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Everyday problems with executive dysfunction and impulsivity in adults recovering from methamphetamine addiction

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Abstract

Objectives—Compared with non-addicted controls (CTLs), adults in remission from methamphetamine addiction (MA-REM) evidence impairments on objective measures of executive functioning and impulsivity.

Methods—To evaluate the impact of these impairments in MA-REM adults, demographically matched groups (MA-REM, n=30; CTLs, n=24) completed objective and self-report measures of executive functioning and impulsivity.

Results—MA-REM adults demonstrated significantly ($p < 0.050$) greater objective and subjective problems with executive functioning and impulsivity.

Conclusions—These results suggest that adults in MA-REM are aware of their deficits and that these deficits have significant impact in everyday life.

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Keywords

Methamphetamine; Impulsivity; Executive Function

Introduction

Methamphetamine (MA) addiction is purportedly associated with long-term structural changes to regions of the brain that regulate cognitive and psychiatric function as well as dysregulation of dopaminergic, serotonergic, noradrenergic, and glutamatergic systems (Nordahl et al.,2003; Chang et al., 2007; Scott et al., 2007; Hoffman et al., 2008; Schwartz et al., 2010). Adults seeking treatment for MA addiction present with high rates of cognitive impairments and psychiatric disorders that frequently persist for months to years into remission (Hoffman et al., 2008; Schwartz et al., 2010). A third to a half or more of MA dependent adults evidence mood and other psychiatric disorders during remission (Shoptaw et al., 2003; London et al., 2004; Darke et al., 2008; Glasner-Edwards et al., 2010; Zweben et al., 2004), and remission from MA dependence is associated with global cognitive impairments, including speed of information processing, learning, memory, motor, language, visuoconstruction, attention, working memory, and executive function (EF) (Hoffman et al., 2006; Scott et al., 2007; Fernandez-Serrano et al., 2011; Loftis et al., 2011).

Deficits related to EF and impulsivity are of significant concern within this population because of their association with increased risk for impairments in activities of daily living and unemployment (Cattie et al., 2012; Weber et al., 2012). Our group and others have previously shown that, compared with non-addicted controls (CTLs), adults in early remission (< 6 months) from methamphetamine addiction (MA-REM) continue to evidence impairments on objective measures of EF, which may also persist long-term (≥ 6 months) (Fernández-Serrano et al., 2011; Hoffman et al., 2006; Loftis et al., 2011). Likewise, compared with CTLs, adults in MA-REM exhibit an increased tendency to discount delayed rewards on the delay discounting task (DDT), a behavioral measure of impulsivity (Hoffman et al., 2006). The purpose of this study was to evaluate whether adults in MA-REM self-report problems in their daily life related to executive dysfunction and impulsivity and if this impact is clinically significant and adults in MA-REM are aware of it.

Materials and Methods

Participants were demographically matched samples (age, gender, ethnicity, baseline intellectual function) of 30 adults in early remission from MA addiction (MA-REM group) recruited from Portland-area addiction treatment centers and 24 non-addicted controls (CTLs) recruited from the community via word of mouth and advertisement. Inclusion criteria for the MA-REM group included MA use ≥ 0.5 g/day for ≥ 5 days/week for ≥ 2 years and meeting the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; 1994) criteria for MA dependence, verified with a Structured Clinical Interview for DSM Disorders, Research, Patient Version (SCID-I/P; First et al., 2002). All MA-REM participants were in remission from MA addiction ≥ 2 weeks and ≤ 160 days. MA-REM and CTL subjects were excluded for a positive urine drug screen at the time of scanning. MA-

REM participants were excluded for abuse or dependence within the past 5 years for any other substance, excluding nicotine and caffeine, or any past/present Axis I psychiatric diagnosis, excluding substance dependence or depression. CTLs were excluded if they had any history of drug abuse or dependence, excluding nicotine or caffeine, lifetime use of any illicit drug other than cannabis, or any past/present Axis I psychiatric diagnosis, excluding depression. No participants were currently taking medications that might affect cognition, or suffered from any past/present medical illnesses that might affect cognition or central nervous system function. Participants were compensated for their participation in the form of a $100 gift certificate to a local store. All participants completed the following assessment measures:

1. Wide Range Achievement Test 3, Reading Subtest (WRAT3-Reading; Wilkinson, 1993). WRAT3-Reading is a well-validated measure of word recognition reading that is commonly used in research and clinical settings for estimating premorbid intelligence (Strauss et al., 2006).
2. Delay Discounting Task (DDT; Mitchell, 1999). This measure was included as a brief objective measure of impulsivity and has been described previously (Huckans et al., 2011; Mitchell, 1999). A series of items are presented to participants on a computer screen with a choice of an immediate reward ranging from $1-$99, versus a fixed delayed reward of $100. Participants are asked which they would prefer, a ranging monetary value “now” (sooner), or $100 later with a ranging delay period (in 7, 30, 90, 180 or 365 days). For each delay period, the point at which the participant switched their preference to the smaller immediate reward instead of the larger delayed reward ($100) was termed I (indifference point). A nonlinear regression was then used to solve for the function that best fit these indifference points, represented as, $I=\frac{1}{1+K\cdot t}$, where t represents the delay time, and K is a constant that characterizes the degree of discounting. Because the distribution of K values is not normal, K values are then natural log (ln) transformed. Less negative ln(K) values indicate greater impulsivity.
3. Behavior Rating Inventory of Executive Function – Adult Version (BRIEF-A; Roth et al., 2005). A well-validated and clinically-normed self-report measure consisting of 75 items and nine clinical scales (see Table 1) that evaluate the degree to which adults experience problems related to executive functioning and self regulation in their daily life.
4. Barratt Impulsiveness Scale (BIS-11; Patton, Stanford & Barratt, 1995). A well-validated self-report questionnaire consisting of 30 items that measure the degree to which adults experience everyday problems related to long-term trait impulsivity.

Results

Results were considered significant at $p \leq 0.050$. According to independent sample t tests or chi square tests, groups did not significantly differ in terms of demographics (MA-REM: age = 33 ± 7, 40% male, 93% Caucasian, WRAT3- Reading standard score = 100 ± 8; CTLs: age = 35 ± 11, 46% male, 88% Caucasian, WRAT3-Reading standard score = 104 ± 10). An

independent samples t test revealed significant between-group differences on the DDT ($t(38) = 3.996$, $P < .001$); compared with CTLs, the MA-REM group's mean ln(K) value was significantly higher (less negative), indicating greater impulsivity (see Table 1). A one-way multivariate analysis of variance (MANOVA) was conducted with group as an independent variable and the nine clinical scale scores of the BRIEF-A and 6 factor scores of the BIS-11 entered as dependent variables; a significant group effect was found (Wilks $\Lambda(18,32) = .454$, $p = .030$). Follow up univariate analyses of variance (ANOVAs) indicated significant differences between groups in all areas of executive functioning measured by the BRIEF-A, including all nine clinical scales (see Table 1). Follow up univariate ANOVAs also indicated significant differences between groups in all areas of impulsivity as measured by the BIS-11, including all six factors (See Table 1).

Discussion

Consistent with previous research showing that adults in MA-REM evidence objective deficits in EF and impulsivity (Loftis et al., 2011; Fernández-Serrano et al., 2011; Scott et al., 2007; Hoffman et al., 2006), we found that, compared with CTLs, adults in MA-REM were significantly more likely to discount larger delayed rewards in favor of smaller immediate rewards on the DDT. Moreover, we found that this objective deficit corresponded with subjective problems in daily functioning on the BRIEF-A and BIS-11. These results extend the literature on executive dysfunction in addictions by demonstrating that individuals in MA-REM demonstrate awareness of their impulsivity and executive dysfunction and that these deficits are clinically significant, resulting in impairment in their daily life. The MA-REM group evidenced significant elevations on all nine clinical scales of the BRIEF-A and all six factors of the BIS-11, indicating that their EF deficits are global, ranging from problems with behavioral, motor, and emotional disinhibition to difficulties with attention and working memory, planning and organization, and mental flexibility (e.g., set shifting and perseveration). Results point to the value of including measures of impulsivity, EF and daily functioning in cognitive assessment batteries with addiction populations, as deficits in these areas are pervasive.

