Abstract

Objective: The aim of this study was to compare neuropsychological function between people with substance abuse and normal counterparts. **Method:** The present research was a causal study. The statistical population of this study consisted of the male substance abusers presenting to Imam Reza Hospital in Khorramabad city in 2016. The sample consisted of 30 drug addicts under methadone treatment and 30 non-addicted people who were selected via convenience sampling method. For data collection, Wechler Memory Scale and Continuous Performance Test were performed. **Results:** The results showed that the substance abuse group's performance was significantly different from that of the normal group ($p < 0.05$). **Conclusion:** The chronic consumption of psychoactive substances causes damage to multiple brain regions, such as the prefrontal cortex and the hippocampus; thus, it disrupts the cognitive functions of these regions.
Keywords: neuropsychological function, executive functions, memory, attention, substance abuse

Comparison of Neuropsychological Function between People with Substance Abuse and Normal Counterparts

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Introduction

Drug addiction is a relapsive and chronic mental illness that is associated with severe motivational disorders and loss of behavioral control (Dallas, David, & Julie, 2010). The fifth Diagnostic and Statistical Manual of Mental Disorders (2013) refers to one of the cognitive, behavioral, and physiological symptoms as an important feature of substance abuse disorder where people continue to use drugs despite significant problems associated with drug abuse. In addition, this diagnostic set also suggests that substance abuse disorder brings about an underlying change in brain circuits (especially in people with severe disorders), which may also remain even after detoxification (Diagnostic and Statistical Manual of Mental Disorders, 2013). Therefore, clinical observations, conventional wisdom, and theoretical mechanisms suggest that the acute and chronic use of psychoactive substances disrupts individuals' cognitive function (Lundqvist, 2005). In this regard, executive functions are considered among the most effective processes of cognitive performance and its role in addiction to substance abuse has been emphasized (Lyvers, Leggio, Abenavoli, & Gasbarrini, 2005). Executive functions are a set of superior capabilities for organizing and integrating that are neuro anatomically interconnected to different pathways of neuronal interactions, such as the prefrontal cortex (Robert, Robbins, & Weiskrantz, 1998). These functions include goal prediction and setting, planning, self-regulation and goal monitoring, implementation of and effective feedback on plans, working memory, etc. (Lezak, 1995), which are crucial for independent and goal-oriented activities and successful adaptation. In this line, a wealth of research evidence has suggested that the long-term use of drugs is associated with high levels of neuro-psychological deficits (Grant, Adams, Carlin, & Rennick, 1977).

Darke, Sims, McDonald, & Wicks (2000) compared cognitive deficits between two groups of methadone-treated addicts and normal people, and reported that methadone-treated subjects had a weaker performance in the tasks pertaining to Wisconsin Card Sorting Test and Wechsler Memory Scale. Von Geusau, Stalenhoef, Huizing, Snel, & Ridderinkhof (2004) and Reneman et al (2001) in separate studies indicated that cognitive resilience in drug abusers gets disrupted and leads to the severity of preservation behaviors in them. Hence, it has been assumed that preservation is the consequence of failure in control of attention to the inhibition of irrelevant information which is applied inappropriately as a result of the rules relating to previous actions even when they are in disharmony with the current situation (Salo et al., 2005). Kalechstein, Newton, & Green (2003) and Lundqvist (2005) compared the people who had stopped taking morphine, people under methadone maintenance treatment, and normal subjects and reported that the methadone-treated group significantly suffered cognitive dysfunction, the first and third groups were in the next ranks. In this regard, in addition to executive function deficits in people with substance abuse, memory is one of the cognitive actions that plays an important role in individuals' activities (Eysenck, 2000). In general, memory is a mechanism for encoding, storing, and recalling information (Millner, Squire, & Kandel, 1998). Memory is divided into two types of short-term and long-term memory in terms of the duration of data storage. Long-term memory deals with the type of information that needs to be kept in memory from a few minutes to the whole lifetime and can be of a variety of types, such as explicit, semantic, episodic, and implicit sorts (Hergenhan, & Olson, 2001; translated by Seif, 1995). In this regard, various studies have reported defects and deficits in memory processes, verbal learning, response control, concentration, attention, and recall among drug users (Darke et al., 2000). Yan, Li, & Xiao (2013) reported that heroin-dependent addicts showed low performance in working memory tasks compared to the control group. In the same way, Mcketin, & Marric (1997) found that there was a relationship between the severity of amphetamine dependency and poor performance in Wechsler Memory tasks. In this vein, Miller (1985) compared morphine users, chronic heroin users, and normal people in terms of functional memory, spatial memory, planning, and sequencing; and it was found that there was a significant difference between the performance of the two groups with the normal group in different aspects, although the type of disorder was different in the two types of drugs consumed by the subjects. Similarly, several studies have also documented a great deal of evidence for cognitive dysfunction as a result of the severe and prolonged use of cannabis, which included impaired perceptual-motor functions, especially memory and learning (Curran, Brignell, Fletcher, Middleton, & Henry, 2002; O'leary et al., 2002). In this regard, according to the presented points, numerous studies have confirmed the effects of addictive substances on the brain and, consequently, on cognitive abilities. On the other hand, due to the increasing trend of drug use in Iran, it is required to pay more attention to the physical and psychological complications of drug use, especially in the cognitive domains that are useful for healthy performance in interpersonal relationships and appropriate social behaviors. Therefore, the present study was inspired by the above findings in order to develop a harm reduction approach and compare neuropsychological function between substance abusers and their normal counterparts.

