cumulative and regressive changes in the structure and integrity of white matter and other brain tissue (i.e., grey matter). Further investigating this, Sorg et al. (2015) used DTI scans and the Digit Symbol Coding Test among a sample with a mean age of 49 years and found that older participants with AUD had increased WMI degeneration in combination with slower processing speed. These data illustrate a necessity to consider the relationship between alcohol intake (as well as other substance use) and processing speed among those experiencing changes in certain areas of cognitive functioning due to cognitive aging.

Reasons for alcohol use among older adults.

As alcohol use among older adults increases, it is important to understand the reasons for their alcohol consumption and the risk factors associated with it. Race, gender, education, perceived health status, socioeconomic status (SES), and religion tend to have strong influences on usage in this cohort. Aging adults at an increased risk for engaging in high risk drinking include: men, Whites, and people of higher SES (Kuerbis et al., 2014). Those at high risk of increased drinking also include those with more education, less religious affiliation, and greater perceived health (Barry & Blow, 2016). In some cases, lower education and financial burdens are associated with heavy drinking in older men (Shaw, Agahi, & Krause, 2011). Some aging adults report having strong social motives for their drinking, including drinking to gain confidence and drinking because they are involved in more social commitments or arrangements than they were in previous years (Britton & Bell, 2015; Gilson et al., 2017). In reference to gender differences, older women report having more psychological motives for drinking, such as depression (Britton & Bell, 2015). Middle-aged and older men who engage in light drinking may continue drinking as they age if they participate in daily exercise. Middle-aged men who are classified as "at-risk drinkers" or heavy drinkers (defined as having more than three drinks a day) are less likely to decline their alcohol consumption if they binge drink and have high self-perceived health (Bobo, Greek, Klepinger, & Herting, 2013).

Cigarette smoking trends among older adults.

Worldwide, and across various age groups, tobacco use accounted for roughly 100 million deaths during the 20th century and is projected to cause approximately one billion deaths in the 21st century (World Health Organization [WHO], 2008). In the United States, adults use cigarettes more than any other form of tobacco, and, in 2015, 8% of adults aged 65 and older smoked cigarettes (Jamal et al., 2016). While aging adults are not the only population that experiences negative consequences of smoking, this population is exposed to greater mortality and frailty, especially when smoking is excessive (Hubbard, Searle, Mitnitski, & Rockwood, 2009). Smoking among aging adults is also linked to increased risk of cerebrovascular disease, which may cause depression (Almeida & Pfaff, 2005). Female smokers in the 60 to 69 age group have a higher probability of heart disease, and a significantly higher risk than their male counterparts (Huxley & Woodward, 2011). One study found that, in a sample of 54- to 89-year-old participants, female ex-smokers had a 68% higher risk of developing Rheumatoid Arthritis than non-smokers (Di Giuseppe, Orsini, Alfredsson, Askling, & Wolk 2013). Generally, both male and female smokers of older age have an increased chance of developing Alzheimer's disease (AD), and, compared to ex-smokers, current older smokers may be at a particular risk for AD (Peters et al., 2008).

According to Kuerbis et al. (2014), older adults are more likely to smoke cigarettes long-term and have an increased occurrence of nicotine dependence, which may indicate lower rates of smoking cessation. Using 1995 data from the National Institutes of Health-American Association for Retired Persons Diet and Health Study, Nash, Liao, Harris, and Freedman (2017) investigated the relationship between cigarette smoking, age of smoking cessation, the age when they began smoking, and mortality among aging adults in America. Among the participants, 6% were current cigarette smokers, 5% quit after 60 years of age, 39% never smoked cigarettes, and 51% quit before 60 years of age. Those who reported being current smokers were over three times more likely to be deceased during follow-up than those who reported never smoking. Those who quit smoking during any age range had a decreased risk of mortality compared to the current smokers, and those who quit smoking between the ages of 30 and 39 years of age had the lowest risk of mortality, compared to those who quit smoking at an older age (Nash et al., 2017). These findings support the significance of smoking cessation in this population, especially at earlier ages. Further investigation of the potential health benefits of smoking cessation in later life has shown that abstinence from smoking may decrease chances of a stroke and respiratory tract diseases, and increased quality of life and physical functioning (Filion et al., 2011; Hsu & Pwu, 2004).

Effects of cigarette smoking on older adults' processing speed.

