Alcohol & Alcoholism Vol. 34, No. 4, pp. 601–608, 1999

A COMPARISON OF COGNITIVE PERFORMANCE IN BINGE VERSUS REGULAR CHRONIC ALCOHOL MISUSERS

ANNA KOKAVEC and SIMON F. CROWE*

School of Psychological Science, La Trobe University, Bundoora, Australia 3083

(*Received* 9 *April* 1998; *in revised form* 24 *November* 1998; *accepted* 7 *January* 1999)

Abstract — One hundred cases of individuals assessed for alcohol-related cognitive performance were examined. The assessment included demographic and alcohol consumption data, as well as performance on tests of auditory verbal learning, memory, motor skills, general intellectual functioning, and visuo-spatial functioning. All participants regularly drank in excess of 10 standard drinks/session. Fifty cases were binge drinkers who consumed alcohol on 2 days/week or less and 50 cases were individuals who consumed alcohol daily. The two groups of drinkers were statistically matched on a number of demographic and misuse factors. The results indicated similar performance for both the binge drinkers and the regular drinkers in visuo-motor speed, visuo-spatial organization and planning, learning, proactive interference, retroactive interference, and retrieval efficiency. However, performance differences were observed on tasks that required semantic organizational ability, with binge drinkers performing better than regular drinkers on these tasks. Due to the differences in the cognitive performance of the two groups, it was concluded that drinking pattern is an important factor in investigating cognitive performance in alcoholics.

INTRODUCTION

The Wernicke–Korsakoff syndrome (WKS) is in most cases the end product of many years of chronic alcohol abuse (Victor *et al*., 1989; Pratt *et al*., 1990). However, alcoholics who do not develop WKS can still display cognitive impairment (Grant *et al*., 1987). Non-Korsakoff alcoholics generally perform worse on tasks designed to assess learning and memory (Reed *et al*., 1992), abstraction and problem solving (Brandt *et al*., 1983), visuo-spatial ability (Molina *et al*., 1994), and visuo-spatial motor speed (Di Sclafani *et al*., 1995), when compared to non-alcoholic controls. Furthermore, the strategies employed by alcoholics when asked to complete problem-solving tasks is qualitatively similar to the approach adopted by WKS patients (Oscar-Berman, 1973; Butters, 1985; Grant *et al*., 1987).

While alcoholics score within normal limits on verbal ability (Yohman and Parsons, 1985), a clear deficit emerges when more complex verbal abstraction and problem-solving tasks are assessed (Nixon *et al*., 1987; Williams and Skinner, 1990). However, results have shown considerable variability with anything from 20 to 40% of alcoholics scoring within the normal range (as defined by controls), in any study on tests designed to assess abstraction and problem solving. With respect to tests associated with learning and memory, the discrepancy between alcoholics and non-alcoholic controls is less, indicating a much larger overlap in distributions (Parsons, 1994).

Whilst there is considerable variability in the results on neuropsychological assessments when alcoholics are compared to normal controls, there is also considerable variability within alcoholics themselves (Kupke and O'Brien, 1985; Clifford, 1990). Up to 85% of alcoholics without Korsakoff psychosis may show evidence of cognitive decline, and up to 50% of abstinent alcoholics show no noticeable signs of cognitive impairment (Parsons, 1994).

While researchers have been unsuccessful in isolating one factor which could successfully account for the variability in these data, numerous factors have been proposed as possible mediators of this relationship. These include: gender (Begleiter *et al*., 1984); diet (Kupke and O'Brien, 1985); family history of alcoholism (Pessione *et al*., 1995); drinking history (Molina *et al*., 1994); number of detoxifications (Kupke and O'Brien,

*Author to whom correspondence should be addressed.

