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Addictive Behaviors 30 (2005) 301–314
ADDICTIVE BEHAVIORS

Memory, executive cognitive function, and readiness to change drinking behavior

Arthur W. Blume[a,*], Karen B. Schmaling[a,b], G. Alan Marlatt[c]

[a]*Department of Psychology, University of Texas at El Paso, Room 224, El Paso, TX 79968-0553, USA*
[b]*Office of the Provost, USA*
[c]*Department of Psychology, University of Washington, USA*

Abstract

The transtheoretical model of Prochaska and DiClemente [*Psychother. Theory Res. Prac. 19* (1982) 276] postulates that cognitive skills are critical for drinking behavior change. Memory and executive cognitive function likely influence the execution of skills that are implicated for both motivating and sustaining drinking behavior change. Participants who met criteria for alcohol abuse or dependence ($N = 117$) were administered a battery of standardized memory and executive cognitive function tests that included the Wechsler Memory Scale-Revised (WMS-R), Controlled Oral Word Association Test (COWAT), Ruff Figural Fluency Test (RFFT), and Wisconsin Card Sort Test (WCST). Lower verbal and higher delayed recall memory score at baseline significantly predicted precontemplation, higher verbal memory scores predicted contemplation, and better attention–concentration at baseline significantly predicted reduced drinking at 3-month follow-up, after controlling for baseline alcohol consumption. The study findings indicate that explicit memory processes may have utility for predicting readiness to change drinking behavior.

Keywords: Memory; Executive cognitive function; Motivation; Alcohol; Transtheoretical

1. Introduction

Alcohol abuse has been associated with memory and executive cognitive dysfunction, including problems with attention–concentration and regulation of behavior (Kolb &

* Corresponding author. Tel.: +1-915-747-6056; fax: +1-915-747-6553.
E-mail address: ablume@utep.edu (A.W. Blume).

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doi:10.1016/j.addbeh.2004.05.019

Whishaw, 1996; Lezak, 1995). For example, chronic alcohol abuse has been associated with short-term memory and learning problems that are often exacerbated by task complexity (Ryan & Butters, 1986), and drinking to intoxication has been associated with difficulties in novel and effortful learning associated with verbal memory tasks (Tracy & Bates, 1999). It was once thought that only long-term chronic alcohol abuse was associated with cognitive problems, but new evidence suggests that even adolescent abusers of alcohol may be at risk for cognitive impairment (Brown, Tapert, Granholm, & Delis, 2000). Furthermore, motivation to change and self-regulation of drinking behavior may be significantly associated with memory and executive cognitive function (Blume, Davis, & Schmaling, 1999; Giancola & Moss, 1998).

The Transtheoretical Stages of Change Model (Prochaska & DiClemente, 1982; Prochaska, DiClemente, & Norcross, 1992) posits that cognitive skills are involved with successful health behavior change, being associated with both the motivation to change behavior and the ability to regulate and control behavior while taking action to change. According to the transtheoretical model, cognitive processes related to motivation seem to be most important during earlier stages of change (e.g., precontemplation, contemplation, and preparation), when awareness of drinking problems is of primary concern (Perz, DiClemente, & Carbonari, 1996). For example, recalling the consequences of alcohol use seems to be a source of motivation for drinking behavior change (Blume & Marlatt, 2000; Blume & Schmaling, 1996; Miller & Rollnick, 2002; Prochaska & DiClemente, 1982; Prochaska et al., 1992).

On the other hand, some people may be motivated but unable to successfully reach their goals for drinking reduction. The transtheoretical model posits that cognitive processes related to the self-regulation of behavior are associated with successful behavior change during the action and maintenance stages (Perz et al., 1996). Difficulties in maintaining drinking behavior change may be related to misjudgments, misperceptions, and the inability to plan well and follow through on plans. People who cannot maintain behavior change often find it difficult to identify high-risk drinking situations, to elicit skillful behavioral responses within those situations, and may make apparently irrelevant decisions that place them in such situations (Marlatt, 1985). Problems with self-regulation of behavior may be associated with the loss of control common to addictive behaviors (Baumeister, Heatherton, & Tice, 1994; Kanfer, 1970). Memory and executive cognitive function skills also may be associated with the ability to identify high-risk situations, to make healthy decisions, or to use the appropriate coping skills at the appropriate time among people interested in behavior change.

