The Difference in the Profile of Working Memory, Auditory Working Memory, and Spatial Working Memory between Drug, Stimulant, and Methadone Abusers and Normal People

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Abstract

Objective: The present study was an attempt to examine the difference in the profile of working memory, auditory working memory, and spatial working memory between drug, stimulant, and methadone abusers and normal people. **Method:** This study was a causal-comparative one with between-group comparison methodology. All the individuals addicted to opiates, stimulants, and methadone who had referred to Khomeini treatment centers of the city from September 2013 to February 2014 constituted the statistical population of the study. The number of 154 abusers (54 drug abusers, 50 stimulant abusers, and 50 methadone abusers) and the number of 50 normal participants were chosen as the sample of the study by purposive sampling method. The participants responded to Wechsler Memory Scale—third edition (WMS-III). **Results:** There was a significant difference between the normal group and drug, stimulant, and methadone abusers in terms of working memory, auditory working memory, and spatial working memory. **Conclusion:** Drug and stimulant use leads to sustained damage in cognitive processes such as working memory. However, research indicates that these cognitive processes will improve with the passage of time.

Keywords: Drug Abuse, Working Memory, Auditory Working Memory, Spatial Working Memory

Introduction

Addiction is a complex disorder of the nervous system that happens to the people who suffer from certain biological, mental, and physical vulnerabilities. Addiction is a chronic relapsing disorder that is problematic for both the individual and society (Gordon, Tinsely, Godfrey & Parrott, 2006). The present neurological models regard addiction as a brain disorder that includes severe nerve damages and leads to persistent drug use despite its negative consequences (Moreno-López, et al., 2012; Baler & Volkaw, 2006). There is strong evidence that substance abusers suffer from large deficits in their neuropsychological functions. These defects are especially prominent in executive functions (Fernandez-Serrano & Perez-Garcia, 2011). In addition, research shows that these neuronal defects affect the nervous systems involved in motivation, emotion, learning, memory, and executive functions (Milton & Everitt, 2012; Ersche, Roiser, Robbins & Sahakian, 2008; Verdejo-Garcia & Bechara, 2009).

Although addiction to drugs is associated with changes in the whole brain, one of the key nervous systems in substance abuse is cortico-limbic-striatal circuit that plays some part in motivation, reward, learning, and memory. Amygdala, hippocampus, and lateral striatum (including nucleus accumbens and the prefrontal cortex) are among the key neural structures associated with addiction in cortico-limbic-striatal circuit that are effective in memory. These areas are extremely vulnerable to drug use (Milton, et al., 2012; Sanchis-Segura & Spanagel, 2008). Working memory is one of the most important cognitive processes that underlies thinking and learning and helps the maintenance and preservation of information in mind (Kasaeian, Kiamanesh & Bahrami, 2014). Working memory is a system that is responsible for temporary maintenance and processing of information on a series of cognitive tasks. This memory plays a very crucial role in learning and other cognitive tasks (Cheraghi, Moradi & Farahani, 2008). Many studies have supported this hypothesis that substance abuse ruins the neural processes involved in memory and learning. For example, cocaine and heroin use can have an impact on the lateral amygdala and, thereby, influence memory consolidation (Luo, Xue, Shen & Lu, 2013; Li, et al., 2010). Furthermore, according to the research conducted in this area, the use of cocaine, which increases dopamine release, causes the loss of dopamine reserves of the brain in the long run. Then, some disorders occur to the functions of prefrontal cortex, cerebral cortex, and different areas of cortico-limbic-striatal circuit; therefore, the individual’s memory, cognition, and emotions undergo damages and craving for drug use raises (Aram, Bailey, Lavin & See, 2011; Hester & Garavan, 2004). Many researches have been conducted on the effectiveness of some of the cognitive abilities so far. For example, in a review study, Scott, et al. (2007) showed that methamphetamine users suffer from some defects in such areas as learning, executive functions, memory, speed of processing, and to a lesser extent from language compared to healthy individuals. In addition, Indlekofer, et al. (2009) indicated that regular consumption of ecstasy has negative effects on learning, verbal memory, and complex attention functions. Other studies have shown that using drugs such as crystal is associated with defects and impaired cognitive executive functions at a higher level, including determination, purposive acts, problem solving, abstract thinking, and memory (Simon, Dean, Cordova, Monterosso & London, 2010; Salo, et al., 2007). Darke, Sims, McDonald & Wickes (2000) stated that methadone has a negative impact on information processing, visual working memory, verbal working memory, long-term verbal memory, attention, and problem solving. Karimian Bafghi, Alipur, Zare & Nahrvanian (2010) reported that addicts show weaker performance in implicit memory, concentration, and problem solving ability compared to the healthy people.

