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Substance use and mental health characteristics associated with cognitive functioning among adults who use methamphetamine

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Abstract

This study describes cognitive functioning and its relation to psychiatric and substance use severity among adults with long duration methamphetamine (MA) use careers. Study participants (N=405) completed a battery of tests from the Automated Neuropsychological Assessment Metrics (ANAM), examining cognitive accuracy, processing speed and efficiency. Multivariate analyses indicate lower accuracy but faster speed on tests of learning and spatial and delayed memory were correlated with more days of past-month MA use. Lifetime months of MA use was not related to cognitive functioning. Poorer cognitive efficiency was related to other problems including crack/cocaine use, depressive symptomatology and poorer emotional state.

Keywords

Methamphetamine; cognitive functioning; substance use; mental health

INTRODUCTION

Studies examining cognitive functioning in people with substance use disorders indicate deficits in memory, executive functions and information processing speed have been observed, and may be related to cognitive differences predating substance use as well as the effects of long-term heavy use.^{1–3} Gould¹ reports that the brain regions and neural processes that underlie addiction overlap extensively with those that support cognitive functions, and with continued drug use, cognitive deficits ensue that exacerbate the difficulty of establishing sustained abstinence. Regarding methamphetamine (MA) use specifically, research suggests cognitive impairments in memory, learning, psychomotor speed, and information processing are common in chronic MA users, and these impairments have the potential to compromise the ability of MA users to engage in, and benefit from psychosocially based substance abuse treatment.⁴ A study by Simon et al⁵ indicates that MA use has been associated with impairment on recall tasks, sequencing, mental flexibility, psychomotor speed, manipulation of information, selective attention and the ability to ignore irrelevant information. In addition, findings from neuroanatomical, neurochemical, and imaging studies support the conclusion that MA abuse causes damage to multiple transmitter systems that are distributed throughout the brain.⁶

The extent of MA-related impairment/damage, and whether it is permanent or reversible over time has not yet been determined. A study by McCann et al⁷ indicates lasting effects of neurocognitive memory deficits were observed in a cohort of abstinent MA users. Similarly,

studies found deficits among both abstinent and non-abstinent MA users in verbal memory, perceptual motor speed and tasks that require mental flexibility.^{8,9} However, Chang et al.¹⁰ found cognitive performance of MA dependent adults who were abstinent for two or more weeks was in the normal range on standard neuropsychological tests; however, they were slower on several tasks that required working memory. Some research indicates acute doses of MA administered to drug-naïve subjects produced improvements in cognitive processing, while other studies found no cognitive improvements associated with amphetamine administration.^{1, 6} Scott et al.¹¹ concluded that the acute cognitive effects of therapeutic doses of MA tend to increase attentiveness and speed of processing, but also decrease ability to filter information.

Numerous factors may affect the extent of the impact of MA use on cognition; for example, younger age at first MA use may be an important factor, as research indicates exposure to substances in childhood or adolescence produces long-lasting changes in cognition.¹ Scott et al.¹¹ report that the neurocognitive effects of MA may potentially be explained by factors including demographics (e.g., gender), characteristics such as duration of MA abstinence, and the influence of common psychiatric and neuro-medical comorbidities such as HIV infection. The study found that gender had a relatively minor, but significant, influence on the magnitude of the MA-associated effect sizes, in that a larger proportion of men in a MA sample was associated with greater overall levels of neuropsychological impairment. Normal aging is associated with structural and functional changes in prefrontal systems,¹² which may lead to additive cognitive deficits in an aging population of MA users.¹³ Scott et al.¹¹ report that neither education nor the between-group discrepancy in education had a significant influence on the effect size estimates, and the length of MA use was also not correlated with the magnitude of effect.

In addition to demographic characteristics, use of other substances may also affect cognitive functioning, particularly since many MA users are also extensive poly-drug users, with high levels of alcohol, marijuana, heroin and other stimulant use commonly reported.^{14–16} Ornstein et al.¹⁷ compared amphetamine users to heroin users on a neuropsychological test battery and found both groups were impaired on some tests of spatial working memory and pattern recognition memory, however the heroin users also showed impairment in learning. Additionally, chronic alcohol abuse has been associated with cognitive impairment including deficits in learning and memory,¹⁸ and research suggests that between 50% and 80% of individuals with alcohol use disorders experience mild to severe neurocognitive impairment.¹⁹

The purpose of this paper is to describe the performance of adults with lengthy MA use careers on several learning and memory tests in relation to MA use severity, other substance use characteristics, and mental health problems. A better understanding of demographic and clinical attributes associated with cognitive problems among MA-users may help identify individuals in greater need for more intensive or specialized treatment interventions that take into account possible learning and memory difficulties.

METHODS

Participants

Data for the current analysis are from a follow-up interview (2010–2012) in a natural history study of MA use. Subjects are from two cohorts from earlier studies: 1) clients treated in publicly funded Los Angeles County treatment programs in 1995–97 (n=230 in current analysis); and 2) a cohort from the same communities who have not previously participated in formal substance abuse treatment at their original recruitment in 2001–2004 (n=175 in current analysis). The original treated sample (N=351) was recruited from a stratified (by

gender, ethnicity, treatment modality) random sample of 1995–1997 treatment admission records in Los Angeles County and was first interviewed in 1999–2001, and again in 2001–04. The original not-treated sample (N=298) was recruited and using community approaches including an acquaintance sampling approach, key informants, and extensive outreach in a range of Los Angeles county community venues to achieve socio-demographic and MA use behavior diversity; they were first interviewed in 2001–04. All participants were English or Spanish speaking. Detailed description of the treated sample and study procedures can be found in Brecht et al.²⁰ The first 405 participants interviewed in an ongoing 2009–12 follow-up study who completed the ANAM test battery are included in this analysis. Because the cognitive tests (ANAM) could not be administered in jails or prisons, only non-incarcerated participants are included in this analysis. In addition, ANAM data were not available for participants who: were interviewed by phone (n=4), declined to complete the battery (n=1), or were legally blind (n=1); data could not be retrieved for two respondents due to computer problems. Thus, of the original non-incarcerated surviving sample who agreed to participate in the follow-up study (N=520), 78% have thus far completed ANAM data and are included in this analysis.

The sample examined in this analysis (N=405) was 44% female, 41% White, 30% Hispanic, 17% African American, 7% multi-ethnic, 2% Asian American and 2% Native American; the mean age was 42.5 years (SD=8.5). About one-fourth (27%) had less than a high school education, 25% completed high school, and 48% received additional education after high school; 43% were currently employed. The mean age of first MA use was 19.5 (SD=6.2); 57% of the current sample received treatment prior to study recruitment and 43% had not received treatment. Participants initiated MA use an average of 23 years prior to the interview; 25% used MA in the past 30 days and 44% had been MA-abstinent for five or more years. While all study participants were previously or currently regular MA users, many were also regular users of alcohol to intoxication (69%), crack/cocaine (39%), tranquilizers/benzodiazapines (16%), and heroin (14%).