1985); medical history and complications (Adams and Grant, 1986); level of social drinking (Waugh *et al*., 1989); and childhood behavioural problems (Tarter *et al*., 1977). It has also been shown that socio-economic status (Williams and Skinner, 1990), age (Ryan and Butters, 1980; Grant *et al*., 1984), education (Brandt *et al*., 1983; Molina *et al*., 1994), and personality factors (Omenn and Motulsky, 1972; Vrasti *et al*., 1993) may each also be important contributors to cognitive performance.

Cognitive impairment in alcoholics may develop gradually, and could be specifically related to the amount of alcohol ingested, and the period of alcohol use (Tarter, 1995). Studies have shown that performance on complex verbal memory tasks, which included a delay trial or when interference was introduced, is impaired in individuals who consume in excess of 130 g of alcohol/day, compared with moderate drinkers who drank less than 80 g/day (Waugh *et al*., 1989). In contrast, a recent study which investigated verbal memory performance in heavy (>47.5 ml), and light (<47.5 ml) social drinkers found no difference in total number of words recalled between groups (Fox *et al*., 1995).

Drinking pattern as well as the total amount of alcohol ingested at any one time is a variable that may have an important impact on long-term cognitive functioning. 'Regular' drinkers consume large amounts of alcohol on a daily basis, 'social' drinkers consume small to moderate amounts of alcohol regularly, and 'binge' drinkers consume large amounts of alcohol on an irregular basis. Parker and Noble (1977) were the first to show that drinking behaviour, in addition to amount of alcohol consumed, was an important consideration in the development of cognitive impairment. Later studies from the same laboratory have confirmed that performance on tasks assessing abstraction, concept formation, and adaptive abilities was related to the amount of alcohol consumed/session in individuals who drank alcohol on 2 to 3 days a week (Parker *et al*., 1991). It is thus possible that 'binge' drinkers, who consume a large amount of alcohol during each session, may be as vulnerable as regular drinkers to specific cognitive impairment.

The aim of the present study was to investigate whether cognitive performance in individuals who drink in excess of 10 standard drinks/session (i.e. >100 g/session), differed from those who drink more regularly.

METHODS

Participants

Individuals who had been referred for alcohol-related problems to the Alcohol Related Brain Injury Assessment Support (A.R.B.I.A.S.) centre in Melbourne, Australia from 1995–1997 were examined. In order to obtain a homogeneous sample, participants were excluded if there was evidence that they had: (1) a previous history of psychiatric disorder; (2) a neurological disease unrelated to alcohol misuse; (3) any major physical complaints; (4) a childhood learning disorder; (5) a history of intellectual disability; (6) a record of previous head injury which required hospitalization; or (7) a history of drug misuse before they started misusing alcohol. All subjects selected met the DSM-IV diagnostic criteria for alcohol abuse and/or dependence (American Psychiatric Association, 1994). Furthermore, only individuals who had remained alcohol-free for a period of at least 2 weeks prior to assessment were selected.

Approximately 600 case files were examined and a total of 100 cases met the criteria for selection. Of the total cases selected, 82 cases were males, and 18 were females. Ages for the male sample ranged from 25–68 years (mean ± SD = 42.3 ± 11.1 years), and between 26–68 years for the female sample (43.2 ± 11.4 years). Participants were all white Caucasians of Australian, European, or American origin.

Self-reported information was available with respect to: level of education; the number of occasions per week that alcohol was consumed; how much alcohol was consumed on each occasion; the type of alcohol consumed; drinking history, which included onset of drinking age, and length of problem in years; highest occupational level achieved; length of sobriety; employment status; cohabitation status; family history of alcoholism; and number of detoxification periods. The data from the above variables allowed subjects to be divided into two statistically matched drinking pattern groups which were labelled 'binge drinkers' (BD) and 'non-binge drinkers' (NBD). Individuals were classified as NBD if at assessment they reported consumption of 10 or more standard drinks daily, and BD if they reported drinking 10 or more standard alcoholic drinks on an irregular basis, on no more than 2 days/week. The number of sessions

Table 1. Summary of factors used to match individuals in binge (BD) and non-binge (NBD) drinker groups

