Cognitive Functioning in Alcoholic Patients with and without Cocaine Dependence

Michael David Homer

Medical University of South Carolina and Ralph H. Johnson Department of Veterans Affairs Medical Center

Neuropsychological functioning of 32 cocaine-dependent, alcoholic patients was compared to that of 55 alcoholic patients without cocaine use at the beginning of treatment. When the effects of age were statistically controlled, cocaine-dependent patients performed more poorly on measures of immediate and delayed verbal memory. There were no other group differences on screening measures of attention, visuoconstructional ability, visuospatial memory, abstract reasoning, or practical judgment. Thus, in this sample of alcoholic patients, a specific decrement in verbal memory was associated with chronic cocaine use. The brief screening battery used in this study might have failed to detect other, more subtle impairments in the cocaine-dependent group.

Despite the prevalence of cocaine dependence in the United States, relatively few published studies have explored the cognitive effects of chronic cocaine use. In contrast to the neuropsychological sequelae of chronic alcoholism, which have received considerable attention in the literature, the question of cognitive impairment among recently abstinent cocaine-dependent patients remains largely unexplored, and the results to date have been inconsistent.

In one recent study (Beatty, Katzung, Moreland, & Nixon, 1995), abstinent cocaine-abusing patients were compared to abstinent alcoholic patients and to drug-free controls on a variety of neuropsychological measures. Cocaine-abusing patients performed more poorly than controls on several tests of general intellectual functioning, verbal memory, executive functions, visuoconstruction, and psychomotor speed. Another well-controlled study (Berry et al., 1993) also found that cocaine-dependent patients without other concurrent substance abuse, who had been abstinent for 2 weeks, demonstrated impairment of memory and visuoconstructional ability relative to matched, drug-free controls. Mittenberg and Motta (1993) reported impairment of verbal memory, compared to matched controls, in a similar sample. In addition, deficits in various other cognitive domains have occasionally been reported among patients with “uncomplicated” cocaine dependence (O’Malley, Adamse, The author is grateful to Charles V. Dawson III and Susan T. Haidary for their assistance with data collection, to Jacqueline Alston for her assistance with data entry, and to John W. Cahill for his assistance with data management. Address correspondence to: Michael David Homer, Ph.D., Mental Health Service (116), Ralph H. Johnson DVA Medical Center, 109 Bee Street, Charleston, South Carolina 29401-5799; E-mail: homermd@musc.edu.
Heaton, & Gawin, 1992; Waid et al., 1994). However, another group of recent studies has failed to identify cognitive deficits in this population (Azrin, Millsaps, Schneider, & Mittenberg, 1995; Selby, Azrin, Ireland, Quiroga, & Malow, 1995; van Gorp et al., 1995).

Several other studies have not controlled for other concurrent substance abuse/dependence among cocaine-abusing patients, or have not described explicitly their inclusion and exclusion criteria. Few consistencies exist across these investigations; findings include impairment of memory (Manschreck et al., 1990) and information processing speed (Herning, Glover, Koeppl, Weddington, & Jaffe, 1990). Still other studies have compared patients' scores to published norms rather than to the scores of matched controls, making interpretation difficult (Ardila, Rosselli, & Strumwasser, 1991; Strickland et al., 1993).

Thus, findings to date are equivocal, and many studies have been hampered by methodological difficulties regarding inclusion criteria, selection of appropriate control subjects, verification of abstinence, and various other issues. Furthermore, in the attempt to identify neuropsychological sequelae attributable to chronic cocaine use, most studies have examined cocaine-dependent patients without other substance use disorders (Azrin et al., 1995; Berry et al., 1993; Mittenberg & Motta, 1993; O'Malley et al., 1992; van Gorp et al., 1995; Waid et al., 1994). While this approach is of clear merit in isolating the cognitive effects of chronic cocaine use, it necessarily excludes the majority of cocaine-dependent patients seeking treatment, who frequently meet criteria for alcohol abuse or dependence (Brown, Seraganian, & Tremblay, 1994). Thus, the results of studies of patients with "uncomplicated" cocaine dependence might be of limited generalizability to the majority of patients presenting for treatment. It has also been suggested that cocaine-dependent patients who abuse alcohol might be at greater risk for neuropsychological impairment (O'Malley & Gawin, 1990).