Procedures

In-depth, face-to-face interviews were conducted during which the ANAM was administered, followed by a Natural History Interview which assessed a comprehensive array of variables including sociodemographic and substance use characteristics and mental health status. Respondents were paid \$40 for interview participation, and interviews were conducted in English or Spanish according to the participant's preference. Trained bilingual interviewers provided participants with a complete description of the study, and participants provided signed informed consent. The Institutional Review Board at the University of California, Los Angeles approved this study.

Measures

ANAM—The Automated Neuropsychological Assessment Metrics (ANAM) is a computer-assisted battery of tests designed to assess attention, memory, and thinking ability.²¹ The following five ANAM tests were administered in this study, and scores were calculated for accuracy (i.e., percent of correct responses), speed (number of taps per interval), and efficiency (i.e., combined speed and accuracy; percent correct divided by speed score).

Code substitution (learning)—This 72-item test is used as an index of complex scanning, visual tracking, and attention. A digit-symbol pair is displayed with a set of defined digit-symbol pairs (i.e., the key). The respondent indicates whether the pair in question represents a correct or incorrect mapping relative to the key.

Mathematical processing (working memory)—This 20-item test assesses basic computational skills, concentration, and working memory, in which arithmetic problems involving three single-digit numbers and two operators are displayed (e.g., “ $5 - 2 + 3 =$ ”). The respondent indicates whether the answer is less than five or greater than five.

Matching to sample (spatial memory)—This is a 20-item test of spatial processing and visuo-spatial working memory. The respondent examines a pattern produced by eight shaded cells in a 4×4 sample grid. The sample is then removed and two comparison patterns are displayed side by side. One grid is identical to the sample grid and the other grid differs by one shaded cell. The user is instructed to identify the grid that matches the sample.

Code substitution delayed (delayed memory)—This 36-item test of learning and delayed visual recognition memory (delayed recall) assesses recognition of digit/symbol pairs that were shown approximately 20 minutes earlier during the Code Substitution Learning test.

Procedural reaction time (processing speed)—This 32-item test measures basic reaction time and processing efficiency; the respondent is instructed to designate numbers on the screen as “low” if they are 2 or 3, or “high” if they are 4 or 5.

Natural History Interview—The first segment of the Natural History Interview assessed a comprehensive array of variables including demographics, substance use characteristics, and health and mental health status. The second segment collected detailed life-course data on use of selected substances, treatment utilization, criminal behavior, and legal status over time using a timeline follow-back approach with recall anchored by subjects’ critical life events.^{22,23} In addition, depression was assessed using the Beck Depression Inventory.

Sociodemographic characteristics—Age, gender, education level (less than high school; high school graduate; more than high school education), and current employment were assessed at the follow-up interview; race/ethnicity was assessed at the baseline interview.

Substance use and treatment—At each interview, respondents were asked to report whether they had used various substances, including heavy use of alcohol (5 or more drinks per sitting) MA, crack/cocaine, heroin, and tranquilizers/benzodiazapines; whether they ever used these substances on a regular basis; and how long ago they last used each substance. Regular use of alcohol to intoxication, crack/cocaine, heroin or tranquilizers/benzodiazapines, and past year use of MA and crack/cocaine were examined in this analysis.

To assess MA use severity, a cumulative measure of lifetime years of MA use was derived from total months with any MA use from age 14 to recent follow-up interview date, based on timeline follow-back data from baseline and follow-up interviews. Additionally, respondents reported the number of days in the past month they used MA, with responses ranging from 0–30, and their age when they first began using MA. Treatment participation at recruitment, comparing the treated to the not-treated sample, was also examined.

Mental health—Respondents were administered the 21-item Beck Depression Inventory²⁴ as part of the follow-up interview. Higher scores reflect greater depression symptoms (α for this sample was .90). Respondents were also asked how they would rate their general emotional state (on a five-point scale, with response options of 0=poor to 4=excellent), and whether they had experienced specific mental health problems in the past 30 days that were not a direct result of drug or alcohol use. Problems included serious depression that lasted

two or more weeks; serious anxiety that lasted two or more weeks; trouble concentrating, understanding or remembering that lasted two or more weeks; and trouble controlling violent behavior.

Analysis

Correlations, one-way ANOVA and t-tests examined ANAM accuracy, speed and efficiency scores in relation to demographics, mental health and substance use variables. Linear regression was used to predict the ANAM scores from mental health and substance use variables, adjusting for demographic characteristics (age, education level, race/ethnicity and gender); a separate regression was estimated for each user characteristic.

RESULTS

Tables 1 and 2 show differences in ANAM scores by demographics, substance use, and mental health variables; Table 3 shows correlations of ANAM scores with age, substance use, and mental health variables; and Table 4 shows results from regression analyses (parameter estimates, standard errors) predicting ANAM scores for each demographic, substance use, and mental health variable after adjusting for age, education level, race/ethnicity and gender. As shown in Table 1, younger age and more years of education were related to higher accuracy, speed and efficiency on most of the five cognitive tests. Accuracy scores appeared to decline steadily until age 50–59, and although not statistically significant, showed an increase for those age 60–72 ($p < .1$ for delayed memory accuracy compared to those age 50–59). Women had higher scores on learning speed and efficiency than men. Higher accuracy, speed and efficiency scores were found for those who were employed, and most efficiency scores remained significantly higher in multivariate analysis for those employed.

Higher accuracy scores were found for those who were MA-abstinent in the past year compared to those who used MA in the past year, specifically for learning and spatial memory after adjusting for demographic differences (Table 2). Speed was higher for past-year MA users, with a significant difference found for working memory speed. Lower accuracy scores for working and delayed memory were found for regular crack/cocaine users, however, unlike findings for MA users, speed scores were also lower. Consequently, efficiency scores were lower for regular crack users compared to those who did not use crack regularly, and statistically significant differences remained for spatial memory after adjusting for demographics. Regular alcohol use to intoxication was associated with lower learning accuracy. MA users who had not received drug treatment at study recruitment had higher accuracy scores for learning, and higher speed and efficiency scores for spatial memory compared to those who did receive treatment.

Regarding mental health problems, poorer learning speed and efficiency were related to past-month depression and anxiety problems; additionally, self-report of past-month problems understanding, concentrating or remembering were consistent with lower ANAM scores. Poorer accuracy scores (and faster speed for delayed memory) were related to violent behavior problems. Higher Beck depression scores and poorer emotional state were related to lower accuracy on spatial and delayed memory, and lower learning speed and efficiency scores; higher scores on procedural reaction time (speed and efficiency) were related to better emotional state.