Due to the increasing growth of drug use in today's society, the examination of physical and psychological complications resulting from drug use (especially given the diversity that exists in the field of drug abuse) seems essential. Several studies have been conducted on the physical symptoms associated with drug use, such as the effects of different drugs on the gastrointestinal tract and respiratory system and such diseases as AIDS and hepatitis; however, more research is required to be carried out on the psychological effects of various substances, especially their effects on cognition and cognitive abilities. Therefore, research in this area and informing the people is essential to prevent substance abuse. The present study was an attempt to examine the difference in the profile of working memory, auditory working memory, and spatial working memory between drug, stimulant, and methadone abusers and normal people.

Method

Population, sample, and sampling method

A causal-comparative method and a multi group research design were used for the conduct of this study. In this study, the independent variable had four levels of drug users (opium and heroin), stimulant users (crystal), people under methadone treatment, and normal group who were compared in terms of the two dependent variables of working memory. All the substance and stimulant abusers who had referred to rehab centers of Khomeini Shahr from September, 2013 to February 2013 constituted the statistical population of this study. The sample of this study consisted of 154 abusers (54 narcotic users (opium and heroin), 50 crystal users, and 50 people under methadone treatment) who were selected via purposive sampling method. The criteria for the inclusion of participants in this study were as follows: membership in the 20-to-35-year-old age group, referring to psychiatrist or doctor based on the primary diagnosis of drug dependence in accordance with the diagnostic criteria of the fifth revised edition of the Diagnostic and Statistical Manual of Mental Disorders, no consumption of antipsychotic drugs, no history of physical and psychological problems, history of at least one ,time relapse, and the minimum primary school education. The comparison group contained 50 normal individuals who accompanied the patients who were matched with the first group in terms of age (P> .05, t=1.010), gender (P>.05, Chi-square=.98), and education (P>.05, Chi-square= .88). In addition, normal individuals did not have the history of drug abuse or use of antipsychotic drugs and did not suffer psychological or physical illnesses. To match them, clinical psychologists gave them diagnostic interviews.

Instrument

Working memory scale: It is one of the sub-scales of Wechsler Memory Scale—third edition that consists of two dimensions, namely letter-number sequencing and spatial span. Letter-number sequencing is a phonetic task wherein auditory working memory is measured while spatial span is a visual task wherein spatial working memory is measured (Wechsler, 1997; cited in Ramezani, Moradi & Ahmadi, 2009). This profile is administered individually. The subscale of letter-number sequencing includes seven items, and each item is composed of three attempts. In this subscale, a cluttered collection of numbers and letters is read to the participant and s/he should organize the numbers from smallest to largest and also organize the letters alphabetically in his/her mind, and recite them. The other subscale, i.e. spatial span includes forward and backward spatial spans. The reliability of this scale was obtained desirable through test-retest method (within a two-week interval). The correlation coefficients through this method were reported to be .53, .54, and .58 for letter-number sequencing, spatial span, and the total scale, respectively. Similarly, the Cronbach's alpha reliability of this test was obtained equal to .73, .76, and .74 for letter-number sequencing, spatial span, and the total scale, respectively (Zare, 2012).

Results

The descriptive statistics of the variables have been displayed for each group in the following table1.

Multivariate analysis of variance was used to compare th mean scores of the four groups in working memory test. The equality of covariance matrix is one of the assumptions for using this test. Box test results suggest the satisfaction of this assumption (P>.05, F=.35). Another assumption of this test is the equality of variances. Levene’s test results are presented in the table 2.

Table 1: Descriptive statistics of the variables under study for each group

Variable	*Group*	*Mean*	*SD*
Working memory	Drugs (opium and heroin)	15.02	5.34
	Stimulant (crystal)	14.33	3.52
	Methadone	20.75	2.89
	Normal group	31.65	4.39
Auditory working memory	Drugs (opium and heroin)	8.4	2.04
	Stimulant (crystal)	7.33	1.49
	Methadone	11	1
	Normal group	16.8	2.01
Spatial working memory	Drugs (opium and heroin)	6.62	1.95
	Stimulant (crystal)	7	1.53
	Methadone	9.75	1.25
	Normal group	14.85	1.84

Table 2: Leven's test results representing the equality of variances

Variable	*F*	*Sig.*
Working memory	.88	.39
Auditory working memory	1.99	.17
Visual working memory	.11	.75

The results of multivariate analysis of variance indicated the presence of a significant difference between the groups (05/0, P <057/5 =, F129 / 0 = Lambda Wilkes) (P<.05; F=5.057; Wilks Lambda=.129). To examine the difference in patterns, univariate analysis of covariance was used as follows.

Table 3: Results of univariate analysis of covariance representing difference in patterns

Variable	*F*	*Sig.*
Working memory	121.3	.0005
Auditory working memory	89.21	.0005
Spatial working memory	123.12	.0005

As it is observed in the table above, there is a significant difference at least between two groups in all the three components. Tukey test was used for the pairwise comparison of groups as follows.