An alternative approach is to compare patients with concurrent cocaine and alcohol dependence to patients dependent on alcohol only. This approach allows for the identification of neuropsychological sequelae specifically attributable to chronic cocaine use, while studying patients more typical of those who present for treatment. This type of design was recently employed by Brown et al. (1994), who found no group cognitive differences that were not attributable to age. However, their use of a limited number of cognitive tests leaves open the possibility of neuropsychological differences between cocaine-dependent alcoholic patients and "uncomplicated" Alcoholics. The present study employed a wider range of cognitive measures to explore further the neuropsychological sequelae of chronic cocaine use among alcoholic patients.

**METHODS**

**Participants**

Data were obtained from 121 consecutive admissions to the Ralph H. Johnson DVA Medical Center's Substance Abuse Treatment Center, a comprehensive program offering a continuum of inpatient and outpatient treatment. Some patients were evaluated as inpatients, while others received all assessment and intervention services as outpatients.

Of the 121 patients, 55 met DSM-IV (American Psychiatric Association, 1994) criteria for alcohol dependence with no cocaine use, and 32 met criteria for both alcohol and cocaine dependence. All patients were male except for three in the cocaine-dependent group. Concurrent Axis I psychiatric diagnoses in the sample are shown in Table 1; their distribution did not differ significantly between the two groups ($\chi^2 = 6.18$, ns). Smoking was the primary route of administration for all cocaine-dependent patients. While systematic data were not available on length or severity of substance dependence, these individuals were generally typical of those seeking treatment in VA substance abuse programs; severe alcohol depen-
TABLE 1

Frequency of Concurrent Axis I Psychiatric Diagnoses among Alcoholic Patients with and without Cocaine Dependence

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Cocaine and Alcohol Dependent</th>
<th>Alcohol Dependent Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression (major episode or substance-induced)</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Dysthymia</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Posttraumatic stress disorder</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Panic disorder</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

dence, long drinking histories (often 20 years or more), and multiple prior substance abuse treatments were common in this sample. Similarly, among cocaine-dependent patients, usage and dependence patterns appeared to be at least as severe as that of the general population presenting for treatment, with many patients reporting prior treatments and hundreds of dollars per week spent on cocaine.

Data were also collected on comorbid use of other substances. Among the alcohol-only group, two patients met DSM-III criteria for cannabis dependence, one met criteria for cannabis abuse, and one met criteria for cannabis dependence in remission. Frequencies were similar in the cocaine-dependent alcoholic group, including one patient with cannabis dependence, four with cannabis abuse, and one with cannabis dependence in remission. One of the cannabis abusers in the cocaine group also met criteria for opioid dependence in remission.

In both groups, the length of abstinence from substances at the time of evaluation varied considerably. Median length of abstinence was 8.5 days in the cocaine-dependent group (range 4–116 days) and 11.0 days in the alcohol-only group (range 0–55 days). While this was typically determined by self-report, all patients were subject to random urinalysis and breathalyzer readings to detect recent substance use. No patients were evaluated until they were judged by one of the Substance Abuse Treatment Center’s attending physicians to be medically stable, and past the acute stage of detoxification and withdrawal. However, many had maintained much longer abstinence, and were well past the withdrawal period at the time of evaluation.

While all patients were medically stable at the time of evaluation, systematic data were not available regarding various medical conditions and other neuromedical risk factors that could have affected neuropsychological performance, such as hepatic and renal disease, and history of traumatic brain injury (Adams & Grant, 1986; Grant, 1987). Nevertheless, inclusion of all consecutive patients who met diagnostic criteria for alcohol dependence, either with concurrent cocaine dependence or without cocaine use, was felt to increase the generalizability of the present findings, and to reflect cognitive functioning of those patients who typically present for substance abuse treatment in this setting.