Method

Population, sample, and sampling method

The present study employed a causal-comparative research design. The statistical population of this study consisted of the male substance abusers presenting to Imam Reza Hospital in Khorramabad city in 2016. Thus, 30 subjects were selected from among the individuals who had referred to the hospital for the first time and had not received any treatment in addiction treatment clinics before their referral to the clinic. It is noteworthy that these individuals were selected as the ones currently using drugs after announcing their consent for participation in the research and getting interviewed. For selecting the normal group, 30 non-addicted people were selected through convenience sampling method from among people who did not have any history of substance abuse and were matched with the experimental group in terms of demographic characteristics. The mean value for the age of the two groups did not differ significantly ($t=0.354$, $p>0.05$).

Instruments

1. Wechsler Memory Scale (Revised Version): Digit span and vocabulary treasure are the subtests of Wechsler Test for adults. Wechsler reported the reliability of the subtests to range from 0.41 to 0.91 with the average value of 0.74. The highest reliability was reported for the vocabulary treasury, i.e. 0.96 and the lowest reliability coefficient was reported for the attachment of parts, i.e. 0.25 (Gross, & Marnat, 1997). In the Persian version of this scale, which was administered to 16-64 year-old participants in Shiraz, the re-test reliability coefficient of the subtests were obtained within the range of 0.28 to 0.98, and the reliability coefficients of 0.68 and 0.73 were reported for the digit span and vocabulary treasure, respectively (Orangi, Atef Vahid, & Ashayeri, 2001).

2. Continuous Performance Test: This test was developed by Rosvold et al. (1956). In this task, individuals are faced with a series of sequential stimuli over a given time period and they should provide responses to target stimuli. This test aims to detect sustained attention deficit performance. In this test, a series of numbers appears at a given interval and two stimuli are determined as the target stimulus. The participant must press the corresponding key on the computer screen while observing the numbers as quickly as possible. The variables measured in this test include the errors of omission (not pressing the target key against the stimulus), the commission error (pressing the key against the non-target stimulus), and the reaction time (average reaction time of the correct responses against the stimulus in millisecond). In this test, the error of omission and reaction time are related to inattention and commission errors pertain to impulsivity. The reliability of this test has been reported through retest method in a 20-day interval within the range of 0.59 to 0.93, which were significant at the level of 0.001. Moreover, a desirable validity has been reported through criterion validity method for this test (Hadianfard, Najarian, Shokrkon, & Mehrabizadeh Honarmand, 2001).

Results

The descriptive statistics of the research variables are presented in Table 1 for each group.

Table 1: Descriptive statistics of the variables for each group

Variables	*Group*	*Mean*	*SD*	*N*
Vocabulary treasure	Addicted	37.13	7.16	30
	Normal	44.20	8.31	30
Memory	Addicted	8.00	2.48	30
	Normal	11.00	3.59	30
Commission error	Addicted	5.27	3.11	30
	Normal	2.87	2.03	30
Omission error	Addicted	7.80	2.98	30
	Normal	2.90	1.72	30
Reaction time	Addicted	7.50	2.81	30
	Normal	5.30	2.71	30

Before running multivariable analysis of variance for the research variables, the assumption of homogeneity of variances was tested via Levene's test. Based on the results, the assumption of the homogeneity of variances in the variables was confirmed for both groups ($P > 0.05$). To test the homogeneity of variance-covariance matrix, the box's test was run and the results showed that this assumption has also been met ($F = 1.73$, $P>0.05$). Therefore, multivariate analysis of covariance was run and the results showed that there is a significant difference between the linear combination of the variables in the two groups ($P <0.001$, $F = 45.41$, Wilks' Lambda = 0.614). To analyze the patterns of difference, univariate analysis of variance was run as presented in Table 2.

