Cognitive functioning and length of abstinence in polysubstance dependent men

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Abstract

To date, there are few large-scale studies that have examined the relationship between duration of abstinence and cognitive functioning in polysubstance-dependent individuals. Existing large-scale studies of polysubstance abusers have reported only minimal recovery of cognitive functioning with abstinence [Arch. Gen. Psychiatry 35 (1978) 1063]. The goal of this study is to test whether length of abstinence (1 day and 14 months) is related to cognitive ability in a large cross-sectional sample of men recovering from dependence on at least two drugs (N = 207). A series of Poisson and linear regressions were run to test whether length of abstinence is associated with neuropsychological performance while controlling for demographic variables, raw Vocabulary score, drug use, and dependency. The primary finding is that increasing length of abstinence was not statistically associated with superior neuropsychological ability. This suggests that the abuse of multiple substances potentially produces long-lasting neuropsychological impairment with minimal recovery of functioning over a 1-year period.

Keywords: Abstinence; Recovery; Polysubstance; Polydrug; Cognitive ability; Neuropsychology

Approximately 44% of the admissions to drug and alcohol treatment centers in the United States are for multiple drug use (Department of Health and Human Services, 1999). Numerous studies have demonstrated cognitive deficits associated with polysubstance abuse, including deficits in verbal and visual memory, problem solving, visuoperceptual and visuomotor skills, attention, concentration, and psychomotor speed (e.g., Beatty, Blanco, Hames, & Nixon, 1997; Fals-Stewart, Schafer, Lucente, Rustine, & Brown, 1994; Grant, Mohns, Miller, & Reitan, 1990).
1976; Selby & Azrin, 1998). However, little is known about recovery of neuropsychological functioning with abstinence from polysubstance abuse, because the majority of abstinence studies are limited to single drugs of abuse or relatively small sample sizes.

The majority of the existing studies that examine cognitive functioning with abstinence have focused on individuals with alcohol abuse histories. With a few exceptions (e.g., Bates, 1997; Glenn, Parsons, & Sinha, 1994; Yohman, Parsons, & Leber, 1985), the studies of individuals diagnosed with alcohol abuse suggest that these patients show considerable recovery of verbal and nonverbal memory abilities, attention, concentration, abstract reasoning, and psychomotor speed within the first several months of abstinence, with continued recovery for up to 5 years (e.g., Drake et al., 1994; Schafer et al., 1991). Sullivan, Rosenbloom, Lim, and Pfefferbaum (2000) report a longitudinal examination of 42 men diagnosed with alcoholism (20 of whom abstained and 22 of whom relapsed) at 1, 2, and 12 months following entry into the study. The abstaining group’s performance on neuropsychological testing was significantly improved from baseline to follow-up on tasks that required nonverbal recall, attention, visuospatial ability, and motor coordination. However, it is unclear whether recovery of functioning occurred within the first 3 months of abstinence, or whether performance continued to improve over time.

In a cross-sectional analysis, Brandt, Butters, Ryan, and Bayog (1983) compared three groups with differing lengths of abstinence from alcohol: 1–3 months, 1–3 years, and 5 years or longer. They found that on tasks requiring short-term verbal memory, psychomotor speed, and visual memory, the short-term abstinent group performed significantly worse than the prolonged abstinent group. Moreover, on these same tasks, the prolonged abstinent group performed comparably to a matched control group of nonalcoholics. Still, long-term memory ability was significantly impaired even after 7 years of continuous abstinence. In contrast, Grant, Adams, and Reed (1984) found that recently detoxified alcoholics demonstrated mild neuropsychological impairment while the long-term sober alcoholics (an average of 3.7 years since last drink) were virtually indistinguishable from controls.

In terms of drugs other than alcohol, studies of individuals diagnosed with primarily cocaine and sedative abuse suggest that increasing lengths of abstinence are statistically related to improved performance on neuropsychological tests (e.g., Bergman, Borg, Engelbrektson, & Vikander, 1989; O’Malley, Adamse, Heaton, & Gawin, 1992; Tönne et al., 1995). In contrast, Solowij (1995) found that subtle deficits in the ability to effectively reject complex irrelevant auditory information were not related to length of abstinence in individuals who chronically abused cannabis.

