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Comparison of Prospective Memory and Cognitive Abilities in Addicts treated by Methadone-Maintenance/without Methadone-Maintenance and Normal People

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Abstract

This research attempts to answer this question "Is there any difference between methadone users, non- methadone addicts and normal people in terms of cognitive abilities and prospective memory? In this research, an ex-post facto study was used to compare the cognitive abilities and prospective memory in methadone addicts, non-methadone addicts and ordinary people. The study population consisted of all rehabilitated addicts (methadone and non-methadone) in Chenaran Prison in 2015, out of whom 56 people (28 methadone and 28 non-methadone addicts) were selected. Also, for the sake of comparison, 20 normal subjects were selected and the cognitive abilities questionnaire and prospective memory questionnaire were given to samples. In the finding there are two parts that used ANOVA for analysis data. In the part one, the results showed that there is no significant comparison between prospective memory in three groups. In the part two, the results showed that memory, inhibitory control, planning, sustained attention, cognitive abilities, social cognition and total score of cognitive abilities in three groups were significantly different ($P < 0.05$). Our research indicates a relative improvement in cognitive abilities. We posit that rehabilitation can elevate the prospective memory of rehabilitated methadone and non- methadone addicts to the level of ordinary people. Also with respect to cognitive abilities, the rehabilitation can improve the cognitive abilities of rehabilitated methadone addicts.

Keywords: Prospective memory, cognitive ability, methadone-maintenance, Addict**.**

Introduction

Substance use disorder in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.) combines substance abuse and substance dependence into a category that covers mild to severe addiction (Hasin et al., 2013). According to the definition of this manual, the basic characteristics of substance use disorder are manifested in form of a series of cognitive, behavioral, and physical symptoms that demonstrate the dependence of an individual on substance abuse despite its serious ensuing problems (America Psychiatric Association, 2013). According to the United States Department of Mental Health and Substance Abuse, nearly 21.6 million Americans (8.2% of the population aged over 12 years) are prone to substance abuse disorders (The Pew Charitable Trusts, John D. and Catherine T. MacArthur Foundation).

With over 1.5 million addicts, Iran has the highest ratio of addicts in the world. This is despite the fact that the growth rate of addiction in Iran is 3 times faster than the population growth (Sarrami, Qorbani, Minooei, 2013; Azam Rajabian, Moshirian Farahi, Asghari Ebrahimabad, 2016).

According to the above points, drug abuse and drug dependence has developed into a public health crisis and today both developed and developing countries are plagued by the consequences of this crisis (Kumar, Nehra, Sunila, and Gupta 2013).

There are medical and non-medical treatments to this disorder, and both have been adopted on a gradual and prompt design. The medical treatments of substance use disorders involve the use of drugs such as methadone Lofexidine, and clonidine (Jandaghi, Neshatdoost, Kalantari, Jabalameli, 2012). Methadone (a synthetic opiate-like substance), which was made in Germany in 1937, was first used as an alternative to morphine as pain killer. This substance was usually administered in the liquid form and patients used it to treat chronic pain. Recently, methadone is used to treat opiate addiction (Wang, Lee, Chiang Fan Ho, Tien, 2014). The psychological, physical, and social functioning of patients are often relatively improved by the treatment, but the use of this drug can impair cognitive abilities (Moghtadaee, Salehi, Afshar, Taslimi, Ebrahimi, 2013).

Cognitive abilities are neural processes involved in the acquisition, processing, storage and application of information. These abilities act as the interface of behavior and brain structure and encompass a wide range of abilities (such as planning, problem solving, simultaneous task completion, attention, response inhibition and cognitive flexibility) (Nejati, 2013; Moshirian Farahi, Azam Rajabian, Asghari Ebrahimabad, 2016). Cognitive ability is a predominantly genetic trait and its inheritance scale is estimated from 40% in early childhood to 80% in late teens. Impairment of cognitive function is ultimately manifested in lower performance on tests of intelligence, and is assumed to be linked to different psychiatric conditions (Ruano, et al., 2010). Recent evidences derived from the analysis of psychiatric growth disorders (e.g. autism spectrum disorders, and schizophrenia) suggest that family of small guanosine triphosphatases (GTPases) and their regulators could be involved in this process (Iwata et al., 2014).

