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The comparison of executive functions between active users of methamphetamine and those in abstinence phase

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Original Article

Abstract

BACKGROUND: Addiction to stimuli causes malfunction and morphologic changes in the nervous system. Representation of these changes in exclusive functions is accompanied by contradictory findings. This study was conducted aiming to compare the executive functions of two groups of users and non-users of methamphetamine in Tehran, Iran.

METHODS: This study was conducted in the form of a case–control study from October 2014 to March 2014. In this regard, 30 men who were active users of methamphetamine and 35 men who were in abstinence phase in Tehran were selected using respondent-driven sampling (RDS) method and assigned into two groups. The executive functions of the two groups were evaluated using the software version of the Wisconsin Card Sorting Test (WCST) and the data were analyzed using t-test and chi-square test using SPSS software.

RESULTS: The exclusive function index in methamphetamine users significantly decreased in comparison with the control group. Also, the preservation errors in consumer group were greater than the control group ($P < 0.050$).

CONCLUSION: The results of this study showed that exclusive functions in stimulant users were associated with significant damage. Considering the importance of executive functions as a mediating factor in the recurrence of consumption, it is desirable to decrease the function of this index in the treatment of dependence to methamphetamine to be on the center of clinical attention.

KEYWORDS: Executive Functions, Methamphetamine, Neuropsychological Tests, Wisconsin Card Sorting Test

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Introduction

Drug use disorder is a recognized global challenge worldwide and one of the most harmful social damages of the present age, with many social and economic consequences.[1]

Addiction is a brain disease that causes malfunction and morphologic changes in the nervous system and the mechanism of response to rewards and pleasure.[2] Methamphetamine is a group of stimulants that increases the mood, consciousness, and stimulation of the central nervous system (CNS).[3] It is estimated that more than seventy-five thousand people in the United States use methamphetamine, cocaine, and ketamine, and this figure is on the rise.

Chronic methamphetamine use is

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associated with cognitive impairment and psychiatric syndrome.[4] Methamphetamine consumption causes significant disorders in some neuropsychiatric domains, including the creation of some deficiencies in exclusive functions, attention, social cognition, flexibility, and working memory.[5] Changes in hormonal and biological functions are the side effects of chronic methamphetamine use.[6] The results of the study by Baicy and London[7] showed that the use of methamphetamine led to defect in the markers of the dopaminergic and serotonergic system that was associated with cognitive deficits such as disorder in the inhibition control and exclusive functions.

Studies have shown that these hormonal changes are associated with psychological consequences such as anxiety and depression, and methamphetamine users show higher levels of cortisol in facing stressors.[6] The results of the study by Farhadian et al.[8] suggest that chronic use of methamphetamine is associated with damage to executive functions, although these damages can be improved by avoiding consumption. In fact, exclusive functions are mechanisms for modulating the functions of cognitive processes.[8] The exclusive functions are called a set of self-command acts, that their ultimate goal is self-regulation.[3]

Changes in grey matter due to drug use and its relation to cognitive functions indicate that these areas play an important role in the development of depression and addiction disorders.[9] Also, the findings of the study by Zhang et al.[9] showed that biologic changes caused by the use of methamphetamine had a significant association with borderline personality disorder (BPD) and antisocial personality disorder (ASPD).

It is expected that stimuli-dependent patients experience two types of disorder in the Wisconsin Card Sorting Test (WCST): the preservation error (inability to stop the sequence of actions) and the shortfall in the number of completed classes that refer to the correct course sequences that represent a frontal lobe disorder in these people.[3]

Anderson et al.[10] and Avants et al.[11] pointed to the deficiencies in the completion of classes by stimuli-consumer subjects in the WCST. On the other hand, there is some inconsistent evidence with these findings that shows that methamphetamine use is not associated with these defects. For example, in the study by Chang et al.,[12] there was no difference in the working memory, expression, reaction time, processing speed, and executive functions between the two methamphetamine and control groups.

In the perspective of prevention, damage to executive functions is the basis for avoiding the patient from the treatment process and increasing the slip in stimulant users. Low flexibility and low restraint ability are components of executive functions that contribute to the recurrence of consumption. Studies show that executive functions in interacting with biological system and biological markers can guide the avoidance and treatment process and ultimately predict therapeutic outcomes.[2] Because the therapeutic effects of cognitive-behavioral interventions are realized due to the development of the neurological system and the role of executive functions, this brain-conceptual structure is worthy of clinical attention. Considering the various and significant cognitive damages of methamphetamine consumption and the wide and increasing range of users of this substance in Iran, the present study was conducted aiming to compare the executive functions of the two groups of users and non-users of methamphetamine.