Cognitive aging or maturation in later life is said to interact with cigarette smoking, causing significant speed deficits in both current and former older smokers as they age (Durazzo, Mattsson, & Weiner, 2016). Cigarette smoking can directly affect the processing speed of older adults, as reported by several studies (Durazzo, Meyerhoff, & Nixon, 2010). For example, Hotta et al. (2015) examined gender differences in the impact of cigarette smoking on processing speed among participants with a mean age of 72 years. Both men and women who were classified as "never" smokers earned higher processing speed scores. In addition, men who smoked more cigarettes, as determined by their pack years (history of smoking), earned significantly lower scores compared to those who smoked less and non-smokers, indicating a possible gender difference in the relationship between smoking and processing speed in this cohort. Similarly, in older men between the ages of 50 and 75 years, "never" smokers had higher DSST scores compared to ex-smokers and current smokers. Furthermore, a negative correlation between DSST scores and lifetime smoking (assessed using number of pack years) was identified among the male participants, except when controlling for crystalized cognition (Stewart, Deary, Fowkes, & Price, 2006), indicating the potential influence of prior experience and learning on the relationship between cigarette smoking and cognitive functioning in older age.

Reasons for cigarette smoking among older adults.

While older adults often report a lower amount of smoking when compared to other age groups, several explanations for cigarette use in later life have been identified in the literature. A very prominent, yet mostly inaccurate incentive for smoking initiation in mature adults (also among many other age cohorts) is the belief that smoking reduces stress (Honda, 2005). According to Nordstrom et al. (2000), a strong indicator for continued smoking throughout life is the engagement in excessive smoking (defined as 26 or more cigarettes smoked per day). Those who are more likely to be current smokers in later life include, but are not limited to, those not involved in organized religion and those experiencing financial burdens (Roff et al., 2005; Shaw et al., 2011). Moore et al. (2009) found that aging adults who reported lifetime tobacco use were more likely to be males, between the ages of 65 and 74, and White. Similar to alcohol consumption, psychiatric distress is strongly associated with cigarette smoking initiation in older women. In a 2008 sample of both middle-aged and older adults, both groups of female excessive smokers reported higher psychological distress than non-excessive smokers, although, in contrast to other reports that defined excessive smoking at higher numbers of cigarettes per day, the cited study used a definition of 6 per day (Choi & DiNitto, 2011). Additionally, irrespective of gender, current older smokers may experience more psychiatric distress than ex-smokers (Honda, 2005).

Treatment for alcohol use or cigarette smoking in older adults.

In 2012, there were approximately 14,230 substance use treatment admissions for older adults, and it has been approximated that by year 2020, roughly 5.7 million adults aged 50 and older in the U.S. will have a substance use disorder (Han, Gfroerer, Colliver, & Penne, 2009; Mattson, Lipari, Hays, & Van Horn, 2017). These statistics demonstrate a public health concern and the growing need for substance abuse treatment in this population. In a sample of primarily older adults, 17% reported self-medicating with alcohol, cigarettes, a prescription medication, or another substance as a means of coping with stress (Mauro, Canham, Martins, & Spira, 2015), indicating a need for treatment methods designed to promote healthy coping mechanisms in older age groups. Regarding AUD, older adults are more receptive to treatment and have lower incidence of relapse, in some cases (Caputo et al., 2012). Social support-based programs such as Alcoholics Anonymous (Keuberis et al., 2014) and cognitive-behavioral therapy in combination with a medical aid (e.g., Naltrexone, a drug that assists in reducing alcohol cravings) have been proposed as potentially effective intervention options for AUD (Caputo et al., 2012). As stated above, smoking cessation in later life is associated with many health benefits and lower mortality. Similar to AUD interventions, age-appropriate smoking cessation treatment may include behavior-based therapy, along with a pharmacological aid such as Bupropion, a medication that helps to reduce tobacco cravings (Zbikowski, Magnusson, Pockey, Tindle, & Weaver, 2012). Physical activity has also been proposed as a healthy medium to smoking cessation (Treviño et al., 2014).

Combined usage trends among older adults.

Although there is limited data on the prevalence of comorbid alcohol intake and smoking behaviors among mature adults, cigarette use and binge drinking are said to have a strong relationship. For example, a group of older adults who engaged in cigarette smoking within the past year were more likely to have consumed five or more alcoholic beverages in one setting within the past 30 days than non-smokers (Blazer & Wu, 2012). Moreover, in a 2009 study assessing substance usage prevalence in this population, 44% of participants drank and used tobacco products concurrently within the past year (Moore et al., 2009). Choi and DiNitto (2011) observed that adults aged 50 and older who smoked cigarettes and consumed alcohol within the past 30 days were more likely to be male, White, married, have a high school diploma, and be currently employed, denoting potential risk factors for comorbid substance use in this age group.