Variable	Mean BD (n = 50)	Mean BD (SD)	Mean NBD (n = 50)	Mean NBD (SD)	t	P
Age (years)[a]	40.8	(10.7)	44.2	(11.4)	–1.54	0.126
Age first started drinking (years)	18.9	(7.6)	17.3	(6.5)	1.16	0.250
Length of problem (years)	20.4	(9.9)	18.9	(11.7)	0.62	0.538
Length of sobriety (years)	9.6	(26.4)	13.3	(50.4)	–0.47	0.640
No. of detoxifications	1.9	(3.1)	1.9	(4.6)	0.04	0.970
Standard drinks/session	40.7	(20.9)	38.2	(21.6)	0.41	0.651
WAIS-R full scale IQ	88.9	(13.9)	88.5	(13.8)	0.14	0.886

[a]Age range for BD = 25–68 years and for NBD = 25–68 years.

where alcohol was consumed in large amounts for individuals classified as BD ranged from once a month to twice a week, with the majority of individuals falling into the latter category (82%). All NBD (prior to detoxification) had been alcohol-dependent on 7 days/week and had maintained that pattern for an extended period of time. The data for the matching criteria are presented in Table 1, whereas drinker group demographic factors are presented in Table 2.

Measures

Full-scale, Verbal and Performance IQ scores were obtained for each subject from the pro-rated Wechsler Adult Intelligence Scale–Revised (WAIS-R; Wechsler, 1981), which included five

Table 2. Summary of demographic factors for binge (BD) and non-binge (NBD) drinker groups showing frequency of occurrence

Variable	Level	n BD (n = 50)	n BD %	n NBD (n = 50)	n NBD %	χ^2	P
Sex	Male	38	76	44	88	2.44	0.118
	Female	12	24	6	12		
Education level	Secondary	45	90	46	92	0.122	0.727
	Tertiary	5	10	4	8		
Highest occupation	Professional	12	24	9	18	1.98	0.371
	Skilled manual	10	20	16	32		
	Unskilled manual	28	56	25	50		
Current employment	Pensioner	15	30	22	44	6.59	0.086
	Unemployed	30	60	18	36		
	Part-time	2	4	2	4		
	Full-time	3	6	8	16		
Cohabitation status	Alone	20	40	15	30	2.44	0.655
	Friends/other	12	24	19	38		
	Relatives	3	6	3	6		
	Parents	6	12	5	10		
	Spouse/child	9	18	8	16		
Family history of alcoholism	Yes	22	44	23	46	0.04	0.841
	No	28	56	27	54		
Type of beverage consumed	Beer only	11	22	15	30	1.94	0.586
	Wine only	14	28	9	18		
	Spirits only	4	8	3	6		
	Combination	21	42	23	46		

performance subtests (Digit–Symbol Substitution, Object Assembly, Picture Completion, Picture Arrangement, and Block Design), and five of the verbal subtests (Similarities, Information, Arithmetic, Comprehension, and Digit Span). The Rey Auditory Verbal Learning Test (RAVLT) (Trials I–VII, delay and recognition) trial data (Rey, 1964), were used as a measure of acquisition, proactive and retroactive interference, and retrieval efficiency, whereas data from the Rey Complex Figure Test (immediate copy and recall) (Rey, 1941) were used as a measure of visuo-spatial planning and organizational ability. Assessment data from the Wechsler Memory Scale–Revised (WMS-R) Logical Memory subtest (immediate and delay) (Wechsler, 1987) were used as a measure of verbal memory and the Visual Reproduction (immediate and delayed) subtest scores were used as a measure of visuo-spatial memory skills (Wechsler, 1987). In order to assess visual search and motor speed, data from the Trail Making Test (Part A and Part B) were employed. All tests were administered according to standard assessment procedures (Lezak, 1995).