As shown in Table 3, more frequent MA use in the past 30 days was associated with poorer accuracy scores on learning, spatial memory and delayed memory, and higher speed scores on spatial and delayed memory ($p = .080$ for number of days of past month MA use predicting learning speed in multivariate analysis). Thus, efficiency scores showed no

differences based on frequency of past month MA use. Lifetime months of MA use was significantly related to poorer accuracy, slower speed and lower efficiency on several cognitive tests, however, after adjusting for demographic characteristics (specifically age and education level), findings were not statistically significant. Younger age at first MA use was related to higher accuracy score on working memory.

DISCUSSION

Overall, this sample of adults with a history of MA use showed somewhat similar accuracy and efficiency scores on several ANAM tests (spatial and delayed memory) compared to another sample of substance abuse patients,²⁵ although our sample scored higher on tests of learning and working memory. Comparing our under 30 subsample to a young adult normative/reference sample (average age of 23), similar learning (46.4) and working memory (18.7) efficiency scores were reported,²⁶ suggesting cognitive functioning in our sample may be somewhat similar to a normative sample. However, substantial variability was observed based on demographics, substance use, and mental health problems. Interestingly, our results suggest that for specific memory (delayed and spatial) and learning tasks, more frequent recent MA use was associated with poorer accuracy but faster cognitive processing speed. Accordingly, efficiency (throughput) scores showed no association with recent MA use.

Separate analyses of accuracy and speed scores suggest current/recent MA users may be able to compensate for lower accuracy with faster cognitive processing, and is suggestive of conclusions reported by Scott et al.¹¹ that therapeutic doses of MA may increase speed of processing, but decrease ability to filter information. Similarly, those who were abstinent from MA for one or more years had higher accuracy scores on learning and spatial memory, but slower processing speed on the working memory task compared to those who used MA in the past year. Poorer performance on memory and learning tests was associated with use of other substances and specific mental health problems. However, lifetime MA use was not related to cognitive test scores, which is consistent with several studies indicating little or no relationship of cognitive functioning to cumulative MA quantity and duration of use.^{27,28} Likewise, age at first MA use was not related to poorer cognitive functioning, in fact, younger age at first use was associated with higher working memory accuracy.

Regular use of other stimulants (i.e., crack/cocaine) showed a similar effect on accuracy as recent and past-year MA use, but processing speed scores were somewhat lower for regular crack/cocaine users compared to those who did not use crack/cocaine regularly, thus, significantly lower efficiency scores were observed for regular crack users. Previous studies indicate cocaine users showed significant impairment in short-term verbal and working memory, and unlike our findings for MA use, neuropsychological test scores were correlated with lifetime amount of cocaine used.^{29,30} A lower learning accuracy score was predicted by regular use of alcohol to intoxication, however, regular use of other substances (tranquilizers, heroin) was not associated with cognitive test scores.

Some mental health problems found to be prevalent in MA-using individuals (i.e., depression, violent/aggressive behavior⁴) along with age, education and gender were related to poorer cognitive functioning on various tests in this study. This finding is in contrast with an earlier study indicating age, gender, and psychiatric problems were of no predictive value in determining performance on any of the cognitive tasks administered; the sample was 65 MA users with a mean age of 32, all of whom tested positive for MA at the time of cognitive testing.⁵ Likewise, in a younger sample of Caucasian, rural, predominantly female MA users, few cognitive deficits were observed and differences in cognitive performance did not vary by demographic or clinical characteristics on tests of working memory or learning

ability, but were found for a test of fine motor skills indicating more frequent MA use was associated with better performance among males; the authors suggest that the high proportion of females in the study may partially explain the lack of cognitive deficits seen in the sample.³¹ Differences in study findings may be related to the larger and more diverse sample in our study (e.g., only 41% were Caucasian; 25% used MA in the past month with some using daily, and 44% had over five years of MA abstinence), the older age in our sample, the use of different measures of cognitive performance, and the separate assessment of accuracy and processing speed.

Similar to findings for recent MA use, violent behavior problems were related to poorer accuracy on most cognitive tests, and faster processing speed on delayed recall. This may reflect a tendency for aggressive individuals to respond on these tests in an impulsive manner. Aggressive individuals have been found to have a multitude of cognitive deficits including impulsivity, poor planning ability, working memory deficits, and low verbal intelligence.^{32,33}

Unemployment was also significantly associated with poorer cognitive efficiency on four of the five tests after adjusting for demographics. This is consistent with previous research indicating that within a MA-dependent sample, greater impairment in neurocognitive functioning significantly predicted unemployment status.³⁴ Like our study, Weber et al.³⁴ found no association between employment status and delayed recall, but significant associations with learning and working memory, and these results support efforts to integrate targeted cognitive rehabilitation interventions (e.g., as reported in Bickel et al.³⁵) into traditional MA-use treatment programs.

MA users who seek and obtain treatment may exhibit greater cognitive impairment than those who do not attend treatment, as suggested by results indicating lower learning accuracy and spatial memory processing speed and efficiency were found for those treated compared to those without treatment. Treatment providers may need to modify engagement and retention strategies based on severity of MA-users' memory deficits. As indicated in previous research,⁵ treatment for MA abuse commonly involves cognitive-behavioral interventions, thus it is important for providers to understand the cognitive capabilities of this population, and how individual and clinical characteristics may be related to these abilities. MA-users presenting with high levels of past-month MA use, poly-substance use (particularly crack/cocaine), violent behavior problems, and/or significant depressive symptomatology, in addition to older age and lower levels of education, may be at particular risk for cognitive deficits.

While study strengths include a large and diverse sample, our results should be interpreted in the context of potential methodological limitations. The cross-sectional design does not allow us to examine changes in cognitive functioning that may be associated with substance use and mental health problem severity, and the study lacks information on cognitive functioning prior to the onset of MA use. Also, the lack of a demographically-matched control group does not allow us to clearly attribute the findings of cognitive test differences to MA use or other characteristics. Data on substance use and mental health problems are self-reported and retrospective, thus may be affected by respondents' ability to remember and accurately report information. Future work should longitudinally assess cognitive functioning in relation to MA use and related factors. Further study of poly-substance use would be useful in understanding whether differences in cognitive functioning are due to use of a specific substance or to its interaction with MA and/or other substances.

These findings underscore the importance of adapting outreach and intervention strategies to account for potential learning and memory difficulties that may be more prevalent among

specific MA-using populations. Some research involving MA-dependent individuals shows that cognitive function improves with protracted drug abstinence,³⁶ and effective interventions to treat neuropsychological impairments that may contribute to the maintenance of addictive behavior are being developed.³⁷ Identifying individuals who may benefit from effective interventions that target cognitive deficits may improve outcomes for difficult-to-treat MA-using populations.

