Experimental and Clinical Psychopharmacology
2010, Vol. 18, No. 6, 539–545

1064-1297/10/$12.00 DOI: 10.1037/a0021559

A Comparative Study of Drug-Related Attentional Bias: Evidence From Iran

Javad Salehi Fadardi and Seyedeh Soleil Ziaee
Ferdowsi University of Mashhad

The Addiction-Stroop test has been widely used to investigate the attentional correlates of alcohol and drug abuse; however, the majority of the studies have been conducted with European and American participants. The present study tested whether Iranian drug abusers show higher attentional bias for drug-related stimuli. Participants included drug abusers ($N = 53$; 100% male), with a clinical history of opium and heroin abuse, who were in a Methadone Maintenance Therapy program. Only nonabusers ($N = 71$; 71, 54% male) with a history of having never abused of drugs or alcohol participated in the study as controls. All participants completed a computerized Persian version of classic and addiction Stroop tests. The results of a multivariate analysis of covariance (MANCOVA) showed that drug abusers had a higher attentional bias for drug-related stimuli than nonabusers, after the effects of age and education had been controlled. The results of repeating the MANCOVA (a) limited to men only, and (b) to men and women in the nonabuser sample showed that the observed difference in the drug-related attentional bias of drug-abusers and nonabusers was not an artifact of gender imbalance. Our findings support the idea that drug-related attentional bias is culture-free.

Keywords: addiction, drug, Stroop test, attentional bias

Iran has the highest number of narcotics abusers in the world per capita (2.8% of the population; United Nations, 2005) and regardless of the governmental efforts, drug abuse is still increasing among the population, particularly the young (Sarami & Ghomashchi, 2003). Consequently, the various medical, psychological, and social negative effects of addiction have endangered the health and welfare of the Iranian society. For example, between 1973 and 2002, drug abuse was the second most common (i.e., 24.6%) psychiatric disorder after affective disorders (Movaghar et al., 2005). Despite a fortified effort in the country to tackle the problem, the prevalence and the relapse rates are still very high (Iran Drug Control Headquarters, 2010).

The challenging, multifactorial nature of drug abuse, its various etiologies, and problems associated with it suggest that it is difficult to construct a global and scientifically valid model of drug abuse and its treatment. A comprehensive model, which can encompass various etiologies of the behavior within a unifying framework, would represent progress in the field.

Javad Salehi Fadardi and Seyedeh Soleil Ziaee, Department of Psychology, Ferdowsi University of Mashhad, Iran.

We thank Dr. Hamid Salehpour for providing access to his private clinic (Mashhad Drug Services Clinic) to collect data from drug abusers and providing us with research space. We also thank Dr. Mohammad Saeedi and Dr. S. Amir Aminyazdi for their assistance with the university part of the study. We thank Professor Eric Klinger, who kindly provided us with his useful comments on an earlier version of this article.

Correspondence concerning this article should be addressed to Dr. Javad Salehi Fadardi, Department of Psychology, Ferdowsi University of Mashhad, Mashhad, Iran. E-mail: j.s.fadardi@um.ac.ir

The original motivational model of drug use that has been suggested by Cox and Klinger (1988) seems to bring together the biological, psychological, and sociocultural factors of drug use and abuse. Recently, formulating the roles that implicit cognitions and attentional factors play in the model brought together motivational and cognitive determinants of drug and alcohol abuse (Cox & Klinger, 2004; Cox, Fadardi, & Pothos, 2006). In this model, distal factors comprise one's heredity, culture, and past learning in relation to drug-related and unrelated wishes, aspirations, and goals; current factors include people's expectancies of the consequences of using drugs and the value that they place on the behavior; and the most proximal factors in the model are the person's attentional hypersensitivities to cues related to drug abuse (Cox & Klinger, 2004). The effects of all factors in the model are channeled through a decision-making process that determines whether the person will use or refrain from using a chemical drug.

Tiffany (1990) suggested that excessive drug abusers' conscious decisions not to drink often fail due to conflicting influences of nonconscious cognitive processes. In fact, increasing evidence related to alcohol abuse (e.g., Fadardi, 2003; Fadardi & Cox, 2006, 2008, 2009); drug abuse (e.g., Fadardi, Ziaee, & Shamloo, 2009; Franken, Kroon, Wiers, & Jansen, 2000); and other addictive behaviors (e.g., Lancho & Cabaco, 2009; McCusker & Gettings, 1997) suggests that attentional hypersensitivity or attentional bias for stimuli related to the abusive behavior can play an important role in its continuation, treatment success, and relapse. Consequently, attentional bias seems to play an important role in weakening the abuser's control over drug use. Some researchers have suggested that abusers' efforts to reduce drug dependence may increase their drug-related attentional bias, hence intensifying their urges to relapse to the habitual behavior (e.g., Cox et al., 2002).