Combined usage effects on older adults' processing speed.

Little is known about the interaction effect of alcohol and cigarette smoking on the processing speed of aging adults. Durazzo, Gazdinski, and Meyerhoff (2007) observed slower speed in individuals who have engaged in comorbid alcohol use and smoking. Using the publicly available 1999-2002 National Health and Nutrition Examination Surveys (NHANES) data, this study will further investigate these relationships by using aging adults' (ages 60 and older) DSST scores (reflective of processing speed), alcohol use, and cigarette smoking data.

Hypotheses

This study was designed to assess the effects of individual and combined alcohol intake cigarette smoking on the processing speed abilities of aging adults. We tested the following two hypotheses:

Hypothesis (1): Participants who engage in concurrent binge drinking and current cigarette smoking receive significantly lower DSST scores than participants who report only binge drinking, only cigarette smoking, or no usage.

Hypothesis (2): Participants who do not engage in either binge drinking or current cigarette smoking receive significantly higher DSST scores than participants who report only binge drinking, only cigarette smoking, or combined usage.

METHOD

Digit Symbol Substitution Test

Participants' processing speed was assessed using the DSST from the Wechsler Adult Intelligence Scale III IQ (WAIS-III) Test, which was given to NHANES participants during the household interview portion of the survey. The DSST is a memory-based measure that requires participants to match nine different symbols with their equivalent numbers in the time allotted (120 seconds). The DSST is scored on a range from 0 to 133, meaning that scores closer to 0 suggest impaired processing speed, whereas scores closer to 133 suggest higher processing speed ability. This study used data from the DSST to measure the effects of individual alcohol intake and cigarette smoking, as well as their combination, on processing speed.

Measures.

Participants' demographics relating to age, race, gender, education level, and marital status were downloaded from the NHANES website (Centers for Disease Control and Prevention [CDC], (n.d.) Publicly available NHANES data on lifetime binge drinking, cigarette smoking, and cognitive functioning were also downloaded from the CDC (n.d).

Procedures

This study used publicly available aging adults' cigarette and alcohol use data collected from 1999-2000 and 2001-2002 NHANES. NHANES is an ongoing study conducted and designed to assess health and nutrition among a sample representative of the United States population that involves a number of components, including interviews, laboratory work, and physical examinations. The 1999-2000 and 2001-2002 NHANES samples were chosen for the study due to their inclusion of a processing speed measure, whereas subsequently completed samples did not. From 1999-2010, the NHANES protocol was reviewed and approved through the National Center for Health Statistics Ethics Review Board. In regard to this present study, Institutional Review Board approval (exemption, under Pulcini as PI) was also obtained from the Eastern Michigan University Human Subjects Review Committee (UHSRC).

The selection process for participants in the 1999-2000 and 2001-2002 NHANES was as follows: (1) 15 counties in the United States that best represented the country were identified, then (2), within each county, groupings of households with a large number of family members were formed, and 20 to 24 groups of households from those counties were selected; (3) afterwards, about 30 households in each group were selected; (4) from there, NHANES interviewers collected demographic information from every household member, and (5) lastly, the final participants from whom full data were collected were selected randomly by a computer algorithm. It was this latter group from whom alcohol, cigarette smoking, and DSST data were made available.

Participants.

The 1999-2000 and 2001-2002 NHANES cycles collected data from over 21,000 individuals in the United States. Participants for the survey were selected based on how well they represented the country demographically (e.g., age, race, and health condition). Of the 21,000 participants in the survey, the DSST was only administered to the 2,975 participants who were age 60 and older. A total of 2,101 of these participants had valid data on alcohol usage, and 1,564 provided data on current smoking status. Because we were interested in relationships between DSST score, alcohol use, and smoking, the analyses presented here are limited to the 1,290 participants who had complete data on all of these variables.

The average age of the participants was 70.30 years (SD=7.475). The sample's overall composition in regard to race was 62.6% Non-Hispanic White, 18.6% Mexican American, 14.3% Non-Hispanic Black, and 4.6% Other. Those who identified as male made up a majority of the sample size at 64.6%, while 35.4% of participants identified as female. In regard to marital status, 64.0% of participants were married, and 19.8% were widowed. Data on their education level showed that 23.6% of participants had graduated from high school or received their GED, 21.2% had completed some college, and 16.1% were college graduates. See Table 1. for a summary of participant demographics.