Despite the fact that almost half of the individuals who abuse drugs take multiple substances, very little is known about the effect of abstinence on cognitive functioning in individuals diagnosed with polysubstance abuse or dependence. Furthermore, the few studies, to date, that have focused on individuals diagnosed with multiple substance abuse have yielded variable results. Adams, Rennick, Schoof, and Keegan (1975) administered a modified Halstead–Reitan battery to 51 individuals diagnosed with polysubstance abuse at admission for treatment, 4–7 days later, at the end of the month, and 1–2 weeks into the second month (total of four assessments within 6 weeks). Improvement of neuropsychological functioning was observed, although it is unclear how much practice effects contributed to the results. Furthermore, this study focused on whether the individuals were grossly impaired or not, and did not examine specific cognitive domains.
In a cross-sectional analysis of neuropsychological functioning in drug abusers, Selby and Azrin (1998) reported that, among the 56 participants diagnosed with polysubstance abuse, greater length of abstinence (mean length of abstinence was 58.36 months, S.D. = 26.16 months) was significantly correlated with improved performance on tasks that required verbal memory, visual memory, and inhibition of overlearned responses (only 5 of the 15 measures administered). However, the polysubstance abusing group demonstrated a weaker relationship between cognitive ability and duration of abstinence than both the alcohol and cocaine abusing groups, even though the mean length of abstinence was, on average, 22.5 months longer than the cocaine group and 15.7 months longer than the alcohol group.

Other studies of individuals with polysubstance abuse have found minimal or no recovery of functioning with 3 months to 1 year of abstinence (e.g., Nixon, 1999; Grant & Judd, 1976). For example, Grant et al. (1978) administered the Halstead–Reitan battery and the grooved pegboard test to 151 individuals diagnosed with polysubstance abuse. They found that, of the individuals diagnosed with polysubstance abuse who were judged to be impaired at the initial testing session, 69% did not improve and 6% substantially worsened at 3-month follow-up. They suggested the possibility that the combination of drugs such as alcohol, sedatives, and opiates may be associated with longer term neuropsychological deficits that reverse more slowly than do similar deficits observed in single drug abusers.

Thus, the current literature on recovery of function in individuals diagnosed with polysubstance abuse/dependence is not consistent with regard to whether or not duration of abstinence is related to cognitive ability. The major goal of the present cross-sectional study is to clarify the statistical relationship between length of abstinence and performance on neuropsychological tests among men recovering from DSM-IV diagnosed dependence on two or more drugs. The substantial sample size (N = 207) allowed for data analytic techniques that partialled out the potential contributions of frequency of drug use, pre-morbid IQ (measured by verbal ability), socio-economic status (level of education, household income, and ethnicity), age, gender, and history of head injury to cognitive performance. In addition, a novel aspect of the study is that we randomly assigned each case to one of two separate groups. Each analysis was run twice, once for each randomly selected group, in order to identify effects that were present consistently across subgroups.

Therefore, within the constraints of a cross-sectional design, the current study thoroughly examines the relationship between abstinence from multiple drugs and cognitive functioning, while controlling for moderating factors associated with cognitive functioning (e.g., Lezak, 1995). It is hypothesized that longer lengths of abstinence will be associated with improved performance on verbal and visual memory, attention and sequencing, and abstract reasoning among polysubstance-dependent men.

1. Method

1.1. Participants

Data were collected in conjunction with a larger study of 276 couples (Medina, Schafer, Shear, & Armstrong, in press) in which the men were recovering from substance abuse or
dependence on two or more drugs as defined by DSM-IV criteria (American Psychiatric Association, 1994). The participants were recruited from the greater Bay Area in Northern California. Half were recruited by advertisement in local newspapers, specialty publications, and by fliers distributed to the Department of Veterans Administration. The other half were randomly selected from public sector drug and alcohol treatment programs.

