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Improvement in memory and static balance with abstinence in alcoholic men and women: Selective relations with change in brain structure

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Abstract

We investigated whether changes in memory or static balance in chronic alcoholics, occurring with abstinence or relapse, are associated with changes in lateral and fourth ventricular volume. Alcoholics meeting DSM-IV criteria for Alcohol Dependence ($n=15$) and non-alcoholic controls ($n=26$) were examined twice at a mean interval of 2 years with standard Wechsler Abbreviated Scale of Intelligence (WASI), Wechsler Memory Scale—Revised (WMS-R) tests, an ataxia battery, and structural MRI. At study entry, alcoholics had been abstinent on average for over 4 months and achieved lower scores than controls on WASI General IQ Index, WMS-R General Memory Index, and the ataxia battery. The 10 alcoholics who maintained sobriety at retest did not differ at study entry in socio-demographic measures, alcohol use, or WASI and WMS-R summary scores from the five relapsers. At follow-up, abstainers improved more than controls on the WMS-R General Memory Index. Ataxia tended to improve in abstainers relative to controls. Associations were observed between memory and lateral ventricular volume change and between ataxia and fourth ventricular volume change in alcoholics but not in the controls. Both memory and ataxia can improve with sustained sobriety, and brain–behavior associations suggest selective brain structural substrates for the changes observed.

Keywords: MRI; Ventricles; Recovery; Ataxia; Brain–behavior association

1. Introduction

Chronic excessive alcohol use can impair a range of cognitive and motor functions (Tarter and Ryan, 1983; Parsons, 1987b; Fein et al., 1990; Nixon, 1993; Sullivan et al., 2000d), but recovery of some of these functions can occur with sobriety (Brandt et al., 1983; Parsons, 1987a; Lishman, 1990; Bates et al., 2005; Rourke and Grant, 1999). Cognitive functions most likely to recover, patient characteristics most likely to predict recovery, and time course for such recovery have important implications for treatment (Goldman, 1995; Nixon et al., 1998; Bates et al., 2002). When memory tasks require active strategies for encoding, semantic organization, and retrieval of learned material, they probably draw on frontal executive systems (e.g., Incisa della Rocchetta and Milner, 1993; Fletcher et al., 1998; Savage et al., 2001) and medial temporal systems

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required for formation of new memories (for review see, Gabrieli, 1998). Deficits in such strategic memory tasks can occur with chronic alcoholism (Brandt et al., 1983; Rourke and Grant, 1999; Munro et al., 2000; Sullivan et al., 2000d, 2002; Fama et al., 2004); for reviews, see Parsons, 1987b; Riege, 1987; Oscar-Berman and Marinkovic, 2003) but can also recover with abstinence (Parsons, 1987a; Fein et al., 1990, 2006). Memory tasks that do not require strategic search through encoded material but instead rely on selection of a correct item from a given set, such as word recognition, are typically spared in uncomplicated alcoholism (Salmon et al., 1986; Oscar-Berman and Pulaski, 1997; Sullivan et al., 1997, 2000d).

There is no consensus on the nature, extent, or course of recovery of memory processes requiring strategic search. One study (Bates et al., 2005) found a clinically significant, moderate effect size for change in memory in a large sample of alcoholics retested 6 weeks after entering treatment, whereas another (Mann et al., 1999) found no evidence for treatment-related improvements in memory tests after a comparable interval in a sample of 49 alcoholic men even though improvement occurred in other functional domains. Cross-sectional studies have shown that alcoholics sober for several months (Sullivan et al., 2000d, 2002; Meyerhoff, 2005; Rosenbloom et al., 2005), 1 year (Hochla et al., 1982; Parsons et al., 1990; Munro et al., 2000; Rosenbloom et al., 2004), or as long as 7 years (Brandt et al., 1983) may still show memory deficits relative to non-alcoholic controls. However, other cross-sectional studies have shown that performance on memory tests is related to length of abstinence (Joyce and Robbins, 1993; Oscar-Berman et al., 2004), and that alcoholics sober for more than 4 years are undistinguishable from controls on memory testing (Grant et al., 1984; Reed et al., 1992; Oscar-Berman et al., 2004; Fein et al., 2006). Furthermore, a longitudinal study showed memory improvement relative to baseline after 4 years of abstinence (Rosenbloom et al., 2004).

In addition to demonstrating fragility in strategic memory processes of the type served by frontal and medial temporal lobe brain systems, alcoholics commonly exhibit impaired static posture, owing to disruption of selective cerebellar systems (Gilman et al., 1990; Sullivan et al., 2000a, 2006). Although partial functional recovery of balance can occur with sobriety (Diener et al., 1984), it may take years to manifest (Rosenbloom et al., 2004).

Structural brain volume deficits in chronic alcoholism include reduction in cortical gray and white matter volume and enlargement of lateral ventricles. Some of these abnormalities reverse with abstinence (Ron et al., 1982; Carlen et al., 1984; Shear et al., 1994; Pfefferbaum et al., 1995; O'Neill et al., 2001; Gazdzinski et al., 2005; Meyerhoff, 2005). Observed associations between longitudinally detected change in brain structure and in memory with abstinence (Sullivan et al., 2000c) suggest that these gross morphological brain changes may have functional significance. Demonstration of such relationships is not always forthcoming, although association between improvement in cognitive performance and MRI-detected levels of spectroscopic measures of tissue integrity have recently been reported (Durazzo et al., 2006).

Given the relevance of functional recovery in the human alcoholic condition, the challenge of retaining alcoholics in longitudinal study, and the relative dearth of clinical reports on this issue, repeated measures findings based even on small samples can contribute to our knowledge of the scope and limits of human neural plasticity following years of excessive drinking. Indeed, we recently demonstrated the value of longitudinal over cross-sectional analysis to detect small brain changes in small subject samples (Rohlfing et al., 2006). Here we report on change over 2 years in performance on standardized tests of memory, intelligence, and ataxia and relate observed changes to morphometrically measured change in the lateral ventricles and the fourth ventricle. Greater volume of the lateral ventricles, which impinge on a number of cortical regions and subcortical structures, has been associated with less volume of cortical gray and white matter as well as of basal ganglia in alcoholics (cf, Symonds et al., 1999). The fourth ventricle, located anterior and adjacent to the cerebellum, is not typically reported to be greater in alcoholics than controls (cf, Sullivan et al., 2000b) but associations between fourth ventricle and cerebellar vermis volumes have been reported in fragile-X patients (Aylward and Reiss, 1991), supporting use of volume change in this structure as a surrogate for change in the volume of the cerebellar vermis.

2. Methods

2.1. Subjects

Presented in this report is a subset of alcoholics (12 men, 14 women) and controls (8 men, 7 women) from a previously described sample (Rosenbloom et al., 2005; Pfefferbaum et al., 2006a,b) who returned for follow-up testing on average after 22±6 months. The sample included five non-Caucasian participants (4 controls and 1 alcoholic). Other group characteristics are summarized