Table 2: Univariate analysis of variance representing patterns of difference

Variables	*Sum of squares*	*Df*	*Mean Square*	*F*	*Sig.*
Vocabulary treasure	749.06	1	749.06	55.68	0.0005
Memory	135.00	1	135.00	56.73	0.0005

As it is observed in table 2, there is a significant difference between the two groups in terms of memory and vocabulary treasure.

In addition, to examine the difference between the two groups in the continuous performance test, multivariate analysis of variance was run. The results showed that there is a significant difference between the two groups ($P <0.001$, Wilks' Lambda = 0.055). To analyze the patterns of difference, univariate analysis of variance was run as presented in Table 3.

Table 3: Univariate analysis of variance representing patterns of difference in continuous performance test

Variables	*Sum of squares*	*Df*	*Mean Square*	*F*	*Sig.*
Commission error	86.40	1	86.40	12.48	0.001
Omission error	360.15	1	360.15	60.45	0.0005
Reaction time	72.60	1	72.60	11.63	0.001

As it has been shown in Table 3, there is a significant difference between the two groups in terms of error of commission, error of omission, and reaction time.

Discussion and Conclusion

The aim of this study was to compare neuropsychological function between substance abusers and their normal counterparts. The results showed that substance abusers had a weaker neurological function than healthy subjects. This finding was consistent with those of the studies conducted by Darke et al. (2000), Amestins et al. (2000), Von Geusau et al. (2004), Reneman et al. (2001), Calstin et al. (2006), Lundqvist et al. (2005). These studies suggest that defects in the executive functions of substance abusers are due to damage to the cerebral cortex. For example, studies on animals and humans have shown some degrees of laziness in ventrolateral prefrontal cortex (Hampshire, 2006). Some studies have also suggested that inferior frontal gyrus and its connections to the basal ganglia are related to the location change of the Wisconsin test tasks (Aron, Sahakian, & Monsell, 2004; Duncan, & Owen, 2000). Therefore, these regions have generally been proposed for better performance in the Wisconsin Sorting Test and dopamine has been proposed as the regulator of these connections in these areas (Nagano - Saito et al., 2008). In this regard, Joyce, & Meador (1997) suggested that the distribution of dopaminergic cortex and neural receptors may lead to various patterns of cognitive disorders among drug abusers. For example, dopamine receptor D1 is present primarily in the anterior neocortex, especially in the prefrontal cortex. Although addictive substances have distinct effects in the cerebellum regions, they are involved in some activities, such as increasing the metabolism of the dopaminergic system (Koob, & Lemoal, 1997; Wise, & Bozarath, 1984). Moreover, some recent theories suggest that chronic drug use is associated with the brain regions involved in memory and learning, such as the frontal cortex (Yang et al., 2009) and the hippocampus (Lu et al., 2010). This means that drug use may increase the apoptosis process (programmed cell death) and neurogenesis inhibition (nerve tissue formation) (Nyberg, 2012) according to cognitive processes that are disrupted by the effect of drugs on hippocampal areas and prehistoric cortex structures. In this regard, the attenuation of neurogenesis arising from drug use has been already observed in the hippocampus of the male rats exposed to morphine (Eisch et al., 2000); therefore, narcotics (e.g., morphine) appear to reduce the neurogenesis process in the subgranular zone (some part of the dentate gyrus in the hippocampus), and this neurogenesis inhibition can contribute to the defects caused by drug abuse in cognitive functions, such as memory tasks (Arguello et al., 2008). It has also been suggested that substance abuse causes apoptosis in human fetal microglia and neurons (Hu et al., 2002). In addition, the apoptosis process is associated with morphine tolerance (Mao et al., 2002) and the apoptotic effect of morphine is blocked by naloxone (opioid receptor antagonist) (Hu et al., 2002).

Failure to compare neuropsychological indices in different types of drugs, ignorance of gender differences, the mere participation of male subjects in this research, the conduct of convenience sampling are among the current research limitations. Thus, it is suggested that future research examine these indices in the different groups of substance users in a comparative manner.

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