Prospective male participants were screened over the phone by trained interviewers. In order to be included in the original study, individuals needed to be married or cohabitating for a minimum of 1 year. The present study only included the men’s data, because the men comprised the target population with polysubstance dependence. To be included in the present study, the men needed to meet DSM-IV criteria for current (past year) dependence on two or more of the following drugs: cannabis, stimulants, sedatives, cocaine/crack, heroin/opioids, phencyclidine (PCP), hallucinogens, inhalants, or alcohol. In addition, individuals needed to be over the age of 18. In order to have the largest range possible, there were no limits to length of abstinence for the current study ($M = 139$ days; $SD = 107.8$ days; range 1–435 days). The current study’s goal was to examine recovery of cognitive functioning among men who were polysubstance dependent; thus, subsets of specific combinations of drugs (or single drugs of abuse) were not selected. Instead, the participants were recruited with the goal of representing the vast array of multiple drug use observed in clinical populations. From the cohort of 276 in the larger study, 207 men met the inclusion criteria.

1.2. Structured interview

Trained assistants conducted the interviews. The participants were first familiarized with the procedure, and informed consent was obtained. The men and their partners were then jointly interviewed for approximately 1 h to obtain drug use history, psychiatric history, and socio-demographic characteristics. Following the structured interview, the neuropsychological battery was administered. Each individual was paid $50.00 for his or her participation.

The last date of alcohol and drug use was obtained during the interview (the men’s substance use was verified by their partners). Information was recorded about handedness, history of head injury, loss of consciousness, and symptoms of depression and anxiety. Information was also obtained about ethnicity, educational background, total family income, and age. Questions were asked based on the Substance Abuse and Dependence portion of the DIS (Robins, Helzer, Przybeck, & Regier, 1988) to determine whether the participant met DSM-IV diagnostic criteria for substance dependence. The average number of days that the participant used each of the drugs during the year prior to abstinence and during their lifetime was collected.

1.3. Brief neuropsychological battery

Trained interviewers administered the brief neuropsychological battery, which included six instruments. These tests have been used extensively in studies of cognitive functioning in substance abusers, and have been found to be sensitive to the deficits in verbal and visual memory,
cognitive disinhibition, abstract reasoning, attention and sequencing, and psychomotor speed often observed in these populations (e.g., Brandt et al., 1983; Drake et al., 1994; Schafer, Birchler, & Fals-Stewart, 1994; Selby & Azrin, 1998). For all of the regression analyses, the neuropsychological raw scores were used (gender, age, and education were controlled for statistically).

1.3.1. Visual memory
The Benton Visual Retention Test (BVRT; Benton, 1974) is a well normed measure of visual memory and visuoperceptive ability. The test materials consist of 10 cards, each of which contains several geometric figures. In the copy condition, the participants are asked to copy each design as accurately as they can with the stimuli in front of them. In the recall condition, participants are shown a card for 10 s, the card is hidden, and participants are asked to draw the figures that they recall. For this study, the total number correct was analyzed for the recall condition.

1.3.2. Verbal memory
The California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan, & Ober, 1987) measures verbal learning and memory using a 16-item word list, which includes items drawn from four semantic categories. The CVLT variables of interest in this study are total recall (across five learning trials) and long-delay free recall scores.

1.3.3. Word knowledge
The Vocabulary subtest of the Wechsler Adult Intelligence Scale—Revised (WAIS-R; Wechsler, 1981) evaluates word knowledge. The participant is asked to define words of increasing difficulty that are read by the examiner and also shown on a written card. This subtest was utilized to provide a pre-morbid IQ estimate.

1.3.4. Abstract reasoning
The Booklet Category Test (BCT; Defillippis, McCampbell, & Rogers, 1979) estimates conceptualization and abstract reasoning ability. There are seven subtests to the BCT (with 8–40 stimuli in each subtest). The participant’s task is to deduce the underlying principle for each set in order to be able to respond correctly. The score is the number of total errors.

