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Comparison of the Effectiveness of Attentional Bias Modification, Approach Bias Modification and their Combination on Cognitive Bias and Relapse in Methamphetamine Abusers

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Abstract

Introduction: Methamphetamine abuse has been growing during the past decade. Recent studies show that computerized training intervention can be useful. The present study compared a variety of cognitive bias modification methods (i.e., attention bias modification, approach bias modification and their combination) on attention bias, approach bias and relapse among methamphetamine abusers.
Method: A total of 108 patients were recruited as the primary sample and the obtained data from 97 patients were analyzed in the final analysis. After being matched according to demographical characteristics, participants were assessed for cognitive bias and relapse to measure the baseline. Afterwards, they were randomly assigned to three different training conditions receiving eight training sessions and a control condition. Finally, all participants underwent a post-assessment similar to the pre-assessment.
Results: Analysis of covariance (ANCOVA) indicated significant reduction both in cognitive bias and relapse in the experimental conditions compared to the control condition. Post-hoc tests suggested no significant differences in relapse in the experimental groups. Furthermore, attention bias decreased in groups after Attention Bias Modification (ABM) and approach bias decreased in the groups which received Approach Avoidance Task (AAT-T).
Conclusion: It can be suggested that different treatments of cognitive bias modification, by reducing cognitive bias and relapse, could be beneficial for methamphetamine abusers.

Keywords: Attentional Bias Modification, Approach Bias Modification, Methamphetamine, Relapse

Introduction

Methamphetamine (MA) is one of the Amphetamine Type Simulants (ATS), which is more frequently abused than the other amphetamine derivatives [1-3] Actually, MA is the second most commonly used drug in the classification of illicit drugs worldwide [4-6]. There has been a lot of research recently on the high prevalence and the extremely high mortality rate of its users [7]. MA dominates the global market for synthetic drugs, especially in East and South-East Asia, parts of North America and Europe [8]. Some studies [9,10-12] have also demonstrated that MA use is associated with physical and psychological problems in Farsi-language communities. Although the prevalence of MA use in the United States has not changed in the last five years, the rate of its related disorders is increasing [1].

On the other hand, most addicts decide to abstain during the period of addiction over and over, but they fail. O'brien and Gardner [13] believe that high rates of relapse following abstinence is a major issue in addiction treatment. It has been explained that one factor

contributing to relapse is cognitive bias towards addiction-related cues [14]. When people frequently use a certain addictive substance, they automatically approach to cues related to that substance [15]. Dual processing model is a theoretical basis of cognitive bias [16, 17] whereby it claims that the automatic processes have an important role in addiction [17, 18]. This model that there is an imbalance between strengthened automatic reaction to substance assumes -relate cues that have acquired a high incentive salience after repeated consumption, while weakened reflective processes and cognitive control are obstructed before they are able to determine the optimal behavioral response [19-21].

The strong attentional bias for drug-related cues is one of the descriptive characteristics of addicted individuals [22, 23]. In fact, when individuals are addicted to a substance, the stimuli associated with that substance acquires a powerful ability to automatically capture attention, which is not evident in the individuals without any history of drug abuse [24, 25] Therefore, the tendency to address the role of neurocognitive factors including the role of attention bias as an indicator of relapse has been increased [26, 27]. In addition, some theoretical models [22, 28-30] posit that attentional bias plays a substantial role in onset, maintenance and relapse of drug use after abstinence. Hence, studies indicate that intensity of attentional bias to drug-related stimuli can predict relapse [31, 32] and treatment outcome in drug abusers [33-36] In addition, the level of attention bias to drug-related pictures has a positive association with the level of drug abuse [22]. Also, regardless of the type of treatment, drug users show less attention bias towards drug-related cues after treatment [37]. Consequently, attention bias can be involved in the relapse process, so it could prevent the relapse and predict better treatment outcomes by affecting attentional bias. The effect of this program has also been shown on other disorders, such as social anxiety [38, 39]. Attention bias modification programs target these automatic processes in addiction treatment [40]. The ABM shows promise as additional intervention for alcohol use disorders [41, 42].

Approach bias can be described as the action tendencies which are activated automatically in order to use the substance because of the motivational value it has [43]. Despite the awareness of the negative consequences of addiction, continued substance use is typical in addictive behaviors [15]. The dual process model justified this discrepancy [17]. Approach Avoidance Task (AAT) is a tool which measures approach bias. Research using AAT have repeatedly shown the approach bias to drug-related cues in nicotine dependency [44, 45], alcohol dependency [46], and cannabis users [15]. Previous studies have also shown that working memory training may improve control of impulsivity and self-regulation in people with methamphetamine use disorders [47]. Therefore, trainings based on the approach bias (i.e., Approach Avoidance Task Training (AAT-T)) could modify automatic tendency to addiction-related stimuli. The AAT-T is considered as a type of approach bias modification. Earlier studies have investigated the effect of these treatment programs on various substance users and demonstrated positive outcomes among hazardous drinkers, alcoholic patients [40, 48, 49], and smokers [44, 50]. Moreover, previous researches [48, 49] have demonstrated that relapse rates decreased more in the AAT group compared to the control group after one-year follow-up.