Demographic variables			**All participants (n=1290)**
Gender (% male)			64.6%
Race (% White)			62.6%
Age			70.30 ± 7.475
Marital Status (% married)			64.0%
Education Level (% at least high school/GED)			23.6%

Table 1. Demographic data on the study participants.

RESULTS

Binge Drinking and Smoking Prevalence by Demographics.

Demographically, male participants were significantly more likely to engage in binge drinking, with 30.0% of men reporting lifetime drinking of five or more drinks in one episode. Although not significant, more women than men reported current smoking, at 24.9%. Non-White participants were significantly more likely to engage in binge drinking and current smoking, with 28.4% of non-Whites endorsing binge drinking, and 26.9% of non-Whites identifying as current smokers. Similarly, those who did not complete a high school diploma/GED were significantly more likely to engage in both binge drinking and current smoking, with 30.8% and 19.0% of those with an education lower than high school engaging in binge drinking and current smoking, respectively. See Table 2. for a summary of participants' alcohol and cigarette smoking prevalence.

Demographic Variables	Binge Drinking = YES	Smoking some or all days = YES
Gender: % Men	30.0%	21.6%
% Women	8.3%***	24.9%
Race: % Whites	18.7%	20.3%
% Non-Whites	28.4%***	26.9%**
Educ: % less than HS	30.8%	28.8%
% HS or more	16.9%***	19.0%***

Table 2. Participants' alcohol and cigarette smoking prevalence. ****p<.001; **p<.01*

Binge drinking and smoking prevalence.

The majority (60.5% (n=781) of the sample reported no binge drinking/smoking. In regard to drinking only (in the absence of smoking), 16.7% (n= 215) of participants reported having one or multiple periods of consuming five or more drinks per day. Data on smoking in the absence of binge drinking showed that 17.1% (n= 221) of participants identified as current smokers. In regard to both drinking/smoking, 5.7% (n=73) of participants reported lifetime binge drinking in combination with current cigarette smoking. Additionally, both groups of current smokers were significantly younger than the binge drinking only and no drink/smoke group. See Table 3. for a summary of participants' alcohol and cigarette use.

Drinking and smoking on processing speed.

We were interested in the possible interaction of smoking and alcohol use on processing speed. Two variables were suitable for this analysis: the SMQ040 variable and the ALC150 variable, which measured drinking and smoking prevalence among the participants. The SMQ040 variable assessed whether the participant identified as a current smoker, and the ALC150 variable assessed whether the participant ever had one or more periods of consuming five or more drinks each day (lifetime excessive binge drinking). See Appendix for a description of the variables.

The no binge-drinking/smoking group had the highest mean DSST score of all other groups at 44.31 (± 18.28), followed by the smoking-only group at 41.96 (± 18.32). The binge drinking-only group followed at 37.04 (± 16.66). The both binge drinking/smoking group had the lowest score at 33.95 (± 16.57). The no drinking/smoking group's DSST score was significantly better than the drinking-only and both drinking/smoking group's scores. Further, the smoking-only group's DSST score was significantly higher than the alcohol-only group and both drinking/smoking-group's scores. See Figure 3.

A 2 (smoke now; yes/no) by 2 (ever binge drink; yes/no) ANOVA was conducted, revealing a significant main effect for alcohol on processing speed, a trend for smoking on processing speed, and a non-significant interaction term, $F(3,1296) = 14.71$, $p<.001$. Notably, DSST scores differed significantly within both the non-smoker, $t(994)=5.26$, $p<.001$ and smoker groups, $t(292)=3.32$, $p<.001$.

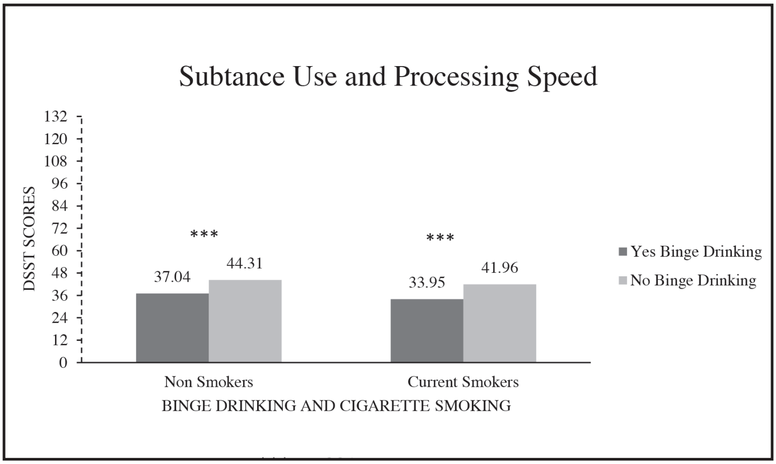

Figure 3. DSST scores for substance use and processing speeds. **** p<.001*

Hypothesis 1.