1.3.5. Inhibition
The Stroop Test (Stroop, 1935) measures the ability to inhibit overlearned responses. It requires the participant to give the color of the ink the word is printed in, as it is distinct from the printed color word. For this project, participants were administered the Stroop Neuropsychological Screening Test by Trennery, Crosson, DeBoe, and Leber (1989).

1.3.6. Attention and visuomotor tracking
The Trail Making Test (TMT; Army Individual Test Battery, 1944) is a task that requires visual scanning, attention, sequencing, and psychomotor speed. The TMT is sensitive to diffuse brain damage (Lezak, 1995). Participants must first draw lines to connect consecutively numbered circles as fast as they can (Part A). Participants are then given Part B, on which
they must alternate between consecutively numbered and lettered circles on a work sheet as quickly as they can (e.g., 1-A-2-B). The TMT variables of interest for this study are the time of completion for Trails A and B.

2. Results

2.1. Demographic and neuropsychological information

Table 1 provides the means, standard deviations, and ranges for age, education, length of abstinence, and scores on the neuropsychological tests. The full sample was divided into two randomly selected groups, which did not differ significantly in their age, ethnicity, neuropsychological performance, and education. The full sample included Asian-Americans (1%), African-Americans not of Hispanic descent (28.5%), African-Americans of Hispanic descent (1%), White of Hispanic origin (17.9%), Native-Americans (1.9%), Caucasian not of Hispanic origin (46.4%), and other ethnicities (3.4%). The participants’ total household incomes were as follows: under $3,000 (3.9%), $3,000–$6,999 (7.2%), $7,000–$9,999 (10.6%), $10,000–$14,999 (21.7%), $15,000–$19,999 (13%), $20,000–$24,999 (11.6%), $25,000–$34,999 (14%), $35,000–$49,999 (9.7%), and $50,000–$99,999 (8.2%). Of the 207 men, 57% reported never having been knocked out, in a coma, or unconscious for any amount of time during their lifetime. The majority of the men were right-handed (88.3%). The two randomly selected groups did not differ significantly in their age, ethnicity, neuropsychological performance, or education.

Although the raw scores were used in the regression analyses, standard scores are provided here for descriptive purposes to allow comparison to normative data. In comparison to published norms for Trail B (Heaton, Grant, & Matthews, 1991), 21.3% of the participants obtained an age, sex, and education corrected T-score within the range of 40–31, while 7.7%

Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>35.49</td>
<td>7.81</td>
<td>19–57</td>
</tr>
<tr>
<td>Education</td>
<td>10.38</td>
<td>4.12</td>
<td>1–19</td>
</tr>
<tr>
<td>Length of abstinence (day)</td>
<td>138.86</td>
<td>107</td>
<td>1–435</td>
</tr>
<tr>
<td>Vocabulary scaled score</td>
<td>8.44</td>
<td>2.44</td>
<td>3–19</td>
</tr>
<tr>
<td>Booklet Category Test (no. of errors)</td>
<td>63.03</td>
<td>29.35</td>
<td>11–137</td>
</tr>
<tr>
<td>Trail B (time in seconds)a</td>
<td>74.26</td>
<td>34.56</td>
<td>20–180</td>
</tr>
<tr>
<td>Stroop</td>
<td>98.28</td>
<td>29.31</td>
<td>33–195</td>
</tr>
<tr>
<td>BVRT (number correct)</td>
<td>6.51</td>
<td>1.72</td>
<td>1–10</td>
</tr>
<tr>
<td>CVLT (total recall of Trials 1–5)b</td>
<td>32.59</td>
<td>15.51</td>
<td>5–69</td>
</tr>
<tr>
<td>CVLT (long-delay free recall)c</td>
<td>–1.46</td>
<td>1.52</td>
<td>–5–2</td>
</tr>
</tbody>
</table>