Materials and Methods

This study was conducted in the form of a case–control study from October 2014 to March 2014. The study population consisted of all men dependent to methamphetamine in two active use and abstinence phases in

Tehran, Iran, who were under treatment in the addiction treatment center of Vardij. They were selected using a respondent-driven sampling (RDS) method that is a combination of chain sampling and a mathematical model (Markov chain theory and networks bias) and is being considered today in the world's major health organizations.

Regarding the uncertainty of the size of the society of methamphetamine users and the impossibility of using sample size tables, the average sample size of the three recent studies on the evaluation of the executive functions was used to select the sample size and a sample size consisting of 70 people was selected. In the registration phase, 5 people were excluded from the study for various reasons and 65 patients were entered the study process (30 consumers and 35 normal individuals).

Screening and preliminary assessments were performed 28 days before the assignment of the subjects by a team of two psychiatrists, three clinical psychologists, and two nurses. The inclusion criteria were: 1) age range of 18-60 years, 2) minimum reading and writing ability, 3) 1-3 years dependence on methamphetamine as a single-use pattern, 4) at least three months of abstinence in control group participants, 5) the amount of consumption being between 0.3 to 1 gr per day as inhalation method, and 6) residence in Tehran or suburb with a deviation of 30 km^2. Exclusion criteria were: 1) co-dependence on other substances, 2) severe psychiatric disorders, and 3) receiving any neuroleptic treatment. The demographic checklist was completed at the baseline stage by the participants. The software version of WCST was used to evaluate exclusive functions. The implementation of WCST was carried out three days a week at 10 am. The test results were sent by e-mail to the participants after a week. Data were analyzed by SPSS software (version 22, IBM Corporation, Armonk, NY, USA). All stages of the research were carried out after obtaining informed consent and based on the latest version of the Helsinki Declaration. [Clinical Trial Registration Code: Thai Clinical Trials Registry (TCTR)20180402001].

In this study, a demographic checklist, Structured Clinical Interview for DSM (SCID), and WCST were used.

Demographic checklist: It was designed and used by the researcher to collect personal information such as education, age, job status, and income.[13]

SCID-4: It is a clinical interview that is used to diagnose dysfunctions of axis 1 based on Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV). The reliability coefficient between evaluators for SCID is reported to be 0.60.[14]. The diagnostic agreement of this tool was favorable for Persian language for most of the specific and general diagnosis with reliability greater than 0.60. The kappa coefficient for all of the current diagnoses and life expectancy diagnosis was 0.52 and 0.55, respectively.[15]

WCST: This tool is designed by Grant and Berg for the purpose of examining exclusive functions.[3] In this test, the number of completed classes represents the success of the subject in completing each of the three patterns (color, shape, number). The purpose of preservation is insistence of the subject on the initial false response or previous successful response in spite of the examiner's feedback to change the pattern of the cards. Validity and reliability of the WCST are desirable.[3] The reliability of this tool according to Cronbach's alpha method was estimated equal to 0.77.

For data analysis, independent t-test was used. The demographic characteristics of the two groups were also assessed by chi-square test. Kolmogorov–Smirnov test (K-S test) was used to assess the precondition for the use of independent t-test based on normal distribution of scores. The results indicated that this criterion was acceptable ($P < 0.050$).

Table 1. Demographic status of the participants in the research in two research groups

Variable	Active users (n = 30)	Abstinence (n = 35)	P
	Frequency	Frequency	
Education			NS
Lower than diploma	13	18	
Above diploma	17	17	
Age			0.040
18-25	18	22	
> 25	12	13	
Job status			NS
Employed	16	20	
Unemployed	14	15	
Monthly income			NS
Less than one million tomans	15	18	
More than one million tomans	15	17	

NS: Non-significant

The precondition of the similarity of variances was tested by Levene's test (P > 0.050). After the confirmation of the assumption of the equality of variances in the two groups, the combined variance was used. Moreover, in order to identify the outlier data, the Grubbs' test was used in the QuickCalc software environment (version 5.3, GraphPad, La Jolla, CA, USA). For this purpose, after calculating the amount of test statistics and comparing it with the standard value of each individual data, the outlier data were identified and removed from the analysis process (at the significance level of 0.050). The examination of the similarity of variances indicated that WCST index was not significant (P > 0.050); thus, it is possible to use the independent parametric t-test to compare the groups.