Although participants who engaged in both drinking/smoking received the lowest DSST scores out of all other participants (33.95 ± 16.56), the interaction term was not significant. Thus, our findings did not support our main hypothesis.

Hypothesis 2.

It was hypothesized that participants who reported no binge drinking/smoking would have higher DSST scores than all other participants. Indeed, the no drinking/smoking group had the highest DSST score at 44.31 ±18.28. Additionally, the group's score was significantly higher than the drinking-only and both drinking/smoking-group's scores, but not significantly higher than the smoking only group's score. Thus, our findings partially supported our hypothesis.

DISCUSSION

We used data from the NHANES 1999-2000 and 2001-2002 cycles to assess the effects of alcohol intake, cigarette smoking, and combined usage on aging adults' processing speed abilities. Contrary to our main hypothesis, our results concluded that there was no significant effect of combined lifetime binge drinking and current smoking on processing speed in later life. However, there was a significant main effect for alcohol on processing speed. Those who did report binge drinking had significantly lower scores than those who did not. These results are congruent with past findings on alcohol's detrimental impact on processing speed in later life. Although previous literature has suggested a slowing of processing speed as a result of smoking in older age, our results show the opposite. Older adults who were current smokers displayed an overall higher rate of processing speed.

In regard to demographics, both the smoking-only group and the both drinking/smoking-group were significantly younger than both non-smoking groups. This may suggest a higher mortality rate in the smoking-only group, as this study's results mirror many former findings of heightened mortality among aging adults who have engaged in both past and present cigarette use. Moreover, men were significantly more likely to drink than women, but not more likely to smoke. Whites were less likely to engage in both smoking-only and drinking-only, a finding that is not commonly found in this age group, as indicated by previous studies.

While it is important to control for confounding variables, such as depression and dementia, when investigating cognitive functioning in older cohorts, our use of secondary data limited our ability to consider and analyze such potential confounds properly. These limitations could possibly explain the non-significant interaction effect and increased processing speed observed among current smokers. In addition, the analysis of the combined influence that other substances may have on the cognitive functioning in older age was also hindered due to limitations of using archival data. Future research should study more complex interactions between substances on the processing speed of aging adults.

REFERENCES

Albinet, C. T., Boucard, G., Bouquet, C. A., & Audiffren, M. (2012). Processing speed and executive functions in cognitive aging: How to disentangle their mutual relationship? *Brain and Cognition,* 79(1), 1-11. doi:10.1016/j.bandc.2012.02.001

Almeida, O. P., & Pfaff, J. J. (2005). Depression and smoking amongst older general practice patients. *Journal of Affective Disorder*s, 86(2–3), 317–321. doi:10.1016/j.jad.2005.02.014

Barry, K. L. & Blow F. C. (2016). Drinking over the lifespan: Focus on older adults. *Alcohol Research*, 38(1), 115-120. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4872606/

Blazer, D. G., & Wu, L. T. (2012). Patterns of tobacco use and tobacco-related psychiatric morbidity and substance use among middle-aged and older adults in the United States. *Aging Mental Health*, 16(3), 296-304. doi:10.1080/13607863.2011.615739

Bobo, J. K., Greek, A. A., Klepinger, D. H., & Herting, J. R. (2013). Predicting 10-year alcohol use trajectories among men age 50 years and older. *American Journal of Geriatric Psychiatry*, 21(2), 204-213. doi:10.1016/j.jagp.2012.10.021

Britton, A., & Bell, S. (2015). Reasons why people change their alcohol consumption in later life: Findings from the Whitehall II cohort study. *PLoS ONE*, 10(3), 1-8. doi:10.1371/journal.pone.0119421

Caputo, F., Vignoli, T., Leggio, L., Addolorato, G., Zoli, G., & Bernardi, M. (2012). Alcohol use disorders in the elderly: A brief overview from epidemiology to treatment options. *Experimental Gerontology*, 47(6), 411-416. doi:10.1016/j.exger.2012.03.019

Centers for Disease Control and Prevention. (n.d.). *National Health and Nutrition Examination Survey*. Retrieved from https://wwwn.cdc.gov/nchs/nhanes