Procedure

Each participant underwent a brief neuropsychological screening as part of routine clinical assessment prior to beginning individualized treatment. Test protocols were administered and scored by two trained psychological technicians, and reviewed by the author. The results of this screening evaluation were used to identify those patients for whom more extensive neuropsychological evaluation was clinically indicated, and to help in some decisions regarding placement in treatment groups.
Thus, several constraints were placed on the number and type of tests included in the battery. As it was administered to all new patients admitted for substance abuse treatment, limitations on available resources, time, and staff required that technicians be able to administer and score it in a very brief period of time. In addition, tests were excluded that might be used if more comprehensive neuropsychological evaluation were to be required later in treatment. The latter consideration was important because the screening battery was typically administered after acute detoxification and stabilization, often after less than 2 weeks of abstinence, the minimum time generally believed to be required before neuropsychological performance reliably indicates longer-term cognitive status (Grant, 1987; Orsini, van Gorp, & Boone, 1988; Schafer et al., 1991; Tarter & Edwards, 1987). Thus, while clinical factors (limited length of inpatient stays, the need to begin appropriate treatment as soon as possible, and the need for a brief measure of patients' cognition at the time they began treatment) required that the screening battery be administered early in recovery, more comprehensive neuropsychological evaluation for patients with possible cognitive impairment was not undertaken until longer abstinence had been achieved. These more comprehensive assessments included common and extensively normed tests, such as the Logical Memory subtest of the Wechsler Memory Scale-Revised (Wechsler, 1987). Including such tests in the screening battery would have precluded their later use in more extensive clinical evaluations, so that measures used in the screening battery were often less common or less extensively normed.

The brevity and timing of the screening battery thus precluded comprehensive cognitive evaluation, and prevented the use of certain tests that might have been more desirable for an empirical investigation. Nevertheless, within these constraints, specific tests were selected to screen a variety of cognitive domains, including attention, visuoconstructional ability, verbal and visuospatial memory, abstract reasoning, and practical judgment. The battery included the following tests.

**Shipley Institute of Living Scale (Zachary, 1991).** This self-administered test includes Vocabulary and Abstraction subtests. The latter is a measure of abstract reasoning that consists of increasingly difficult sequences to be completed. Scores on the subtests are combined to estimate general intellectual functioning (IQ), and to provide an Abstraction Quotient (AQ), a measure of abstract reasoning corrected for individual differences in age and educational level.

**Taylor Complex Figure Test (Spreen & Strauss, 1991).** This test assesses visuoconstructional ability and visuospatial memory. It is an alternate version of the Rey-Osterrieth Complex Figure Test. Participants are asked to copy a complex, geometric design, and, after a delay period, to draw it from memory.

**Babcock Story Recall Test (Babcock & Levy, 1940; Freides & Avery, 1991).** In this verbal memory test, described in detail by Lezak (1995), a brief paragraph is auditorily presented, and immediate recall is obtained. The story is then presented a second time, and after administration of intervening tasks, delayed recall is obtained. As a result of the repeated presentation after immediate recall, scores typically improve from the immediate to the delayed recall conditions. Scores for several normative samples have been reported (Freides & Avery, 1991; Freides, Engen, Miller, & Londa, 1996; Kreutzer et al., 1985; Lezak, 1995; Rapaport, Gill, & Schafer, 1968), and it is considered a valid method for assessing verbal memory (Freides et al., 1996; Lezak, 1995). Good interrater reliability has previously been reported (Freides & Avery, 1991; Kreutzer et al., 1985, cited in Lezak, 1995); in the present
### TABLE 2
T-test Comparisons of Demographic and Mood Variables for Alcoholic Patients with and without Cocaine Dependence

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cocaine and Alcohol Dependent N = 32</th>
<th>Alcohol Dependent Only N = 55</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age*</td>
<td>40.6 (4.6)</td>
<td>48.2 (9.1)</td>
</tr>
<tr>
<td>Years of education</td>
<td>11.7 (1.7)</td>
<td>11.7 (2.0)</td>
</tr>
<tr>
<td>Days abstinent</td>
<td>17.4 (23.5)</td>
<td>14.1 (11.6)</td>
</tr>
<tr>
<td>Beck Depression Inventory score</td>
<td>22.5 (13.4)</td>
<td>19.2 (11.6)</td>
</tr>
</tbody>
</table>

*p < .0001.

study, interrater reliability was .99 for the immediate recall condition and .98 for delayed recall.