BVRT, Benton Visual Retention Test; CVLT, California Verbal Learning Test.
a Time to complete Trail B was cutoff at 180s.
b Based on T-scores.
c Based on z-scores.
obtained an age, sex, and education corrected T-score of 30 or lower. A significant proportion (50.5%) of the participants achieved scores below 99 on the Stroop which, according to norms for the age range of 18–49, suggests the presence of brain damage (Trenerry et al., 1989). Based on norms published in Heaton et al. (1991), 31.4% of the participants age, sex, and education corrected T-scores were within the range of 31–40 on the BCT, while 27.1% obtained an age, sex, and education corrected T-scores below 30. Based on norms published for performance on the BVRT (recall condition), 30% of the participants fall into the suspected visual impairment range (Sivan, 1992). Finally, 46.9% of participant’s T-scores were below 40 on the CVLT total recall of Trials 1–5, while 47.3% of the participant’s performed two or more standard deviations below the mean on the CVLT long-delay free recall (Delis et al., 1987).

2.2. Dependence criteria and drug use frequency

Of the 207 men, 79.2% were diagnosed with dependence on alcohol, 60.9% with dependence on cannabis, 52.2% with dependence on cocaine, 47.8% with dependence on stimulants, 30.4% with dependence on opioids, 10.1% with dependence on sedatives, 5.8% with dependence on PCP, 4.3% with dependence on hallucinogens, and 0.5% with dependence on inhalants. The majority of the sample (26.6%) was diagnosed with dependence on two drugs, followed closely by dependence on three drugs (23.2%), four drugs (22.7%), five drugs (9.7%), six drugs (9.2%), seven drugs (5.8%), eight drugs (1.4%), and nine drugs (1.4%).

Table 2 provides a description of the type and frequency of drug use during the year prior to abstinence, and the frequency of lifetime drug use.

2.3. Data analysis

The full data set was randomly split into two samples (Sample 1, N = 104; Sample 2, N = 103) in order to determine which variables were consistent significant predictors of neuropsychological performance. The dependent variables of interest were the number correct on the BVRT recall, total recall on the CVLT, long-delay free recall on the CVLT, number of

<table>
<thead>
<tr>
<th>Drug</th>
<th>Mean</th>
<th>Median</th>
<th>S.D.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marijuana</td>
<td>705 (21)</td>
<td>678 (7)</td>
<td>493 (23)</td>
<td>0–2035 (0–52)</td>
</tr>
<tr>
<td>Stimulants</td>
<td>285 (16)</td>
<td>156 (0.4)</td>
<td>348 (22)</td>
<td>0–1617 (0–52)</td>
</tr>
<tr>
<td>Sedatives</td>
<td>120 (3)</td>
<td>0 (0)</td>
<td>313 (11)</td>
<td>0–1567 (0–52)</td>
</tr>
<tr>
<td>Cocaine</td>
<td>279 (12)</td>
<td>156 (0.4)</td>
<td>335 (19)</td>
<td>0–1570 (0–52)</td>
</tr>
<tr>
<td>Heroin</td>
<td>204 (8)</td>
<td>0 (0)</td>
<td>428 (17)</td>
<td>0–1713 (0–52)</td>
</tr>
<tr>
<td>Opioid</td>
<td>96 (4)</td>
<td>0 (0)</td>
<td>258 (12)</td>
<td>0–1513 (0–52)</td>
</tr>
<tr>
<td>Hallucinogens</td>
<td>72 (0.3)</td>
<td>0 (0)</td>
<td>180 (1.3)</td>
<td>0–1304 (0–11)</td>
</tr>
<tr>
<td>PCP</td>
<td>44 (1.2)</td>
<td>0 (0)</td>
<td>163 (7)</td>
<td>0–1044 (0–52)</td>
</tr>
<tr>
<td>Inhalants</td>
<td>17 (0)</td>
<td>0 (0.04)</td>
<td>115 (0.4)</td>
<td>0–1566 (0.004)</td>
</tr>
<tr>
<td>Alcohol</td>
<td>822 (30)</td>
<td>790 (30)</td>
<td>526 (22)</td>
<td>0–2270 (0–52)</td>
</tr>
</tbody>
</table>

