

Experimental study on attentional processing towards emotional faces among drug addicts

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Abstract

Objective: To explore the attention bias towards facial emotional faces among drug addicts. **Methods:** The Beck Anxiety Inventory (BAI) and Beck Depression Inventory (BDI) were used to measure the emotional status of both abstinent drug addicts and healthy control group about anxiety and depression. And then we used sad, happy and angry faces as stimuli and all participants completed the classical dot-probe task. **Results:** It was found that there were no significant differences in scores of both depression and anxiety scale between drug addicts and healthy control group. The reaction time of drug addicts was significantly shorter than that of healthy control group. **Conclusion:** There were no differences in both anxiety and depression between drug addicts and healthy control group. And drug addicts were more sensitive to facial emotional information than healthy control group.

Key words: drug addicts; attentional bias; dot-probe; emotional faces

Introduction

Addictive behavior and emotional processing are mutually influential. According

to the negative reinforcement emotional processing model, the primary motivation for drug addiction is an individual's escape and avoidance of negative emotions. Negative emotions are the core motivational mechanism of withdrawal syndrome, and addicts learn to detect pre-conscious emotional cues through repeated cycles of drug use and withdrawal (Baker et al., 2004).

On one hand, negative emotions, particularly trait-related negative emotional states, increase the risk of substance abuse. Negative emotions are common triggers for drug craving and post-withdrawal relapse. On the other hand, drug-using behaviors may lead to more severe negative emotional experiences and an inability to effectively regulate and control these emotions (Baker et al., 2004).

Moreover, emotional cognitive processing in drug addicts may be impaired. Wang Chunguang et al. (2017) noted that methamphetamine addicts exhibit diminished emotional awareness and discrimination capabilities (Wang et al., 2017). Additionally, drug addicts tend to exaggerate negative stimuli, developing a negative bias during emotional processing (Yang et al., 2015). Arcos et al. (2008) discovered that current and withdrawn heroin users, compared to healthy participants, showed stronger emotional responses to neutral images and weaker responses to pleasant images (Arcos et al., 2008).

However, not all research findings are consistent. In an emotion matching task, methamphetamine addicts withdrawing for 5-16 days showed no significant differences from healthy participants in accuracy or reaction time when identifying fearful and angry facial expressions, with no inter-group differences in amygdala

activation (Payer et al., 2008). Similarly, in an emotional Stroop task, methamphetamine addicts displayed no significant differences in reaction times when naming colors of emotional and neutral words (Wang et al., 2015). This seemingly suggests that drug addicts' responses to emotional stimuli are indistinguishable from neutral stimuli, with no specific emotional cognitive processing bias.

However, these studies did not differentiate emotional valence or directly compare positive and negative emotional stimuli. The present study aims to investigate emotional cognitive processing in drug addicts by examining their attentional processing of happy, sad, and angry facial expressions. We first used the Beck Anxiety Inventory (BAI) and Beck Depression Inventory (BDI) to measure recent emotional states of drug addicts during withdrawal, then employed a dot-probe task to explore their attentional processing characteristics for angry, sad, and happy emotional faces.

Subjects and Methods

Research Subjects

Using convenience sampling, 39 drug addicts in withdrawal (22 males, 17 females) were randomly recruited from a compulsory isolation rehabilitation center, with withdrawal periods ranging from 6 to 18 months. A control group of 39 participants (20 males, 19 females) was selected from a community. Drug Addict Group: Age range: 20-40 years ($M=37.44$, $SD=7.86$) Primary drugs: Heroin (32 cases), Methamphetamine (8 cases) Control Group: Age range: 20-55 years ($M=34.87$, $SD=9.44$) No significant age difference between groups ($t=1.30$, $df=76$, $p=0.196$). All

participants provided informed consent.

Research Tools

Measurement Instruments

Beck Depression Inventory (BDI)

The Beck Depression Inventory (BDI) is a self-report scale consisting of 21 items, primarily designed to assess the severity of depressive symptoms over the past week. Each item is scored on a 4-point scale, ranging from 0 (not present) to 3 (severe), with total scores ranging from 0 to 63. Higher scores indicate greater depression intensity. In this study, the Cronbach's α coefficient for the scale was 0.86.

Beck Anxiety Inventory (BAI)

The Beck Anxiety Inventory (BAI) is a 21-item self-report anxiety scale that provides a relatively accurate reflection of subjective anxiety experiences over the past week. The BAI evaluates the severity of various anxiety symptoms using a 4-point rating system: 1 indicates no distress; 2 represents mild distress with minimal interference; 3 indicates moderate distress that is uncomfortable but tolerable; 4 represents severe distress that is barely manageable. Total scores range from 21 to 84, with higher scores indicating greater anxiety intensity. Scores below 37 are considered indicative of no significant anxiety. In this study, the Cronbach's α coefficient for the scale was 0.89.