RESULTS

Table 1 shows that the two samples were matched for mean age, mean number of standard drinks consumed, mean WAIS-R full scale IQ, mean number of years of self-identified problem with alcohol consumption, and the mean age at which drinking commenced. The participants were also matched for the mean length of sobriety and the mean number of detoxification periods. Table 2 indicates that the BD and NBD samples were matched with respect to level of education, employment status, cohabitation, family history of alcoholism, highest occupational status, type of beverage consumed, and contact with family members.

The differences between BD and NBD with respect to cognitive performance were assessed using a 2×2 multivariate analysis of variance (MANOVA). The independent variables were Drinking Pattern (Binge and Non-binge) and Trial (immediate and delayed recall). Assessment data from the Rey Complex Figure Test (copy and recall), the WMS-R Logical Memory (immediate and delay), and WMS-R Visual Reproduction (immediate and delay) subtests were used as dependent variables in the MANOVA design. Descriptive scores are presented in Table 3.

The MANOVA produced two significant main effects and one non-significant interaction. The Trial factor produced a robust and expected result [F (3,184) = 1.75, $P < 0.001$]. Study of univariate F ratios revealed significant Trial effects for the Rey Complex Figure Test [F (1,186) = 307.66, $P < 0.001$], WMS-R Logical Memory [F (1,186) = 16.91, $P < 0.001$], and WMS-R Visual Reproduction [F (1,186) = 47.38, $P < 0.001$] subtests. Furthermore, results obtained for the Drinking Pattern effect were also significant [F (3,184) = 0.08, $P = 0.003$]. Univariate data showed that WMS-R Visual Reproduction [F (1,186) = 10.34, $P = 0.002$], and WMS-R Logical Memory subtests [F (1,186) = 4.27, $P = 0.040$] were significant contributors to the Drinking Pattern effect. No significant

Table 3. Descriptive data for performance on neuropsychological assessment tasks for the binge (BD) and non-binge (NBD) drinker groups showing sample size and mean scores with standard deviations

	Mean BD			Mean NBD		
Variable	*n*	(*n* = 50)	(SD)	*n*	(*n* = 50)	(SD)
WMS-R Logical Memory Immediate	50	20.8	(8.3)	49	18.6	(8.6)
WMS-R Logical Memory Delayed	50	15.8	(8.5)	49	12.9	(8.7)
WMS-R Visual Reproduction Immediate	49	31.2	(7.9)	50	27.8	(9.5)
WMS-R Visual Reproduction Delayed	49	22.3	(11.7)	50	15.9	(12.2)
Rey Complex Figure Copy	48	28.5	(7.2)	49	29.9	(6.2)
Rey Complex Figure Recall	48	12.2	(7.4)	49	10.9	(7.4)
Trail Making Test — Part A	35	51.1	(29.2)	44	56.1	(32.6)
Trail Making Test — Part B	34	121.9	(63.8)	43	141.3	(75.1)

contributions to the Drinking Pattern effect were observed from the Rey Complex Figure Test data [F (1,186) = 0.079, P = 0.778]. The large number of post-hoc univariate comparisons should be interpreted cautiously due to the possible inflation of family-wise error rate. Nonetheless, the overall significant MANOVA comparison indicated that differences do exist between the two groups at a global level. The non-significant interaction between Drinking Pattern and Trial [F (3,184) = 0.009, P = 0.667] showed that the two factors were independent. Univariate data confirmed this result, with non-significant findings for the WMS-R Logical Memory [F (1,186) = 0.168, P = 0.682], WMS-R Visual Reproduction [F (1,186) = 1.11, P = 0.294], and Rey Complex Figure Test [F (1,186) = 1.28, P = 0.259] measures.

In order to determine whether drinking pattern had any effect on visual search or motor speed, assessment data from the Trail Making Test (Parts A and B) were included in a separate MANOVA. Descriptive scores are presented in Table 3. Results obtained from the MANOVA showed a non-significant drinking pattern effect [F (2,74) = 0.019, P = 0.483], which suggested that drinking pattern did not contribute to performance on these two tasks. Univariate data supported this finding, with non-significant results being observed for both Part A [F (1,75) = 0.448, P = 0.505] and Part B [F (1,75) = 1.44, P = 0.233] of the Trail Making Test.