Frequency of drug use was measured in weeks. Past year frequencies are represented in parenthesis.
errors on the BCT, total score on the Stroop, and time to complete the TMT B. The primary independent variable of interest was length of abstinence (in days). The other control variables included: demographic variables (age, education, household income, ethnicity), pre-morbid IQ estimate (raw Vocabulary score), drug use variables (average number of days the participant used each drug during the year prior to abstinence, the average number of days the participant used drugs during his lifetime, and variables indicating whether or not the participant met DSM-IV criteria for dependence on each drug), and history of head injury. All regressions were run twice, once on Sample 1 and once on Sample 2, for the purpose of replicating significant results; inconsistent findings across the two samples were treated as nonsignificant. Decisions about statistical significance were made if probability levels were at .05 or lower for both samples.

2.4. Multivariate relationships

Due to skewed distributions of the BCT scores, time on Trail B, and the reflected BVRT, Poisson regressions were run to test whether length of abstinence was associated with neuropsychological performance. We transformed the BVRT variable using reflection (i.e., the scale was flipped, so that scores of 10 were recoded to 1, and 1 was recoded to 10) so that it was more amenable to use Poisson regression. Linear regressions were conducted to test whether length of abstinence was related to performance on total recall on the CVLT, long-delay free recall on the CVLT, and total score on the Stroop, because these variables were normally distributed and met the assumptions for linear regression.

In order to thoroughly examine the relationship between length of abstinence and neuropsychological functioning, four sets of independent variables were used in separate analyses: (1) demographic and abstinence variables (length of abstinence, age, head injury, education, total household income, ethnicity, and raw Vocabulary score), (2) demographic and abstinence variables plus past year drug use, (3) demographic and abstinence variables plus lifetime drug use, and (4) demographic and abstinence variables plus dependence variables. The demographic variables were included in order to control for potential moderator variables related to cognitive functioning (Lezak, 1995), and Models 2–4 were run in order to examine the relative contributions of frequency of past year and lifetime drug use, as well as dependency status, on cognitive functioning. This was also done to insure that use of specific drugs did not moderate length of abstinence effects. The regressions were run separately for each of the seven neuropsychological tests. Again, decisions about statistical significance were made if the one-tailed t-test yielded probability values at .05 or lower in both Samples 1 and 2.

The regressions were first run with the demographic variables. For each of the dependent variables, length of abstinence was not significantly related to cognitive functioning. Greater age was related to poorer scores on total recall [for Sample 1, *t*(94) = −2.35, *P* < .01; for Sample 2, *t*(94) = −2.13, *P* < .02], and more errors on the BCT [for Sample 1, *t*(94) = 3.11, *P* < .005; for Sample 2, *t*(94) = 2.48, *P* < .01]. Higher raw Vocabulary scores were related to superior performance on total recall [for Sample 1, *t*(94) = 2.72, *P* < .004; for Sample 2, *t*(94) = 2.96, *P* < .002], decreased errors on the BCT [for Sample 1, *t*(94) = −3.68, *P* < .001; for Sample 2, *t*(94) = −1.94, *P* < .05], superior performance on long-delay free recall [for Sample 1, *t*(94) = 2.59, *P* < .006; for Sample 2, *t*(94) = 2.87, *P* < .003], and
decreased time to complete Trail B [for Sample 1, \(t(94) = -3.31, P < .001\); for Sample 2, \(t(94) = -1.74, P < .05\)].

In order to reduce redundancy, results for Sets 2–4 are represented below only if they produced unique results beyond those demonstrated from Set 1. Therefore, unless otherwise specified, results obtained from the latter sets of regressions reflect the same pattern of results as those obtained from the first set of regressions.

For the second set of independent variables (past year drug use and the demographic variables), abstinence was again found to be unrelated to neuropsychological performance. In addition, none of the past year drug use variables consistently predicted neuropsychological performance.

Among the third group of independent variables (lifetime drug use plus the demographic variables), longer lengths of abstinence were found to be related to worse performance on long-delay free recall [for Sample 1, \(t(84) = -2.13, P < .02\); for Sample 2, \(t(84) = -1.81, P < .04\)]. In addition, higher total household income was related to better scores on the Stroop [for Sample 1, \(t(84) = -1.76, P < .05\); for Sample 2, \(t(84) = 2.13, P < .025\)].

