



A discriminant analysis of psychological and brain-behavioural system features to predict methamphetamine dependence

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ABSTRACT

Considering the high prevalence of Methamphetamine dependence and its severe complications, the risk factors and various factors in the tendency to substance should be investigated. Therefore, the aim of the present study was to predict methamphetamine dependence based on psychological and brain-behavioural system features. In this correlational descriptive study, 100 of all eligible methamphetamine dependents admitted in Farabi Hospital, Kermanshah, Iran in 2016 and 100 healthy persons were selected as the control by convenience sampling method. Data were collected from the self-report psychometric questionnaire (SCL-90) and Carver & White's Brain-behavioural Questionnaire, and were analyzed by discriminant analysis. The coefficients of the audit function indicated that discordance, obsession, anxiety and sensitivity in relationships had the most roles in the diagnostic function, and the variables of impulsivity, paranoid, and novelty seeking had the lowest role in diagnostic function and its success. Also, the discriminant analysis method showed that the linear combination of the above variables can explain about 85.3% of the variance difference between two groups. According to the study findings, it is recommended that in prevention, treatment strategies, the role of psychological and brain-behavioural system features consider.

Key Words: psychological, brain-behavioural system, methamphetamine, dependence

DOI Number: 10.14704/nq.2019.17.08.2065

NeuroQuantology 2019; 17(08):24-31

Introduction

Methamphetamine (MA) has become a highlighted and turned into a major problem. MA is a stimulant substance that basic chemical structure of it is amphetamine ($C_9H_{13}N$). The Crystal meth in Iran is known as glass. This substance is highly depended and affects the dopaminergic system of the brain and its immediate effect is called flash or in Rush (Chang et al., 2002; Dolan, Martin and Rohsenow, 2008). MA causes the excretion of dopamine into the corpus striatum and thereby leads to cognitive and motor disorders (Shariat and Elahi, 2010). It also increases the release of norepinephrine and

serotonin neurotransmitters, and on the other hand it leads to glutamate release from reservoirs within neurons which, in turn, leads to functional changes in brain and its mandated duties (Carr, 1999; Galanter, 2006).

A review of the literature suggests that biological, psychological, social and cultural factors are all associated with dependency (Hannedottir et al., 2001; Sadock and Sadock, 2005). One of them is Psychological characteristics. Various studies have shown high prevalence of psychiatric disorders in substance dependents (Bolhari, 2003; polimeni, Moore and Gruenert, 2010), which are paranoid

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received: 10 April 2019; **Accepted:** 22 May 2019



thoughts, depression, obsessive-compulsive disorder, sensitization in Interpersonal relationships, physical complaints, major depression, antisocial personality disorder, phobias, obsessive-compulsive disorder, mania and schizophrenia (Bond, 2005).

Among the reasons for clinical significance of mental disorders of substance dependents, co-infectious psychiatric disorders are considered as major contributors to the aetiology, prognosis and vulnerability of this group (Polimeni et al., 2010). In other words, the prevalence of substance dependence over life is about 1%, and alongside most substance dependents have a different psychiatric diagnosis as well. Today, many studies have confirmed the comorbid of substance and psychiatric disorders (Gold, Redmond and Kleber, 1978; Hajheidari et al., 2015; Hellem, 2016; Marshall and Werb, 2010; McGregor et al., 2005; Sadock and sadock, 2003; Zhang et al., 2015).

On the other hand, from the psychological point of view, substance dependents have vulnerable personality traits (Lukasiewicz et al., 2008) that leading them to dependence (Beauchaine, 2001). Brain-behavioural system is an effective personality trait in the tendency to consume substances. Gray (1990) presented a biomedical model which includes three brain-behavioural systems, a behavioural activation system which is characterized by affection and positive behavioural tendencies, extroversion and impulsivity. Another system is behavioural inhibition which is characterized by behavioural tendencies of fear and passivity, such as introversion, depression and anxiety (Meyer et al., 2005). The War and Escape System which also produces rage, fear and anger (Matthews and Gilliland, 1999). Several studies have shown the role of the brain-behavioural system in the tendency toward substance dependence, including Franken, Muris and Georgieva (2006) in a study that aimed to compare behavioural activation and behavioural inhibition systems among dependent and healthy people, showed that substance dependents got higher BAS than the healthy group.