**Digit Span subtest of the Wechsler Memory Scale, Revised (WMS-R)** (Wechsler, 1987). This commonly used measure of attention and concentration requires forward and backward recitation of auditorily presented strings of digits.

**Similarities subtest of the Neurobehavioral Cognitive Status Examination (NCSE)** (Northern California Neurobehavioral Group, 1988). In this very brief screening measure of abstract verbal reasoning, participants state how pairs of items are similar.

**Judgment subtest of the Neurobehavioral Cognitive Status Examination (NCSE)** (Northern California Neurobehavioral Group, 1988). In this very brief screening test, participants are asked to verbalize the solutions to several everyday, practical problems.

**Symbol Digit Modalities Test** (Smith, 1982). A timed psychomotor task of transcribing numbers associated with coded symbols, this nonspecific test is sensitive to many forms of neuropsychological dysfunction.

**Beck Depression Inventory** (Beck & Steer, 1987). This self-administered questionnaire assesses self-report of depressive symptoms, which could adversely affect cognitive performance.

### RESULTS

Table 2 shows t-test comparisons of demographic and mood variables between cocaine-dependent alcoholic patients and alcoholic patients without cocaine use. There were no group differences in level of education, length of abstinence at time of evaluation, or severity of self-reported depressive symptoms. However, the cocaine-dependent patients were significantly younger ($t = 4.42, p < .0001$). Thus, age was used as a covariate in all subsequent group comparisons.

The performance of the two groups on neuropsychological tests is shown in Table 3. For comparison, normative data for each test are presented in the last column of the table. Overall group differences were first explored using a multivariate analysis of covariance (MAN-
TABLE 3
ANCOVA Comparisons (with Age as Covariate) of Raw Scores on Neuropsychological Tests
for Alcoholic Patients with and without Cocaine Dependence

<table>
<thead>
<tr>
<th></th>
<th>Cocaine and Alcohol Dependent N = 32</th>
<th>Alcohol Dependent Only N = 55</th>
<th>Normative Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td>Shipley Institute of Living Scale:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated IQ</td>
<td>94.2 (10.2)</td>
<td>92.8 (11.6)</td>
<td>100.0 (15.0)†a</td>
</tr>
<tr>
<td>AQ</td>
<td>104.8 (15.0)</td>
<td>95.8 (15.1)</td>
<td>100.0 (15.0)†a</td>
</tr>
<tr>
<td>WMS-R Digit Span</td>
<td>13.0 (3.2)</td>
<td>13.4 (3.8)</td>
<td>15.5 (3.4)†b</td>
</tr>
<tr>
<td>Babcock Story Recall Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediate recall*</td>
<td>9.0 (3.7)</td>
<td>10.4 (4.2)</td>
<td>9.0c</td>
</tr>
<tr>
<td>Delayed recall**</td>
<td>12.4 (3.9)</td>
<td>13.1 (4.5)</td>
<td>15.0c</td>
</tr>
<tr>
<td>Taylor Complex Figure Test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copy</td>
<td>32.2 (3.6)</td>
<td>31.5 (4.3)</td>
<td>33.2 (6.1)c</td>
</tr>
<tr>
<td>Delayed recall</td>
<td>19.7 (6.0)</td>
<td>19.1 (7.2)</td>
<td>19.5 (6.7)c</td>
</tr>
<tr>
<td>NCSE Similarities</td>
<td>5.3 (1.3)</td>
<td>5.6 (1.6)</td>
<td>6.1 (0.6)c</td>
</tr>
<tr>
<td>NCSE Judgment</td>
<td>5.2 (0.9)</td>
<td>4.9 (1.0)</td>
<td>5.1 (0.5)c</td>
</tr>
<tr>
<td>Symbol Digit Modalities Test</td>
<td></td>
<td>39.8 (11.8)</td>
<td>51.5 (8.0)f</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>47.3 (9.6)f</td>
</tr>
</tbody>
</table>

* p < 0.05. **p < 0.01.