For the fourth set of independent variables (diagnosis\(^2\) variables plus demographic variables), longer length of abstinence was found to be related to poorer scores on long-delay free recall [for Sample 1, \(t(86) = -1.94, P < .025\); for Sample 2, \(t(85) = -2.02, P < .023\)]. The diagnosis of dependence on any of the drugs did not significantly predict neuropsychological performance. Higher raw Vocabulary scores were significantly related to higher scores on the BVRT recall [for Sample 1, \(t(86) = -1.76, P < .05\); for Sample 2, \(t(85) = -1.69, P < .05\)].

3. Discussion

The present results are consistent with previously submitted findings that mild-to-moderate neuropsychological deficits are present in individuals diagnosed with polysubstance dependence (e.g., Beatty et al., 1997; Fals-Stewart et al., 1994; Grant et al., 1976; Selby & Azrin, 1998), which we assessed through comparison with published norms. However, inconsistent results have been obtained in previous studies with regard to the degree to which cognitive functioning recovers with abstinence from multiple substances.

Our goal was to examine, within the constrains of a cross-sectional design, the relationship between length of abstinence and neuropsychological performance in men diagnosed with dependence on multiple substances using a split-half validation approach. The primary finding is that there was not a significant relationship in the expected direction between length of abstinence and any of the cognitive domains tested (verbal and visual memory, abstract reasoning, attention and psychomotor speed, and cognitive disinhibition). That is, within the limitations of a cross-sectional design, superior cognitive functioning does not vary systematically with longer periods of sobriety within the first year of abstinence in polysubstance-dependent men.

Higher Vocabulary scores were significantly associated with better performance on tasks that require short-term verbal memory, abstract reasoning, long-term verbal memory, attention, and visuomotor tracking. Also, greater age was associated with inferior performances on tasks

\(^2\) Variables denoting dependence on inhalants were excluded due to small sample sizes.
that require short-term verbal memory and abstract reasoning. These relationships are well
documented within the neuropsychological assessment literature (e.g., Lezak, 1995). Thus,
the lack of significant findings with regard to abstinence stand in contrast to the confirmation
of other expected relationships in the data.

One possible explanation for the observed lack of the predicted relationship between length
of abstinence and neuropsychological performance is that multiple substance use causes longer
term, potentially even permanent neuropsychological deficits when compared to single drugs
of abuse. This explanation is consistent with previous research conducted by Grant et al.
(1976, 1978) suggesting that neuropsychological deficits persisted at both the 3- and 5-month
follow-up. In addition, Nixon (1999) reported no significant recovery of functioning in indi-
viduals diagnosed with alcoholism and multiple drug abuse, alcoholism and stimulant use,
and alcoholism and cannabis use. All these groups (except the alcohol and stimulant groups)
improved the same amount as the control group, suggesting the improved scores were due to
practice effects. However, these findings were based on a small sample size, and on a group
in which 71% of the participants resumed substance use.

Although Selby and Azrin (1998) found recovery of functioning in 5 of the 15 neuropsy-
chological measures (short-term verbal memory, long-term verbal memory, visual memory,
visuospatial ability, and ability to inhibit overlearned responses), the polysubstance group im-
proved the least with abstinence when compared to the alcohol, cocaine, and control groups.
Furthermore, the polysubstance group was the most cognitively impaired group and, on aver-
age, these individuals were abstinent for longer periods than were those in the other comparison
groups. This supports the present findings that polysubstance abuse produces long-lasting, sig-
nificant neuropsychological impairment.