These automatic cognitive mechanisms may lead to a cycle of withdrawal and relapse that usually causes an abuser to experience frequent failures after deciding to quit (Wiers et al., 2002). Brain studies suggest that regions in the limbic system and ventromedial prefrontal cortex selectively respond to drug-related cues and could contribute to the flawed decisions to abuse drugs or to break abstinence (Bernheim & Rangel, 2002; Damasio, 1994). For example, in an functional magnetic resonance imaging study, Park et al. (2007) showed that when drug abusers were exposed to drug cues, activation of specific brain areas (i.e., fusiform gyri, temporal gyri, parahippocampal gyrus, uncus, frontal gyri, and precuneus) was correlated with the level of craving that the participants reported.

Various paradigms have been used in the study of drug-related attentional bias, including expectancy challenge (Musher-Eizenman & Kulick, 2003; Wiers & Kummeling, 2004), visual probe (Schoenmakers, Wires, Jones, Bruce, & Jansen, 2006; Wiers et al., 2006), eye movement measures and event-related potentials (Field, Munafo, & Franken, 2009).

Williams, Mathews, and MacLeod (1996) suggested that experimental investigation of attentional bias usually is based on one of two broader methods. The first method is based on the *facilitation effect*; the effect is evident through a reduction in the persons' attentional and sensory thresholds for salient stimuli. The second method is based on *interference effects*; the effect arises when one's performance suffers in the presence of those stimuli that should be ignored during a task. Within the second category, a commonly used paradigm is a modified version of the classic Stroop test (Stroop, 1935) named *the emotional Stroop test*; the test has consistently been reported to be particularly sensitive to attentional bias for emotionally salient stimuli (Williams et al., 1996).

The emotional Stroop test is a generic name for modifications of the classic Stroop test (Stroop, 1935) that employ at least two categories of stimuli: a control or neutral one and an emotionally salient or valenced category of stimuli (e.g., negative words) that are usually related to the psychopathology being tested. When the modified version contains alcohol, drug or gambling-related stimuli as the salient category (e.g., Fadardi & Cox, 2009; Hogarth, Dickinson, & Duka, 2009), it is called the addiction-Stroop test. The salient findings of this area of research are that alcohol abusers and drug-abusers consistently show higher attentional bias for drug-related stimuli (e.g., they are slower to name the color of the stimulus when its content is drug-related) than do nonabusers or light drug abusers, and the degree of drug abusers' attentional bias is a significant predictor of their ability to reduce their drug abuse (Cox et al., 2002; Field et al., 2009).

Attentional bias for drug-related stimuli contributes to drug abusers' preoccupation with the drugs and their lack of confidence in their ability to control their urges to use (Fadardi et al., 2009; Fadardi & Cox, 2006). A meta-analysis conducted by Field et al. (2009) suggests that attentional bias and craving are related phenomena. Even a brief review of the different approaches would be too long for this article here, hence interested readers may refer to Cox et al. (2006) and Pothos, Calitri, Tapper, Brunstrom, and Rogers (2009).

Gardini, Caffarra, and Venneri (2009) found that drug-related attentional bias in drug abusers depends on their consumption status. Those in treatment programs showed less drug-related attentional bias than active drug users. Although it seems that drug-related attentional bias could be influenced by a variety of factors such as the user's motivation, craving, classical conditioning and drug availability, Gardini et al.'s (2009) findings support the hypothesis that treatment may contribute to decreases in the attentional bias; this may play a critical role in achieving a positive outcome in the treatment of addiction.