Examining the relationship of memory and executive cognitive function with readiness to change drinking behavior seems to be another step toward better understanding of what factors may influence behavior change among people abusing alcohol. To examine this association, 117 participants who met criteria for alcohol abuse or dependence, without other neurocognitive risk factors, were administered a neuropsychological test battery assessing memory and executive cognitive function. It was hypothesized that better memory and executive cognitive functions would predict greater motivation to change drinking and better self-regulation of drinking behavior via reduction in alcohol consumption over time.

2. Method

2.1. Participants

Participants ($N = 117$) aged 18–50 (mean = 26.55; S.D. = 8.87), of both genders, who met *Diagnostic and Statistical Manual of Mental Disorders-IV* (*DSM-IV*; American Psychiatric Association, 1994) criteria for alcohol abuse or dependence, constituted the sample. The participants were mostly men (see Table 1; $n = 70$, 59.8%) and predominantly White ($n = 88$, 75.2%). The typical participant had completed almost 3 years of college education (mean years of education = 14.90; S.D. = 1.86), and less than 3% of the sample identified themselves as unemployed ($n = 3$). Most of the participants identified themselves as "single" ($n = 91$, 77.8%). Most of the study participants met *DSM-IV* criteria for alcohol

Table 1
Descriptive data concerning the participants

Variable	Mean	S.D.
Age	26.55	8.87
Education	14.90	1.86
Variable	***N***	**%**
Gender		
Men	70	59.8
Women	47	40.2
Racial identity		
African American	3	2.6
Asian	12	10.3
Latino	6	5.1
Native American	3	2.6
Pacific Islander	5	4.3
White	88	75.2
Partnership status		
Common law	11	9.4
Married	12	10.2
Separated	3	2.6
Single	91	77.8
Employment status		
At least half-time[a]	114	97.4
Unemployed	3	2.6
Levels of personal income		
< 10,000	70	59.9
10,000–20,000	12	10.3
20,000–30,000	19	16.2
30,000–50,000	10	8.5
> 50,000	6	5.1

[a] Employed includes people who describe themselves as homemakers.

dependence ($n = 76$, 65.0%) rather than alcohol abuse. Very few of the participants had previous alcohol treatment ($n = 9$, 7.7%); of those participants, three had been in treatment twice.

Potential participants were excluded from the study if English were not their first language (because of the nature of the neuropsychological tests) and if they had a history of any neurocognitive insults, such as loss of consciousness for greater than five minutes, extensive exposure to heavy metals, pesticides, herbicides, solvents, or paints, intravenous or subcutaneous drug use, or any neurological diseases or conditions. Furthermore, potential participants were excluded if they met *DSM-IV* criteria for substance use disorders other than nicotine dependence or alcohol dependence and abuse. However, many participants reported the use of substances other than alcohol ($n = 46$, 39.3%) during their lifetime, with the majority reporting marijuana use in addition to alcohol ($n = 40$), and 10 participants reported the use of substances other than alcohol in the last year (again, primarily, marijuana with alcohol; $n = 8$) that did not meet criteria for abuse or dependence.

There were three points of contact with participants who completed the study, with the second point of contact being face to face: initial phone contact, screening and assessment session, and phone follow-up session. The study was described in great detail to potential participants during the initial phone contact, with a review of inclusion and exclusion criteria. Because the potential participants were allowed to disqualify themselves after hearing the review of these study criteria during the initial phone inquiry, it is difficult to know precisely how many excluded themselves for these reasons. Potential participants ($n = 129$) interested in the study were scheduled for an in-person screening session. Eight potential participants were disqualified from the study during the screening session for failing to meet the study criteria, and one participant who completed the screening session and did qualify for the study chose not to participate in the rest of the study. Although potential participants were instructed not to drink 24 h prior to the screening and assessment session, three participants reported to the screening session after consuming alcohol (detected by a sniff test and a question asking if they abided by the no-drinking requests), and they were not tested. This left 117 participants who completed the baseline assessment.

2.2. Measures

The Structured Clinical Interview for *DSM-IV* (SCID; First, Gibbon, Spitzer, & Williams, 1995) was used to screen for current or historic psychotic disorders and nonalcohol substance abuse or dependence and to verify alcohol abuse or dependence. A brief interview was utilized to ask about other neurocognitive risk factors (see exclusion criteria above).