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References

1. Gould TJ. Addiction and Cognition. *Addict Sci Clin Pract.* 2010; 5:4–14. [PubMed: 22002448]
2. Latvala A, Castaneda AE, Perälä J, et al. Cognitive functioning in substance abuse and dependence: a population-based study of young adults. *Addiction.* 2009; 104:1558–1568. [PubMed: 19686526]
3. Parsons OA. Neurocognitive deficits in alcoholics and social drinkers: a continuum? *Alcohol Clin Exp Res.* 1998; 22:954–61. [PubMed: 9660328]
4. Meredith CW, Jaffe C, Ang-Lee K, Saxon AJ. Implications of chronic methamphetamine use: a literature review. *Harv Rev Psychiatry.* 2005; 13:141–154. [PubMed: 16020027]
5. Simon SL, Domier C, Carnell J, et al. Cognitive impairment in individuals currently using methamphetamine. *Am J Addict.* 2000; 9:222–231. [PubMed: 11000918]
6. Nordahl TE, Salo R, Leamon M. Neuropsychological effects of chronic methamphetamine use on neurotransmitters and cognition: a review. *J Neuropsychiatry Clin Neurosci.* 2003; 15:317–25. [PubMed: 12928507]
7. McCann UD, Kuwabara H, Kumar A, et al. Persistent cognitive and dopamine transporter deficits in abstinent methamphetamine users. *Synapse.* 2008; 62:91–100. [PubMed: 17992686]
8. Simon SL, Domier CP, Sim T, et al. Cognitive performance of current methamphetamine and cocaine abusers. *J Addict Dis.* 2002; 21:61–74. [PubMed: 11831501]
9. Kalechstein AD, Newton TF, Green M. Methamphetamine dependence is associated with neurocognitive impairment in the initial phases of abstinence. *J Neuropsychiatry Clin Neurosci.* 2003; 15:215–220. [PubMed: 12724464]
10. Chang L, Ernst T, Speck O, et al. Perfusion MRI and computerized cognitive test abnormalities in abstinent methamphetamine users. *Psychiatry Res.* 2002; 114:65–79. [PubMed: 12036507]
11. Scott JC, Woods SP, Matt GE, et al. Neurocognitive effects of methamphetamine: a critical review and meta-analysis. *Neuropsychol Rev.* 2007; 7:275–297. [PubMed: 17694436]
12. Mielke R, Kessler J, Szelies B, et al. Normal and pathological aging – findings of positron-emission-tomography. *J Neural Transm.* 1998; 105:821–837. [PubMed: 9869321]
13. Craik FI, Bialystok E. Cognition through the lifespan: Mechanisms of change. *Trends in Cognitive Science.* 2006; 10:131–138.
14. Booth B, Leukefeld C, Falck R, Wang J, Carlson R. Correlates of rural methamphetamine and cocaine users: results from a multistate community study. *J Stud Alcohol.* 2006; 67:493–501. [PubMed: 16736068]
15. Brecht M-L, Greenwell L, Anglin MD. Methamphetamine treatment: trends and predictors of retention of completion in a large state treatment system 1992–2002. *J Subst Abuse Treat.* 2005; 29:295–306. [PubMed: 16311182]
16. McKetin R, Lubman D, Lee N, Ross J, Slade T. Major depression among methamphetamine users entering drug treatment programs. *Med J Aust.* 2011; 195:S51–55. [PubMed: 21806520]
17. Ornstein TJ, Iddon JL, Baldacchino AM, et al. Profiles of cognitive dysfunction in chronic amphetamine and heroin abusers. *Neuropsychopharmacology.* 2000; 23:113–126. [PubMed: 10882838]

18. Dingwall KM, Maruff P, Cairney S. Similar profile of cognitive impairment and recovery for Aboriginal Australians in treatment for episodic or chronic alcohol use. *Addiction*. 2011; 106:1419–1426. [PubMed: 21438935]
19. Bates ME, Bowden SC, Danielle B. Neurocognitive impairment associated with alcohol use disorders: Implications for treatment. *Exp Clin Psychopharmacol*. 2002; 10:193–212. [PubMed: 12233981]
20. Brecht ML, O'Brien A, von Mayrhauser C, Anglin MD. Methamphetamine use behaviors and gender differences. *Addict Behav*. 2004; 29:89–106. [PubMed: 14667423]
21. Vista Life Sciences. ANAM Assessment Library; Parker, CO: 2012. Available at <http://www.vistalifesciences.com/anam-assessments.html>
22. Murphy DA, Hser Y, Huang D, Brecht ML, Herbeck DM. Self-report of longitudinal substance use: a comparison of the UCLA Natural History Interview and the Addiction Severity Index. *J Drug Issues*. 2010; 40:495–516. [PubMed: 21212856]
23. McGlothlin WH, Anglin MD, Wilson BD. A follow-up of admissions to the California Civil Addict Program. *Am J Drug Alcohol Abuse*. 1977; 4:179–99. [PubMed: 612196]
24. Beck, AT.; Steer, RA. Manual for the revised Beck Depression Inventory. San Antonio TX: The Psychological Corporation; 1987.
25. Gottschalk LA, Bechtel RJ, Maguire GA, et al. Computerized measurement of cognitive impairment and associated neuropsychiatric dimensions. *Compr Psychiatry*. 2000; 41:326–333. [PubMed: 11011827]
26. Reeves DL, Bleiberg J, Roebuck-Spencer TM, et al. Reference values for performance on the Automated Neuropsychological Assessment Metrics (ANAM) in an active-duty military sample. *Mil Med*. 2006; 171:982–994. [PubMed: 17076451]
27. Iudicello JE, Woods SP, Vigil O, et al. Longer term improvement in neurocognitive functioning and affective distress among methamphetamine users who achieve stable abstinence. *J Clin Exp Neuropsychol*. 2010; 32:704–718. [PubMed: 20198527]
28. Cherner M, Suarez P, Casey C, et al. Methamphetamine use parameters do not predict neuropsychological impairment in currently abstinent dependent adults. *Drug Alcohol Depend*. 2010; 106:154–163. [PubMed: 19815352]
29. Ardila A, Rosselli M, Strumwasser S. Neuropsychological deficits in chronic cocaine abusers. *Int J Neurosci*. 1991; 57:73–79. [PubMed: 1938157]
30. Madoz-Gúrpide A, Blasco-Fontecilla H, Baca-García E, Ochoa-Mangado E. Executive dysfunction in chronic cocaine users: an exploratory study. *Drug Alcohol Depend*. 2011; 117:55–58. [PubMed: 21277707]
31. Price KL, DeSantis SM, Simpson AN, et al. The impact of clinical and demographic variables on cognitive performance in methamphetamine dependent individuals in rural South Carolina. *Am J Addict*. 2011; 20:447–455. [PubMed: 21838844]
32. Elliott, AK.; Mirsky, AF. Cognitive antecedents of violence and aggression. In: Glicksohn, J., editor. *The neurobiology of criminal behavior*. Boston: Kluwer Academic; 2002. p. 111-136.
33. Siever LJ. Neurobiology of aggression and violence. *Am J Psychiatry*. 2008; 165:429–42. [PubMed: 18346997]
34. Weber E, Blackstone KB, Iudicello JE, et al. Neurocognitive deficits are associated with unemployment in chronic methamphetamine users. *Drug Alcohol Depend*. 2012; 125:146–153. [PubMed: 22560676]
35. Bickel WK, Yi R, Landes RD, Hill PF, Baxter C. Remember the future: working memory training decreases delay discounting among stimulant addicts. *Biol Psychiatry*. 2011; 69:260–265. [PubMed: 20965498]
36. Salo R, Nordahl TE, Galloway GP, et al. Drug abstinence and cognitive control in methamphetamine-dependent individuals. *J Subst Abuse Treat*. 2009; 37:292–297. [PubMed: 19339145]
37. Alfonso JP, Caracul A, Delgado-Pastor LC, Verdejo-García A. Combined goal management training and mindfulness meditation improve executive functions and decision-making performance in abstinent polysubstance abusers. *Drug Alcohol Depend*. 2011; 117:78–81. [PubMed: 21277705]

