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Heroin Smokers' Attention Bias toward Cigarette and Heroin Related Cues

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Conflicts of Interest
There are no conflicts to declare.

ABSTRACT

A prominent feature of substance addiction is an attention bias toward substance-related cues. The occurrence and development of drug abuse have been closely related to smoking. The smoking rate of drug abusers is three to four times that of non-drug abusers. This study presents a cognitive model of heroin smokers in the face of cigarette- and heroin-related cues in the context of a compulsory isolated abstinence environment for treatment. Thirty-six male heroin smokers were recruited from the Addiction Recovery Center of Gansu Province in Lanzhou City. A modified emotional Stroop task was used to explore the attention bias of heroin smokers toward two cues: those related to cigarettes and heroin. For heroin smokers, at the correct rate, the three groups of cue pictures were not significantly different. At the time of reaction, the pictures of the three types of cues (heroin-, cigarette-, and neutral-related cue pictures) were significantly different, and the reaction to heroin and cigarette pictures was longer than to neutral pictures. Notably, the reaction time to cigarette pictures was longer than to heroin pictures. In the environment of compulsory detoxification, heroin smokers pay more attention to cigarette-related cues than to heroin-related ones.

Keywords: HEROIN ADDICTS, CIGARETTES RELATED CUES, ATTENTION BIAS, CHINA

Introduction

The abuse of multiple substances is an important public health issue that has been linked with significant adverse health outcomes, dependence, and social harm (Coffin et al., 2003; Nutt et al., 2007). Abuse of multiple substances increases morbidity and mortality among users, and it results in impaired functioning and heavy social and personal costs. Previous studies of substance-use behaviors have shown that the use of multiple substances (also known as polydrug use) through multiple routes of administration is associated with greater drug dependence (Hunt, Trace, & Bewley-Taylor, 2003; Strang et al., 1998), worse mental health outcomes (Smith et al., 2011), the higher probability of aggressive and suicidal behaviors (Borges, Walters, & Kessler, 2000; Feigelman, Gorman, & Lee, 1998), and overdose occurrence (Coffin et al., 2003), as well as a greater risk of HIV infection through the increased likelihood of sharing injection equipment and having unprotected sex (Harrell et al., 2012; Meacham et al., 2016). In the 1970s, research on polydrug use documented patterns among young people who used various licit and illicit drugs, such as alcohol, cigarettes, marijuana, lysergic acid diethylamide, phencyclidine, amphetamines, cocaine, and heroin (Halikas & Rimmer, 1974; Kandel & Faust, 1975; Single, Kandel, & Faust, 1974). Despite the high prevalence rates of polydrug abuse worldwide, which have raised new health concerns, the scientific literature on this issue has remained limited.

Cigarette smoking is a leading preventable cause of death and disease worldwide (World Health Organization [WHO], 2012). Smoking prevalence has declined in many countries in recent years, and overall mortality from smoking-related disease is now decreasing (Peto et al., 2012). However, several vulnerable groups, including people with illicit substance use disorders (SUDs), continue to report a significantly higher prevalence of smoking (Smith, Mazure, & Mckee, 2014). Drug abuse is generally associated with the use of cigarettes, and people with drug-abuse problems smoke three to four times more often than those without (Wapf et al., 2008; Weinberger, Gbedemah, Wall, Hasin, Zvolensky, & Goodwin, 2017).

Heroin abuse is a serious social problem in China and many other countries. Of the 2.35 million drug users in China in 2015, 41.8% used heroin and other opiates (Office of China National Narcotics Control Commission, 2016). Heroin is highly addictive and has the highest fatality rate among all drugs. A significant risk associated with injecting heroin is the spread of HIV/AIDS and other serious infectious diseases; thus, heroin is considered the most harmful to drug users and society (Wang, Jin, & Hao, 2016). Previous studies have also suggested that smoking is common among heroin addicts in China (Li & Zhou, 2008).