Stimulus Materials

Stimuli were selected from the Chinese Affective Picture System (CAPS), comprising 24 happy, 24 angry, and 24 sad facial expressions, with an equal number

of male and female faces. An additional 72 neutral facial expressions were selected (36 male, 36 female). All images were preprocessed using Photoshop to standardize their size to 185×200 pixels, with ears, hair, and neck regions removed.

Experimental Procedure

Upon entering the laboratory, participants were seated in front of a computer. The experimenter provided detailed instructions and informed participants of their right to withdraw at any stage of the experiment. Participants were positioned approximately 60 cm from the screen, with eye level aligned with the screen's center. Experimental materials were presented using E-prime software on a black background.

Participants received the following instructions: "Welcome to the experiment! This is a study on spatial positioning and attention. A '+' will first appear in the screen center; please focus on it. Subsequently, a face will appear on the left and right sides. Following this, a dot '●' will appear in either the left or right face's position. Your task is to determine the dot's location: press the A key if it appears on the left, and the L key if it appears on the right. If you understand, press the spacebar to begin."

Following the experiment, both the experimenter and participant signed a confirmation document, and each participant received 20 yuan as compensation.

In the formal experiment, each trial began with a white '+' fixation point presented centrally on a black screen for 500 ms. Emotional and neutral stimulus pairs were then presented for 1000 ms, after which the images disappeared, and a probe (●) appeared in one of the previous image locations (5s). Participants were instructed to

quickly and accurately determine the probe's location, pressing A for left-side and L for right-side probes. A 500 ms blank screen followed each participant's response before the next trial commenced.

Prior to the formal experiment, participants completed a practice session using neutral images unrelated to the formal experimental materials. The formal experiment consisted of 3 blocks, with 48 trials per block. Each block included 8 pairs of sad-neutral (S-N), angry-neutral (A-N), and happy-neutral (P-N) images (4 male, 4 female face pairs). The lateral positioning of emotional images and the consistency between emotional images and probe locations were carefully balanced.

Statistical Analysis

A 2 (Group: Drug Addicts vs. Control) × 2 (Target-Probe Consistency: Consistent vs. Inconsistent) × 3 (Emotional Face Type: Sad, Angry, Happy) repeated measures ANOVA was conducted, with reaction time and accuracy as dependent variables.

Results

Depression and Anxiety Symptoms

Descriptive statistical results for participants' Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI) scores are presented in Table 1. Independent samples t-tests revealed no significant differences between the experimental and control groups in depression and anxiety scale scores ($t=0.99$, $df=76$, $p=0.32$; $t=0.04$, $df=76$, $p=0.97$).

Table 1 Descriptive Statistics and Intergroup Comparisons of Depression and

Anxiety Scales (N=78)

Measure	Drug Addicts (M±SD)	Control Group (M±SD)	t	df	p
BDI	10.78±7.67	10.89±9.92	0.99	76	0.32
BAI	27.54±8.31	26.03±4.60	0.04	76	0.97

Visual Attentional Bias

Across all experimental conditions, participants' accuracy rates were consistently above 98%.

A 2 (Group: Drug Addicts vs. Control) × 2 (Target-Probe Consistency: Consistent vs. Inconsistent) × 3 (Emotional Face Type: Sad, Angry, Happy) repeated measures ANOVA was conducted using reaction time as the dependent variable (see Table 2).

Results demonstrated a significant main effect of group ($F(1, 76)=23.98, p<0.001, \eta^2=0.24$), indicating that drug addicts' reaction times were significantly shorter than those of the control group. No other main effects or interaction effects reached statistical significance (all $F<1$, all $p>0.05$, all $\eta^2<0.05$).

Table 2 Reaction Times (ms) for Probe Responses in Drug Addicts and Control

Variable	Groups				
	Emotional Face	Drug Addicts (N=39)	Control Group (N=39)		
		M	SD	M	SD

Target-Probe	Sad	560.83	156.59	810.57	290.86
Consistency					
Consistent	Angry	551.94	142.75	807.50	281.13
	Happy	551.58	138.32	819.45	299.75
Inconsistent	Sad	557.09	154.89	809.81	299.62
	Angry	556.99	164.32	806.51	292.69
	Happy	560.25	147.74	816.65	297.47

The translation maintains the academic tone and statistical precision of the original text, presenting the results in a clear, structured manner consistent with scientific reporting standards.

Discussion

Current research has predominantly focused on emotional cognitive processing in drug addicts, with relatively fewer studies exploring their emotional attentional processing. This study utilized the Beck Anxiety and Depression Inventories to assess participants' emotional states over the past week and employed the dot-probe paradigm to investigate the attentional characteristics of emotional face processing in drug addicts.