In general, dependence can be considered as a physical-psychosocial illness that plays a key role in the formation of these pre-addictive factors. Identifying these factors can be effective in controlling and preventing it. Investigating the factors associated with drug abuse is important because substance dependence put their health and well-being at risk raises problems, such as increasing

the risk of injury and death from interpersonal violence, road accidents, increasing high-risk sexual behaviours, unwanted pregnancy, diseases Such as AIDS and also educational problems. Regarding the high prevalence of MA dependence on the one hand and the importance of addressing the underlying factors, and on the other hand, the need for a study on the aetiology of tendency toward MA, the present study aimed to investigate the role of psychological characteristics and brain-behavioural systems for MA dependence.

Methods

The current study is a correlational forecasting research which aims to predict the risk factor of group 3nt connection, is used in MA dependents individuals and healthy individuals. The statistical population is 100 MA dependents who were selected among those that referred to Farabi Hospital due to substance dependence and were diagnosed with DSM IV criteria as MA dependence disorder and voluntarily took part in the study and sampled with convenient approach. The control group also included 100 healthy people with no history of substance dependence and mental disorders who were selected using convenience sampling method and matched with the case group in terms of age, gender, and marital status.

About the inclusion and exclusion criteria of the participants to the present study, it is conducted firstly on those who were volunteers for answering to the questionnaires. Considering MA dependents group, the inclusion criteria were at least 6 months of methamphetamine abuse history and the absence of severe psychiatric disorders; in addition, not having a history of substances abuse and psychological disorder in the healthy population.

This study was approved by the Substance Abuse Prevention Research Center, Kermanshah university of Medical sciences, Kermanshah, Iran. Each participant was verbally provided with information regarding the study and the contents of the information sheet. All participants signed a consent form in which the study procedures were explained. After the agreement to participate and being guaranteed that their data is secret, the samples were investigated and filled the questionnaire.

Self-report psychometric questionnaire (SCL-90), the basic form was designed by Derogatis, Lipman and Covi (1973) to indicate the psychological aspects for physical and mental patient. The aforesaid



questionnaire was revised by Derogatis et al., 1984, and the final form, title as revised psychological symptoms (SCL-90-R), has been published. This questionnaire is included with 90 items and 5 answer options (not at all=0, a little bit=1, moderately=2, quite a bit=3, extremely =4). The questionnaire's content evaluates 9 different dimensions yet to conduct the current study, Questions about obsessive-compulsive disorder, depression, anxiety; paranoid thoughts and aggression were employed (44 questionnaires). High scores in any subscales indicate their sever disorder. Concerning the validity of the questionnaire, it's concurrent, convergent and has constructed and scale validity in terms of mental changes. The reliability of the test was examined by test-retest reliability method and reported 0.78 to 0.90 and its Cronbach alpha coefficient was reported 0.70 to 0.90. This test is taken by Mirzaee (1980) and Bagheri (1994) from 2500 participants in Iran and the reliability was reported more than 0.80 (Shkibai, Esmaili and Karami, 2006).

Brain- behavioural systems: in order to evaluate brain- behavioural systems, Carver and White behavioural inhibition and activation/ system was employed; a 24 items Likert 4 scale which is included with behavioural inhibition system (BIS) and behavioural activation system (BAS). behavioural inhibition scale includes 7 items, behavioural activation system scale includes 13 questions (three subscale of impulsivity, bonus search, novelty seeking) and 4 questions are also deviant. The reliability of inhibition scale system is 0.78 and for the subscales of impulsivity activation system, bonus search and novelty seeking are respectively reported 0.82, 0.75 and 0.76. Concurrent validity test is reported ($r=0.38$), Eysenck ($r=0.37$), the state-trait anxiety scale ($r=0.43$) and negative affect scale ($r=0.40$) by Beck's questionnaires (Sabouri-moghaddam, 2008).