While the brain's reward system is the neural basis for the generation and maintenance of drug addiction, drug use can lead to changes in the reward system and the associated brain areas, resulting in various addictive behaviors (Zhou et al., 2014). Addictive substances have a reward effect for addicts, which manifests as an automatic attention capture when any stimulus appears to be associated with addictive substances (Anderson, 2016). That is, once a conditioned stimulus (substance-related stimulus) appears in

life, it will trigger the conditioned responses of substance addicts. Long-term use of addictive substances can significantly enhance the motivation of the relevant cues for addictive substances. When drug-related cues appear, they induce intense attention bias among addicts and create a feeling of thirst, subsequently triggering the use of addictive substances (Yang, Zhang, & Zhao, 2015). Even in prolonged withdrawal, drug-related cues are likely to lead to relapse among substance addicts (Yun & Fields, 2003). Zhu et al. (2005) investigated attention bias toward heroin-related cues in different rehabilitation phases and found that abstinent heroin users had significant attention bias to relevant cues, which did not significantly improve with the prolongation of the rehabilitation period. The reason is that heroin-related cues receive more attention resources than neutral cues. Abstinent heroin users have significant susceptibility to relevant cues, which makes them "conspicuous" stimuli; such prominence makes dependent patients allocate more attention to the related stimuli and also makes it difficult for them to recognize their attention shift to such stimuli. Therefore, there is a significant need to investigate the attention bias of drug addicts in preventing relapse.

Cues for drug intake are associated with increased craving among substance users (Carter & Tiffany, 1999), whereas stimulus generalization predisposes individuals to relapse (Siegel & Ramos, 2002). In the past, researchers have only explored heroin addicts' attention bias toward drug-related cues or nicotine addicts' attention bias toward cigarette-related cues. These earlier studies have indicated that heroin addicts and nicotine addicts have a noticeable bias toward their addictive substances (Wang & Zhang, 2011; Yang, Zhang, & Zhao, 2015). Few studies, however, have examined the pattern of attention bias among heroin smokers, which could help shed light on their cognitive biases toward substance-related cues in natural contexts. As such, the present study took heroin smokers as subjects and investigated the attention bias of heroin smokers to cigarette- and heroin-related cues through emotional Stroop (e Stroop) tasks. This study hypothesized that (1) heroin smokers have an obvious attention bias toward the related cues of cigarettes and heroin, and (2) heroin smokers' attention to heroin-related cues in a compulsory detoxification environment is greater compared to cigarette-related cues.

Methods and materials

Participants

The Northwest Normal University Research Ethics Board approved this study, and all participants provided written informed consent in advance. Thirty-six male heroin smokers, who were receiving compulsory isolated abstinence treatment at the Addiction Recovery Center of Gansu Province in Lanzhou City during the period of study, were recruited. The mean duration of current abstinence was 7.11 ± 4.94 months. The inclusion criteria for heroin smokers included positive urine tests for opioids, the criteria identified in the Diagnostic and Statistical Manual of Mental Disorders (4th ed., DSM-IV), and the WHO's standard (i.e., heroin smokers are those who smoke a minimum of one cigarette a day over six consecutive months or a cumulative 100 cigarettes). The Addiction Recovery Center of Gansu Province conducted the diagnoses. All

participants underwent drug abstinence after being diagnosed as heroin smokers. All participants were right-handed and reported normal color vision and normal or corrected-to-normal visual acuity. The exclusion criteria included current or past cognitive impairments, learning disabilities, medication for any neurological or psychiatric disorder, current use of psychotropic medication, or use of other recreational drugs.

Stimuli

The stimuli consisted of 20 drug-related images (e.g., heroin-smoking paraphernalia, heroin-addicted scenes), 20 cigarette-related images (e.g., lighters, cigarette boxes), and 20 neutral images (e.g., landscapes). All images used in this study were selected from the collections of the International Mood Picture Library (IAPS) (Lang, Bradley, & Cuthbert, 2008), along with freely available online sources that showed individuals preparing or using heroin, which was matched to the IAPS pictures in terms of size and the ratio of human to non-human content. Each image was self-assessed (Self-Assessment Manikin) by heroin addicts (Bradley & Lang, 1994). The images were selected according to their normative ratings of valence and arousal (see Table 1). The size of all pictures was 12 cm x 8 cm; the central colored square target was superimposed (1 cm x 1 cm; red, yellow, blue, or green).