2.2.1. Drinking measures

To test the study hypotheses, the following measures were utilized to assess the pertinent domains. The Steady Pattern Chart (SP) from the *Comprehensive Drinker Profile* (Marlatt & Miller, 1984), a structured interview that assesses total standard drinks consumed during the

previous 3 months, was utilized to determine both baseline and 3-month follow-up drinking rates. Second, the Brief Readiness to Change Questionnaire (RTC), a self-report instrument based upon the Transtheoretical Stages of Change Model mentioned above, was administered to the participants to assess awareness of problem drinking, as well as recent changes in drinking behavior (Rollnick, Heather, Gold, & Hall, 1992). The RTC, which has good reliability and validity (Heather, Rollnick, & Bell, 1993), has three subscale stage scores based upon the transtheoretical model: precontemplation (P; unawareness for the need to, or lack of readiness for change, scale score range from −8 to 8), contemplation (C; considering the need and desirability of changing drinking behavior, scale score range from −8 to 8), and action (current reports of drinking reduction, scale score range from −8 to 8). Each of these scale scores were used in the study as dependent variables.

2.2.2. Neuropsychological measures

All of the neuropsychological measures administered produced standardized scores with age-based norms that were utilized in this study. Three measures of executive cognitive function were administered to the participants. First, the Controlled Oral Word Association Test (COWAT; Benton & de Hamsher, 1989; see below) was administered. Word generation also has been found to be a reliable test of left frontal and executive cognitive functions (Lezak, 1995; Spreen & Strauss, 1998). The percentile scores for total word generation were used as a predictor variable. Second, the Ruff Figural Fluency Test (RFFT; Ruff, 1996) was administered. The RFFT has been found to measure right frontal and executive cognitive function. The unique designs and perseverative error percentile scores from the RFFT were used as predictor variables. Unique design scores measure the number of different designs that the participant generates in the five 1-min trials, whereas the perseverative error scores measure repeated mistakes in behavioral performance, in this case, the inability to generate novel behaviors under a timed condition. Third, the Wisconsin Card Sort Test (WCST; Berg, 1948; Grant & Berg, 1948; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) was administered. The WCST measures the executive cognitive functions of mental flexibility and complex problem-solving abilities amidst a set-shifting context. Perseverative error (repeated mistakes in matching the cards after being told of the incorrect response) and nonperseverative error scores (unrepeated mistakes; Heaton et al., 1993), were used as predictor variables. Finally, one comprehensive test for memory, the Wechsler Memory Scale-Revised (WMS-R; Wechsler, 1987), was administered. For the purposes of this study, the verbal memory, the visual memory, attention–concentration, and delayed recall indices were used as predictor variables to assess the different domains of memory.[1]

[1] At the time of the development of this research proposal, the WMS-R was the gold standard for assessing memory function, although it has since been updated and other memory measures have since been developed. Although other memory tests were considered for this study, the WMS-R was ultimately selected because it offered the ability to assess a variety of different aspects of memory (e.g., verbal, visual, attention–concentration, and delayed recall) within the administration of one validated measure.

2.2.3. Procedure

Recruitment occurred via newspaper advertisement and posted fliers describing the study. Potential participants expressed interest in the study by calling a research assistant. A brief review of the inclusion and exclusion criteria was made during the initial phone contact to inform the potential participants as to whether they may qualify. A review of the study protocol was given, questions were answered, and the potential participant was invited to the screening session if still interested. This research protocol was reviewed and approved by an institutional review board, and the researchers stringently followed the ethical guidelines of their profession during all aspects of the research study.

Because this study was not intended as an intervention study, the participants were not expected to be abstinent at baseline. Our intent was to examine the naturalistic changes over time as a first step to studying the relationship of memory and executive cognitive function with drinking behavior while the person was still drinking, the condition under which decisions about drinking behavior would be made. However, the participants were told at the time of the phone inquiry to abstain from substance use for 24 h before these tests were administered (to exclude intoxication at time of testing) and were asked about compliance with this request prior to administration of tests. A sniff test was conducted by the research assistant prior to the screening interview. Intelligence was not assessed in this study because of concerns about the similarities of the Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981) and the WMS-R (which have some overlap in subtests). However, levels of education in years were collected and used as a covariate in analyses. Levels of education have been found to be highly correlated with intelligence quotients in past research (Matarazzo, 1972).