In the current study, four groups including attention bias modification group, approach bias modification group, their combination group, and a control group were compared on MA abusers. It is assumed that all types of cognitive bias trainings could reduce cognitive bias and relapse compared to the control group. In addition, it is assumed that the approach bias training was more profitable than the attention bias modification, because of its high engagement effect on the patients' use of zoom-in effect on neutral pictures and zoom-out effect on stimulus pictures. In fact, the bidirectional link between the direction of physical movements and evaluation processes has also been employed to modify attitudes [51]. Furthermore, participants who are exposed to Cognitive Bias Modification (CBM) trainings (both ABM and AAT-T) show a better outcome than those exposed to CBM trainings separately. The difference of the present study from earlier studies is that it has focused on individuals with methamphetamine dependence. The first reason could be its accessibility to MA users, as the MA can be simply produced at home laboratories. Secondly, among amphetamines, MA is extremely more addictive and can also cause more mental health problems [52]. For example, it has been associated with higher risks of psychosis [53], depression [54] and violence [55]. In addition, the lack of specific medication therapy for detoxification highlights the greater importance of psychotherapy. Therefore, it is plausible that cognitive training had positive effects on MA abusers' recovery. It was found out that no relevant studies exist on MA abusers. In addition, AAT-T measurement was developed for the first time to be used for Farsi speakers.

Moreover, the combination of CBM training programs on MA abusers has been investigated. The purpose of present study was investigating the effect of a variety of CBM methods on attention bias, approach bias and relapse among methamphetamine abusers.

Method

To carry out this study, 143 Methamphetamine-dependent patients who were admitted to the addiction treatment center of Gonbad-e Qabus, Iran in 2018 were recruited. The inclusion criteria were as follows: MA abusers who had abused MA in the last episode of their addiction, did not use psychiatric drugs, at least a week passed from the beginning of detoxification and stayed at the clinic for at least eight weeks. The exclusion criteria included: psychotic disorders, delusion and hallucination (12 individuals), color-blind (1 individual), visual problem (7 individuals), inability in the right hand (3 individuals), inability to concentrate (5 individuals) and inability to perform cognitive tasks (7 individuals). Individuals with these problems were identified and dismissed based on

demographic characteristics checklist and clinical interview by a clinical psychologist. Because these problems interfere with the implementation of the programs, 35 individuals were excluded from the study. The remaining 108 individuals were matched based on age, gender, marital status, educational level, duration of MA abuse and the result of cognitive tasks. Thereafter, all participants were randomly assigned to one of four conditions. Participants' flow diagram is presented in Figure 1. The current study was conducted during six months and in three episodes. Ninety-seven participants completed post-test after the last training session, so our final sample included 97 participants (24 participants in each group except for the first group (n=25)). The drop in the sample in all groups was due to unpredictable dismissal of the participants from the centers. The tools used in this study were as follows:

Demographic Characteristics Checklist: The authors prepared this demographic questionnaire for this study. Information about participants' age, gender, educational level, marital status, last drug use, duration of drug use, duration of abstinence, history of psychiatric illnesses, history of physical illnesses, colorblindness, history of brain damages, and dyslexia was gathered. Statistical analyses demonstrated no significant differences among baseline characteristics in different groups. An overview of the baseline characteristics is presented in Table 1.