Table 1

Mean (SD) ANAM scores by demographic variables (N=405)

	Accuracy					Speed					Efficiency				
	Learning	Working memory	Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed
Overall score	96.7 (4.1)	87.4 (14.4)	87.2 (13.1)	74.1 (16.2)	97.2 (5.3)	36.8 (10.0)	19.9 (8.4)	28.1 (7.7)	32.7 (11.4)	84.9 (16.8)	35.6 (9.9)	17.3 (6.2)	24.6 (8.2)	23.7 (10.4)	82.6 (17.2)
Age															
26–29	97.2 (3.2)	87.8 (11.6)	90.9 (11.1)	82.4 (11.1)	96.9 (2.8)	45.4 (8.0)	20.2 (7.4)	30.9 (7.2)	38.9 (10.4)	95.7 (10.8)	44.2 (8.3)	18.0 (7.7)	28.4 (8.2)	31.5 (11.1)	92.6 (10.3)
30–39	96.9 (3.4)	88.1 (15.3)	88.6 (12.1)	77.0 (15.6)	97.4 (4.2)	38.8 (10.0)	20.8 (11.8)	29.7 (7.9)	34.5 (12.5)	88.1 (16.6)	37.7 (10.1)	17.9 (7.6)	25.8 (8.1)	25.9 (10.5)	86.1 (16.9)
40–49	96.7 (3.8)	87.8 (13.5)	87.1 (12.3)	72.0 (16.6)	97.3 (5.0)	36.1 (9.7)	19.5 (5.7)	28.2 (7.3)	31.5 (11.3)	84.1 (15.7)	34.8 (9.0)	17.2 (6.0)	24.6 (7.8)	22.2 (9.8)	82.0 (16.2)
50–59	96.1 (6.1)	86.6 (14.8)	83.0 (16.3)	69.0 (16.0)	96.6 (8.1)	31.5 (8.0)	19.4 (6.2)	25.3 (7.7)	29.8 (8.6)	76.9 (17.9)	30.2 (8.2)	16.8 (6.6)	21.2 (8.3)	19.8 (8.2)	74.3 (18.9)
60–72	97.2 (2.2)	77.6 (19.1)	89.1 (12.2)	77.5 (15.7)	98.0 (2.5)	30.1 (9.1)	18.8 (7.5)	25.0 (8.2)	29.2 (10.8)	76.6 (17.2)	29.3 (9.1)	14.7 (7.9)	22.0 (9.0)	22.7 (10.5)	75 (16.6)
Gender															
Male	96.7 (3.6)	86.3 (14.3)	86.2 (14.2)	72.9 (15.6)	97.1 (5.4)	35.0 (9.6)	20.1 (9.7)	27.9 (7.8)	32.8 (12.0)	84.1 (16.8)	33.8 (9.6)	17.1 (7.0)	24.2 (8.3)	23.2 (10.2)	81.8 (16.9)
Female	96.7 (4.7)	88.9 (14.4)	88.6 (11.3)	75.6 (16.8)	97.3 (5.1)	39.1 (10.1)	19.7 (6.2)	28.4 (7.6)	32.6 (10.8)	85.9 (16.8)	37.8 (9.8)	17.6 (6.7)	25.2 (8.1)	24.4 (10.6)	83.7 (17.7)
Education															
< HS	95.6 (5.4)	83.2 (16.7)	84.0 (14.4)	67.9 (16.7)	95.9 (7.6)	34.1 (9.3)	19.0 (12.4)	26.8 (7.7)	32.9 (13.8)	81.8 (18.0)	32.5 (9.4)	15.4 (7.6)	22.6 (8.3)	21.6 (9.9)	78.9 (18.9)
HS	96.5 (4.3)	88.8 (11.4)	87.4 (14.2)	74.2 (15.9)	97.6 (3.5)	36.9 (11.1)	19.5 (6.6)	27.7 (7.3)	33.1 (11.5)	84.9 (16.4)	35.5 (10.4)	17.1 (5.7)	24.2 (7.5)	24.2 (10.2)	82.9 (16.1)
> HS	97.5 (2.8)	89.0 (14.0)	89.0 (11.2)	77.5 (15.0)	97.7 (4.2)	38.3 (9.6)	20.8 (6.0)	29.1 (7.8)	32.3 (9.9)	86.6 (16.2)	37.3 (9.6)	18.6 (6.7)	26.0 (8.3)	24.7 (10.6)	84.5 (16.5)
Ethnicity															
Black	97.0 (3.4)	84.1 (17.6)	86.8 (14.9)	75.2 (14.4)	97.9 (3.4)	34.0 (9.7)	18.1 (5.5)	25.2 (7.4)	30.8 (11.5)	80.5 (19.0)	33.0 (9.9)	15.2 (6.1)	21.8 (7.7)	22.6 (9.0)	79.1 (19.2)
Hispanic	96.3 (5.2)	87.2 (14.6)	88.4 (12.6)	75.7 (15.1)	97.0 (4.6)	38.1 (10.0)	20.0 (12.3)	27.9 (7.1)	33.3 (13.3)	85.8 (15.4)	36.6 (9.6)	17.0 (7.7)	24.7 (7.9)	24.6 (10.4)	83.3 (15.9)
White	96.7 (3.6)	89.2 (13.1)	86.1 (13.0)	72.1 (17.0)	96.9 (6.0)	36.3 (9.6)	20.5 (6.0)	28.9 (7.9)	32.3 (9.7)	85.1 (16.3)	35.1 (9.7)	18.3 (6.3)	25.0 (8.3)	22.9 (10.4)	82.4 (16.8)
Multi-ethnic	97.3 (4.4)	89.6 (7.7)	88.3 (13.1)	78.1 (15.7)	98.8 (1.8)	41.4 (11.0)	20.4 (6.5)	30.2 (8.3)	35.9 (12.0)	92.8 (16.8)	40.2 (11.0)	18.4 (6.8)	26.7 (9.4)	28.2 (12.4)	91.6 (15.8)
Employed															
No	96.2 (4.8)	85.7 (15.6)	84.7 (15.0)	71.9 (16.5)	96.6 (6.3)	35.4 (10.3)	19.3 (9.8)	27.2 (7.9)	32.5 (12.7)	82.5 (17.2)	34.0 (10.1)	16.3 (6.9)	23.2 (8.4)	22.8 (10.3)	79.8 (17.7)
Yes	97.4 (3.0)	89.7 (12.4)	90.5 (9.0)	76.9 (15.3)	97.9 (3.3)	38.7 (9.4)	20.8 (6.0)	29.3 (7.2)	32.9 (9.6)	88.0 (15.8)	37.6 (9.3)	18.7 (6.4)	26.6 (7.6)	25.0 (10.3)	86.2 (15.9)

[†] p<.1;
* p<.05;
** p<.01; Bold font indicates differences were significant after adjusting for other demographic characteristics.