Choi, N. G. & DiNitto, D. M. (2011). Drinking, smoking, and psychological distress in middle and late life. *Aging & Mental Health*, 15(6), 720-731. doi:10.1080/13607863.2010.551343

Di Giuseppe, D., Orsini, N., Alfredsson, L., Askling, J., & Wolk, A. (2013). Cigarette smoking and smoking cessation in relation to risk of rheumatoid arthritis in women. *Arthritis Research & Therapy*, 15(2), 1-7. doi:10.1186/ar4218

Durazzo, T. C., Gazdzinski, S., & Meyerhoff, D. J. (2007). The neurobiological and neurocognitive consequences of chronic cigarette smoking in alcohol use disorders. *Alcohol and Alcoholism*, 42(3), 174-185. doi:10.1093/alcalc/agm020

Durazzo, T. C., Mattsson, N., & Weiner, M. W. (2016). Interaction of cigarette smoking history with APOE genotype and age on amyloid level, glucose metabolism, and neurocognition in cognitively normal elders. Nicotine and *Tobacco Research*, 18(2), 204–211. doi:10.1093/ntr/ntv075

Durazzo, T. C., Meyerhoff, D. J., & Nixon, S. J. (2010). Chronic cigarette smoking: Implications for neurocognition and brain neurobiology. *International Journal of Environmental Research and Public Health*, 7(10), 3760–3791. doi:10.3390/ijerph7103760

Durazzo, T. C., Mon, A., Pennington, D., Abé, C., Gazdzinski, S., & Meyerhoff, D. J. (2014). Interactive effects of chronic cigarette smoking and age on brain volumes in controls and alcohol-dependent individuals in early abstinence. *Addiction Biology*, 19(1), 132–143. doi:10.1111/j.1369-1600.2012.00492.x

Edwards, J. D., Bart, E., O'Connor, M. L., & Cissell, G. (2010). Ten years down the road: Predictors of driving cessation. *Gerontologis*t, 50(3), 393-399. doi:10.1093/geront/gnp127

Filion, K. B., Steffen, L. M., Duval, S., Jacobs, D. R., Blackburn, H., & Luepker, R. V. (2011). Population-based smoking trends in older adults: The Minnesota Heart Survey. *Journal of the American Geriatrics Society*, 59(10), 1970-1971. doi:10.1111/j.1532-5415.2011.03610_7.x

Finkel, D., Reynolds, C. A., McArdle, J. J., & Pedersen, N. L. (2007). Age changes in processing speed as a leading indicator of cognitive aging. *Psychology and Aging*, 22(3), 558-568. doi:10.1037/0882-7974.22.3.558

Gilson, K. M., Bryant, C., & Judd, F. (2017). Understanding older problem drinkers: The role of drinking to cope. *Addictive Behaviors*, 64, 101-106. doi:10.1016/j.addbeh.2016.08.032

Grant, B. F., Chou, S. P., Saha, T. D., Pickering, R. P., Kerridge, B. T., Ruan, W. J., … Hasin, D. S. (2017). Prevalence of 12-month alcohol use, high-risk drinking, and DSM-IV alcohol use disorder in the United States, 2001-2002 to 2012-2013: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *JAMA Psychiatry*, 74(9), 911-923. doi:10.1001/jamapsychiatry.2017.2161

Han, B., Gfroerer, J. C., Colliver, J. D., & Penne, M. A. (2009). Substance use disorder among older adults in the United States in 2020. *Addiction*, 104(1), 88-96. doi:10.1111/j.1360-0443.2008.02411.x

Harada, C. N., Natelson Love, M. C., & Triebel, K. L. (2013). Normal cognitive aging. *Clinics in Geriatric Medicine*, 29(4), 737-752. doi:10.1016/j.cger.2013.07.002

He, W., Goodkind, D., & Kowal, P. (2016). U.S. Census Bureau, International Population Reports, P95/16-1, An Aging World: 2015, U.S. Government Publishing Office, Washington, DC, 2016. Retrieved from https://www.census.gov/library/publications/2016/demo/P95-16-1.html

Honda, K. (2005). Psychosocial correlates of smoking cessation among elderly ever-smokers in the United States. *Addictive Behaviors*, 30(2), 375-381. doi:10.1016/j.addbeh.2004.05.009

Hotta, R., Doi, T., Shimada, H., Makizako, H., Yoshida, D., Anan, Y., … Suzuki, T. (2015). Cigarette smoking and cognitive health in elderly Japanese. *American Journal of Health Behavior*, 39(3), 294-300. doi:10.5993/AJHB.39.3.1