Another variable that seems to be associated with methadone-induced damages is prospective memory. It is a type of memory which involves the ability to encode an intention and its successful recall for desirable implementation (Cohen, Jaudas, Gollwitzer, 2008). In this context, two types of prospective memory could be considered: time-based and event-based. The time-based prospective memory refers to the recalling of doing something at a certain time. The event-based prospective memory involves remembrance of doing something in a particular situation (Volle, Gonen-Yaacovi De Lacy Costello, Gilbert, Burgess, 2011). Despite the importance of this type of memory, there is a paucity of studies on prospective memory (Smith, and Bayen, 2004). The prospective memory is basically related to the forehead, executive functions and perfect function of the hippocampus (memory). Evidences on the role of frontal systems is originated in the studies of Barges, Coils, and Ferris (2001) and Okoda (1998) (in these studies, positron emission tomography has been used), which indicates an increase of brain blood flow in the frontal areas during prospective memory tasks. Moreover, the prospective memory deficits in patients with Parkinson's disease express the need for flawless performance of frontal and temporal areas in relation to the prospective memory (Contardo, Black, Beauvais and, Dieckhaus, Rosen, 2009).

Numerous studies have examined the effect of addictive substances on brain and consequently cognitive abilities and prospective memory. The study of Verdojo, Toribio, Orozco, Puente, Pérez-García (2005), suggests that methadone consumption could be a significant cause of cognitive defects. Dark, Sims, MacDonald and Wickes (2000) in their study on 30 patients receiving methadone and 30 healthy subjects found that the performance of methadone consumers in the areas of attention, problem solving, information processing, verbal short-term and long-term memory and visual short-term memory was lower than those in the control group. The study of Qanbarzadeh, Akbasrzadeh, Akbarzadeh, Ismaelpour (2015) revealed that prospective memory performance in

addicts was significantly different from normal people so that errors related to prospective memory in addicts were greater than those of healthy people.

It should be noted that we found no comparative study on the performance of prospective memory in healthy people and methadone users in the literature review. However, some studies suggest the negative effects of substances such as cannabis (Bartholomew, Holroyd, Heffernan, 2010) and nicotine (Heffernan, Carling, O'Neill, 2014), on prospective memory.

Given the lack of studies on the complications of drugs, especially methadone consumption on cognitive abilities and prospective memory, and the rapid prevalence rate of drug addiction in the world, the necessity of exploring these psychological complications and sharing the findings of such studies is strongly felt. This research attempts to answer this question “Is there any difference between methadone users, non- methadone addicts and normal people in terms of cognitive abilities and prospective memory?

Methods

In this research, an ex-post facto study was used to compare the cognitive abilities and prospective memory in methadone addicts, non-methadone addicts and ordinary people. The study population consisted of all rehabilitated addicts (methadone and non-methadone) in Chenaran Prison in 2015, out of whom 56 people (28 methadone and 28 non-methadone addicts) were selected. Also, for the sake of comparison, 20 normal subjects were selected via convenience sampling. The inclusion criteria were:

- at least 1 year of imprisonment;
- the first and second groups should include methadone users and non- methadone addicts respectively;
- aged between 20 and 50 years
- with a minimum of middle school certificate or a maximum of associated degree

After meeting the inclusion criteria and obtaining informed consent orally, the cognitive abilities questionnaire and prospective memory questionnaire were given to samples.

Cognitive abilities questionnaire: This questionnaire explores a list of cognitive functions of the brain, including memory, types of attention (selective, divided, sustained and transitional), planning, decision-making, social cognition and cognitive flexibility. The 30-item questionnaire is scored on a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). Nejati (2013) examined the psychometric properties of this questionnaire, reporting a Cronbach's Alpha of 0.83 for the questionnaire with all scales being related at the significance level of 0.01.

Prospective Memory Questionnaire: This questionnaire, developed by Hannon et al. (1995), is used for subjective assessment of prospective memory. It consists of 52 items related to different defects of prospective memory and techniques that contribute to prospective memory. The questionnaire included four subscales, out of which three subscales are related to the defects of prospective memory and one is associated with the strategies contributing to this type of memory. Three dimensions of prospective memory measured by this questionnaire are as follows:

- items 1 to 14 assess normal short-term prospective memory;
- items 15 and 28 assess the long-term events-based prospective memory
- items 29 to 38 measures self-initiated environmental prospective memory (internal).