Table 1. Parameter analysis of three kinds of pictures

Project	Picture type	Mean	SD	*F*	*P*	*LSD*
Arousal	Heroin pictures	5.20	2.028	24.140	.000	Neutral < Heroin, Cigarette
	Cigarette pictures	6.00	2.087			
	Neutral pictures	3.25	1.214			
Pleasure	Heroin pictures	5.35	2.270	14.698	.000	Neutral < Heroin, Cigarette
	Cigarette pictures	6.00	1.894			
	Neutral pictures	3.82	1.195			

Procedure

To complete all modified eStroop runs, each participant was required to finish 240 trials, which were interrupted by short breaks (each picture was presented four times with a differently colored superimposed central square). Each trial began with the presentation of a fixation cross in the center of the screen for 500–1000 ms, followed by a blank screen lasting 200–400 ms. Then, the stimuli were presented randomly for 500 ms, followed by a blank screen lasting 1000 ms. During the experiment, the participants were instructed to identify the target color of the small square as quickly and accurately as possible while ignoring the

surrounding pictures. The buttons were color-coded with “red,” “yellow,” “blue,” or “green,” corresponding to “D,” “F,” “J,” or “K,” respectively.

After completion of the task, the participants filled out four questionnaires: the Beck Depression Inventory (BDI-II) (Beck, Steer, & Brown, 1996), the Beck Anxiety Inventory (BAI) (Steer & Beck, 1997), the Opioid Addiction Severity Scale (Lian & Liu, 2003) (0–2 points: lower; 3–4 points: low; 5 points: moderate; 6–7 points: high; 8–10 points: higher), and the Nicotine-dependent scale (FTND) (Pan, Jing, Wang, & Bai, 2010). There were additional questions for the heroin users, such as age at the onset of heroin use, amount of heroin use per day before becoming abstinent, and duration of abstinence. Demographic information (age, years of education, marital status, etc.) and drug use history (age at the onset of drug use, frequency and amount of current daily use, history of previous treatment, etc.) were also collected through a questionnaire developed for this study.

Results

Sample characteristics

The sample population comprised 36 male heroin smokers aged 25–50 years (40.78 ± 7.70). Table 2 presents the participants’ demographic characteristics.

Table 2. Participants’ demographic characteristics

		Frequency	Percentage (%)
Degree of education	Illiterate/semi-literate	5	13.9
	Primary school	10	27.7
	Junior high school	18	50.0
	High school	2	5.6
	College	1	2.8
	Undergraduate	-	-
Occupation	Unemployed	26	72.2
	Individual business	1	2.8
	Service industry	3	8.3
	Peasants	1	2.8
	Workers	5	13.9
	Staff	-	-
	Others	-	-
Marital status	Single	4	11.1
	Married	19	52.8
	Divorce	11	30.6
	Separated	1	2.8
	Widowed	-	-

Unmarried cohabitation	1	2.8

Usage condition of addictive substances

The results of the analysis showed that among the 36 male heroin users, 32 (88.9%) mainly swallowed heroin, and four (11.1%) received the intravenous injection. Of the 36 heroin users, 29 (81.6%) had had a relapse while the rest (19.4%) had not had a relapse. As for the severity of the addiction, 13 (36.1%) were severe heroin users, 22 were moderate users (61.1%), and 1 (2.8%) was a mild user. In terms of FTND severity, 3 (8.3%) were lower, with low levels of heroin; 7 were low (19.4%); 6 (16.7%) were moderate; 19 (52.8%) were high, and 1 (2.8%) was higher. with an average of 0.51 ± 0.35 g for each drug use. The amount of smoking was 25.33 ± 10.90. The earliest smoking age was 16.58 ± 5.46 years, confirming that heroin addicts tend to be particularly young the first time they smoke.

Table 3. Participants' use of addictive substances

	N	*M*	*SD*
A few daily	36	25.33	10.90
Age when user smoked for the first time	36	16.58	5.46

Participants' emotional problems

In Beck's Anxiety Inventory, the heroin addicts scored 1.63 ± 0.45. Under Beck's classification for depression, they scored 0.89 ± 0.39.

Table 4. Participants' emotional problems

	N	*M*	*SD*
Beck anxiety	36	1.63	0.45
Beck depression	36	0.89	0.39

Behavioral results

The results of RT and accuracy for heroin smokers are shown in Table 5. The accuracy rates for heroin smokers in the three groups of pictures were not significantly different: F (2, 70) = 1.27, p = 0.286. The RT for the three groups of pictures revealed a significant effect: F (2, 70) = 22.55, p < 0.001. The LSD test results showed that reaction times to the heroin pictures (t = -11.89, p < 0.001) and cigarette pictures (t = -20.55, p < 0.001) were longer compared to the neutral pictures, whereas the reaction times to cigarette pictures were longer compared to the heroin pictures (t = 8.667, p < 0.01).