Drug abuse adversely affects the abusers' executive cognitive functions (ECF), including inhibitory processes that are responsible for selective attention (Fadardi, 2003; Fadardi & Cox, 2006, 2008, 2009; Williams et al., 1996). Al-Zahrani and Elsayed (2009) reported that the functions of specific brain regions underlying cognitive control were significantly impaired in drug abusers; the severity of the impairment was related to the type of drug, duration of the abuse and number of hospitalizations. However, Fadardi and Cox (2006) administered a drug-Stroop test and the classic Stroop test (as a general measure of inhibitory processes) with a sample of drug abusers and reported that attentional bias for drug-related stimuli was not an artifact of the abusers' faulty inhibitory processes. In the study, the abusers' drug-attentional bias was proportional to the abusers actual amount of drug consumption.

Searching PsycINFO, PubMed, and Science Direct revealed that during 1993 to 2010, 63 drug abuse investigations were conducted using the Stroop paradigm: 25 on smoking behaviors, 11 on drug dependence, two on the and methodological considerations in the use of the drug Stroop test and 25 studies on alcohol abusers.

Despite the fact that drug abuse has been widely studied in Iran, evidence on the role of implicit cognitions in addictive behaviors is scarce (Nazer, Sayady, & Khaleghi, 2002). Systematic Iranian studies with the addiction Stroop test could be important for testing whether findings by other researchers in other cultures (mostly Western societies) can be replicated in an Eastern country. Moreover, the specifics of developing and administering an addiction Stroop test can strongly affect the validity and reliability of the test. For example, unlike English-language researchers, who can access sources of lexical frequencies of written and spoken words (e.g., Baayen, Piepenbrock, & Van Rijn, 1993; Kucera & Francis, 1967), there is no lexical reference in the Persian (Farsi) language for use by the researchers.

Finally, research on attentional mechanisms involved in drug abuse still need to be expanded, particularly for people from culturally diverse backgrounds. For example, in Iran, drug abuse is highly stigmatized; this usually pushes the abusers to the margins of the society and such marginality may lead to different responsiveness to social contexts, including testing sessions, in different societies (Anderson

& Levy, 2003). Moreover, Iranian drug abusers still fear legal convictions; the fear may adversely affect their honesty when reporting their drug abuse via explicit measures—despite the fact that for more than a decade drug abuse has been seen and treated as an illness in the country.

There is also evidence from brain studies that support the ecological validity of the emotional versions of the Stroop test: (a) studies (see Fadardi & Cox, 2006) have shown that performance on the Stroop tests tap brain structures that are responsible for executive cognitive functions (ECF); (b) Ardila (2008) divided executive functions into metacognitive (responsible for planning, concept formation, strategy development and implementation, controlling attention, working memory, and so on), and emotional/motivational parts (responsible for coordinating cognition and emotion/motivation to fulfill needs in a given context); Ardila argues that the metacognitive part of executive functions is extremely dependent on culture and cultural means of communication; and (c) Ishii, Reyes, and Kitayama (2003) showed that, on an emotional Stroop test, Americans were more distracted by the verbal content of the stimuli than their vocal tone; Japanese showed an opposite pattern from Americans; and Tagalog-English bilinguals showed an attentional bias for vocal tone regardless of the language used—suggesting that the Stroop effects are largely due to cultural differences rather than linguistic differences. Tapper, Pothos, Fadardi, and Ziori (2008) also showed cultural differences on food-related attentional bias across Britain, Iran, and Greece.

Therefore, the goal of this research was to develop an addiction-Stroop test and to compare the drug-related attentional bias of a sample of in-treatment drug-abusers with nonabusers in Iran. We hypothesized that attentional bias for drug-related stimuli as assessed by the addiction-Stroop test developed in this study will discriminate drug-abusers from nonabusers.

Method

Participants

Nonabusing participants were students, academic staff, and other personnel of Ferdowsi University of Mashhad and people from the local community who were visiting the university ($N = 71$, 54% male). Their mean age was 26.62 ($SD = 8.40$); 63% were married and 73% had completed their undergraduate studies or a higher education degree. Participation in the study was voluntary. The study was publicized through advertisements displayed on the university's departmental notice boards. It was advertised as a project investigating people's reaction times and response precision in reaction to a series of colored words that would appear on a computer screen. Potential participants were informed that they would also be required to anonymously answer a number of questions regarding their use of nonprescribed drugs.

Drug-abusers ($N = 53$, 100% male), who responded to the same ads mounted in a local drug-use services clinic were required to be under Methadone Maintenance Therapy. The abusers who participated had been using methadone for an average of 48 ($SD = 1.86$) months. Their mean age was 36.57 ($SD = 9.00$); 75.5% were married; and 64.7% had at least a high school diploma. All participants gave their informed consent prior to participation in the study. There was no monetary reward for participation in the study. Upon completion of the experiment participants were debriefed and thanked for taking part.