Moreover, items 39 to 52 assess recalling techniques, with higher scores in this subscale indicating greater use of recalling strategies. In this scale, participants rank their prospective memory defect on a five-level grading band (1= Never, 2= slight, 3=average, 4= high, 5= extreme).

The high reliability of the components of this scale has been shown and an internal consistency coefficients of 0.78 to 0.90 and retest coefficients of 0.64 to 0.88 has been reported (Hannon et al., 1995).

Data processing

After collecting questionnaires, the data were given to SPSS19 software and then analyzed based on descriptive and analytical indicators (analysis of variance (ANOVA) and Scheffe test). In one-way analysis of variance, a p-value of 0.05 was considered.

Results

The results of this study can be divided into two parts. The first part covers the prospective memory and the second part is related to cognitive abilities. The data were analyzed by SPSS19 software.

Part I

Table 1. Descriptive indexes of Prospective Memory in Addicts treated by methadone-maintenance/without methadone-maintenance and normal people

Variables	Group	Mean	Standard deviation
Normal short-term prospective memory	methadone-maintenance	34.18	8.86
	without methadone-maintenance	30.46	9.97
	normal people	27.45	10.82
the long-term events-based prospective memory	methadone-maintenance	26.00	9.16
	without methadone-maintenance	25.14	7.77
	normal people	21.90	7.02
Self-initiated environmental prospective memory	methadone-maintenance	22.46	6.82
	without methadone-maintenance	21.07	6.69
	normal people	19.20	9.02
Recalling techniques	methadone-maintenance	35.11	9.48
	without methadone-maintenance	32.54	11.53
	normal people	36.50	11.13
Prospective Memory	methadone-maintenance	117.75	25.35
	without methadone-maintenance	109.21	24.14
	normal people	105.05	31.14

Table 1 shows the descriptive statistics on prospective memory scales between methadone addicts, non-methadone addicts and ordinary people. As Table 1 shows, at the descriptive level, methadone users scored higher in terms of short-term prospective memory. In events-based long-

term prospective memory scale, the mean score of methadone user was higher. Also, methadone user gained higher mean score on self-initiated environmental prospective memory. The normal group, however, scored significantly higher in recalling techniques.

Table 2. ANOVA results of Prospective Memory in Addicts treated by methadone-maintenance/without methadone-maintenance and normal people

Variables	df	Mean square	F	Significant
Normal short-term prospective memory	2	271.430	2.818	0.066
the long-term events-based prospective memory	2	104.465	1.576	0.214
Self-initiated environmental prospective memory	2	62.167	1.130	0.329
Recalling techniques	2	99.152	0.864	0.426
Prospective Memory	2	1033.911	1.465	0.238

Part II

Table 3. Descriptive indexes of Cognitive Abilities in Addicts treated by methadone-maintenance/without methadone-maintenance and normal people

Variables	Group	Mean	Standard deviation
Memory	methadone-maintenance	14.04	3.55
	without methadone-maintenance	11.07	4.89
	normal people	11.10	3.47
Inhibition	methadone-maintenance	17.46	3.24
	without methadone-maintenance	14.50	4.41
	normal people	14.50	4.54
Decision-making	methadone-maintenance	13.29	4.39
	without methadone-maintenance	12.89	3.85
	normal people	10.80	3.63
Planning	methadone-maintenance	8.61	3.31
	without methadone-maintenance	7.07	3.15
	normal people	4.95	1.76
Sustained attention	methadone-maintenance	9.21	2.80
	without methadone-maintenance	7.54	2.93
	normal people	7.40	2.70
Social cognition	methadone-maintenance	10.18	2.59
	without methadone-maintenance	9.18	2.81
	normal people	11.05	1.79
Cognitive flexibility	methadone-maintenance	11.79	2.88
	without methadone-maintenance	10.29	3.55
	normal people	10.15	3.32
Cognitive abilities	methadone-maintenance	84.57	13.46
	without methadone-maintenance	72.53	17.86
	normal people	69.95	15.89

Table 2 shows the results of one-ways analysis of variance to evaluate differences of prospective memory variables in the three groups. According to findings, there was not any significant difference between the three groups in terms of prospective memory. Accordingly, the post hoc test was used to evaluate the difference between two groups.