Statistical analysis and results

Data analysis was performed using descriptive statistics (frequency, percentage, mean, and standard deviation) for describing demographic characteristics such as age, gender, and marital status. To compare the experimental groups in grouped variables, chi-square test was used. Finally, discriminant analysis was applied to make a separation between two groups. In each of the two groups of control and case, 100 subjects entered the study. The highest and lowest frequencies of age were related to age groups 26-35

(66 subjects in the control group and 42 subjects in the case group) and 46-51 (1 subject in the control group and 6 subjects in the case group), respectively. In terms of gender, 31 subjects in the control group and 24 subjects in the case group were female. In addition, 4 healthy persons and 56 MA dependent had a high school diploma, while only 70 subjects in the control group had a bachelor's degree or higher. The data also indicated that 40 healthy persons and 6 MA dependent were working in state jobs or as an employee. In the case group, the history of physical illnesses and mental disorders was observed in 11 and 11 persons, respectively, while these figures in the control group were 2 and 0. In terms of economic status, 49 subjects in the control group and 55 subjects in the case group were in a poor situation. All statistical analyses were conducted in SPSS 20 at the level of 5%. The Results Showed that subscales of proximity, dependence and anxiety remained stable in a Table 1: The relationship between the two groups in terms of age, gender, marital status, educational attainment, job and physical illness and mental disorder, family history of dependence and economic status.

Evaluation of the relationship between the two studied groups in terms of age, gender, marital status, educational attainment, job, physical illness, mental disorder, family history of dependence and economic status showed that there is a significant difference between the two groups in educational attainment, job, history of physical illness, history of mental illness and family history of dependence ($P<0.05$), while such a difference was not found between them in terms of age, gender, economic status and Marital status ($P>0.05$) (Table 1).

The current study considers the role of psychological and brain- behavioural system features the risk factor of MA dependence with by diagnostic analysis. The independent variables which were analyzed as a predictor of MA dependence includes psychological features (physical complaints, obsessions, allergies in Relationships, Depression, Anxiety, Aggression, Fear, Paranoid, Psycho-Discrimination) and Brain- behavioural System (impulsivity, Recent Searches, Sensitivity to rewards and behavioural brain systems). The results of the analysis showed that all 200 people entered the analysis. Table 2 shows the results of the comparison of the mean of independent variables between the two groups of healthy and MA dependent individuals. As the table's result shows, the standard



Table 1. Participants' characteristics (n = 200)

Characteristics	Groups		Sig
	Healthy persons (n = 100)	MA dependents (n=100)	
Age	15-25	16	0.18
	26-35	56	
	36-45	22	
	46-51	6	
Marital status	Single	46	0.75
	Married	37	
	Divorced	17	
Gender	Females	31	0.17
	Males	69	
Level of education	primary	0	0.01
	High school	4	
	Diploma	18	
	High diploma	8	
	Bachelor of Science	49	
	College graduate or more	21	
Occupation status	Employee	33	0.001
	government job	7	
	Contractual job	9	
	Self-employed	11	
	Farmer and rancher	0	
	Retired	0	
	Unemployed	33	
	housewife	7	
Physical illness	Yes	2	0.009
	No	98	
Mental illness	Yes	0	0.001
	No	100	
Family history of addiction	Yes	93	0.001
	No	7	
Economic Status	Poor	49	0.28
	Medium	29	
	good	19	
	excellent	3	

deviations of each of the independent variables are not significantly different between the two groups of healthy and dependents individuals. Also, with respect to the values of wilks lambda, F statistic and their significant level, With the exception of the two independent variables of the inhibition system and the sensitivity to reward, the difference in the mean of the other independent variables between the two groups of healthy people and MA dependent persons is significant when its less than 0.05 at error level. Hence, we can say that the mean variables of physical complaints, obsession, sensitivity in relationships, depression, anxiety, aggression, fear, paranoid, mental dissociation, impulsivity and novelty seeking are different between the two groups (all Ps<0.0001). The difference between each predictor in terms of the mean and the total average is a proven statement.

The BOX test showed that the covariance matrix was 28.58 in the healthy group and 28.98 in the case group so the results of the measurements of covariance matrix between the two groups by M-Box test showed that, with the probability of F=3.290, p<0.0001, the covariance matrices of the two groups were statistically significant; therefore, Considering the values of the covariance matrices of the two groups and the small difference between them, this can be attributed to the high sensitivity of this test to the large sample sizes (Table 2).