Researchers have advocated for continued examination of EF, impulsivity, and decision making abilities in MA dependent individuals, arguing that this is perhaps one of the most important directions for future research (Semple et al., 2005; Scott et al., 2007). Previous studies have shown that related deficits are associated with poorer addiction treatment outcomes. Carroll and colleagues (2011) found that higher levels of risk taking on a computerized task predicted lower treatment attendance, homework completion and fewer days of abstinence in individuals receiving cognitive behavioral therapy (CBT) for addictions. Passetti and colleagues (2008) found that impaired affective decision making on a computerized gambling task was associated with increased risk for relapse in opiate-dependent individuals. Our results indicate that deficits in impulsivity and EF interfere with daily functioning and may hamper other essential aspects of the recovery process following sobriety, such as the ability to repair important life roles previously damaged by addiction (e.g., employment, relationships).

Results highlight the need for addiction treatments that incorporate methods for addressing EF deficits, such as cognitive rehabilitation therapy (CRT). Although the literature on CRTs for addiction is in an early stage and requires replication through larger randomized controlled trials, investigators have shown that compared with CBT alone, CBT supplemented with restorative cognitive training (i.e., computer-assisted training through attention, memory, and EF tasks) significantly reduces psychological distress and craving in alcohol addicted individuals (Rupp et al., 2012). Another group found that alcohol addicted adults who completed 25 weeks of working memory training tasks drank on average 10 drinks less per week than those who completed control tasks during that period (Houben et al., 2011). This literature and our own results suggest that additional research is warranted to evaluate the potential efficacy of CRTs in improving EF, reducing relapse and increasing daily functioning in adults recovering from MA and other addictions.

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Table 1

Bivariate comparisons of adults in remission from methamphetamine addiction (MA-REM) versus non-addicted controls (CTLs) on measures of executive function and impulsivity

Measure	MA-REM (n=30)	CTLs (n=24)	p value
DDT [ln(K)]	-3.79±1.01	-5.04±1.06	<0.000
BRIEF-A			
Inhibit	63.41±9.97	50.33±8.67	<0.000
Shift	57.48±10.70	49.04±8.83	0.003
Emotional Control	55.34±8.94	47.17±8.39	0.001
Self-Monitor	60.69±9.62	47.12±8.12	<0.000
Initiate	57.21±10.30	50.63±11.04	0.029
Working Memory	60.03±8.91	53.75±10.64	0.023
Plan/Organize	58.07±10.00	51.29±10.04	0.018
Task Monitor	57.03±8.35	50.71±9.97	0.015
Organization of Materials	52.48±10.82	50.17±9.90	0.042
BIS-II			
Attention	11.83±2.82	9.43±2.01	0.001
Cognitive Instability	6.24±2.72	5.35±1.85	0.045
Motor	17.31±3.08	14.39±2.73	0.001
Self-Control	15.34±3.13	11.57±2.64	<0.000
Cognitive Complexity	13.93±2.51	11.17±2.74	<0.000
Perseverance	9.24±1.64	8.26±1.96	0.050

MA-REM = Methamphetamine Remission, CTL = Control. DDT = Delay Discounting Task, BRIEF-A = Behavior Rating Inventory of Executive Function–Adult Version, BIS-II = Barratt Impulsiveness Scale. *DDT results are reported as mean log of the constant that characterizes the degree of discounting Ln(k) values ± standard deviation (SD). BRIEF-A results are reported as mean t scores ± SD, and BIS-II results are reported as mean factor scores ± SD. p values are the results of between group comparisons. An independent samples t test was used to compare DDT values. Univariate analyses of variance (ANOVA)s were used to compare means on the BRIEF-A clinical scales and BIS-II factor scales.