Table 3 shows the mean and standard deviation for scales of cognitive abilities in three groups of methadone users, non-methadone addicts and ordinary people. As Table 2 shows, at the descriptive level without any significant test, the mean memory, inhibitory control, decision making, planning, sustained attention, and cognitive flexibility in methadone users was greater, but the mean social cognition of ordinary people was higher than the other two groups. In general, descriptive findings indicated higher score of mean cognitive ability in the methadone group. However, the inferential analysis of the significance test was required to test hypotheses. Accordingly, one-way analysis of variance test was used to test hypotheses.

Table 4. ANOVA results of Cognitive Abilities in Addicts treated by methadone-maintenance/without methadone-maintenance and normal people

Variables	df	Mean square	F	Significant
Memory	2	77.077	4.617	0.013*
Inhibition	2	77.695	4.715	0.012*
Decision-making	2	39.697	2.469	0.092
Planning	2	78.020	9.135	0.000*
Sustained attention	2	26.728	3.338	0.041*
Social cognition	2	20.859	3.331	0.041*
Cognitive flexibility	2	21.530	2.023	0.140
Cognitive abilities	2	1559.430	6.216	0.003*

According to the results of one-way analysis of variance, memory, inhibitory control, planning, sustained attention, cognitive abilities, social cognition and total score of cognitive abilities in three groups were significantly different ($P < 0.05$), but no significant difference was observed for other variables in the three groups. To evaluate the difference between two groups of variable, Scheffe test was utilized. In memory dimension, Scheffe test showed a significant difference between methadone users and non- methadone groups, but this difference was not significant in the normal group. This deviation from mean was more notable in memory (mean: 2.96).

With regard to the inhibitory control, Scheffe test showed a significant difference between the methadone users and non- methadone addicts, but it was not significant in the normal group. This difference between methadone users and non-methadone addicts was caused by higher mean of methadone users (mean: 2.96). As for the planning dimension, there was a significant difference between methadone users and normal group, with methadone group scoring higher mean (mean: 3.65).

With regard to the sustained attention, although ANOVA test showed a significant difference among the three groups, there was no inter-group difference based on Scheffe test. In the dimension of social cognition, Scheffe test revealed a significant difference between two groups of non-methadone addicts and ordinary people, with the mean score being higher in the normal group (mean= 1.87). Finally, considering the total score of cognitive ability, the findings demonstrated a significant difference between the two groups of methadone users and ordinary people (mean=

14.62) and methadone user and non-methadone addicts (mean= 12.03), which the highest inter-group mean belonging to methadone users, non-methadone rehabilitated individuals and ordinary people respectively.

Discussion and Conclusion

The aim of the present study was to compare prospective memory and cognitive abilities in rehabilitated methadone and non-methadone addicts and ordinary people. The results of the first section did not reveal any significant difference among the three groups in terms of prospective memory. However, the findings Ghanbari, Akbarzadeh, Akbarzadeh and Esmaeilpour (2015) showed that prospective memory was significantly different in addicts, rehabilitating addicts and ordinary people, though their findings did not show any significant difference in retrospective memory. The results of this study, however, are not consistent with the study of Ghanbari and his colleagues. Other studies on alcoholic dependent individuals demonstrate their deficiency in prospective memory compared to normal people (Griffiths et al., 2012), but the results of the present study are not in line with the previous research. It should be noted that this paper explored addicts in general whereas Griffiths's study focused on people addicted to alcohol.

In the second part of the study, findings suggested that memory, inhibitory control, planning and sustained attention, cognitive abilities, social cognition and total score were significantly different in the three groups. Tronson and Taylor (2012) found that addicts had defective memory. In a meta-analysis on behavioral inhibition in addicts using go/no go and stop-signal techniques, the findings revealed that the majority of studies supported deficits in inhibitory control (Smith, Mattick, Jamadar, Iredale, 2014). With regard to the sustained attention, the study of Goldstein et al. (2007) showed that cocaine addicts were deficient in sustained attention. Also with regard to social cognition, the study of Bora and Zorlu (2016) reported that addicts were impaired in social cognition, especially facial emotion recognition and theory of mind. Overall, Gold (2010) argued that the addict had trouble in cognition and cognitive functions such as learning, memory and reasoning. In general, the findings of this study are not consistent with the results of Tronson and Taylor (2012), Smith et al. (2014), Goldstein et al. (2007) and Gould (2010). The disparity, for example with the study of Smith et al. (2014), is in the application of instruments. This research adopted questionnaires as the main research instrumentation but the meta-analysis of Smith et al. (2014) was based on techniques such as stop-signal and go / no go for investigating addicts. Nevertheless, the results of this study are in agreement with the study of Bora and Zorlu (2016). They found that addicts had impaired social cognition. This study showed that the average social cognition in rehabilitated addicts was lower than normal group, and this indicated a defect in this group of individuals.