The implementation of diagnostic analysis showed a focal diagnostic function that considering its specific value, V = 1.05, it can be said that this diagnostic function has a high explanatory power in dividing the groups from each other, And these functions can determine 100% of the variance of the



Table 2. Comparison of psychological features and brain-behavioral system between MA dependent and healthy controls

	Variable	Group	Number	Mean±SD	F	sig
Psychological features	Physical Complaint	healthy persons	100	8.32±7.03	63.63	<0.0001
		MA dependent	100	17.87±9.69		
	Obsession	healthy persons	100	10.49±6.34	28.10	<0.0001
		MA dependent	100	15.48±6.95		
	Sensitivity in relationships	healthy persons	100	7.70±5.55	31.29	<0.0001
		MA dependent	100	12.90±7.29		
	Depression	healthy persons	100	10.55±8.93	44.81	<0.0001
		MA dependent	100	20.68±12.21		
	Anxiety	healthy persons	100	5.99±5.95	96.12	<0.0001
		MA dependent	100	15.87±8.13		
	Aggression	healthy persons	100	4.63±3.92	32.34	<0.0001
		MA dependent	100	8.34±5.21		
Brain-behavioral system	Fear	healthy persons	100	3.25±3.85	59.49	<0.0001
		MA dependent	100	8.30±5.29		
	paranoid	healthy persons	100	5.96±4.70	30.56	<0.0001
		MA dependent	100	9.69±4.83		
	Psychoticism	healthy persons	100	4.69±5.58	123.24	<0.0001
		MA dependent	100	15.34±7.79		
system behavioral inhibition	system behavioral inhibition	healthy persons	100	18.95±2.84	0.125	0.724
		MA dependent	100	18.82±2.33		
	Impulsivity	healthy persons	100	10.28±2.51	20.72	<0.0001
		MA dependent	100	12.04±2.94		
novelty search	healthy persons	100	11.08±2.69	24.40	<0.0001	
	MA dependent	100	12.86±2.39			
Sensitivity to rewards	healthy persons	100	16.59±2.89	1.93	0.167	
	MA dependent	100	17.13±2.59			

groups. The value of the focal correlation coefficient that is equal to $RC = 0.716$, Showed that there is a strong correlation between the diagnostic scores and the studied groups and the diagnostic function was able to divide the two groups of healthy people and MA dependent from one another. In the other word, the model was able to explain 51.3% of the change

in the variable of MA dependence. The values of the wilks lambda and Chi-square data are respectively $\lambda = 0.487$ and $\chi^2 = 137.79$ and their significant level of $p < 0.0001$, indicates the difference between the groups and suggests that the diagnostic function failed to explain $\eta^2 = 48.7\%$ the variable variation of MA abuser (Table 3).



Table 3. The results of the tests performed in the diagnostic analysis

Covariance Matrix Groups (BOX s M Test)					Power explanatory modeltest	canonical correlation	Equivalence test for groups mean		
healthy persons	MA dependent	BOXs M	F	p	v	Rc	λ	χ ²	P
28.58	28.98	321.46	3.290	<0.0001	1.053	0.716	0.487	137.79	<0.0001

The focal diagnostic function coefficients along with the standardized focal diagnostic function coefficients, the classified function coefficients and the structural coefficient matrix are shown in Table 3. These results show that among the 13 independent variables examined, accordingly, psychological variables of discretization, obsession, anxiety and sensitivity in relationships, in the order of the standard coefficients of 1.11, 0.613, 0.464, and 0.391 have a higher independent scatter than the other independent variable and mostly are involved in diagnostic function. The variables of inhibition systems, impulsivity, paranoid and novelty seeking with 0.007, 0.072, 0.095 and 0.122 coefficients have the least role in the diagnostic function and its success. Also, structural coefficients showed that psychological variables of discordance, anxiety, physical complaints and fear with correlation coefficients of 0.769, 0.679, 0.552 and 0.534 respectively, have a stronger relationship with diagnostic function. In contrast to the variables of inhibition systems, reward sensitivity, impulsivity and novelty seeking, with the correlation coefficients of 0.024, 0.096, 0.315, 0.342 respectively, have the weakest relation with the diagnostic function. The focal diagnostic function coefficients are also the estimates of the detection function with non-standard coefficients and according to them, the equation of diagnostic function is as follows:

Diagnostic function score (DF1) = -3.062 (constant) +0.035 (Physical Complaint)-0.092 (Obsession) - 0.060 (Sensitivity in relationships) - 0.015 (Depression) +0.065 (Anxiety) -0.079 (aggression) +0.055 (fear) +0.20 (paranoid) +0.163 (Discretionary Psychology)-0.003 (Brain and behavioural systems) +0.026 (impulsivity) +0.048 (novelty seeking) +0.090 (Sensitivity to rewards)

This equation means that by increasing the unit value of the physical complaint, assuming to keep the effect of other independent variables, the value of the diagnostic function is increased to 0.035. It can also be said that by increasing a unit in obsessive variables, assuming to keep the effect of the other independent variables in the model, the amount of diagnostic

function is decreased to 0.92. This is a distinct equation for both healthy people and MA dependent and by replacing the values of the following equation for each person presented in the study, the diagnostic function score for that responsive is set and according to the fact that the value that is obtained is close to the value of the function in the center of gravity of the healthy population group or the MA dependent group, the respondent is placed in that group.

The classification of individuals in the group of ordinary and dependent persons was done by using the coefficients of the classification function as follows:

Healthy people group classification function: -47.374 (constant number) +0.429 (Psychoticism) -0.785 (Anxiety) +0.162 (Physical problems) +0.893 (Fear) -0.404 (Depression) +0.190 (Aggression) -0.172 (Sensitivity in relationships) +0.144 (paranoid) +0.477 (Obsession) +0.528 (novelty seeking) +0.621 (Impulsivity) +1.752 (Sensitivity to rewards) +2.604 (system behavioural inhibition)

MA dependent group classification function: -53.628 (constant number) + 0.763 (Psychoticism)-0.652 (Anxiety) +0.234 (Physical problems) +1.005 (Fear) -0.434 (Depression) +0.030 (Aggression) -0.295 (Sensitivity in relationships) +0.185 (paranoid) +0.289 (Obsession) +0.626 (novelty seeking) +0.675 (Impulsivity) +1.936 (Sensitivity to rewards) +2.599 (system behavioural inhibition)

In the end, the respondent is a member of the group that the most values of the graded function of this respondent is in that group (Table 4).

Grading people in 2 groups of dependents and healthy people based on Leave- one-out method. In table 5, the number and percentage of people that are correctly or incorrectly graded in the two groups are shown, the grading results showed that 90 of healthy people (0.90%) are graded in the right group and 10 are put in MA dependent group by mistake (0.10%). 85 of MA abuser (0.85%) are graded in the right group and 15(0.15%) are graded in the



Table 4. The values of the focal discriminant function coefficients along with the standardized focal discriminant function coefficients, the coefficients of the grading function and the matrix

Variable	Focal diagnostic function coefficients	Standardized focal diagnostic function coefficients	Coefficients of classification detection function		Matrix of structural coefficients
			MA dependent	healthy persons	
Psychoticism	0.163	1.109	0.763	0.429	0.769
Anxiety	0.065	0.464	- 0.652	- 0.785	0.679
Physical Complaint	0.035	0.297	0.234	0.162	0.552
Fear	0.55	0.254	1.005	0.893	0.534
Depression	- 0.015	- 0.157	- 0.434	- 0.404	0.464
Aggression	-0.079	- 0.363	0.030	0.190	0.394
Sensitivity in relationships	- 0.060	- 0.391	- 0.295	- 0.172	0.387
paranoid	0.020	- 0.095	0.185	0.144	0.383
Obsession	- 0.092	- 0.613	0.289	0.477	0.367
novelty search	0.048	0.122	0.626	0.528	0.342
Impulsivity	0.026	0.072	0.675	0.621	0.315
Sensitivity to rewards	0.090	0.248	1.936	1.752	0.096
system behavioral inhibition	- 0.003	- 0.007	2.599	2.604	0.024-
constant	-----	-----	-53.628	- 47.374	-----

Table 5. Classification of subjects in two groups of healthy persons and MA dependent based on Leave-one-out method

Groups			Group foreseen for membership		Total
			healthy persons	MA dependent	
Main group	Number	healthy persons	90	10	100
		MA dependent	15	85	100
	Percent	healthy persons	0.90	0.10	100
		MA dependent	0.15	0.85	100
valid Crossover Group	Number	healthy persons	87	13	100
		MA dependent	20	80	100
	Percent	healthy persons	0.87	0.13	100
		MA dependent	0.20	0.80	100

group of healthy people. Therefore, the accuracy of the grading of the healthy group was 90% and the accuracy of the grading of the MA dependent group was 85%. According to the accuracy of the grading, 87.5% of the people were correctly graded into two groups. Also, in order to show, the ability of the discriminant function of grading individuals in other samples, Leave-one-out 83.5% correctly graded them correctly (Table 5).