COVA), with age as the covariate and scores on all cognitive measures as the dependent variables. This analysis revealed a significant overall difference between alcoholic, cocaine-dependent patients and alcoholic patients without cocaine use [F(10, 47) = 3.48, p < .01].

The next set of analyses explored group differences on individual neuropsychological tests, using a series of one-way analyses of covariance (ANCOVAs) with age as the covariate and each test score as the dependent variable in separate analyses. The groups did not differ in IQ, as estimated by the Shipley Institute of Living Scale. Cocaine-dependent alcoholic patients performed more poorly than alcoholic patients without cocaine use on both the immediate and delayed recall conditions of the Babcock Story Recall Test [immediate: F(1, 84) = 4.91, p < .05; delayed: F(1, 84) = 8.09, p < .01]. There were no group differences on any of the other neuropsychological measures.

Inspection of the data in Table 3 indicates that, for both groups, mean scores on neuropsychological tests were generally within 1 SD from the mean, according to published norms. Exceptions were the performance of the cocaine-dependent group on the Similarities subtest of the NCSE, which fell 1.33 SD below the mean obtained by that test’s normative sample, and on the Symbol Digit Modalities Test, which fell 1.43 SD below that test’s normative mean.

In the final set of analyses, the relationship of neuropsychological functioning to self-reported length of abstinence from substances was explored using simple correlations. For each group separately, length of abstinence was correlated with scores on each neuropsychological test. Among the cocaine-dependent patients, none of these correlations approached significance. Among patients dependent on alcohol only, there was a marginally significant trend toward a negative correlation between delayed recall of the Taylor figure and length of abstinence (r = −.26, p = .05); thus, longer abstinence was weakly associated with poorer performance. No other correlations approached significance.
DISCUSSION

This study sought to investigate the presence of neuropsychological impairment attributable to chronic cocaine use. In order to increase the generalizability of the findings to the cocaine-dependent population, in which alcoholism is common (Brown et al., 1994), patients were chosen for participation who met DSM-IV (APA, 1994) criteria for both cocaine and alcohol dependence. Alcoholic patients without cocaine use served as a comparison group.

The groups did not differ in estimated IQ, level of education, depressive symptomatology, length of abstinence from substances, or frequency of other Axis I psychiatric disorders. As the cocaine-dependent group was significantly younger than the alcohol-only group, age was used as a covariate in all group comparisons of neuropsychological performance. Using scores on all cognitive tests as dependent variables in a multivariate analysis, the cocaine-dependent patients were found to be impaired relative to patients dependent on alcohol only. Further analysis indicated that this difference was largely attributable to poorer performance among cocaine-dependent patients on measures of immediate and delayed verbal memory. There were no cognitive decrements associated with cocaine dependence on tests of attention, visuospatial memory, visuoconstructive ability, abstract reasoning, and psychomotor speed. In addition, self-reported length of abstinence was not a significant predictor of neuropsychological performance for either group.

The poorer immediate story recall among cocaine-dependent patients could be attributable to compromised efficiency in initial encoding of the stimulus material. However, as the Babcock Story Recall Test protocol includes a second presentation of the story between immediate and delayed recall, additional factors might be responsible for these patients’ relatively impaired performance on the delayed recall condition. In particular, deficits in the ability to profit from repetition of the material, or in retention of the information over time, could have further contributed to their observed decrement in delayed verbal recall.

While the cocaine-dependent, alcoholic patients in this study manifested no other cognitive decrements relative to the alcoholic comparison group, it remains possible that chronic cocaine use among alcoholic patients leads to other neuropsychological impairments that were not detected in the present study. Because of limitations imposed by collecting the current data in a clinical setting, only a brief battery of tests was used, rather than a more comprehensive neuropsychological evaluation. Group differences could thus exist in the many cognitive domains that were not assessed.