Results

The demographic status of the participants in the study is presented in table 1.

The results of the chi-square test on the demographic characteristics of the two groups of users and non-users indicated that the two groups showed a significant difference in the age index component and most of the participants who used drugs were in the age range of 18-25 (P < 0.050).

As shown in table 2, there was a significant difference between the two groups of active use and abstinence in the two sub-tests of the completed classes and the preservation errors at the level of 0.050.

Discussion

This study was conducted aiming to compare the exclusive functions in users and non-users of methamphetamine. The results showed that individuals dependent to methamphetamine showed significant defects in executive functions compared with control group, which indicates the damage of the precursor region in managing attention and changing the attention and position from one situation to another.

In line with the results of the present study, the results of the study by Pirnia et al.[3] showed that there was a significant difference between the exclusive functions in the users and non-users of methamphetamine.

Table 2. The results of independent t-test in sub-tests of exclusive functions in two groups

Variable	Users (mean ± SD)	Non-users (mean ± SD)	T	P
Completed classes	10.83 ± 1.47*	13.94 ± 1.85	2.89	0.039*
Preservation errors	15.71 ± 1.44	13.09 ± 1.83*	3.12	0.041*

* P < 0.050; SD: Standard deviation

Also, the findings of Farhadian et al.[8] showed that chronic use of methamphetamine was associated with damage to executive functions. In this regard, the results of the study by Mizoguchi and Yamada[5] showed that chronic use of methamphetamine was associated with damage to exclusive functions. Moreover, the results of the meta-analysis by Potvin et al.[16] showed that methamphetamine use was associated with a wide range of cognitive defects, including impairment in exclusive functions. Van der Plas et al.[17] also showed that stimulant users experienced injuries in exclusive functions. High impulsivity and poor exclusive functions are the hallmarks of methamphetamine use disorder.[18]

The higher rate of preservation errors in the methamphetamine-user group is consistent with previous research findings. Simon et al.,[19] for example, found that the rate of preservation errors in the users group was significantly higher than the control group.

Part of the results of this study showed that methamphetamine users in completing classes showed significant defects in comparison with the control group. These results are consistent with the results of Verdejo-Garcia et al.[20]

In explaining these results, it can be argued that the destruction resulted from methamphetamine generally happens at the frontal lobe of the forehead,[21] and since this area has the task of the exclusive functions, obviously seems that the use of methamphetamine changes this area of the brain and affects the exclusive functions. In this regard, the results of study by Meredith et al.[22] showed that methamphetamine users, as compared to heroin users, showed greater damage in the WCST, which suggests damage to the forehead area.

The study of addiction and impulse control disorders has shown that drug use behaviors are associated with neurobiological changes related to brain networks of reward, stress, and executive functions.[23] In addition to damaging the dopaminergic and serotonergic neural terminals, damage to energy-producing cells in the orbitofrontal cortex (OFC) and posterior parietal cortex (PPC) can be responsible for the attention deficit in the methamphetamine users. The results of this study, considering the effectiveness of cognitive and executive processes in the management of avoiding from drugs and the ability to continue the non-consumption process, can be applied and used in designing preventive and therapeutic interventions.

The results of this study were accompanied by several limitations. The main limitations were: (1) according to the small size of the sample due to the existing restrictions, it is necessary to interpret the findings of this study as primary outcomes, and (2) the cross-sectional nature of the study prevents the total inference and comprehensive prediction. It is recommended to use a larger sample in future studies, so that, due to statistical error less than one from one hand and the actual significance level on the other hand, it would be possible to be more confident about the characteristics of the society. It is also suggested that a similar study be conducted in the female society.

Conclusion

The results of the present study showed that exclusive functions in the form of two components of completed classes and preservation errors in methamphetamine users showed a significant decrease compared to abstinence (non-user) group. These findings reflect the biological and psychological consequences of the use of stimulants and can have clinical applications in the field of therapeutic and rehabilitation interventions.

Conflict of Interests

Authors have no conflict of interests.

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