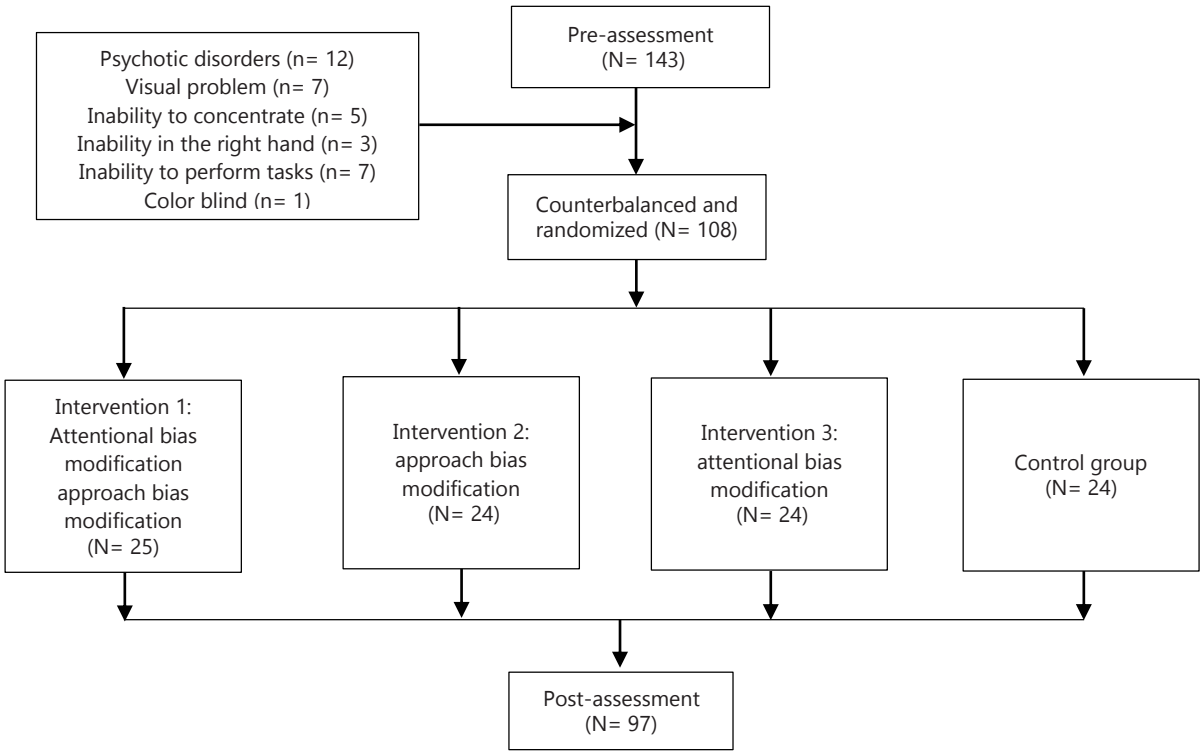

Fig. 1. Participants flow Diagram

Table 1. Overview of Baseline Characteristics

Variable	ABM+AAT (N= 25)	AAT (N= 24)	ABM (N= 24)	Control (N= 24)	
Age (years)	M= 32.88 SD= 7.81	M= 32.08 SD= 8.85	M= 35.08 SD= 8.7	M= 30.71 SD= 8.5	F(3, 97)= 1.12 *p*= .34
Gender ratio (F/M)	8:17	7:17	7:17	8:16	
Level of education (years)	M= 8.52 SD= 4.28	M= 6.9 SD= 4.25	M= 7.5 SD= 4.44	M= 6.9 SD= 4.6	F(3, 97)= .56 *p*= .64
Marital status (S/M)	14:11	12:12	10:13	13:10	
Duration of drug user (years)	M= 4.2 SD= 3.92	M= 4.67 SD= 3.21	M= 4.46 SD= 4.09	M= 3.92 SD= 2.81	F(3, 97)= .2 *p*= .89

Relapse Prediction Scale (RPS): The Relapse Prediction Scale [RPS; 56] is a self-report scale with 50 items and two parts including intensity of urge in a particular condition and probability of use in that condition. Participants were instructed to assume themselves on 50 particular conditions, then grading (0-4) the intensity of urge and probability of use in that condition. Finally, all the scores of the participants were summed up. The result is the score that indicates the amount of relapse. Mehrabi et al. [57] reported the validity of this questionnaire using Cronbach's alpha method for the intensity of urge scale 0.98 and for the probability of use scale 0.97. The internal consistency for this scale in the present study by Cronbach's alpha was 0.98.

In the beginning, after a brief communication and acquaintance, patients completed demographic

characteristics checklist and informed consent forms. After the participants were matched based on age, gender, marital status, educational level, duration of MA abuse and the result of cognitive tasks, they were randomly assigned to one of the three different conditions of the cognitive bias modification training or a control group. Then, participants completed the pre-test including dot-probe task, approach avoidance task and a relapse measurement. The experimental group participants were asked to complete eight training sessions across four weeks (twice a week), while participants in the control group received no training. An earlier research [49] demonstrated no significant difference between no-training and sham-training. Each training session of ABM and AAT-T groups lasted for 15 min with a short break in halfway, but the combination group lasted for 30 min in each session. The experimental groups' participants were tested 5 to 10 days after the final session in the post-test during two sessions. In total, MA abusers practiced for 12 sessions including two pretest sessions, eight intervention sessions, and two posttest sessions. The control group participants completed post-test, five weeks after the pre-test. Two months after the end of the study, the control group received four sessions of cognitive bias training over two weeks.

Dot-probe Task: The dot-probe task on MA abusers was applied by presenting MA-related and neutral picture stimuli. The computer-administered dot-probe task is the most commonly used behavioral measurement to assess attention biases as well as the impact of ABM on attention bias [58]. It's a computerized speeded reaction time task to respond to probes located on the computer screen. These probes are presented in two spots on the computer screen; in half of the trials it places the methamphetamine-related stimuli and in the other half the methamphetamine-unrelated stimuli. In this task, each trial started with a fixation cross for 500ms in the middle of the screen. Afterwards, a neutral picture and a methamphetamine-related picture were presented next to each other at 500ms which then disappeared. A probe was replaced to the position of one of the two pictures randomly. Participants were asked to respond to the location of the probe on the screen as accurately and quickly as possible. The attention bias score was calculated by subtracting the mean of the reaction times of the participant's correct efforts when the arrow appeared instead of neutral pictures from the mean of the reaction times of the participant's correct efforts when the arrow appeared instead of the pictures related to MA. As a result, the negative score indicates a bias towards the stimuli associated with methamphetamine, the positive score points to avoidance from the stimuli associated with methamphetamine. Each session consisted of 160 trials presented randomly to different stimuli locations (i.e., MA-related picture on right or left of the screen) and the probe location. The probe replaced the location of one of the two pictures randomly. Before each task, participants were presented with 10 practice trials. The reliability of this task has been evaluated by cognitive exports. The validity for the dot-probe task in the present study by Cronbach's alpha was 0.84.

Attention Bias Training: The ABM was similar to the dot-probe task, with the exception that the probe always replaced the MA-unrelated pictures. Thus, participants were trained to focus on the neutral pictures and draw it away from MA-related pictures. In all versions of tasks and trainings, the participants were instructed to identify the direction of the probe by pressing right or left keys and to ignore the picture stimuli content. Two versions of dot-probe were verified on pictures. Twenty pairs of pictures (20 neutral and 20 MA-related) were used for ABM. These pictures were different from the assessment but were similar to the treatment tasks. The task started with 10 practice trials with non-addiction-related pictures. Participants responded to 160 trials with a short break halfway [59].