Table 5. Correct rate and reaction time, *M (SD)*

Picture type	ACC (n = 36)	RT (n = 36)
Heroin	0.78 ± 0.12	634.12 ± 91.96

Cigarettes	0.79 ± 0.13	642.79 ± 88.20
Neutral	0.78 ± 0.11	622.23 ± 92.48

Conclusion

In the present study, behavioral measures were used to investigate three kinds of cue reactivity in heroin smokers during a modified eStroop task. The main finding of this study was that the accuracy of the images showed no significant differences. Heroin smokers had a significant bias toward cigarette- and drug-related cues in their responses, and attention to cigarettes tended to be more biased than drug attention. These results reveal not only heroin smokers' attention to drug-related cues but also their greater attention bias in the context of compulsory detoxification. The results are partly consistent with the study's hypotheses.

Attention bias is related to the craving for a substance, and one of the salient features of addiction is the attention bias toward substance cues, which plays an important role in substance-seeking behavior and the recurrence of substance abuse. For material-dependent people, attention to any stimulus that is associated with rewards is automatic (Anderson, 2016). Regarding heroin addicts' attention to drug-related cues, researchers have used the push-pull lever task (pull/push task) to investigate the attention bias of patients suffering from heroin withdrawal, compared with a control group; heroin withdrawal significantly tended to be associated with heroin-related stimulation (pull). However, in the face of the demand for heroin stimulation, heroin addicts have shown slight dullness, indicating a bias toward heroin-related stimuli, which are difficult to escape (Zhou, Li, Zhang, Zhang, Zhu, & Shen, 2012). Meanwhile, smokers have been found to show an approach tendency toward smoking-related cues in modified go/no-go tasks (Detandt, Bazan, Quertemont, & Verbanck, 2017). The results of the current research coincide with these earlier findings.

However, there is no research and discussion on the attention bias of heroin smokers toward multiple addictive substances and the differences in attention bias patterns for multiple addictive substance cues. This study found that heroin smokers have a tendency to pay attention to cigarette- and heroin-related cues. They tend to pay more attention to cigarette-related cues; however, the incentive-sensitization model emphasizes that attention bias and craving for drug-related cues are interrelated (e.g., positive correlation). Conner and Stein (1999) suggested that reducing heroin use and risk behavior in drug therapy may lead to increased use of cigarettes, which may be a form of substance substitution. They further posited that this tendency is an important reason for the greater attention bias of heroin addicts to cigarettes. An ecological momentary assessment confirmed that smoking and tobacco craving are strongly associated with the use of and craving for cocaine and heroin (Epstein, Marrone, Heishman, Schmittner, & Preston, 2010).

The current study also found that heroin addicts began to smoke at a younger age and had a long duration; there was a significant positive correlation between nicotine addiction severity and opioid addiction. Earlier studies have shown that drug use can, in turn, increase the amount of smoking (Frosch, Stein, & Shoptaw, 2002). From the perspective of the gateway hypothesis of substance abuse, the lower the smoking age, the higher the risk of using illicit drugs in adulthood (Kandel, D., & Kandel, E., 2015;

McCambridge & Strang, 2005). In terms of smoking, heroin addicts have a larger daily smoking intake and a higher degree of addiction, as indicated in the present results. Thus, the smoking problem of heroin smokers is an important issue requiring attention (Agrawal, Madden, Bucholz, Heath, & Lynskey, 2008).

Although this study showed that heroin smokers had a greater attention bias toward cigarette-related cues than heroin, it nonetheless has some shortcomings. (1) The subjects in this study were male heroin addicts in compulsory detoxification settings. Other aspects merit closer investigation comprehensively: methadone maintenance treatment, voluntary detoxification, and heroin users' smoking status and the cognitive situation concerning heroin and cigarette cues. Indeed, the relationship between cigarettes and heroin in different detoxification settings requires attention in future research. (2) This research focused on male heroin addicts. Men and women have obvious differences in their use of legal substances (such as cigarettes), and as such, the use of legitimate substances and their effects on drug addiction and withdrawal need to be further studied. (3) This research only explored heroin smokers' attention bias toward heroin- and cigarette-related cues at the behavioral level; for heroin smokers, the combination effect at the implicit level between cigarettes and heroin use needs to be verified.

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