Table 2

Mean (SD) ANAM scores by substance use and mental health variables (N=405)

	Accuracy				Speed				Efficiency						
	Learning	Working memory	Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed
Past year MA use	*		**	*			*								
No	97.2 (3.0)	88.2 (14.2)	88.8 (12.5)	75.5 (15.7)	97.5 (4.6)	36.6 (9.2)	19.3 (5.9)	27.9 (7.3)	31.9 (9.9)	85.2 (16.4)	35.6 (9.2)	17.1 (6.4)	24.9 (8.1)	23.7 (9.5)	83.3 (16.5)
Yes	96.0 (5.4)	86.1 (14.7)	84.8 (13.7)	71.7 (16.7)	96.7 (6.2)	37.1 (11.0)	21.1 (11.3)	28.6 (8.3)	33.9 (13.6)	84.2 (17.6)	35.5 (11.0)	17.8 (7.5)	24.3 (8.4)	23.8 (11.7)	81.5 (18.3)
Past year crack/cocaine use						*		†		*	*		*		*
No	96.7 (4.2)	87.7 (13.7)	87.7 (12.4)	73.9 (16.2)	97.3 (4.5)	37.2 (10.0)	19.8 (6.3)	28.4 (7.7)	32.8 (11.0)	85.6 (16.8)	35.9 (9.9)	17.3 (6.4)	25.0 (8.2)	23.8 (10.5)	83.4 (17.1)
Yes	96.5 (3.6)	85.9 (18.8)	83.9 (16.7)	75.1 (16.1)	96.6 (8.9)	34.0 (9.4)	21.3 (16.7)	26.3 (7.7)	32.0 (14.1)	79.7 (15.9)	32.9 (9.8)	17.6 (9.5)	22.1 (8.0)	23.5 (9.5)	77.1 (17.1)
Regular crack cocaine use		**	†	**		*		**			**	*	**	**	
No	97.0 (4.3)	89.2 (13.5)	88.3 (12.0)	75.8 (16.0)	97.0 (5.3)	37.8 (10.5)	20.3 (9.3)	29.1 (8.5)	33.3 (12.6)	85.6 (17.9)	36.6 (10.2)	18.0 (7.0)	25.8 (8.7)	24.8 (11.1)	83.2 (18.2)
Yes	96.3 (3.7)	84.9 (15.2)	85.7 (14.5)	71.5 (16.2)	97.5 (5.2)	35.2 (9.1)	19.4 (6.8)	26.7 (6.0)	31.8 (9.4)	83.7 (15.1)	33.9 (9.2)	16.4 (6.4)	22.9 (7.0)	22.1 (9.0)	81.7 (15.6)
Regular heavy alcohol use	**									†	*				†
No	97.6 (2.5)	88.3 (14.1)	88.0 (12.1)	74.5 (16.9)	97.5 (3.7)	37.9 (9.7)	20.5 (11.5)	28.6 (7.3)	33.3 (12.0)	87.1 (16.5)	37.0 (9.7)	17.8 (7.6)	25.3 (7.9)	24.2 (10.8)	84.8 (16.7)
Yes	96.4 (4.6)	87.1 (14.4)	86.9 (13.05)	73.9 (15.9)	97.1 (5.8)	36.2 (10.2)	19.7 (6.5)	27.9 (7.9)	32.4 (11.2)	83.9 (16.9)	34.9 (9.9)	17.2 (6.5)	24.4 (8.4)	23.5 (10.2)	81.6 (17.4)
Regular heroin use			*			*					*				
No	96.8 (4.1)	87.8 (14.3)	87.8 (12.8)	74.4 (16.3)	97.3 (5.5)	37.2 (10.1)	20.1 (8.8)	28.0 (7.6)	32.7 (11.9)	84.9 (16.9)	35.9 (9.9)	17.5 (6.9)	24.7 (8.2)	23.9 (10.7)	82.7 (17.4)
Yes	96.4 (4.3)	85.9 (14.6)	84.1 (14.2)	72.2 (15.6)	96.8 (3.7)	34.3 (9.7)	19.3 (5.6)	28.7 (8.2)	32.6 (8.1)	84.6 (16.6)	33.1 (9.8)	16.6 (6.2)	24.1 (8.1)	22.5 (7.9)	81.8 (16.3)
Regular tranquilizer use				**											†
No	96.8 (4.2)	87.8 (13.6)	87.6 (12.7)	74.7 (15.9)	97.4 (4.5)	37.0 (9.6)	20.0 (8.8)	28.2 (7.8)	32.7 (11.2)	85.3 (16.8)	35.9 (9.7)	17.4 (6.9)	24.8 (8.3)	24.0 (10.3)	83.2 (17.0)
Yes	96.3 (3.7)	85.7 (17.5)	85.3 (14.8)	70.4 (17.3)	95.9 (8.1)	35.3 (12.0)	19.9 (6.0)	27.9 (7.2)	32.5 (12.9)	82.1 (17.1)	33.7 (11.0)	17.3 (6.7)	24.0 (8.0)	22.5 (10.9)	78.8 (18.2)
Received drug treatment	*		*	*		*		*		†			**	†	†
No	97.3 (3.2)	87.4 (14.0)	87.8 (13.7)	75.9 (15.6)	97.4 (4.4)	38.0 (10.0)	20.5 (11.0)	29.4 (8.6)	33.6 (12.3)	86.5 (16.6)	37.0 (10.1)	17.7 (7.8)	26.0 (8.9)	24.9 (11.3)	84.4 (16.7)
Yes	96.3 (4.7)	87.5 (15.0)	86.8 (12.5)	72.7 (16.5)	97.0 (5.8)	35.9 (10.0)	19.5 (5.6)	27.2 (6.7)	32.0 (10.7)	83.6 (16.9)	34.5 (9.7)	17.1 (6.0)	23.6 (7.5)	22.9 (9.5)	81.3 (17.5)
Depression past month						**				*	**				*
No	96.8 (4.2)	87.4 (14.3)	87.6 (12.9)	74.5 (15.9)	97.2 (5.3)	37.3 (10.0)	20.0 (8.6)	28.2 (7.6)	32.8 (11.7)	85.6 (16.8)	36.1 (9.9)	17.4 (6.8)	24.8 (8.2)	24.0 (10.5)	83.3 (17.2)
Yes	96.5 (3.3)	87.2 (15.1)	84.4 (13.8)	70.8 (18.0)	96.9 (5.3)	32.6 (8.9)	19.2 (6.9)	27.9 (8.1)	31.6 (9.4)	79.7 (15.9)	31.4 (9.2)	16.7 (6.9)	23.4 (8.0)	21.8 (9.0)	77.6 (16.9)
Anxiety past month						*					*				
No	96.8 (4.1)	87.3 (14.3)	87.5 (12.9)	74.3 (16.0)	97.3 (5.2)	37.3 (10.0)	20.0 (8.3)	27.9 (7.6)	32.8 (11.7)	85.1 (16.8)	36.0 (9.8)	17.4 (8.8)	24.6 (8.2)	23.9 (10.5)	83.0 (17.2)
Yes	96.3 (4.1)	87.9 (15.0)	85.6 (14.1)	72.5 (17.2)	96.4 (5.5)	33.8 (9.6)	19.8 (8.8)	29.4 (8.0)	31.7 (10.0)	83.2 (16.9)	32.6 (9.7)	17.1 (7.1)	25.1 (8.5)	22.6 (9.8)	80.4 (17.4)
Problems concentrating		**	**	**	†	**			*	*	**	**	*	*	*