Approach-Avoidance Task (AAT): Approach bias is measured and trained by AAT [46, 60-62]. Tasks were based on prior studies that have used AAT and AAT-T on alcoholic inpatient [e.g., 40] and smokers [50]. It's a computerized speeded reaction time task to respond to rotation of the stimuli. Participants were asked to respond to the rotation of the stimuli by two right and left arrow keys (i.e., pictures rotated to the right vs. pictures rotated to the left) and to ignore the stimulus content. In this task, a fixation cross appeared on the center of the screen for 500ms. Afterwards, a MA-related picture or a neutral picture appeared which tilted 3 degrees to the right or 3 degrees to the left randomly. Pressing the right key increased the pictures size whereas pressing the left key decreased it. In order to calculate the approach avoidance bias score, the mean reaction time of avoiding from the mean reaction time of the approach was subtracted for each category of pictures (pictures related to MA and neutral pictures). The approach reaction time faster than avoidance is shown by a negative score while the avoidance reaction time faster than approach is shown by a positive score. Every session consisted 160 trials with a short break halfway and 10 practice trials in the beginning. The reliability of this task has been evaluated by cognitive exports. The validity for the dot-probe task in the present study by Cronbach's alpha was 0.81.

Approach-Avoidance Task Training (AAT-T): The AAT-T is similar to the AAT, with the exception that the MA-related pictures are presented on a left-away format and neutral pictures are presented on a right-closer format in all the trials. In this way, stimulus pictures get away from participants and neutral pictures get closer after pressing left and right, respectively. A trial of each task is presented in Figure 2.

Attention bias and approach-avoidance task scores were calculated by reaction times. Lower scores in the AAT and dot-probe tasks show cognitive bias for the MA-related stimuli while the higher scores in the AAT and dot-probe show no cognitive bias to MA-related pictures. In addition to the cognitive bias, relapse rate was also measured. The effects of three experimental conditions were compared with the control condition. In addition, the three experimental conditions were compared together.

The data were analyzed by SPSS version 24 software. There were no missing data. ANOVA showed no significant difference in pre-test scores of the variables among different groups. ANCOVA was conducted to test the study hypotheses. Post-test scores served as dependent variable and mean baseline scores or pre-test as covariates [63]. This process was applied to avoid regressions to the mean and to control for baseline differences [64, 65]. For comparing the outcome variables of the experimental conditions both together and with the control condition, the Bonferroni post-hoc tests were conducted if the main effects were significant. Pretest and posttest means for the main variables (i.e., AB, AAT and the relapse) for all the groups with the effect sizes are presented in Table 2.

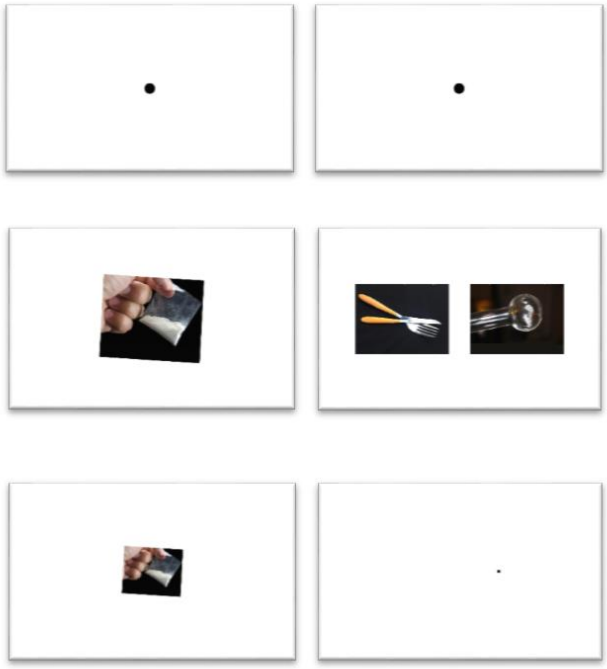

Figure 2. Examples of trials in the attentional bias modification (right) and in the approach bias modification (left).

Table 2. Group comparisons and results of the ANCOVAs for the outcome measures for pre-, post-, and across time-, per- protocol analyses.

Condition/variable	Attentional bias	Approach-Avoidance	Relapse rate
pretest			
combination	-11.36	27.16	112.92
AAT-T	-7.71	18.04	117.67
ABM	-6.08	23.75	112.75
Control	-8.17	26.17	115.13
Per protocol between-group difference pre	F<1, p> .05	F<1, p> .05	F<1, p> .05
posttest			
combination	39.52	80.96	47. 24
AAT-T	11.08	79.88	58.13
ABM	40.46	-3.42	52.92
Control	.88	-8.96	90.75
Per protocol between-group difference pre-post, ANCOVA	F(3, 97) = 4.15, p< .05, η_p^2 = .11	F(3,97) > 4.75, p< .05, η_p^2 = .13	F(3,97) = 5.9, P< .05, η_p^2 = 0.16

Note. df = degree of freedom; AAT-T = Approach-Avoidance Task; ABM = Attentional Bias Modification

Results

At pre-test, groups did not differ in the demographic and cognitive bias variables (p> .05). One-way ANOVAs indicated no significant differences in the attention bias scores for the MA-related picture stimuli (F (3, 97) = .03, p > .05), approach bias scores for MA-related picture stimuli (F (3, 97) = .03, p > .05), and relapse (F (3, 97) = .02, p > .05) at pre-test. The post-test was completed by 97 of the 108 participants present at pre-test.