Hubbard, R. E., Searle, S. D., Mitnitski, A., & Rockwood, K. (2009). Effect of smoking on the accumulation of deficits, frailty and survival in older adults: A secondary analysis from the Canadian study of health and aging. Journal of *Nutrition, Health and Aging*, 13(5), 468-472. doi:10.1007/s12603-009-0085-y

Huxley, R. R., & Woodward, M. (2011). Cigarette smoking as a risk factor for coronary heart disease in women compared with men: A systematic review and meta-analysis of prospective cohort studies. *Lancet*, 378(9799), 1297-1305. doi:10.1016/S0140-6736(11)60781-2

Hsu, H. C., & Pwu, R. F. (2004). Too late to quit? Effect of smoking and smoking cessation on morbidity and mortality among the elderly in a longitudinal study. *Kaohsiung Journal of Medical Science*s, 20, 484-491. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/15553808

Jamal, A., King, B.A., Neff, L.J., Whitmill, J., Babb, S.D., & Graffunder, C.M. (2016). Current cigarette smoking among adults — United States, 2005–2015. *Morbidity and Mortality Weekly Report*, 65, 1205-1211. doi:10.15585/mmwr.mm6544a2

Jobe, J. B., Smith, D. M., Ball, K., Tennstedt, S. L., Marsiske, M., Willis, S. L., … Kleinman, K. (2001). Active: A cognitive intervention trial to promote independence in older adults. *Controlled Clinical Trials*, 22(4), 453-479. doi:10.1016/S0197-2456(01)00139-8

Kerchner, G. A., Racine, C. A., Hale, S., Wilheim, R., Laluz, V., Miller, B. L., & Kramer, J. H. (2012). Cognitive processing speed in older adults: Relationship with white matter integrity. *PLoS ONE*, 7(11), 1-10. doi:10.1371/journal.pone.0050425

Kuerbis, A., Sacco, P., Blazer, D. G., & Moore, A. A. (2014). Substance abuse among older adults. *Clinics in Geriatric Medicine*, 30(3), 629-654. doi:10.1016/j.cger.2014.04.008

Mattson, M., Lipari, R. N., Hays, C., & Van Horn, S. L. (2017). *A day in the life of older adults: Substance use facts. The CBHSQ Report*. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/28650597

Mauro, P. M., Canham, S. L., Martins, S. S., & Spira, A. P. (2015). Substance-use coping and self-rated health among US middle-aged and older adults. *Addictive Behaviors*, 42, 96-100. doi:10.1016/j.addbeh.2014.10.031

Moore, A. A., Karno, M. P., Grella, C. E., Lin, J. C., Warda, U., Liao, D. H., & Hu, P. (2009). Alcohol, tobacco, and nonmedical drug use in older U.S. adults: Data from the 2001/02 national epidemiologic survey of alcohol and related conditions. *Journal of the American Geriatrics Society*, 57(12), 2275-2281. doi:10.1111/j.1532-5415.2009.02554.x

Nash, S. H., Liao, L. M., Harris, T. B., & Freedman, N. D. (2017). Cigarette smoking and mortality in adults aged 70 years and older: Results from the NIH-AARP cohort. *American Journal of Preventive Medicine*, 52(3). doi:10.1016/j.amepre.2016.09.036

Nettelbeck, T., & Burns, N. R. (2010). Processing speed, working memory and reasoning ability from childhood to old age. *Personality and Individual Differences*, 48(4), 379-384. doi:10.1016/j.paid.2009.10.032

Nordstrom, B. L., Kinnunen, T., Utman, C. H., Krall, E. A., Vokonas, P. S., & Garvey, A. J. (2000). Predictors of continued smoking over 25 years of follow-up in the normative aging study. American *Journal of Public Health,* 90(3), 404-406. doi:10.2105/AJPH.90.3.404

Peters, R., Poulter, R., Warner, J., Beckett, N., Burch, L., & Bulpitt, C. (2008). Smoking, dementia and cognitive decline in the elderly, a systematic review. *BMC Geriatrics*, 8(32), 36-43. doi:10.1186/1471-2318-8-36

Rebok, G., Ball, K., & Guey, L. (2014). Ten-year effects of the ACTIVE cognitive training trial on cognition and everyday functioning in older adults. *Journal of the American Geriatrics Society*, 62(1), 16-24. doi:10.1111/jgs.12607.Ten-Year

Rexroth, D. F., Tennstedt, S. L., Jones, R. N., Guey, L. T., Rebok, G. W., Marsiske, M. M.,…Unverzagt, F. W. (2013). Relationship of demographic and health factors to cognition in older adults in the ACTIVE study. *Journal of Aging Health,* 25(8), 128S-146S. doi:10.1177/0898264313498415

Riddle, D. R. (2007). *Brain aging: Models, methods, and mechanism*s. Boca Raton, FL: CRC Press.