Furthermore, many of the tests that were used might not be sufficiently sensitive to detect subtle deficits in this population. For example, the Neurobehavioral Cognitive Status Examination is primarily a screening instrument, and the two of its subtests used in the present study have a relatively restricted range of scores. As both groups’ mean scores on the Similarities and Judgment subtests were near the maximum attainable scores, these tests might not have been sufficiently difficult to discriminate between groups. Thus, more sensitive tests of executive functions might well have detected group differences that were not identified by these screening measures. Similarly, the failure to find group differences on the Digit Span subtest of the WMS-R does not necessarily imply that chronic cocaine use is not associated with attentional decrement among alcoholic patients; it is possible that a more sensitive task with heavier attentional demands, such as the Paced Auditory Serial Addition Test (Gronwall, 1977), might better discriminate between these two groups.

The notion that the measures used in the present study might not have been sufficiently sensitive is strengthened by the fact that, compared with published norms, most neuropsychological test scores for both patient groups fell in the low average to average range. Cocaine-dependent patients scored more than 1 SD below the normative mean only on the Symbol Digit Modalities Test and the Similarities subtest of the NCSE, while the alcohol-
only group's scores fell within 1 SD of the mean on all tests. However, as an alcohol- and drug-free control group was not included in the present study, the performance of the study sample relative to matched, "normal" controls remains an open question. In general, the present results appear consistent with the notion that many substance abuse patients perform in the normal range on various neuropsychological tests, while a subgroup falls in the impaired range of functioning (e.g., Parsons, 1994).

The possibility should be noted that the observed verbal memory decrement among cocaine-dependent patients could be due to uncontrolled sources of variance between the two groups, rather than to chronic cocaine use. For example, the incidence of traumatic brain injury, neuromedical risk factors, or other premorbid characteristics could have differed between the two groups. However, the groups appear to have been drawn from very similar populations (i.e., alcoholic patients seeking treatment at a VA Medical Center), and were equivalent on demographic indices. Thus, there is no clear apriori reason to assume that such factors differed systematically between groups, or were entirely responsible for the observed, selective deficit in verbal memory.

This study adds to a growing body of evidence suggesting neuropsychological decrement associated with chronic cocaine use. Several previous studies have similarly reported verbal memory impairment among cocaine-abusing patients (Beatty et al., 1995; Berry et al., 1993; Mittenberg & Motta, 1993), although negative findings have also been reported (Azrin et al., 1995; Selby et al., 1995; van Gorp et al., 1995). Notably, most previous studies have examined cocaine-abusing patients without other, concurrent substance use disorders. The present study, in contrast, is among the first to examine cognitive functioning in patients who meet diagnostic criteria for both cocaine and alcohol dependence, compared with "uncomplicated" alcohol-dependent patients. One other study that compared such groups (Brown et al., 1994) found no cognitive decrement associated with chronic cocaine use, but no memory measures were included in that test battery. Thus, the present findings should be considered preliminary, and further studies are needed to determine whether chronic cocaine use is reliably associated with cognitive deficits in alcoholic patients. The relationship of such findings to patterns of cognitive functioning in patients with uncomplicated cocaine dependence and uncomplicated alcohol dependence also remains to be explored.

As patients in the present study were examined after only a brief period of abstinence, after which cognitive improvement in alcoholic patients has often been observed (Grant, 1987; Orsini et al., 1988; Tarter & Edwards, 1987), the findings do not necessarily reflect these patients' long-term neuropsychological functioning. Nevertheless, the results do accurately reflect the cognitive status of patients beginning individualized substance abuse treatment. This investigation has attempted to expand upon previous research by examining cognition in cocaine-dependent patients more typical of those seen in treatment, that is, those with comorbid alcohol dependence. It is hoped that future investigations will determine with more certainty the generalizability of these findings, as well as exploring with more sensitive and comprehensive measures the neuropsychological functioning of individuals recovering from comorbid cocaine and alcohol dependence.

REFERENCES