Analysis of covariance was used to investigate differences between groups. To use covariance analysis, its assumptions were first examined and observed. Analysis of ANCOVA showed significant reduction of attention bias in the experimental groups compared to the control group (F (3, 97) = 4.15, p < .05, η^2_p = .11). The

post-hoc test indicated significant reduction of attention bias in both the combination group (M= 39.52, SD=43.81, p < .05) and the ABM group (M= 40.46, SD= 43.43 p < .05) compared to the control group (M= .88, SD= 52.9), whereas there was no significant difference between the AAT-T (M= 11.08, SD= 53.16) and control groups (p > .05). Also, there was no significant differences between the experimental groups. For the approach bias, the experiment groups showed significantly greater reduction compared to the control group (F (3, 97) = 4.75, p < .05, η^2_p = .13). In addition, the post-hoc test indicated significant reduction in both the combination group (M= 80.96, SD= 111.68, p < .05) and the AAT-T group (M= 79.88, SD=110.77 p < .05) compared to the control group (M= -.88, SD= 119.13), whereas the ABM group (M= -3.42, SD= 110.11) showed no significant differences with the control group (p > .05). Also, there were no significant differences between the experimental groups. Relapse showed significant differences between the combination group (M= 47.24, SD= 40.2), AAT-T group (M= 58.13, SD= 40.31) and ABM group (M= 52.92, SD= 40.19) with control group (F (3, 97) = 5.9, p < .05, η^2_p = .16). However the experimental groups did not demonstrate significant improvements compared to each other.

Discussion

The present study compared cognitive bias in three groups of attention bias and approach bias and the relapse rate in three versions of cognitive bias modifications (i.e., attention bias modification, approach bias modification and their combination) and a control group. The main findings can be summarized as follows: 1) Attention bias in the ABM group and combination training group significantly reduced compared to the AAT-T and control groups, but the AAT-T group was not significantly different from the control group. 2) Approach bias in the AAT-T group and combination training group significantly reduced compared to the control group, but the ABM group was not significantly different from the other groups. 3) The reduction in the relapse rate in all of the experimental conditions was significantly different from the control group, but the experimental conditions had no significant difference with each other.

The main finding of the present study was that the CBM treatment may be an effective intervention for methamphetamine abusers. Previous research have investigated the effectiveness of CBM treatment on alcoholic abusers [36, 66-68], smoker [69, 70], and marijuana users [71]. The present study, in addition to replicating the effects of CBM treatment both on cognitive bias (i.e., attention bias and approach bias towards MA-related stimuli) and outcome treatment (e.g. relapse rate), indicated that these interventions were useful for MA-abusers. The short term effects of CBM treatment were observed as well.

Comparing the two types of reaction times, a negative score was used to show faster approach-reaction time and a positive score was used to show avoidance-reaction time. It is indicated that patients learned to shift attention and approach from MA-related cues to neutral cues. A reason could be the prevalence of cognitive deficits among MA abusers [72]. In fact, MA affects dopamine release [73] which plays a considerable role in cognitive functions. Hence, MA abusers have significant cognitive deficits that are strong predictors of poor clinical outcomes and relapse. These attentional bias deficits could be related to total reaction time which increased due to inhibition and weakening of executive function [74]. It means that these treatment programs could have beneficial outcomes by modifying cognitive bias and executive function recovery since the participants had to perform the correct movement.

In the current study, the effects of a combination of different CBM trainings was investigated. Findings of the present study indicated no significant difference between the variants of CBM training and their combination on cognitive bias and relapse rate. Formerly, separate effects of different versions of CBM have been investigated in various samples of drug abusers except for methamphetamine users [50]. In fact, one of main hypotheses was not confirmed. We hypothesized that the combination training group would have stronger reductive effects on the cognitive bias and relapse rate than the groups with only one of the CBM trainings. We also hypothesized that the AAT-T group would have more benefits than ABM group. However, results showed no significant difference among different training conditions. One plausible explanation can be that we used keyboard instead of joystick in AAT. Furthermore, in the present study, cognitive bias has been relatively stable among the participants of the control group, while in the other studies [31, 37], it has been claimed that the cognitive bias reduced after any type of treatment.

The strength of this study is related to its region aspect. The CBM training has been frequently carried out in different countries, but it was the first time that AAT-T was used in Farsi speaking participants. In addition, although the effectiveness of ABM training was only demonstrated in substance abusers [75] and smokers [76], it was extended to MA users.

Methamphetamine abusers aim to use drugs, so they are easily stimulated by drug stimuli; while participants were asked to ignore the stimulus content and to respond to the rotation of the stimuli (AAT-T) or the location of probe on the screen (dot-probe). This shifts the participants' goals to their motivation levels. As a result, the person's motivational system was activated by rotation of the stimuli and the location of probe.

The present study had a number of limitations. Most MA abusers had multiple consumptions that made it difficult to find a sample. Access to a female sample was also difficult. The present study lasted for two months for each participant, so we did not perform follow-up tests and faced sample drop. There was a limitation about the time duration of the combination group. We had to choose one option for time challenge: between complete treatment, but doubled time (15 min for each treatment) or incomplete implementation, but like other groups' time (7.5 min for each treatment). As the first option was selected, time duration of combination group was double

compared with other groups. As this was the first study comparing different conditions of CBM as a treatment tool among methamphetamine dependents, results need to be replicated. It is suggested to replicate this study by using joystick and among other drug abusers. Also, future studies can execute this protocol with sham-training groups.