Our research indicates a relative improvement in cognitive abilities. However, previous studies have not addressed rehabilitating addicts adequately. The strength of this study lies in its exploration of rehabilitation effect on improving cognitive ability and prospective memory as an ex post facto study. We posit that rehabilitation can elevate the prospective memory of rehabilitated methadone and non- methadone addicts to the level of ordinary people. Also with respect to cognitive abilities, the rehabilitation can improve the cognitive abilities of rehabilitated methadone addicts.

However, the social cognition of this individuals is still impaired and dysfunctional. It is because they are held in prison without access to required teachings to foster their understanding and social processing. It is worth mentioning that this study homogenized the degree of education and age in the three groups under study, but other researches did not apply any homogenization for the level of education, which could be a strong control variable for predicting cognitive abilities.

One of the limitations of this study is the instrumentation. Future studies can take advantage of more accurate techniques such as Stroop, stop-signal and other computer-based cognitive tests. Another limitation of this study is its small sample size. It is recommended that futures studies focus more on the benefits of rehabilitating methadone and non-methadone addicts in improving brain structure using neuroimaging techniques such as QEEG and fMRI.

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References

Association American Psychiatric. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.).* Arlington, VA: American Psychiatric Publishing.

Azam Rajabian, A., Moshirian Farahi, S.M.M., Asghari Ebrahimabad, M.J. (2016). Prediction of short-term prospective memory due to the cognitive flexibility in addicts. 4th National Conference on Mental Health and Well-being, Quchan, Iran.

Bartholomew, J., Holroyd, S., Heffernan, T. M. (2010). Does cannabis use affect prospective memory in young adults? *J Psychopharmacol, 23*(2), 241-246.

Bora, E., Zorlu, N. (2016 in press). Social cognition in alcohol use disorder: A meta-analysis. Addiction, DOI: 10.1111/add.13486

Cohen, A. L., Jaudas, A., Goll witzer, P. M. (2008). Number of cues influences the cost of remembering to remember. *Memory & Cognition, 36*(1), 149-156.

Contardo, C., Black, A. C., Beauvais, J., Dieckhaus, K., Rosen, M. I. (2009). Relationship of Prospective Memory to Neuropsychological Function and Antiretroviral Adherence. *Archives of Clinical Neuropsychology, 24*, 547-554.

Darke, S., Sims, J., McDonald, S., Wickes, W. (2000). Cognitive impairment among methadone maintenance patients. *Addiction, 95*(5), 687-695.

Ghanbari, S., Akbarzadeh, D, Akbarzadeh, H., Esmailpour, K. (2015). Comparison of prospective and retrospective memory in addicted men, have left addicts, and healthy individuals. *Journal of Shahrekord University of Medical Sciences*, 16(6), 54-60.

Goldstein, R. Z., Tomasi, D., Alia-Klein, N., Zhang, L., Telang, F., & Volkow, N. D. (2007). The effect of practice on a sustained attention task in cocaine abusers. *Neuroimage*, 35(1), 194-206. doi: 10.1016/j.neuroimage.2006.12.004

Griffiths, A., Hill, R., Morgan, C., Rendell, P. G., Karimi, K., Wanagaratne, S., & Curran, H. V. (2012). Prospective memory and future event simulation in individuals with alcohol dependence. *Addiction*, 107(10), 1809-1816. doi: 10.1111/j.1360-0443.2012.03941.x

Gould, T. J. (2010). Addiction and cognition. *Addict Sci Clin Pract*, 5(2), 4-14.