Instruments

Substance Use Questionnaire. The Persian Substance Use Questionnaire (P-SUQ; Fadardi, 2005; Fadardi et al., 2009) measures nonaddicts' frequency of using 11 nonprescribed substances with no overt reference to Class A to C drugs. The test was used to exclude from the study those participants in the control group who were suspected of having a past or current history of substance abuse.

Stroop tests. The classic and drug-related Stroop tests' construction was the same as described in Fadardi et al. (2009) except for the exclusion of the concern-related stimuli from the test. Therefore, four types of words were used in the Stroop tests utilized in this study. To compose the classic Stroop test (Stroop, 1935), congruent (e.g., *yellow* printed in yellow ink) and incongruent (e.g., *green* printed in blue ink) color words were used. Four color words appeared four times with an ink color consistent with their meaning to make 16 congruent color words; the set was repeated three times. The same color words appeared three times each (skipping the congruent stimulus for each color) to make 12 incongruent color words; the set repeated four times. The third category of words was drug-related (crystal, opium, heroin, tablet, syringe, straw, lighter). The fourth category of words comprised seven control words (i.e., emotionally neutral /not salient to the respondents) that were related to building items (door, window, stair, fence, cupboard, key, ceiling). The latter category of words is necessary to provide a baseline for calculating the interference scores—an index of attentional bias for drug related words. The drug-related and control words were repeated as 7 (words) $\times$ 4 (colors) $\times$ 2 (series), making 56 stimuli in each of the two latter lists. In sum, a total of 208 stimuli were presented on the screen (i.e., 48 congruent color words; 48 incongruent color words; 56 drug-related words; 56 control words).

The drug-related and control word lists were balanced for their number of letters, syllables, and semantic relatedness (e.g., Kucera & Francis, 1967 in American English and CELEX; Baayen et al., 1993 in British English). However, because there is no reference on the frequencies of usage in the Persian language, it was not possible to control for the words' frequencies. There is persuasive evidence on the reliability and validity of the emotional versions of the Stroop tests (e.g., Fadardi, 2003; Siegrist, 1995, 1997).

Apparatus

SuperLab Pro (SKD; Cedrus-Corporation, 1999) was used to make the computerized Stroop tests. A PC and a 17" display (located 40–55 cm away from the participant's eyes) were used for presenting the stimuli. The input device was a standard keyboard with four keys marked as response keys.

Procedure

Upon giving their informed consent and prior to the main computerized test, all participants were given 50 practice stimuli with color patches to familiarize them with the computerized test procedure. Only during the practice phase, the computer gave feedback for correct, incorrect and late responses. If necessary, the practice session could be repeated until the participants had learned the necessary key-pressing skills.

Each word stimulus was presented at the center of the display for a maximum of three seconds. The stimuli were separated by a cross (+) that appeared for 500 ms upon pressing a key and prior to presentation of the next word. All stimuli from each category were presented on a mixed, randomized basis. The computer recorded error responses and reaction times to each individual word. After completing the Stroop tests, participants were asked to complete the P-SUQ and brief demographic questionnaire. All data were collected individually in an experimental room. At the end participants were debriefed and thanked for taking part.

Results

The individuals' drug-related Stroop interference scores were calculated as the difference between individuals' mean reaction times to the neutral stimuli and their mean reaction times to the drug stimuli (Williams et al., 1996). The P-SUQ scores ranged between zero and 77. On the questionnaire, the mean score for the nonabusers was 8.49 ($SD = 6.05$). Only two participants in the control group were eliminated from the data analysis because they scored greater than 22 on the P-SUQ or identified themselves as users of hard drugs. A score equal to or less than 22 on the P-SUQ indicates mild or occasional use of nonprescribed but legal substances such as tea, coffee, analgesics, herbal infusions, and so on. The control participants' mean score on P-SUQ was 8.49 ($SD = 6.05$).

The average methadone dose in the drug-abusers group was 75 ($SD = 27.81$) milligrams per day. The result of a series of t tests comparing drug-abusers and nonabusers showed that the groups were significantly different in age, $t(120) = 6.32$, $p = .001$, $d = 1.14$, with drug-abusers ($M = 36.5$, $SD = 9.007$) being older than nonabusers ($M = 26.62$, $SD = 8.40$), and in education, $t(120) = -8.31$, $p = .001$, $d = 1.52$, with drug-abusers ($M = 10.25$, $SD = 2.93$) reporting fewer years of formal education than nonabusers ($M = 15.07$, $SD = 3.37$).