Firstly, the study found no significant differences in Beck Anxiety and Depression Inventory scores between drug addicts and the control group. This finding aligns with these results (Zhou et al., 2014), which showed no differences in depression, state anxiety, and trait anxiety levels between the control group and

mid-term withdrawal group (6 months). The drug addicts in this study were all physically rehabilitated and in good health, with withdrawal periods exceeding 6 months. Compared to early and long-term stages of addiction, these participants exhibited more stable emotional states, without anxiety or depression arising from adapting to rehabilitation environments or anticipating new social contexts. Zhou Pingyan et al.'s research further corroborated this explanation by finding that long-term (18 months) and short-term (4 months) withdrawal groups showed higher depression levels compared to mid-term and control groups, with similar patterns observed in state anxiety (Zhou et al., 2014).

Moreover, this could be related to improvements in positive emotion processing capabilities among drug addicts. Martin et al. (2006) discovered that heroin addicts with an average withdrawal period of 6 months showed significantly shorter reaction times in identifying surprised, pleasant, and fearful facial expressions compared to currently active drug users, with no significant differences between the withdrawal and control groups (Martin et al., 2006). This suggests that emotional processing abilities may recover as withdrawal duration increases.

Secondly, the study found that drug addicts' reaction times were significantly shorter than those of the control group. In the experiment, pleasant, sad, and angry faces were paired with neutral faces. Regardless of whether the probe appeared after emotional (consistent) or neutral (inconsistent) faces, drug addicts could rapidly disengage attention from emotional and neutral faces and shift focus to the probe location, quickly responding. Consequently, drug addicts showed no differences in

reaction times under consistent and inconsistent conditions. Furthermore, they appeared more capable of disengaging attention from both emotional and neutral stimuli compared to the control group. This seemingly indicates that, for drug addicts, both emotional and neutral stimuli carry less significance, resulting in reduced allocation of attentional resources for deeper processing.

Previous research has suggested that drug addicts may experience emotional cognitive impairments post-withdrawal (Jiang et al., 2007). However, this study found no differences in attentional processing of positive and negative facial expressions among withdrawal-stage drug addicts, contrasting with earlier findings. Some studies have reported attentional bias towards negative emotions in drug addicts (Yang et al., 2015). For instance, mid-term heroin addicts (6 months) showed significantly larger P300 and SPW components for positive and negative stimuli compared to neutral stimuli, with negative stimuli eliciting larger amplitudes (Zhou et al., 2014).

Research has also indicated impaired processing of positive emotions among drug addicts. Some studies found no P300 amplitude differences across neutral, pleasant, and unpleasant emotional conditions for drug addicts, while control groups showed smaller amplitudes for pleasant stimuli (Marques-Teixeira & Barbosa, 2005). Compared to healthy participants, both current and withdrawn heroin users exhibited stronger emotional responses to neutral images and weaker responses to pleasant images (Arcos et al., 2008). Heroin withdrawal patients demonstrated faster search positioning for negative emotional stimuli, with this attentional bias potentially contributing to relapse (Zhou et al., 2012).

Notably, this unconscious amplification of negative emotional stimuli and weakening of positive emotional stimuli during emotional processing could significantly increase negative emotional experiences. However, this study found no differences in anxiety and depression levels between drug addicts and the control group, suggesting that withdrawal-stage drug addicts maintain normal negative emotional levels. This may indicate that in the absence of heightened negative emotions, attentional bias towards negative stimuli does not manifest. Emotional regulation could potentially be a pathway to correcting negative emotional attentional bias.

Limitations and Future Perspectives

This study preliminarily explored the attentional processing of different emotional types in drug addicts, but several limitations exist. In terms of the sample, the data analysis did not consider potential differences between genders, different types of addictive substances, variations in addiction duration, and different stages of drug withdrawal, which need to be addressed in future research. Moreover, the sample consisted only of mid-stage rehabilitation drug addicts, without comparing early and late withdrawal stages, necessitating cautious interpretation of the findings. Future research could consider including drug addicts from early and late withdrawal stages for comparison or conducting longitudinal tracking studies.

From a methodological perspective, the dot-probe paradigm task is relatively simple and relies solely on behavioral data. Future studies could increase task complexity to explore participants' attentional processing characteristics under varying task

difficulties. The current conclusions await further verification through advanced neuroimaging techniques such as Event-Related Potentials (ERP) and functional Magnetic Resonance Imaging (fMRI) to provide deeper insights into the underlying neural mechanisms.

Conclusion

This study found no significant differences in depression and anxiety between drug addicts and the control group, and revealed that drug addicts demonstrate more sensitive attention to facial emotional information.

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