Another possible explanation for the present findings is that the majority of recovery occurs
within the first few weeks and, consequently, that the majority of participants in the present
study had already experienced recovery (albeit with persistent impairment) prior to their en-
rollment. This may be a potential reason why the present findings contrast with Adams et al.
(1975) and Meek, Clark, and Solana (1989), who reported significant recovery of functioning
in individuals diagnosed with polysubstance abuse. Both of these studies were conducted over
a very short period of abstinence (approximately 1.5 months and 2 weeks, respectively). A
few studies on recovery of functioning in individuals diagnosed with alcohol dependence have
reported recovery within the first few weeks of abstinence with no or minimal further recovery
over the next 6 months to a year (e.g., Yohman et al., 1985). In contrast to what would be
expected were this hypothesis to hold for our data, scatter plots of the current sample reveal
no trend towards recovery of functioning among the men who have been abstinent between
1 week and 1 month (e.g., see Figs. 1 and 2). It is possible that the self-reported lengths of
abstinence in this community sample were not accurate. However, we attempted to combat
this possibility by obtaining collaborative information about the men’s drug use from their
female partners.

We considered the possibility that the participants are receiving scores that fall in the im-
paired range not because of drug neurotoxicity but, rather, because of socio-demographic
factors. Thus, the ethnic minority participants may be appearing disproportionately impaired
due to a lack of appropriate comparative norms. There are several aspects of the data that do not
support this explanation. Even among the highly educated (13+ years) Caucasian participants,
who had an average Vocabulary score of 10.7, performance on the neuropsychological tasks was consistently 1–1.5 standard deviations below the mean. In addition, on some measures, the highly educated African-American and/or Hispanic participants were performing better than the Caucasian participants (e.g., Trail B, Stroop, and BVRT). Finally, length of education and ethnic identification were not significant predictors of performance on any of the neuropsychological tests. Therefore, it is unlikely that the demographic characteristics of the sample explain the results. It is, however, possible that some of the observed neuropsychological deficits existed prior to the substance abuse, which we cannot examine in the present design.

In our data, there was not a significant relationship between the frequency of drug use and neuropsychological performance. In other words, no single drug contributed significantly to the prediction of neuropsychological performance. Because the majority of the participants regularly used alcohol, cannabis, stimulants, cocaine, and opioids (including heroin) during the year prior to abstinence and met the dependence criteria, it is very difficult to distinguish the influence of any single drug on neuropsychological performance.

The present findings are limited by the cross-sectional design of the study. A longitudinal study design is necessary to validate the conclusions that there is minimal or no recovery of
functioning within the first year of abstinence from multiple drug dependence. Furthermore, it is difficult to determine exact drug combinations that lead to neuropsychological impairment. It is unclear whether or not differences exist between certain drug combinations in the recovery of neuropsychological functioning. However, in the current study, no individual drug frequency variables significantly predicted cognitive functioning. Still, this finding needs to be replicated in further studies focusing on polysubstance abuse. In addition, the results cannot necessarily be generalized to women diagnosed with multiple drug use considering that only men participated in this study. Still, considering the large range of abstinence, sheer amount of drug use, and large sample size ($N = 207$), the results are provocative.

The presence of sustained neuropsychological deficits in this sample of polysubstance-dependent men gives further evidence of the merits of employing neuropsychological testing in treatment planning for substance abuse and dependence. Complicated verbal therapies early in treatment need to be assessed to determine whether or not they are realistic techniques to apply with cognitively impaired clients. Follow-up testing after a few months of abstinence may give an accurate prognosis of cognitive functioning for the upcoming year, and relapse prevention techniques should incorporate the individual’s potential cognitive deficits. Of course, further
research is necessary to replicate these findings and examine whether cognitive functioning improves over longer lengths of abstinence (e.g., up to 7 years).

Given that there is a high rate of polysubstance-dependent individuals entering treatment centers in the United States, further research on the unique neuropsychological consequences and recovery of functioning for these individuals is critical. In addition, future studies need to assess the influence of long-lasting cognitive impairment on vocational abilities, relapse, and psychopathology among individuals diagnosed with polysubstance abuse or dependence. Considering the disparate results of studies focused on single drugs of abuse (particularly cocaine, alcohol, cannabis, and stimulants), further research is needed to determine which combinations of drugs are risk factors for longer lasting cognitive impairment.

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