Differences in performance across RAVLT Trials I–V were used to assess acquisition of auditory verbal material (see Table 4) between BD and NBD. A mixed design ANOVA using RAVLT Trials I–V (5) as a within-subjects factor and Drinking Pattern (2) as a between-subjects factor was performed in order to assess the effect of drinking pattern on verbal learning ability. A non-significant between-subjects main effect was obtained with respect to drinking pattern [F (1,94) = 3.75, P = 0.056], suggesting no difference in number of words recalled in each trial between type of drinker. A significant within-subjects main effect for Trial was observed [F (4,376) = 211.83, P < 0.001], which indicates that there was a difference in number of words correctly recalled across learning trails. The non-significant interaction between drinking pattern and learning trials [F (4,368) = 2.21, P = 0.067] suggested that the rate of learning between BD and NBD was the same across trials.

A comparison between number of words correctly recalled on RAVLT Trials I and VI was used as a measure of proactive interference (see Table 4). A mixed design ANOVA using RAVLT Trials I and VI (2) as a within-subjects factor and Drinking Pattern (2) as a between-subjects factor produced a non-significant between-subjects main effect for drinking pattern [F (1,95) = 3.18, P = 0.078] which suggested similar performance between BD and NBD with trials. A significant within-subjects main effect for Trial showed that number of words recalled was higher on Trial I than on Trial VI [F (1,95) = 33.45, P < 0.001], showing that the previously learned material was affecting the recall of material on Trial VI. No significant interaction between drinking pattern and learning trials was observed [F (1,95) = 1.47, P = 0.228], which showed that performance by BD and NBD was similar across trials.

Table 4. Mean number of words correctly recalled on Rey Auditory Verbal Learning Test trials with standard deviations for binge (BD) and non-binge (NBD) drinker groups

	Mean BD			Mean NBD		
Variable	*n*	(*n* = 50)	(SD)	*n*	(*n* = 50)	(SD)
RAVLT — Trial I	47	5.5	(1.9)	50	4.7	(1.7)
RAVLT — Trial II	47	7.6	(2.6)	50	6.9	(2.4)
RAVLT — Trial III	47	8.9	(2.4)	50	7.8	(3.1)
RAVLT — Trial IV	47	9.9	(2.8)	50	8.6	(3.3)
RAVLT — Trial V	46	10.5	(2.7)	50	9.2	(2.9)
RAVLT — Trial VI	47	4.2	(1.8)	50	3.9	(1.6)
RAVLT — Trial VII	47	8.3	(3.5)	50	6.9	(3.4)
RAVLT — Recognition	31	12.3	(3.2)	30	10.7	(3.9)

The number of words correctly recalled on RAVLT Trials V and VII was compared in order to obtain a measure of retroactive interference (see Table 4). A mixed design ANOVA using RAVLT Trials V and VII (2) as the within-subjects factor, and Drinking Pattern (2) as the between-subjects factor showed a significant between-subjects main effect for drinking pattern [F (1,94) = 4.37, P = 0.039]. Inspection of the means in Table 4 showed that BD scored higher than NBD on both trials. The significant within-subjects main effect for Trial showed that number of words recalled was higher on Trial V than on Trial VII [F (1,94) = 148.16, $P < 0.001$]. No significant within-subject Drinking Pattern by Trial interaction effect [F (1,94) = 0.00, P = 0.991] was observed, suggesting similar performance between BD and NBD across trials.