	Accuracy					Speed					Efficiency						
	Learning		Working memory		Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed
No	96.9 (4.2)		88.4 (13.9)		88.5 (12.2)	75.3 (15.7)	97.4 (5.3)	37.5 (9.9)	20.2 (8.4)	28.2 (7.4)	32.7 (11.7)	85.7 (16.9)	36.3 (9.8)	17.8 (6.8)	25.0 (8.0)	24.1 (10.4)	83.5 (17.3)
Yes	95.9 (3.5)		82.3 (16.3)		80.7 (15.3)	67.4 (17.2)	96.1 (4.7)	32.6 (9.6)	18.7 (8.4)	28.0 (9.3)	32.5 (10.3)	80.3 (15.6)	31.3 (9.6)	15.1 (6.5)	22.7 (9.3)	21.7 (10.1)	77.5 (16.3)
Violent behavior problems	*	***	***		***	*			†					***			
No	96.9 (3.9)		88.2 (14.0)		87.7 (12.8)	74.6 (16.0)	97.2 (5.4)	36.8 (9.7)	20.2 (8.5)	28.2 (7.7)	32.3 (10.7)	85.1 (16.9)	35.7 (9.8)	17.7 (6.8)	24.8 (8.2)	23.8 (10.4)	82.8 (17.3)
Yes	94.1 (6.2)		76.9 (15.4)		80.9 (14.5)	66.7 (16.8)	97.3 (2.7)	35.9 (14.0)	17.1 (4.9)	27.9 (7.8)	37.7 (17.9)	82.1 (16.2)	33.2 (12.0)	12.9 (5.0)	22.7 (8.3)	23.5 (10.2)	79.9 (16.1)

† p<.1;
* p<.05;
*** p<.01; Bold font indicates differences were significant after adjusting for demographic characteristics.

Table 3

Correlations of ANAM scores with substance use and mental health variables (N=405)

	Accuracy					Speed					Efficiency				
	Learning	Working memory	Spatial memory	Delayed memory	Processing speed	Learning	Working memory	Spatial memory	Delayed memory	Processing speed	Learning	Working memory	Spatial memory	Delayed memory	Processing speed
Age at ANAM test	-.06	-.09[†]	-.14^{**}	-.17^{**}	-.02	-.37^{**}	-.03	-.23^{**}	-.22^{**}	-.32^{**}	-.38^{**}	-.07	-.25^{**}	-.26^{**}	-.31^{**}
Number of days used MA past month	-.15^{**}	-.03	-.16^{**}	-.16^{**}	-.05	.08[†]	.05	.13[*]	.12[*]	.03	.05	.05	.00	-.03	.01
Lifetime months of MA use	-.03	-.06	-.11[*]	-.16^{**}	-.05	-.16^{**}	-.01	-.04	-.11 [*]	-.15^{**}	-.17^{**}	-.04	-.08	-.17^{**}	-.15^{**}
Age at first MA use	-.01	-.17^{**}	-.01	-.09[†]	.05	-.19^{**}	-.01	-.11[*]	-.07	-.16^{**}	-.19^{**}	-.09[†]	-.07[*]	-.09[†]	-.14^{**}
Beck depression score	-.08	.03	-.17^{**}	-.16^{**}	-.07	-.12[*]	-.09[†]	-.02	-.02	-.08	-.13^{**}	-.07	-.10[*]	-.11[*]	-.09[†]
Emotional state (0=poor; 3=excellent)	.07	.08[†]	.14^{**}	.16^{**}	.07	.14[*]	.04	.06	-.06	.14^{**}	.15^{**}	.08	.12[*]	.04	.15^{**}

[†] p<.10;
* p<.05;
** p<.01; Bold font indicates differences were significant after adjusting for demographic characteristics.

Regression results (Parameter estimate, standard error) for ANAM scores adjusting for age, education, race/ethnicity and gender