2.2.4. Baseline session

First, the SCID and the neurocognitive risk factor questions were administered as part of the screen to potential participants to exclude other drug dependencies, *DSM-IV* Axis I psychotic disorders, and other neurological insults. Potential participants who met exclusionary criteria were thanked for their interest and excused from further participation. Next, demographic variables were collected, such as level of education in years, and the SP was administered to establish the baseline drinking rates. Finally, the RTC was completed by the participants, followed by the administration of the WMS-R, RFFT, COWAT, and WCST. The SCID, neuropsychological tests, and all other measures were administered by one highly experienced psychometrist who had been trained to adherence on all measures. The participants were paid US$50 by check after completing the assessment session.

2.2.5. Follow-up session

The participants were mailed a letter reminding them of the follow-up interview at approximately 10 weeks following the assessment session. Approximately 12 weeks after assessment, the participants completed the SP by phone. This interview took approximately 10 minutes to complete. As a last resort, if contact was not made by phone, the SP was mailed with a letter explaining how to complete it and a self-addressed stamped return envelope for

return. Those who completed the SP in this fashion were noted because of potential underreporting of drinking amounts by mail. Participants who completed the follow-up SP were mailed an additional US$5 check for completing the study.

2.2.6. Data analytic plan

To test if memory and executive cognitive function were associated with different stages of change, three multiple linear regression analyses were used to predict each stage score from the RTC. The analyses used a forced entry of baseline consumption rates from the SP, *DSM-IV* alcohol disorder diagnosis, and level of education by years as a first step, followed by forced entry of COWAT word generation, RFFT perseverative error and unique designs, WCST nonperseverative and perseverative percentile scores, and WMS-R verbal and visual memory, attention–concentration, and delayed recall indices as a second step. Second, to test if memory and executive cognitive function were associated with drinking reduction, multiple regression was used to predict the total standard drinks at follow-up, as assessed by the SP with a forced entry of baseline consumption rates from the SP and level of education by years as a first step, followed by forced entry of COWAT word generation, RFFT perseverative error and unique designs, WCST nonperseverative and perseverative percentile scores, and WMS-R verbal and visual memory, attention–concentration, and delayed recall indices as a second step.

3. Results

One hundred eleven of the participants (94.8%) completed both baseline and follow-up assessments. The average time between baseline and follow-up was 96.8 days. Eighteen participants (15.8%) completed the follow-up SP by mail when not reached by phone. Participants who completed the SP by mail were found to have statistically significant higher mean rates of consumption at follow-up than those who completed by phone [$t(17.37) = -2.37$; $P < .05$; corrected for unequal sample variances], which suggests that using mailed follow-ups as a last resort may have prevented the loss of some heavier drinking participants. Attrition analysis found no statistical differences between those who completed the study and those who did not for any alcohol measure scores, for all neuropsychological variables of interest, for age, education, and gender, and for alcohol abuse versus dependence diagnostic criteria.

Table 2 presents the descriptive data concerning the drinking measures used for the study. The participants consumed approximately 342 standard drinks, on average, during the 3 months prior to baseline assessment. By follow-up, the mean consumption rates of the sample were reduced to approximately 260 standard drinks. The participants tended to have some concerns about their drinking, given the negative mean scores for precontemplation and positive mean scores for contemplation, but generally were not taking many steps toward changing alcohol use, as suggested by the slightly negative mean action scores (Table 2).

Multiple-regression analyses were conducted as described previously. In the first analysis, lower baseline alcohol consumption and lower WMS-R verbal memory and

Table 2
Descriptive data concerning measures

Variable	*N*	Mean	S.D.	Range
RTC precontemplation scores	117	−2.34	2.98	−8 to 6
RTC contemplation scores	117	2.63	3.52	−6 to 8
RTC action scores	117	−0.09	3.95	−8 to −8
SP total consumption	117	342.34	307.15	56.64 to 2752.47
SP follow-up consumption	111	259.66	313.30	8 to 1978.00
COWAT word generation	117	71.94	24.73	1 to 99
RFFT perseverative errors	117	58.83	28.34	0.90 to 92.90
RFFT unique designs	117	61.05	28.35	2 to 100
WCST nonperseverative errors	117	51.48	29.23	1 to 96
WCST perseverative errors	117	55.70	33.74	1 to 99
WMS-R attn–conc index	117	102.15	11.29	69 to 125
WMS-R delayed recall index	117	106.65	13.05	77 to 138
WMS-R verbal index	117	106.14	12.08	75 to 138
WMS-R visual index	117	107.03	12.29	78 to 136