Retrieval ability was determined by assessing group differences in number of words correctly recalled between RAVLT Trial VII and RAVLT Recognition Trial (see Table 4). A mixed design ANOVA was performed using RAVLT Trial VII and RAVLT Recognition (2) as the within-subjects factor and Drinking Pattern (2) as the between-subjects factor. No significant between-subjects main effect was obtained for drinking pattern [F (1,59) = 3.78, P = 0.057], which indicates that performance was similar between BD and NBD within trials. As frequently reported in the alcohol literature, a significant within-subjects main effect for Trial showed that number of words recalled was higher on the recognition trial than on Trial VII [F (1,59) = 103.95, $P < 0.001$]. The non-significant within-subjects Trial × Drinking Pattern interaction [F (1,59) = 0.12, P = 0.730] showed that performance was similar between BD and NBD across trials.

DISCUSSION

The results of this investigation have demonstrated significant group differences in the performance on verbal and visual memory tasks, in a comparison between heavy BD and heavy NBD. BD subjects generally performed better on these tasks, than did NBD subjects. However, no significant group differences between BD and NBD subjects were observed for performance on tests of visuo-motor speed, visuo-spatial organization and planning, learning, proactive interference, retroactive interference, and retrieval efficiency.

Impairment on visuo-motor speed (Parsons, 1994), visuo-spatial (Molina *et al*., 1994), and problem-solving tasks (Brandt *et al*., 1983) is well documented in the alcohol literature, and although it was not possible to determine whether the subjects in the present study were impaired on these tasks due to the lack of a matched non-drinking comparison group, it is interesting to note that drinking pattern in heavy drinkers has been reported to show no effect on either visuo-motor speed, or visuo-spatial organization and planning performance. These tasks have traditionally been associated with the frontal lobes (Lishman, 1990); thus the present results indicate that executive functioning in heavy BD and heavy NBD are comparable.

With respect to memory performance, drinking pattern was shown to influence performance on WMS-R immediate and delayed recall of verbal and visual information, with BD in general performing better on these tasks than NBD participants. The WMS-R Logical Memory subtest is not just a test of immediate memory, because the test is confounded by the semantic strategy given. When semantic strategies are given, retention or recall of verbal material is enhanced as meaning can be applied to the test data. In addition, the WMS-R Visual Reproduction subtest is not a pure test of visuo-spatial ability, as verbal meaning can be ascribed to the pictorial designs which would again require semantic organizational ability (Lezak, 1995). Results from this study show that semantic organizational ability is better in BD than in NBD. Furthermore, the results show that NBD are less likely than BD to take advantage of semantic strategies automatically when supplied.

As far as the acquisition of verbal material is concerned, it was shown that performance between BD and NBD was comparable on each learning trial. Furthermore, the rate of learning across the five learning trials was the same irrespective of drinking pattern. This result suggests that BD and NBD are acquiring and learning auditory verbal information at the same rate.

Proactive interference results showed similar performances in BD and NBD on RAVLT Trials I and VI. Both BD and NBD recalled significantly more words on RAVLT Trial I, than on the distracter trial (RAVLT Trial VI). Furthermore, the difference in performance across trials was the

same for both BD and NBD, showing that both BD and NBD responded equally to proactive interference effects. Measures of retroactive interference showed that, whereas the total number of words correctly recalled was significantly higher on both RAVLT Trial V and RAVLT Trial VII in BD, the non-significant within-subjects Drinking Pattern × Trial interaction observed indicated that recall of information was influenced to the same degree in both drinking pattern groups after the interference trial had been given.

Retrieval ability appears to be similar when a comparison between BD and NBD is made. Performance within trials was not significantly different between the drinker groups, and the number of words correctly recalled was higher on the recognition trial than on Trial VII in both groups. Furthermore, performance by BD and NBD was comparable across trials, which shows that retrieval ability was similar in BD and NBD.

The present study has been successful in highlighting the importance of drinking pattern to neuropsychological test performance. The differences observed between BD and NBD subjects suggest that semantic organizational ability is poorer when a large quantity of alcohol is consumed each day. However, performance on tasks traditionally associated with executive functions appears to be similar between the two groups.