Hasin, D,S., O'Brien, C. P., Auriacombe, M., Borges, G., Bucholz, K., Budney, A., Compton, W. M., Crowley, T., Ling, W., Petry, N. M., Schuckit, M., Grant, B. F. (2013). DSM-5 Criteria for Substance Use Disorders: Recommendations and Rationale. *Am J Psychiatry, 170*(8), 834-851.

Hannon, R., Adams, P., Harrington, S., Fries-Dias, C., Gibson, M.T.(1995). Effects of brain injury and age on prospective memory self-rating and performance. *Rehabil Psychol*, 40(4), 289-297.

Heffernan, T., Carling, S. O'Neill, T. (2014). Smoking damages executive function and related prospective memory. *European Psychiatry, 29*.

Iwata,R. Ohi, K., Kobayashi, Y., Masuda,A., Iwama, M., Yasuda, Y., ... & Iwasato, T. (2014). RacGAP a2-Chimaerin Function in Development Adjusts Cognitive Ability in Adulthood. *Cell Reports, 8*, 1257–1264.

Jandaghi, F., Neshat Doost, H, Kalantari, M., Jabal Ameli, L. S. (2013). The Effectiveness of Cognitive-Behavioral Stress Management Group Training on Anxiety and Depression of Addicts under Methadone Maintenance Therapy (MMT). Journal Of Cliniclal Psychology, 4(4), 41-50.

Kumar V, Nehra DK, Kumar P, Sunila, Gupta R. (2013). Prevalence and Pattern of Substance Abuse: A study from de-addiction center. *Delhi Psychiatry Journal, 16*(1), 110-114.

Moghtadaei, K., Salehi, M, Afshar, H., Taslimi, M., Ebrahimi, A. (2013). The comparison of executive functions between heroin dependents, methadone users, and control group. *J Res Behav Sci*, 11(3), 196-207.

Moshirian Farahi, S.M.M., Azam Rajabian, A., Asghari Ebrahimabad, M.J. (2016). Prediction of long-term prospective memory due to the cognitive flexibility in addicts. 4th National Conference on Mental Health and Well-being, Quchan, Iran.

Nejati, V. (2013). Cognitive Abilities Questionnaire: Development and Evaluation of Psychometric Properties. *Advances in Cognitive Science*, 15(2), 11-19.

Ruano, D., Abecasis, G. R., Glaser, B., Lips, E. S., Cornelisse, L. N., de Jong, A. P., ... & Posthuma, D. (2010). Functional gene group analysis reveals a role of synaptic heterotrimeric G proteins in cognitive ability. *The American Journal of Human Genet, 86*(2), 113-125.

Sarrami, H., Ghorbani, M., Minooei, M. (2013). Survey of Four Decades of Addiction Prevalence Researches in Iran. *Journal of Research on Addiction, 7*(26), 52-59.

Smith, R. E., Bayen, U. J. (2004). A Multinomial Model of Event-Based Prospective Memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*(4), 756-777.

Smith, J. L., Mattick, R. P., Jamadar, S. D., & Iredale, J. M. (2014). Deficits in behavioural inhibition in substance abuse and addiction: a meta-analysis. *Drug Alcohol Depend*, 145, 1-33. doi: 10.1016/j.drugalcdep.2014.08.009

The Pew Charitable Trusts, the John D. and Catherine T. MacArthur Foundation. (2015). *Substance Use Disorders and the Role of the States.*

Tronson, N. C., & Taylor, J. R. (2013). Addiction: a drug-induced disorder of memory reconsolidation. *Curr Opin Neurobiol*, 23(4), 573-580. doi: 10.1016/j.conb.2013.01.022

Verdejo, A., Toribio, I., Orozco, C., Puente, K. L., & Pérez-García, M. (2005). Neuropsychological functioning in methadone maintenance patients versus abstinent heroin abusers. *Drug and alcohol dependence, 78*(3), 283-288.

Volle, E., Gonen-Yaacovi, G., de Lacy Costello, A., Gilbert, S. J., Burgess, P. W. (2011). the Role of rostral prefrontal cortex in prospective memory: a voxel-based lesion study. *Neuropsychologia, 49*, 2185–2198.

Wong, C. S., Lee, Y. J., Chiang, Y. C., Fan, L. W., Ho, I.K., Tien, L. T. (2014). Effect of prenatal methadone on reinstated behavioral sensitization induced by methamphetamine in adolescent rats. *Behav Brain Res, 258*, 160-165.