As Table 1 shows, the two groups differed from each other on the number of errors made on the congruent words, $t(120) = 2.085$, $p = .039$, $d = 0.38$, with drug-abusers making more errors on the congruent words than the nonabusers. The drug-abusers also had higher numbers of errors on the incongruent words than nonabusers, $t(80.87) = 2.25$, $p = .027$, $d = 0.78$). Moreover, the number of errors on the neutral words in the drug-abuser group was higher than for the nonabusers, $t(120) = 2.08$, $p = .039$, $d = 0.38$, the drug-abuser's total errors on the classic Stroop, $t(92.05) = 2.48$, $p = .015$, $d = 0.47$ and their total errors on the drug-Stroop, $t(120) = 1.92$, $p = .057$, $d = 0.23$ was higher than for the nonabusers. But the participants' differences regarding the number of errors on drug-related word categories were not significant.

Calculating a correlation matrix showed that *education* was negatively correlated with age ($r = -0.46$, $p = .001$), and drug-related interference scores ($r = -0.21$, $p = .009$).

To test the hypothesis that drug-abusers and nonabusers differ on the classic and drug-related interference scores, a multivariate analysis of covariance (MANCOVA) was calculated. In the MANCOVA model, interference scores from the classic and drug Stroop tests were entered as the dependent variables, Group (drug-abusers vs. nonabusers) as the independent variable (Factor), and education and age as covariates. The covariates were included because of their potential effects (e.g., Verhaeghen & De Meersman, 1998) on the participant's performance on the Stroop tests. Moreover at the baseline, abusers and nonabusers significantly differed in terms of age and education. Such differences could mean collinearity among the independent variables; therefore, we calculated the tolerance (Min: 0.60) and VIF (Max: 1.73) as collinearity diagnostic statistics, which showed that collinearity was not a problem.

Considering the classic Stroop interference scores, there was no significant effect for age [$F = (1, 122) = 0.22$, $p = .63$, $\eta^2 = 0.002$] and education [$F = (1, 122) = 0.013$, $p =$

Table 1
Number of Errors and Interference Scores on the Stroop Tests, Separately for Drug Abusers and Nonabusers

	Drug-abuser		Non-abuser	
	M	*SD*	*M*	*SD*
Number of errors on congruent category of classic Stroop	4.58	3.83	3.14	3.80
Number of errors on incongruent category of classic Stroop	7.40	7.25	2.85	4.47
Total number of errors on classic Stroop	11.98	9.82	7.99	7.35
Number of errors on drug-related category of addiction Stroop	3.11	3.06	2.44	2.84
Number of errors on neutral category of addiction Stroop	2.89	2.54	1.99	2.24
Total number of errors on addiction Stroop	3.11	3.06	2.44	2.84
Interference score on classic Stroop	88.44	77.35	75.87	83.24
Interference score on addiction Stroop	90.40	89.78	24.15	97.90

.91, η^2 = 0.001], nor was there a significant effect for Group [F = (1, 122) = 0.62, p = .43, η^2 = 0.005]. However, the effect of Group on drug interference was significant [F = (1, 122) = 9.34, p = .003, η^2 = 0.072], though no significant effect was found either for age [F = (1, 122) = 0.65, p = .42, η^2 = 0.005] or for education [F = (1, 122) = 0.14, p = .70, η^2 = 0.001] (see Figure 1).

To assure that the results from the MANCOVA model described above (Model A) are not artifacts of gender imbalance across the samples, we repeated the model two more times: in Model B, we omitted females from the data set and included only male nonabusers and male abusers in the analysis; and in Model C, we ran the model on the nonabusers only with gender entered into the model as Factor. The results obtained with Model B replicated those of Model A; that is, when only men from both samples were included, only the effect of Group on drug interference was significant [F = (1, 87) = 4.81, p = .031, η^2 = 0.052]. For Model C, the results showed that there was no significant effect on drug interference for either the age and education covariates or for Gender ($p > .05$). The results suggest that the significant effect for Group in the first MANCOVA was not an artifact of the samples' gender imbalance.