	Accuracy					Speed					Efficiency				
	Learning	Working memory	Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed	Learning	Working memory	Spatial memory	Delayed memory	Process speed
<i>Demographics:</i>															
Age at ANAM test	-.04 (.02) $\hat{+}$	-.19 (.08) *	-.022 (.08) **	-.34 (.09) **	-.02 (.03)	-.42 (.05) **	-.04 (.05)	-.22 (.04) **	-.28 (.07) **	-.08 (.09) **	-.42 (.05) **	-.07 (.04) $\hat{+}$	-.24 (.05) **	-.31 (.06) **	-.067 (.10) **
Female gender	-.18 (.41)	1.61 (1.45)	1.86 (1.30)	1.85 (1.57)	.15 (.54)	2.80 (.92) **	-.82 (.85)	-.03 (.75)	-.59 (1.15)	-.25 (1.62)	2.66 (.90) **	-.11 (.68)	0.03 (.80)	.30 (1.02)	-.25 (1.67)
Education	.99 (.24) **	2.69 (.85) **	2.75 (.77) **	5.26 (.92) **	.88 (.31) **	2.62 (.54) **	1.03 (.50) *	1.50 (.44) **	.13 (.68)	3.11 (.95) **	2.90 (.53) **	1.68 (.40) **	2.04 (.47) **	1.97 (.60) **	3.50 (.98) **
White ethnicity	-.04 (.42)	2.70 (1.46) $\hat{+}$	-2.20 (1.31) $\hat{+}$	-3.05 (1.58) *	-.68 (.54)	-.152 (1.01)	.30 (.94)	0.77 (.83)	-.47 (1.27)	1.37 (1.63)	-.133 (.99)	.89 (.75)	-.03 (.87)	-.156 (1.12)	.43 (1.67)
Employed	.77 (.42) $\hat{+}$	2.67 (1.46) $\hat{+}$	4.80 (1.30) **	2.87 (1.59) $\hat{+}$	1.05 (.54) $\hat{+}$	1.48 (.94)	.91 (.87)	1.04 (.77)	.06 (1.13)	3.72 (1.62) *	1.80 (.91) *	1.51 (.69) *	2.22 (.80) **	1.12 (1.03)	4.42 (1.66) **
<i>Drug use:</i>															
Number of days used MA past month	-.09 (.03) **	-.06 (.11)	-.031 (.10) **	-.32 (.012) **	-.03 (.04)	12 (.07) $\hat{+}$	.06 (.06)	0.14 (.06) *	.19 (.09) *	.05 (.12)	.07 (.07)	.05 (.05)	-.031 (.06)	-.04 (.08)	.00 (.12)
Past year MA use	-.98 (.42) *	-.172 (1.47)	-3.39 (1.31) *	-2.61 (1.59)	-.67 (.54)	1.35 (.93)	2.01 (.87) *	0.96 (.76)	1.81 (1.15)	-.48 (1.64)	.87 (.91)	1.08 (.69)	-.020 (.80)	.41 (1.03)	-.127 (1.68)
Lifetime months of MA use	.00 (.00)	.00 (.01)	.00 (.00)	-.01 (.01)	.00 (.00)	.01 (.01)	.00 (.01)	.01 (.01)	.00 (.01)	.00 (.01)	.01 (.01)	.00 (.01)	.00 (.01)	.00 (.01)	.00 (.01)
Age at first used MA use	.01 (.03)	-.33 (.12) **	-.015 (.11)	-.14 (1.14)	.04 (.04)	-.09 (.08)	.06 (.07)	.00 (.07)	.03 (.10)	-.012 (1.14)	-.09 (.08)	-.02 (.06)	-.002 (.07)	.01 (.09)	-.06 (1.14)
Past year crack cocaine use	-.02 (.61)	-.100 (2.14)	-.325 (1.92)	2.21 (2.31)	-.52 (.78)	-.103 (1.40)	2.55 (1.30) $\hat{+}$	-.062 (1.14)	-.31 (1.68)	-.427 (2.36) $\hat{+}$	-.99 (1.37)	1.50 (1.03)	-.141 (1.21)	.63 (1.49)	-.469 (2.42) $\hat{+}$
Regular crack cocaine use	-.046 (.42)	-3.16 (1.46) *	-.214 (1.33)	-3.56 (1.60) *	.59 (.54)	-.64 (.96)	-.39 (.90)	-.139 (.77) $\hat{+}$	-.93 (1.15)	-.13 (1.63)	-.82 (.94)	-.70 (.70)	-1.73 (.81) *	-.175 (1.02) $\hat{+}$	.38 (1.67)
Regular heavy alcohol use	-1.03 (.44) *	-.58 (1.52)	-.15 (1.38)	.80 (1.67)	-.21 (.57)	-.55 (.98)	-.76 (.91)	-.30 (.80)	-.63 (1.23)	-.206 (1.72)	-.98 (.96)	-.40 (.72)	-.34 (.85)	.07 (1.08)	-.186 (1.76)
Regular heroin use	-.29 (.58)	-.191 (2.02)	-.299 (1.83)	-.92 (2.21)	-.39 (.75)	-.190 (1.30)	-.84 (1.21)	0.91 (1.05)	-.07 (1.60)	.18 (2.26)	-.192 (1.27)	-.76 (.95)	-.036 (1.11)	-.111 (1.42)	-.40 (2.33)
Regular tranquilizer use	-.18 (.56)	-.135 (1.94)	-.088 (1.77)	-.182 (2.12)	-.134 (.72) $\hat{+}$	-.24 (1.25)	.35 (1.16)	0.52 (1.01)	.42 (1.54)	-.94 (2.17)	-.56 (1.22)	.32 (.92)	0.31 (1.07)	-.28 (1.37)	-.212 (2.24)
Received drug treatment at recruitment	-.87 (.41) *	.53 (1.45)	0.11 (1.31)	-.162 (1.58)	-.39 (.52)	-.96 (.93)	-.83 (.86)	-1.71 (.75) *	-.69 (1.15)	-.65 (1.61)	-.134 (.91)	-.55 (.68)	-1.60 (.79) *	-.94 (1.02)	-.92 (1.65)
<i>Mental health:</i>															
Depression	-.10 (.62)	.28 (2.18)	-.244 (1.96)	-.228 (2.56)	-.18 (.81)	-3.48 (1.38) *	-.63 (1.29)	0.34 (1.13)	-.75 (1.73)	-.442 (2.42) $\hat{+}$	-3.39 (1.35) *	-.47 (1.02)	-.067 (1.20)	-.138 (1.53)	-.392 (2.51)
Anxiety	-.50 (.58)	.38 (2.04)	-.174 (1.84)	-.151 (2.21)	-.92 (.75)	-3.24 (1.29) *	-.32 (1.20)	1.35 (1.06)	-.93 (1.61)	-.158 (2.27)	-3.28 (1.26) **	-.45 (.95)	0.46 (1.12)	-.115 (1.43)	-.223 (2.33)
Problems concentrating	-.67 (.56)	-5.33 (1.93) **	-7.09 (1.72) **	-6.61 (2.19) **	-.109 (.72)	-3.77 (1.23) **	-.112 (1.15)	0.48 (1.01)	-.06 (1.54)	-4.40 (2.17) *	-3.86 (1.20) **	-2.12 (.91) *	-.159 (1.07)	-.191 (1.37)	-4.93 (2.33) *
Violent behavior	-2.51 (.77) **	-10.4 (2.70) **	-6.64 (2.46) **	-7.23 (2.96) *	.43 (1.01)	-.36 (1.76)	-.252 (1.63)	0.50 (1.44)	4.95 (2.15) *	-.293 (3.06)	-.191 (1.71)	-3.90 (1.28) **	-.132 (1.51)	-.17 (1.93)	-.274 (3.14)
Beck depression score	-.03 (.02)	.07 (.08)	-0.21 (.07) **	-2.22 (.085) *	-.03 (.03)	-.10 (.05) $\hat{+}$	-.08 (.05)	0.01 (.04)	-.02 (.06)	-.10 (.09)	-10 (.05) *	-.04 (.04)	-.006 (.04)	-.10 (.05) $\hat{+}$	-.12 (.09)
Emotional state (0=poor; 3=excellent)	.14 (.18)	.78 (.63)	1.30 (.57) *	1.52 (0.68) *	.25 (.23)	.80 (.40) *	.10 (.37)	0.15 (.33)	-.58 (.49)	1.62 (.70) *	.84 (.39) *	.23 (.30)	0.57 (.34)	.15 (.44)	1.80 (.72) *

$\hat{+}$ p<.1;

* p<.05;

10<sup>d
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