Conclusion

In conclusion, our preliminary findings demonstrate that AAT-T and ABM might be valuable instruments in the treatment of methamphetamine dependents. Considering the novelty, easy accessibility and economical efficiently of time and professional resources, the present study is recommended as a supplementary treatment program.

Conflict of Interest

Authors declare no conflicts of interest. Participants entered the study with satisfaction and they were informed about the purpose of the research.

Ethical Approval

All ethical principles were considered in this study.

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References

1. Courtney KE, Ray LA. Methamphetamine: an update on epidemiology, pharmacology, clinical phenomenology, and treatment literature. Drug and alcohol dependence. 2014;143:11-21.
2. Palamar J. How ephedrine escaped regulation in the United States: a historical review of misuse and associated policy. Health Policy. 2011;99(1):1-9.
3. Rasmussen N. Chapter two-amphetamine-type stimulants: the early history of their medical and non-medical uses. International review of neurobiology. 2015;120:9-25.
4. United Nations Office on Drugs and Crime (UNODC) O. United Nations Office on Drugs and Crime. Crime and criminal justice statistics. 2012.
5. Morley KC, Cornish JL, Faingold A, Wood K, Haber PS. Pharmacotherapeutic agents in the treatment of methamphetamine dependence. Expert opinion on investigational drugs. 2017;26(5):563-78.
6. Merz F. United Nations Office on Drugs and Crime: World Drug Report 2017. 2017. SIRIUS–Zeitschrift für Strategische Analysen. 2018;2(1):85-6.
7. Passaro A, Soavi C, Marusic U, Rejc E, Sanz JM, Morieri ML, et al. Computerized cognitive training and brain derived neurotrophic factor during bed rest: mechanisms to protect individual during acute stress. Aging (Albany NY). 2017;9(2):393.
8. UNODC O. United Nations Office on Drugs and Crime. Crime and criminal justice statistics. 2015.
9. Ahmadi-Jouibari T, Fattahi N, Shamsipur M. Rapid extraction and determination of amphetamines in human urine samples using dispersive liquid–liquid microextraction and solidification of floating organic drop followed by high performance liquid chromatography. Journal of pharmaceutical and biomedical analysis. 2014;94:145-51.
10. Alaee A, Zarghami M, Farnia S, Khademloo M, Khoddad T. Comparison of brain white matter hyperintensities in methamphetamine and methadone dependent patients and healthy controls. Iranian Journal of Radiology. 2014;11(2).
11. Mohajerin B, Dolatshahi B, Shahbaz AP, Farhoudian A. Differences between expressive suppression and cognitive reappraisal in opioids and stimulant dependent patients. International journal of high risk behaviors & addiction. 2013;2(1):8.
12. Solhi H, Malekirad A, Mohammad Kazemifar A, Sharifi F. Oxidative stress and lipid peroxidation in prolonged users of methamphetamine. Drug metabolism letters. 2013;7(2):79-82.
13. O'brien CP, Gardner EL. Critical assessment of how to study addiction and its treatment: human and non-human animal models. Pharmacology & therapeutics. 2005;108(1):18-58.
14. Dias NR, Schmitz JM, Rathnayaka N, Red SD, Sereno AB, Moeller FG, et al. Anti-saccade error rates as a measure of attentional bias in cocaine dependent subjects. Behavioural brain research. 2015;292:493-9.
15. Cousijn J, Goudriaan AE, Wiers RW. Reaching out towards cannabis: approach- bias in heavy cannabis users predicts changes in cannabis use. Addiction. 2011;106(9):1667-74.
16. Cisler JM, Koster EH. Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. Clinical psychology review. 2010;30(2):203-16.
17. Stacy AW, Wiers RW. Implicit cognition and addiction: a tool for explaining paradoxical behavior. Annual review of clinical psychology. 2010;6:551-75.
18. Bechara A. Decision making, impulse control and loss of willpower to resist drugs: a neurocognitive perspective. Nature neuroscience. 2005;8(11):1458-63.
19. Gladwin TE, Figner B, Crone EA, Wiers RW. Addiction, adolescence, and the integration of control and motivation. Developmental cognitive neuroscience. 2011;1(4):364-76.
20. Robinson TE, Berridge KC. The incentive sensitization theory of addiction: some current issues. Philosophical Transactions of the Royal Society B: Biological Sciences. 2008;363(1507):3137-46.
21. Wiers RW, Gladwin TE, Hofmann W, Salemink E, Ridderinkhof KR. Cognitive bias modification and cognitive control training in addiction and related psychopathology: Mechanisms, clinical perspectives, and ways forward. Clinical Psychological Science. 2013;1(2):192-212.
22. Field M, Cox WM. Attentional bias in addictive behaviors: a review of its development, causes, and consequences. Drug and alcohol dependence. 2008;97(1-2):1-20.
23. Rooke SE, Hine DW, Thorsteinsson EB. Implicit cognition and substance use: A meta-analysis. Addictive behaviors. 2008;33(10):1314-28.
24. Hogarth L, Dickinson A, Duka T. Explicit knowledge of stimulus–outcome contingencies and stimulus control of selective attention and instrumental action in human smoking behaviour. Psychopharmacology. 2005;177(4):428-37.
25. Nikolaou K, Field M, Critchley H, Duka T. Acute alcohol effects on attentional bias are mediated by subcortical areas associated with arousal and salience attribution. Neuropsychopharmacology. 2013;38(7):1365-73.
26. Kavanagh DJ, Andrade J, May J. Beating the urge: Implications of research into substance-related desires. Addictive Behaviors. 2004;29(7):1359-72.
27. Kosten TR, Scanley BE, Tucker KA, Oliveto A, Prince C, Sinha R, et al. Cue-induced brain activity changes and relapse in cocaine-dependent patients. Neuropsychopharmacology. 2006;31(3):644-50.
28. Cox WM, Fadardi JS, Pothos EM. The addiction-stroop test: Theoretical considerations and procedural recommendations. Psychological bulletin. 2006;132(3):443-76.
29. Franken IH. Drug craving and addiction: integrating psychological and neuropsychopharmacological approaches. Progress in Neuro-Psychopharmacology and Biological Psychiatry. 2003;27(4):563-79.
30. Wiers RW, Field M, Stacy AW. Passion's slave?: Conscious and unconscious cognitive processes in alcohol and drug abuse. The Oxford handbook of substance use and substance use disorders. 2016;1:311-50.
31. Marissen MA, Franken IH, Waters AJ, Blanken P, Van Den Brink W, Hendriks VM. Attentional bias predicts heroin relapse following treatment. Addiction. 2006;101(9):1306-12.
32. Powell J, Dawkins L, West R, Powell J, Pickering A. Relapse to smoking during unaided cessation: clinical, cognitive and motivational predictors. Psychopharmacology. 2010;212(4):537-49.
33. Conklin CA, Parzynski CS, Salkeld RP, Perkins KA, Fonte CA. Cue reactivity as a predictor of successful abstinence initiation among adult smokers. Experimental and clinical psychopharmacology. 2012;20(6):473.