For the WMS-R attention/concentration (attn–conc), delayed recall, verbal, and visual memory indices, the standardized population mean scores = 100, S.D. = 15. COWAT, RFFT, and WCST indices are presented as standardized percentile scores.

higher delayed recall indices scores significantly predicted higher RTC precontemplation scores (Table 3), whereas the other variables were not found to be significant predictors in the model. The full regression model accounted for approximately 22% of the observed

Table 3
Forced entry regression model predicting RTC precontemplation scores ($N = 117$)

Predictor variable(s)	Cum R^2	β	t	95% C. I.
Step one				
SP baseline consumption		−.20	−2.07*	−.004 to .000
DSM-IV Dx (abuse vs. dependence)		−.15	−1.53	−2.096 to .273
Level of education	.09	−.02	−0.18	−.335 to .277
Step two				
COWAT word generation		.05	0.48	−.018 to .030
RFFT perseverative errors		−.01	−0.14	−.022 to .019
RFFT unique designs		.09	0.87	−.012 to .031
WCST nonperseverative errors		−.25	−1.66	−.056 to .005
WCST perseverative errors		.26	1.82	−.002 to .049
WMS-R attn–concentration		−.09	−0.92	−.075 to .028
WMS-R delayed recall		.43	2.79**	.028 to .167
WMS-R verbal memory		−.47	−3.54**	−.181 to −.051
WMS-R visual memory	.22	−.18	−1.60	−.100 to .011

$R^2 = .22$; $F(12,104) = 2.50$; $P < .01$ for the full model. Cum R^2 = cumulative R^2 for each step; Dx = *DSM-IV* diagnosis. Betas, t values, and 95% confidence intervals for each regression coefficient listed are for the full model.

* $P < .05$.

** $P < .01$.

variance in the awareness scores [R^2=.22; $F(12,104)=2.50$; $P<.01$]. In the second analysis, *DSM-IV* alcohol dependence diagnosis and greater WMS-R verbal memory index scores significantly predicted greater RTC contemplation scores (Table 4), whereas the other variables were not found to be significant predictors in the model. The full regression model accounted for approximately 28% of the observed variance in the awareness scores [R^2=.28; $F(12,104)=3.35$; $P<.001$]. These findings partially support the study hypothesis since lower WMS-R verbal memory scores significantly predicted precontemplation scores and higher WMS-R verbal memory scores significantly predicted contemplation scores, but the relationship of higher WMS-R delayed recall scores with higher precontemplation scores was unpredicted.

The third regression analysis found that only *DSM-IV* alcohol dependence diagnosis was a significant predictor in the regression equation for predicting higher action stages scores, with participants meeting criteria for alcohol dependence being more likely to report recent changes in drinking than did participants meeting criteria for alcohol abuse (Table 5). However, in the fourth multiple-regression analysis, greater SP baseline alcohol consumption and greater WMS-R attention–concentration memory index scores significantly predicted lower consumption rates at 3-month follow-up (Table 6), accounting for 65% of the observed variance in the follow-up consumption rates in the full regression model [R^2=.65; $F(12,98)=14.84$; $P<.001$]. However, the other memory and executive cognitive function scores were not significant predictors in the model. Again, these results partially support the study hypothesis that only an alcohol-dependence diagnosis predicted higher

Table 4
Forced entry regression model predicting RTC contemplation scores ($N=117$)

Predictor variable(s)	Cum R^2	β	t	95% C. I.
Step one				
SP baseline consumption		.14	1.50	−.001 to .004
DSM-IV Dx (abuse vs. dependence)		.33	3.55**	1.067 to 3.762
Level of education	.20	.03	0.30	−.291 to .405
Step two				
COWAT word generation		.02	0.20	−.025 to .030
RFFT perseverative errors		.02	0.26	−.020 to .026
RFFT unique designs		−.02	−0.15	−.026 to .023
WCST nonperseverative errors		.11	0.75	−.021 to .048
WCST perseverative errors		−.18	−1.25	−.047 to .011
WMS-R attn–concentration		−.02	−0.17	−.064 to .054
WMS-R delayed recall		−.07	−0.46	−.097 to .061
WMS-R verbal memory		.30	2.37*	.015 to .163
WMS-R visual memory	.28	.00	0.04	−.061 to .064

R^2=.28; $F(12,104)=3.35$; $P<.001$ for the full model. Cum R^2=cumulative R^2 for each step; Dx=*DSM-IV* diagnosis. Betas, t values, and 95% confidence intervals for each regression coefficient listed are for the full model.