The effect of constant alcohol withdrawal on cognitive performance in alcoholics is an area which has not been thoroughly investigated in humans, and it may be that heavy irregular drinkers are vulnerable to acquiring some, but not all, of the cognitive impairments that are usually seen in the alcoholic patient. However, the issue of total alcohol consumption over time needs to be addressed. While the BD and NBD groups in this study have been statistically matched on consumption/occasion, the amount of alcohol being consumed by the NBD group over time was considerably greater. The BD group consumed an average of 40.7 standard alcoholic drinks on 2 days (or less)/week (i.e. < 814 g of ethanol/week), whereas the NBD group consumed on average 38.2 standard alcoholic drinks on a daily basis (i.e. 2674 g of ethanol/week). It may be that cognitive impairment develops gradually, and is dependent on the amount of alcohol consumed over time (Tarter, 1995). If this was the case, then this could explain the performance differences observed between BD and NBD on verbal and visual memory tasks. The areas of the brain responsible for performance on these tasks may be less vulnerable to abuse by alcohol than those associated with the executive functions. However, as the present study could not control for total consumption by each group, the effects observed may be attributable to consumption level, rather than drinking pattern *per se*. Further investigations into the differing effects of drinking pattern may thus be necessary.

Acknowledgements — We would like to thank the clients and staff at A.R.B.I.A.S. for their support during the project.

REFERENCES

Adams, K. M. and Grant, I. (1986) Influence of premorbid risk factors on neuropsychological performance in alcoholics. *Journal of Clinical and Experimental Neuropsychology* **8**, 362–370.

American Psychiatric Association (1994) *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn. American Psychiatric Association Press, Washington, DC.

Begleiter, H., Porjesz, B., Bihari, B. and Kissin, B. (1984) Event-related brain potentials in boys at risk for alcoholism. *Science* **225**, 1493–1496.

Brandt, J., Butters, N., Ryan, C. and Bayog, R. (1983) Cognitive loss and recovery in long-term alcohol abusers. *Archives of General Psychiatry* **40**, 435–442.

Butters, N. (1985) Alcoholic Korsakoff's syndrome: some unresolved issues concerning etiology, neuropathology, and cognitive deficits. *Journal of Clinical and Experimental Neuropsychology* **7**, 181–210.

Clifford, C. A. (1990) Drinking and cognitive impairment: current concepts and controversies. *Drug and Alcohol Review* **9**, 119–123.

Di Sclafani, V., Ezekiel, F., Meyerhoff, D. J., MacKay, S., Dillon, W. P., Weiner, M. W. and Fein, G. (1995) Brain atrophy and cognitive function in older abstinent alcoholic men. *Alcoholism: Clinical and Experimental Research* **19**, 1121–1126.

Fox, A. M., Michie, P. T., Coltheart, M. and Solowij, N. (1995) Memory functioning in social drinkers: a study of event-related potentials. *Alcohol and Alcoholism* **30**, 303–310.

Grant, I., Adams, K. M. and Reed, R. (1984) Aging, abstinence, and medical risk factors in the prediction of neuropsychologic deficit among long-term alcoholics. *Archives of General Psychiatry* **41**, 710–718.

Grant, I., Reed, R. and Adams, K. M. (1987) Diagnosis of intemediate-duration and subacute organic mental disorders in abstinent alcoholics. *Journal of Clinical Psychiatry* **48**, 319–323.

Kupke, T. and O'Brien, W. (1985) Neuropsychological impairment and behavioral limitations exhibited within