Roff, L. L., Klemmack, D. L., Parker, M., Koenig, H. G., Sawyer-Baker, P., & Allman, R. M. (2005). Religiosity, smoking, exercise, and obesity among southern, community-dwelling older adults. *Journal of Applied Gerontology*, 24(4), 337-354. doi:10.1177/0733464805278132

Sacco, P., Bucholz, K. K., & Spitznagel, E. L. (2009). Alcohol use among older adults in the National Epidemiologic Survey on Alcohol and Related Conditions: A latent class analysis. *Journal of Studies on Alcohol & Drugs*, 70(6), 829-838. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/19895759

Salthouse, T. A. (1996). The processing speed theory of adult age differences in cognition. *Psychological Review*, 103(3), 403-428. doi:10.1037/0033-295X.103.3.403

Schuckit, M. A. (2017). Remarkable increases in alcohol use disorders. *JAMA* Psychiatry, 74(9), 869-870. doi:10.1001/jamapsychiatry.2017.1981

Shaw, B. A., Agahi, N., & Krause, N. (2011). Are changes in financial strain associated with changes in alcohol use and smoking among older adults? *Journal of Studies on Alcohol and Drugs*, 72(6), 917-925. doi:10.15288/jsad.2011.72.917

Sorg, S. F., Squeglia, L. M., Taylor, M. J., Alhassoon, O. M., Delano-Wood, L. M., & Grant, I. (2015). Effects of aging on frontal white matter microstructure in alcohol use disorder and associations with processing speed. *Journal of Studies on Alcohol and Drugs*, 76(2), 296-306. doi:10.15288/JSAD.2015.76.296

Stewart, M. C. W., Deary, I. J., Fowkes, F. G. R., & Price, J. F. (2006). Relationship between lifetime smoking, smoking status at older age and human cognitive function. Neuroepidemiology, 26(2), 83-92. doi:10.1159/000090253

Tennstedt, S. L., & Unverzagt, F. W. (2013). The ACTIVE study: Study overview and major findings. *Journal of Aging & Health,* 25(8), 3S-20S. doi:10.1177/0898264313518133

Treviño, L. A., Baker, L., McIntosh, S., Mustian, K., Seplaki, C. L., Guido, J. J., & Ossip, D. J. (2014). Physical activity as a coping strategy for smoking cessation in mid-life and older adults. *Addictive Behavior*s, 39(5), 885-888. doi:10.1016/j.addbeh.2014.01.014

Turken, A. U., Whitfield-Gabrieli, S., Bammer, R., Baldo, J. V., Dronkers, N. F., & Gabrieli, J. D. E. (2008). Cognitive processing speed and the structure of white matter pathways: Convergent evidence from normal variation and lesion studies. *NeuroImage*, 42(2), 1032-1044. doi:10.1016/j.neuroimage.2008.03.057

Wolinsky, F. D., Vander Weg, M. W., Martin, R., Unverzaft, F. W., Willis, S. L., Marsiske, M.,… Tennstedt, S. L. (2010). Does cognitive training improve internal locus of control among older adults? Journal of Gerontology. Series B, *Psychological Sciences and Social Sciences*, 65B(5), 591-598. doi:10.1093/geronb/gbp117

World Health Organization. (2008). WHO report on the global tobacco epidemic 2008. Retrieved from http://www.who.int/tobacco/mpower/mpower_report_full_2008.pdf

Zbikowski, S. M., Magnusson, B., Pockey, J. R., Tindle, H. A., & Weaver, K. E. (2012). A review of smoking cessation interventions for smokers aged 50 and older. *Maturitas*, 71(2), 131-41. doi:10.1016/j.maturitas.2011.11.019

APPENDIX

Binge Drinking and Smoking Measures

SMQ040: Do you now smoke cigarettes? Score: Every day – 1 / Some days – 2 / Not at all – 3

ALQ150: Was there ever a time or times in your life when you drank 5 or more drinks of any kind of alcoholic beverage almost every day? Score: Yes – 1 / No – 2