Discussion

The main goal of the present study was to compare the attentional bias of drug-abusers and none-abusers as measured by a Persian version of the addiction-Stroop test. The result showed that the drug-abusers had higher interference scores than nonusers for drug-related stimuli. This finding shows that the Persian addiction-Stroop test that was developed for this study has differential validity; the finding is important because the target population was culturally different from those in the Western studies, and the effect was observed despite the lack of lexical controllability for the frequency of usage of the written and spoken words in the Persian language. The test can be used in future Persian studies that aim to study drug-related attentional bias in Iranian drug abusers. For example, one question that awaits future research is whether Iranian female drug abusers show the same attentional bias as Iranian male drug abusers.

The finding was consistent with evidence that, compared with nonusers, drug-abusers show higher interference scores for drug related stimuli (e.g., Asgaard, Gilbert, Malpass, Sugai, & Dillon, 2010; Cox et al., 2002; Cox et al., 2006; Cane, Sharma, & Albery, 2009; Fadardi & Cox, 2006, 2008, 2009; Gardini et al., 2009; Roberts & Koob, 1997); also the result supports the previous evidence (Verhaeghen & De Meersman, 1998) that showed drug attentional bias is independent from gender, age, and education. The attentional bias is important from various viewpoints; higher attentional bias for drug-related stimuli means more awareness of drugs in the person's proximal environment. This causes the person's attentional and cognitive resources to be preoccupied with drugs and thoughts of abusing them, leaving less mental energy and space for focusing on other important goals in the abuser's life.

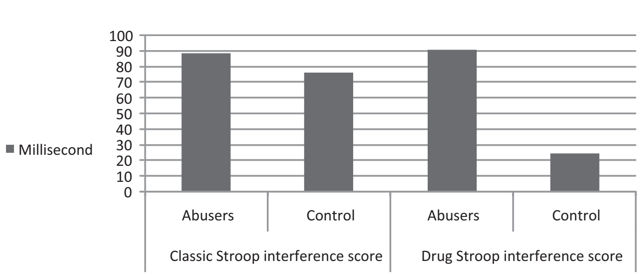

Figure 1. Drug Abusers' and Controls' Mean Reaction Times on Classic and Drug Stroop Tests.

Moreover, according to Tiffany (1999, 1990); Robinson and Berridge (2000, 2003) and Fadardi and Cox (2006, 2008, 2009), when the drug-related cognitive processes start, they trigger a sequence of drug-related decisions and behavioral models that may directly cause drug abuse. Shamloo (2007) showed that experimental manipulation of sense of control was associated with increases in drug-related attentional bias and urges to drink. Therefore, the activation of attentional bias may lead to feelings of temptation (craving or urge) which demands additional mental energy to ban the interfering effects of such feelings on conscious decision-making processes. Additionally, there is a significant relationship between craving and relapse (e.g., Tiffany, 1999, 1990; Sherman, Zinser, Sideroff, & Baker, 1989).

The total number of errors in classic Stroop and addiction Stroop tests made by drug abusers was higher than nonabusers. This can suggest deficits in the abusers' cognitive executive function and cognitive sharpness (e.g., Stormark, Laberg, Nordby, & Hugdahl, 2000). However, there was no difference between the two groups in terms of their classic Stroop interference scores. The two findings are inconsistent with the results of current research (e.g., Fadardi & Cox, 2009). But it should be noted that drug abusers in the present study have been under treatment for a long period (M = 48 months, SD = 1.91) that may have helped them to improve some aspects of their cognitive performance that had been adversely affected by their abusive behavior. Evidence (e.g., Fadardi & Cox, 2006; Bowden, Crews, Bates, Fals-Stewart, & Ambrose, 2001) also supports the notion that such improvement can happen for ex-drug abusers after staying in a long term therapeutic program. It suggests that cross-sectional or longitudinal studies should be conducted to compare the cognitive functions of drug abusers in early or late stages of treatment.

To conclude, in regard to the potential role of drug attentional bias in the continuation of and relapsing to drug abuse, it is important to address drug attentional bias in drug-use services programs across various cultures. Future research should focus on the effects of cognitive interventions on reducing drug attentional bias. The Persian addiction Stroop test provides Persian-speaking researchers with a new tool to study cognitive mechanisms underlying the development of drug-abuse behaviors.