an alcohol treatment program. *Journal of Clinical and Experimental Neuropsychology* **7**, 292–304.
Lezak, M. D. (1995) *Neuropsychological Assessment*, 3rd edn. Oxford University Press, New York.
Lishman, W. A. (1990) Alcohol and the brain. *British Journal of Psychiatry* **156**, 635–644.
Molina, J. A., Bermejo, F., del Ser, T., Jimenez-Jimenez, F. J., Herranz, A., Fernandez-Calle, P., Ortuno, B., Villanueva, C. and Sainz, M. J. (1994) Alcoholic cognitive deterioration and nutritional deficiencies. *Acta Neurologica Scandinavica* **89**, 384–390.
Nixon, S. J., Kujawski, A., Parsons, O. A. and Yohman, J. R. (1987) Semantic (verbal) and figural memory impairment in alcoholics. *Journal of Clinical and Experimental Neuropsychology* **9**, 311–322.
Omenn, G. S. and Motulsky, A. G. (1972) A biochemical and genetic approach to alcoholism. *Annals of the New York Academy of Sciences* **197**, 16–23.
Oscar-Berman, M. (1973) Hypothesis testing and focusing behavior during concept formation by amnesic Korsakoff patients. *Neuropsychologia* **11**, 191–198.
Parker, E. S. and Noble, E. P. (1977) Alcohol consumption and cognitive functioning in social drinkers. *Journal of Studies on Alcohol* **38**, 1224–1232.
Parker, E. S., Parker, D. A. and Harford, T. C. (1991) Specifying the relationship between alcohol use and cognitive loss: the effects of frequency of consumption and psychological distress. *Journal of Studies on Alcohol* **52**, 366–373.
Parsons, O. A. (1994) Determinants of cognitive deficits in alcoholics: the search continues. *The Clinical Neuropsychologist* **8**, 39–58.
Pessione, F., Gerchstein, J. L. and Rueff, B. (1995) Parental history of alcoholism: a risk factor for alcohol-related peripheral neuropathies. *Alcohol and Alcoholism* **30**, 749–754.
Pratt, O. E., Rooprai, H. K., Shaw, G. K. and Thomson, A. D. (1990) The genesis of alcoholic brain tissue injury. *Alcohol and Alcoholism* **25**, 217–230.
Reed, R. J., Grant, I. and Rourke, S. B. (1992) Long-term abstinent alcoholics have normal memory. *Alcoholism: Clinical and Experimental Research* **16**, 677–683.
Rey, A. (1941) Psychological examination of traumatic encephalopathy. *Archives de Psychologie* **28**, 286–340.
Rey, A. (1964) *L'Examen Clinique en Psychologie*. Presses Universitaires de France, Paris.
Ryan, C. and Butters, N. (1980) Learning and memory impairments in young and old alcoholics: evidence for the premature-aging hypothesis. *Alcoholism: Clinical and Experimental Research* **4**, 288–293.
Tarter, R. E. (1995) Cognition, aging and alcohol. In *Alcohol and Aging*, Beresford, T. and Gomberg, E., eds. Oxford University Press, New York.
Tarter, R., McBride, H. and Buonpane, N. (1977) Differentiation of alcoholics according to childhood history of minimal dysfunction, family history and drinking pattern. *Archives of General Psychiatry* **34**, 761–768.
Victor, M., Adams, R. D. and Collins, G. H. (1989) *The Wernicke–Korsakoff Syndrome and Other Related Neurologic Disorders Due to Alcoholism and Malnutrition*, 2nd edn. F.A. Davis, Philadelphia, PA.
Vrasti, R., Eisemann, M. and Bucur, M. (1993) Discriminate features of alcoholics classified according to family history. *Journal of Substance Abuse* **5**, 145–155.
Waugh, M., Jackson, M., Fox, G.A., Hawke, S. H. and Tuck, R. R. (1989) Effect of social drinking on neuropsychological performance. *British Journal of Addiction* **84**, 659–667.
Wechsler, D. (1981) *WAIS-R Manual*. The Psychological Corporation, New York.
Wechsler, D. (1987) *Wechsler Memory Scale–Revised Manual*. The Psychological Corporation, San Antonio, TX.
Williams, C. M. and Skinner, A. E. G. (1990) The cognitive effects of alcohol abuse: A controlled study. *British Journal of Addiction* **85**, 911–917.
Yohman, J. R. and Parsons, O. A. (1985) Intact verbal paired-associate learning in alcoholics. *Journal of Clinical Psychology* **41**, 844–851.