34. Janes AC, Pizzagalli DA, Richardt S, Frederick BdB, Holmes AJ, Sousa J, et al. Neural Substrates of Attentional Bias for Smoking-Related Cues: An fMRI Study. Neuropsychopharmacology. 2010;35:2339.
35. Marhe R, Luijten M, van de Wetering BJM, Smits M, Franken IHA. Individual Differences in Anterior Cingulate Activation Associated with Attentional Bias Predict Cocaine Use After Treatment. Neuropsychopharmacology. 2013;38:1085.
36. Schoenmakers TM, de Bruin M, Lux IF, Goertz AG, Van Kerkhof DH, Wiers RW. Clinical effectiveness of attentional bias modification training in abstinent alcoholic patients. Drug and alcohol dependence. 2010;109(1):30-6.
37. Gardini S, Caffarra P, Venneri A. Decreased drug-cue-induced attentional bias in individuals with treated and untreated drug dependence. Acta Neuropsychiatrica. 2009;21(4):179-85.
38. Shafiee H. Development and validation of the computer-based word dot-probe task for investigation of the effect of attentional bias on social anxiety. International Journal of Behavioral Sciences. 2014;8(2):149-54.
39. Ebrahimi Kheir Abadi A. Effectiveness of cognitive-behavioral therapy in attentional bias components of patients with generalized anxiety disorder: A single subject study. International Journal of Behavioral Sciences. 2015;9(2):121-8.
40. Wiers RW, Houben K, Fadardi JS, Van Beek P, Rhemtulla M, Cox WM. Alcohol cognitive bias modification training for problem drinkers over the web. Addictive behaviors. 2015;40:21-6.
41. Rinck M, Wiers RW, Becker ES, Lindenmeyer J. Relapse prevention in abstinent alcoholics by cognitive bias modification: Clinical effects of combining approach bias modification and attention bias modification. Journal of Consulting and Clinical Psychology. 2018;86(12):1005.
42. Wiers RW, Zerhouni O, den Uyl T, Boffo M. Cognitive bias modification in the treatment of addiction. Cognition and Addiction: Elsevier; 2020. p. 231-41.
43. Field M, Caren R, Fernie G, De Houwer J. Alcohol approach tendencies in heavy drinkers: Comparison of effects in a relevant stimulus-response compatibility task and an approach/avoidance Simon task. Psychology of addictive behaviors. 2011;25(4):697-701.
44. Machulska A, Zlomuzica A, Adolph D, Rinck M, Margraf J. "A cigarette a day keeps the goodies away": smokers show automatic approach tendencies for smoking—but not for food-related stimuli. PLoS One. 2015;10(2):1-15.
45. Wiers CE, Kühn S, Javadi AH, Korucuoglu O, Wiers RW, Walter H, et al. Automatic approach bias towards smoking cues is present in smokers but not in ex-smokers. Psychopharmacology. 2013;229(1):187-97.
46. Wiers R, Rinck M, Dictus M, Van den Wildenberg E. Relatively strong automatic appetitive action- tendencies in male carriers of the OPRM1 G- allele. Genes, Brain and Behavior. 2009;8(1):101-6.
47. Brooks SJ, Wiemerslage L, Burch K, Maiorana S, Cocolas E, Schiöth HB, et al. The impact of cognitive training in substance use disorder: the effect of working memory training on impulse control in methamphetamine users. Psychopharmacology. 2017;234(12):1911-21.
48. Eberl C, Wiers RW, Pawelczack S, Rinck M, Becker ES, Lindenmeyer J. Approach bias modification in alcohol dependence: do clinical effects replicate and for whom does it work best? Developmental cognitive neuroscience. 2013;4(14):38-51.
49. Wiers RW, Eberl C, Rinck M, Becker ES, Lindenmeyer J. Retraining automatic action tendencies changes alcoholic patients' approach bias for alcohol and improves treatment outcome. Psychological science. 2011;22(4):490-7.
50. Machulska A, Zlomuzica A, Rinck M, Assion H-J, Margraf J. Approach bias modification in inpatient psychiatric smokers. Journal of psychiatric research. 2016;76:44-51.
51. Wittekind CE, Feist A, Schneider BC, Moritz S, Fritzsche A. The approach-avoidance task as an online intervention in cigarette smoking: a pilot study. Journal of behavior therapy and experimental psychiatry. 2015;46:115-20.
52. Topp L, Degenhardt L, Kaye S, Darke S. The emergence of potent forms of methamphetamine in Sydney, Australia: A case study of the IDRS as a strategic early warning system. Drug and Alcohol Review. 2002;21(4):341-8.