References

Al-Zahrani, M. A., & Elsayed, Y. A. (2009). The impacts of drug abuse and dependence on neuropsychological functions in a sample of patients from Saudi Arabia. *Behavioural Brain Functioning, 48,* 5–48. doi: 10.1186/1744-9081-5-48

Anderson, T. L., & Levy, J. A. (2003). Marginality among older injectors in today's illicit drug culture: Assessing the impact of ageing. *Addiction, 98,* 761–770.

Ardila, A. (2008). On the evolutionary origins of executive functions. *Brain and Cognition, 68,* 92–99.

Asgaard, G. L., Gilbert, D. G., Malpass, D., Sugai, C., & Dillon, A. (2010). *Experimental and Clinical Psychopharmacology, 18,* 51–60.

Baayen, H. R., Piepenbrock, R., & van Rijn, H. (1993). *The CELEX lexical database* [CDROM]. Philadelphia, PA: Linguistic Data Consortium, University of Pennsylvania.

Bernheim, B. D., & Rangel, A. (2002). *Addiction and cue-conditioned cognitive processes. NBER Working Papers, 9329.* Cambridge, MA: National Bureau of Economic Research, Inc.

Bowden, S. C., Crews, F. T., Bates, M. E., Fals-Stewart, W., & Ambrose, M. L. (2001). Neurotoxicity and neurocognitive impairments with alcohol and drug-use disorders: Potential roles in addiction and recovery. *Alcoholism: Clinical and Experimental Research, 25,* 317–321.

Cane, J. E., Sharma, D., & Albery, I. P. (2009). The addiction Stroop task: Examining the fast and slow effects of smoking and marijuana-related cues. *Journal of Psychopharmacology, 23,* 510–519.

Cedrus-Corporation. (1999). SuperLab Pro SKD (Version 2.1) [Software]. San Pedro: CA: Cedrus-Corporation.

Cox, W. M., Fadardi, J. S., & Pothos, E. M. (2006). The addiction-Stroop test: Theoretical considerations and procedural recommendations. *Psychological Bulletin, 132,* 443–476.

Cox, W. M., & Klinger, E. (1988). A motivational model of alcohol use. *Journal of Abnormal Psychology, 97,* 168–180.

Cox, W. M., & Klinger, E. (2004). A motivational model of alcohol use: Determinants of use and change. In W. M. Cox & E. Klinger (Eds.), *Handbook of motivational counseling: Concepts, approaches, and assessment* (pp. 121–138, 217–239). Chichester, England: Wiley.

Cox, W. M., Schippers, G. M., Klinger, E., Skutle, A., Stuchlikova, I., Man, F., . . . Inderhaug, R. (2002). Motivational structure and alcohol use of university students across four nations. *Journal of Studies on Alcohol, 63,* 280–285.

Damasio, A., R. (1994). *Descartes' error: Emotion, reason and the human brain.* New York: Avon Books.

Fadardi, J. S. (2003). *Cognitive-motivational determinants of attentional bias for alcohol-related stimuli: Development of an attentional-control training programme.* Unpublished Ph.D. Thesis, University of Wales, Bangor.

Fadardi, J. S. (2005). *Persian Substance Use Questionnaire* (*PSUQ*). Mashhad, Iran: Ferdowsi University of Mashhad.

Fadardi, J. S., & Cox, W. M. (2006). Alcohol attentional bias: Drinking salience or cognitive impairment? *Psychopharmacology, 185,* 169–178.

Fadardi, J. S., & Cox, W. M. (2008). Alcohol-attentional bias and motivational structure as independent predictors of social drinkers' alcohol consumption. *Drug and Alcohol Dependence, 97,* 247–256.

Fadardi, J. S., & Cox, W. M. (2009). Reversing the sequence: Reducing alcohol consumption by overcoming alcohol attentional bias. *Drug and Alcohol Dependence, 101,* 137–145.

Fadardi, J. S., Ziaee, S. S., & Shamloo, Z. S. (2009). Substance use and the paradox of good and bad attentional bias. *Experimental Psychopharmacology, 17,* 456–463.

Field, M., Munafò, M. R., & Franken, I. H. A. (2009). A meta analytic investigation of the relationship between attentional bias and subjective craving in substance abuse. *Psychological Bulletin, 135,* 589–607.

Franken, I. H., Kroon, L. Y., Wiers, R. W., & Jansen, A. (2000). Selective cognitive processing of drug cues in heroin dependence. *Journal of Psychopharmacology, 14,* 395–400.