* $P<.05$.

** $P<.01$.

Table 5
Forced entry regression model predicting RTC action scores ($N = 117$)

Predictor variable(s)	Cum R^2	β	t	95% C. I.
Step one				
SP baseline consumption		−.12	−1.18	−.004 to .001
DSM-IV Dx (abuse vs. dependence)		.22	2.13*	.120 to 3.459
Level of education	.05	.07	0.66	−.287 to .575
Step two				
COWAT word generation		.03	0.28	−.029 to .039
RFFT perseverative errors		−.04	−0.35	−.034 to .024
RFFT unique designs		−.20	−1.80	−.058 to .003
WCST nonperseverative errors		.27	1.68	−.006 to .079
WCST perseverative errors		−.28	−1.84	−.069 to .003
WMS-R attn−concentration		.04	0.40	−.058 to .087
WMS-R delayed recall		−.13	−0.78	−.136 to .059
WMS-R verbal memory		.18	1.28	−.033 to .151
WMS-R visual memory	.12	−.01	−0.12	−.082 to .073

$R^2 = .08$; $F(12,104) = 1.16$; *ns* for the full model. Cum R^2 = cumulative R^2 for each step; Dx= *DSM-IV* diagnosis; *ns* = not statistically significant. Betas, t values, and 95% confidence intervals for each regression coefficient listed are for the full model. * <.05.

action scores and that attention−concentration scores predicted changes in drinking rates over time among study participants, but the other neuropsychological variables of interest did not.

Table 6
Regression model predicting total alcohol consumption at 3-month follow-up ($N = 111$)

Predictor variable(s)	Cum R^2	β	t	95% C. I.
Step one				
SP baseline consumption		.77	11.21*	.496 to .710
DSM-IV Dx (abuse vs. dependence)		.12	1.83	−5.225 to 130.419
Level of education	.58	−.09	−1.38	−29.373 to 5.268
Step two				
COWAT word generation		−.10	−1.49	−2.401 to .342
RFFT perseverative errors		−.03	−0.44	−1.407 to .893
RFFT unique designs		.09	1.26	−.448 to 2.002
WCST nonperseverative errors		−.06	−0.53	−2.250 to 1.304
WCST perseverative errors		.09	0.85	−.850 to 2.116
WMS-R attn−concentration		−.23	−3.35*	−7.788 to −1.997
WMS-R delayed recall		.10	0.97	−2.039 to 5.906
WMS-R verbal memory		−.11	−1.17	−5.892 to 1.522
WMS-R visual memory	.65	.11	1.39	−.952 to 5.385

$R^2 = .65$; $F(12,98) = 14.84$; $P < .001$ for the full model. Cum R^2 = cumulative R^2 for each step; Dx= *DSM-IV* diagnosis. Betas, t values, and 95% confidence intervals for each regression coefficient listed are for the full model.

* $P < .005$.

4. Discussion

Because lower verbal memory scores were found to predict precontemplation scores, and higher verbal memory scores were found to predict contemplation stages scores, verbal memory may be related to greater awareness of drinking problems. Skills for learning new verbal knowledge and information (factual short-term memory) may be associated with increased motivation (via awareness) to change drinking behavior, but this hypothesis will need to be explored in future research. On the other hand, participants who had higher delayed recall memory scores also had higher precontemplation scores, which was not predicted. It is possible that better recall memory may have been taken as evidence by participants that their drinking was not problematic. On the other hand, because lower baseline consumption rates also were significantly associated with higher precontemplation scores, it simply may have been that participants scoring high in precontemplation had not experienced many drinking-related consequences. These interpretations are highly speculative and should be tested in future research.