53. McKetin R, Kelly E, McLaren J. The relationship between crystalline methamphetamine use and methamphetamine dependence. Drug and alcohol dependence. 2006;85(3):198-204.
54. Semple SJ, Patterson TL, Rant I. Methamphetamine use and depressive symptoms among heterosexual men and women. Journal of Substance Use. 2005;10(1):31-47.
55. Sommers I, Baskin D, Baskin-Sommers A. Methamphetamine use among young adults: health and social consequences. Addictive behaviors. 2006;31(8):1469-76.
56. Wright FD, Beck AT, Newman CF, Liese BS. Cognitive therapy of substance abuse: theoretical rationale. NIDA research monograph. 1993;137:123-.
57. Rahbarian M, Doosti P. Effect of training the communication skills with cognitive-behavioral model to drug dependent couples on communication patterns and recurrent relapse. Journal of Inflammatory Disease. 2016;20(5):51-43.
58. Clerkin EM, Magee JC, Wells TT, Beard C, Barnett NP. Randomized controlled trial of attention bias modification in a racially diverse, socially anxious, alcohol dependent sample. Behaviour research and therapy. 2016;87:58-69.
59. khodadadi M NM, Amani H, . DOT PROBE TASK &COGNITIVE BIAS modification software institute for behavioral &cognitive sxience. 2015.
60. Rinck M, Becker ES. Approach and avoidance in fear of spiders. Journal of behavior therapy and experimental psychiatry. 2007;38(2):105-20.
61. van Deursen DS, Salemink E, Smit F, Kramer J, Wiers RW. Web-based cognitive bias modification for problem drinkers: protocol of a randomised controlled trial with a 2x2x2 factorial design. BMC Public Health. 2013;13(1):674.
62. Wiers RW, Rinck M, Kordts R, Houben K, Strack F. Retraining automatic action- tendencies to approach alcohol in hazardous drinkers. Addiction. 2010;105(2):279-87.
63. Field A. Discovering statistics using SPSS: Sage publications; 2009.
64. Borm GF, Fransen J, Lemmens WA. A simple sample size formula for analysis of covariance in randomized clinical trials. Journal of clinical epidemiology. 2007;60(12):1234-8.
65. Vickers AJ, Altman DG. Analysing controlled trials with baseline and follow up measurements. Bmj. 2001;323(7321):1123-4.
66. Fadardi JS, Cox WM. Reversing the sequence: reducing alcohol consumption by overcoming alcohol attentional bias. Drug and alcohol dependence. 2009;101(3):137-45.
67. Schoenmakers T, Wiers RW, Jones BT, Bruce G, Jansen A. Attentional re- training decreases attentional bias in heavy drinkers without generalization. Addiction. 2007;102(3):399-405.
68. Heitmann J, Bennik EC, van Hemel-Ruiter ME, de Jong PJ. The effectiveness of attentional bias modification for substance use disorder symptoms in adults: a systematic review. Systematic reviews. 2018;7(1):160.
69. Attwood AS, O'sullivan H, Leonards U, Mackintosh B, Munafò MR. Attentional bias training and cue reactivity in cigarette smokers. Addiction. 2008;103(11):1875-82.
70. Field M, Duka T, Tyler E, Schoenmakers T. Attentional bias modification in tobacco smokers. Nicotine & Tobacco Research. 2009;11(7):812-22.
71. Metrik J, Aston ER, Kahler CW, Rohsenow DJ, McGeary JE, Knopik VS, et al. Cue-elicited increases in incentive salience for marijuana: craving, demand, and attentional bias. Drug and alcohol dependence. 2016;167:82-8.
72. Nordahl TE, Salo R, Leamon M. Neuropsychological effects of chronic methamphetamine use on neurotransmitters and cognition: a review. The Journal of neuropsychiatry and clinical neurosciences. 2003;15(3):317-25.
73. Dalley JW, Everitt BJ, Robbins TW. Impulsivity, compulsivity, and top-down cognitive control. Neuron. 2011;69(4):680-94.
74. Giancola PR, Moss HB. Executive cognitive functioning in alcohol use disorders. Recent developments in alcoholism. 14: Springer; 1998. p. 227-51.
75. Fadardi JS, Barerfan Z. The effect of drugs-atenttion control training program on drug-related attentional bias and improving other indices of recovery. Studies in education & psychology 2011;11(2):29-56.
76. Nowrouzi A, Taghavi MR. Smokers' Attentional Bias Modification: Effect of Operant Conditioning. International Journal of Drug Policy. 2014;24(6):624-7.