As it can be observed in the table 4, there is a significant difference between the mean scores of the normal group with those of the other three groups in all the variables. However, there is no significant difference between the three groups of drug abusers, stimulant abusers, and methadone users in these three variables. Of course, there is a statistically significant difference between methadone users and the other two groups in working memory.

Table 4: Results of Tukey test representing the pairwise comparison of groups

Variable	*Group 1*	*Group 2*	*Mean difference*	*Standard error*	*Sig.*
Working memory	Narcotics	Stimulant	.69	1.52	.231
		Methadone	-5.73	3.58	.004
		Normal	-16.63	2.25	.001
Auditory working memory	Stimulant	Methadone	-6.42	2.70	.005
		Normal	-14.32	3.62	.0005
	Methdone	Normal	-10.9	3.81	.001
Spatial working memory	Narcotics	Stimulant	1.07	5.25	.584
		Methadone	-2.6	4.62	.359
		Normal	-8.4	3.31	.001
	Stimulant	Methadone	-3.67	4.69	.845
		Normal	-9.47	5.87	.005
	Methdone	Normal	-5.8	2.31	.041
Working memory	Narcotics	Stimulant	-.38	4.23	.720
		Methadone	-3.13	3.31	.542
		Normal	-8.23	4.54	.001
	Stimulant	Methadone	-2.75	3.27	.369
		Normal	-7.85	2.87	.005
	Methdone	Normal	-5.1	2.64	.009

Discussion and Conclusion

The results of the current study showed that all the groups including drug users, stimulant users, and the group under methadone treatment undergo much devastation in cognitive functions, such as working memory, auditory working memory, and spatial working memory cimpared to the normal group. The pairwise comparison of groups revealed that drug users and stimulant users had lower performance compared to the normal group. However, the comparison of the normal group and methadone users led to similar results. In fact, the findings of this phase indicate that drug abusers have a weaker working memory compared to the normal group. Based on these results, although patients treated with methadone outperformed the drug and stimulant users in terms of working memory, they are still placed in a lower level than the normal group in terms of working memory performance. These findings are consistent with the results obtained by Aram, et al. (2011), Simon, et al. (2010), Hester & Garavan (2004), Indlekofer, et al. (2009), Scott, et al. (2007), Salo, et al. (2007), Gruber, et al. (2006), Davis, Liddiard & McMillan (2002), Hepner, Homewood & Taylor (2002), and Darke (2000). In addition, the

The results of this study showed that cognitive disorder in auditory working memory and spatial working memory in patients treated with methadone is similar to cognitive disorders in drug users and stimulant users that is confirmed by the findings of the studies done by Davis et al. (2002) and Mintzer & Stitzer (2005). Several possible explanations can be given for the findings of cognitive disorders in people addicted to drugs. Cognitive disorders in drug addicts may be caused by the direct impact of drug abuse. People with drug abuse and people under methadone maintenance therapy achieved lower scores in memory. The fact that drugs directly influence one’s central nervous system and brain as a result of passing through blood of the brain, has been confirmed in laboratory studies on animals. Studies have shown that drugs influence the hippocampus, which plays an important role in the formation of working memory, and also affect the lateral amygdala, which plays some role in memory consolidation (Luo, et al., 2013; Li, et al., 2010; and Kelley, Anderson & Itzhak, 2004). It is also found that drug addicts may also use or abuse various types of drugs at the same time. Thus, cognitive deficits in working memory of such addicts may be due to the interactions resulting from simultaneous use of more than one drug.

Cognitive damage in alcohol and cocaine users is more intense than that in drug users. Researchers have found little difference in cognitive functions between people under methadone treatment and drug abusers. The negative impacts of drug use still remain active even long after detoxification and withdrawal and these negative effects are not related to the amount of methadone they use. Although the findings of the already-conducted researches indicate that there is no change in cognitive function as a result of methadone withdrawal, it is possible that a recovery is met after a long period (Prosser, et al., 2006). In addition, there is the possibility that the cognitive defects identified in substance abusers is a manifestation of a disease that has already existed and continues through drug use and addiction treatment. That the current findings indicate that there is similar cognitive disorder in both people under methadone treatment and drug users reflects a situation that shows the investigation of drugs and their effects on cognition requires further research (Sorg, 2012 ; Mintzer, et al., 2005).

The results of this study have important clinical implications. Here, the previous findings that there is a cognitive disorder in chronic drug users was approved. It seems that the participants in substance abuse treatment programs will have still problems in attention and memory, and these defects may also be at play for months and even years after detoxification. Therefore, cognitive status may play an important role in the effectiveness of treatment. The defects in both groups of methadone receivers and drug users suggest that this population may benefit from further treatment programs based on training and retraining of cognitive skills such as memory rehabilitation skills and problem-solving skills. The lack of awareness of the memory function before substance abuse is one of the limitations of this study. In addition, the effect of factors such as mood or emotion on memory are uncontrolled while these factors affect memory performance.

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