Alcohol dependence diagnosis significantly predicted taking action to change, which may suggest that experiencing significant drinking-related consequences in multiple life domains may be important for initiating change. However, the neuropsychological variables of interest were not significant predictors of taking action. On the other hand, attention–concentration scores significantly predicted changes in drinking behavior, accounting for modest amounts of the variance in drinking rates above and beyond the contribution of baseline consumption for participants (ΔR^2=.07 for the second step of the regression model). Attention–concentration skills may be related to self-regulation abilities over time, but these results await replication in future studies. Problems of self-regulation of behavior have been previously noted to be the result of difficulties with attention and concentration (e.g., Lezak, 1995).

Although memory scores were significant predictors of precontemplation and contemplation stage scores, and attention–concentration scores predicted changes in consumption over 3 months, some study participants may have simply decided to suspend or relax self-regulation of drinking behavior because they wanted to drink heavily, or perhaps changed their drinking environment to enhance safety without necessarily reducing consumption rates. Motivation and drinking contexts are not necessarily static. Changes in personal motivation to reduce drinking over time and in drinking context were not assessed in the study, thus, it is unclear how much these variables may have been associated with changes in drinking behavior. The results of the study not only provide modest support of the efficacy of memory and attention–concentration abilities to predict drinking behavior, but also leave many questions unanswered.

4.1. Potential shortcomings in the study

This study utilized a volunteer sample, which limits the external validity of these results. Furthermore, the study had practical limits on the number and length of neuropsychological assessments that could be administered, which may limit the ability to fully interpret the results. Future researchers may wish to broaden the battery of tests to define which specific

mechanisms of memory and executive cognitive function may be associated with motivation to change drinking and actual drinking behavior change. Because an extensive neuropsychological battery was not conducted, it is unclear whether the significant relationship between memory and attention–concentration scores with changes in drinking behavior are related to specific problems in memory processes or to more general cognitive deficits. However, the lack of a significant association between the levels of education and drinking behavior may suggest that intelligence was not a significant predictor of changes in drinking behavior in this study. In addition, the study did not address whether memory and executive cognitive function had been influenced by drinking history, whether premorbid memory function predisposes people to difficulties regulating drinking behavior, or whether both premorbid function and subsequent drinking may account for difficulties regulating drinking behavior.

The study also lacked collateral data concerning drinking rates. However, gathering data about drinking rates via self-report may be as valid as using collateral measures (Babor, Steinberg, Anton, & Del Boca, 2000). Furthermore, it is possible that the order of instrument administration influences the responses of subsequent measures; for example, administering the SP prior to the RTC could have influenced those answers. Future research may wish to manipulate the order of administration, as such instruments in subsequent studies, to control for this potential confound. Because changes in motivation over time and drinking context were not assessed, it also was unclear how much these factors influenced changes in the self-regulation of drinking behavior. Assessing consumption rates instead of consumption patterns also may have missed changes in drinking patterns that may have reduced harmful consequences for participants at follow-up. In addition, the results of this study may not generalize to people using substances other than alcohol.

Although efforts were made to prevent participants from drinking for 24 h prior to neuropsychological assessment, and researchers screened possible participants prior to administering the tests by asking about recent (within 24 h) alcohol consumption and utilizing a sniff test to detect alcohol on the breath, it is possible that some participants had alcohol in their system during the assessment, which may have influenced performance on the memory tests. The researchers also were aware that withdrawal from alcohol could affect performance on the tests. However, as previously mentioned, our intent was to examine the relationship of memory and executive cognitive function with changes in drinking behavior in as naturalistic conditions as possible, given that these would be the conditions in which decisions about drinking behavior would be made.

4.2. Implications for future research

Future researchers may wish to focus on the generalizability of these findings to other types of addictive behaviors, as well as to other important health psychology questions. It would interesting to examine the effect of memory and executive cognitive functions in other areas of inquiry, and intervention, such as adherence with medical advice and pharmacological regimens, may be associated with diminished cognitive function (disorders that may involve cognitive distortions or impulse control problems). Finally, we recommend that a new

model that includes both explicit (declarative, conscious memory) and implicit memory processes (habitual memory) should be tested for its efficacy to predict changes in drinking behavior over time.

Acknowledgements

This study was funded, in part, by a small grant from the Alcohol and Drug Abuse Institute of the University of Washington and, in part, by Merit Award AA 5 R37AA05591 from the National Institute on Alcohol Abuse and Alcoholism (National Institute of Health).

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