Discussion

The purpose of this study was to investigate the role of psychological characteristics and behavioural brain system in prediction of MA dependence. The analysis method showed that the linear combination of the above variables can explain 3. 85% of the variance of the difference between two groups.

The standardized coefficient of the audit function indicated that psychoticism, obsession, anxiety and sensitivity in relationships play the most important role in the discriminant function and the variables of impulsivity, paranoid and novelty seeking have the least important role in the discriminant function and its success.

This finding is consistent with the results of previous research (Povarain, 2006; Mami et al., 2013; Akbari-Shadeh et al., 2012; Askari et al., 2010; Bahrami et al., 2010 and Hosseini et al.,2008).

In explaining this finding, it can be stated that those who have mental disorder syndrome, obsession, anxiety and sensitivity in relationships, due to their negative feelings, have no proper ability to adapt to the environment and it is likely that these people



have irrational thoughts and it is difficult for them to adapt to environmental stressors. Also, it is unlikely for these people to express their feelings, emotions, beliefs and thoughts, all of which lead to a tendency to substance abuse. In justifying this finding, it can be said that people with mental disorders sometimes resort to substance dependent to escape from the problems and find a place for life without stress and with vitality and peace.

On the other hand, the MA dependence and mental disorders are not irrelevant, but they are the elements of a set that are affected by other aspects of life. Low economic status, unemployment, low education and low age of marriage increase the degree of vulnerability of the substance dependents towards the problems of everyday life and putting them at increasing risk of mental disorders. In fact, it can be argued that in the presence of psychological disorders, it can be predicted that the tendency toward substance dependent increases and this also shows the comorbidity of the psychiatric disorders in MA dependents.

Another finding of the present study was that brain- behavioural systems, especially reward sensitivity, could be a good predictor of MA dependent. This finding is consistent with studies of Kazemi et al. (2014), Alimoradi et al. (2012), Franken, et al. (2006) but it contradicts with Loxton and Dawe's study (2001). In explaining this finding, it can be said that the high level of reward sensitivity leads to behavioural tendencies to pleasurable stimulants. High level of sensitivity to rewards has a significant relation with characteristics like risk taking, swing, novelty seeking, diversity which are characteristics associated with drug use. In other words, the more active is the system, the more these people actively and unconsciously and only for pleasure look for pleasant stimulus.

This situation leads to a defective cycle in these people. These people because of impulsivity and pleasure enter the cycle of dependents. Consumption causes the response of the dopaminergic system and the user will be attracted to no other incentive except substances. Consequently, vitality and happiness of these people is only towards the drugs and can find excitement in using them.

Conclusion

The findings of this study indicated that brain-behavioural systems and psychological disorders like

mental disorder, obsession and anxiety can play a role in the tendency of people to take methamphetamine. In sum, it can be said that the combination of a set of biological readiness, such as high sensitivity to rewards and the effects that substances has on the nervous system over time, can make people more vulnerable to starting and continuing to use substances. Given these findings, it can be argued that the clinical problems of the person who abuse the substance are rooted in the biological and psychological processes and some of the psychological characteristics, make it easier for the person to use substance. Therefore, the identification and treatment of these cases may prevent people's desire to take substances.

Limitation

One of the most important limitations of this study was being cross-sectional, possibility of bias choice and unreal responses due to the use of self-report questionnaires and not considering mediating variables in analyzes was another limitation of this research.

Acknowledgements

The authors would like to thank the Substance abuse prevention research center and clinical Research Development Unit (CRDU) of Emam Khomeini Hospital, Kermanshah university of Medical sciences, Kermanshah, Iran for their support, cooperation and assistance throughout the period of study (Grant number: 94224).

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