Gardini, S., Caffarra, P., & Venneri, A. (2009). Decreased drug-cue-induced attentional bias in individuals with treated and untreated drug dependence. *Acta Neuropsychiatrica, 21,* 179–185.

Hogarth, L., Dickinson, A., & Duka. (2009). Detection versus sustained attention to drug cues have dissociable roles in mediating drug seeking behavior. *Experimental and Clinical Psychopharmacology, 17,* 21–30.

Iran Drug Control Headquarters. (2010). *Addiction encyclopedia: Iran's addiction statistics.* Retrieved from http://www.dchq.ir/html/index.php?module=htmlpages&func=display&pid=30

Ishii, K., Reyes, J. A., & Kitayama, S. (2003). Spontaneous attention to word content versus emotional tone: Differences among three cultures. *Psychological Science, 14,* 39–46.

Kučera, H., & Francis, W. N. (1967). *Computational analysis of present-day American English.* Providence: Brown University Press.

Lancho, C. P., & Cabaco, A. S. (2009). Attentional processing analysing of tobacco and health related information using a modified Stroop task. *Estudios De Psicologia, 30,* 21–30.

McCusker, C. G., & Gettings, B. (1997). Automaticity of cognitive biases in addictive behaviours: Further evidence with gamblers. *British Journal of Psychology, 36,* 543–554.

Movaghar, A., Sharifi, V., Mohammadi. M., Farhodian, A., Ezadian, A., Godarzi, S., & Mansori, N. (2005). Surveying 30 years addiction research in Iran. *Hakeem, 8,* 37–44.

Musher-Eizenman, D. R., & Kulick, A. D. (2003). An alcohol expectancy-challenge prevention program for at risk college women. *Psychology of Addictive Behaviors: Journal of the Society of Psychologists in Addictive Behaviors, 17,* 163–166.

Nazer, M., Sayadi, A., & Khaleghi, A. (2002). The role of Environment Management, attention control and thought stopping techniques in reducing the temptation of drug dependents. *Journal of Thought and Behavior, 8,* 49–55.

Park, M. S., Sohn, J. H., Suk, J. A., Kim, S. H., Sohn, S., & Sparacio, R. (2007). Brain substrates of craving to alcohol cues in subjects with alcohol use disorder. *Alcohol and Alcoholism, 42,* 417–422.

Pothos, E. M., Calitri, R., Tapper, K., Brunstrom, J. M., & Rogers, P. J. (2009). Comparing measures of cognitive bias relating to eating behaviour. *Applied Cognitive Psychology, 23,* 936–952.

Roberts, A. J., & Koob, G. F. (1997). The neurobiology of addiction: An overview. *Alcohol Health and Research World, 21,* 101–106.

Robinson, T. E., & Berridge, K. C. (2000). The psychology and neurobiology of addiction: An incentive-sensitization view. *Addiction, 95,* S91–S117.

Robinson, T. E., & Berridge, K. C. (2003). Addiction. *Annual Review of Psychology, 54,* 25–53.

Sarami, P., & Ghomashchi, F. (2003). The relationship between ADHD and Juridical and Social problems. *Tazkiyeh, 49,* 45–55.

Schoenmakers, T., Wires, R. W., Jones, B. T., Bruce, G., & Jansen, T. M. (2006). Attentional re-training decreases attentional bias in heavy drinkers without generalization. *Addiction, 102,* 399–405.

Shamloo, Z. S. (2007). *Information enhancement and goal setting: Interventions for enhancing motivation.* Unpublished doctoral thesis, University of Bangor, Wales.

Sherman, J. E., Zinser, M. C., Sideroff, S. I., & Baker, T. B. (1989). Subjective dimensions of heroin urges: Influence of heroin-related and affectively negative stimuli. *Addictive Behaviours, 14,* 611–623.

Siegrist, M. (1995). Reliability of the Stroop test with single-stimulus presentation. *Perceptual and Motor Skills, 81,* 1295–1298.

Siegrist, M. (1997). Test-retest reliability of different versions of the Stroop test. *Journal of Psychology, 131,* 299–306.

Stormark, K. M., Laberg, J. C., Nordby, H., & Hugdahl, K. (2000). Alcoholics' selective attention to alcohol stimuli: Automated processing? *Journal of Studies on Alcohol, 61,* 18–23.

Stroop, J. R. (1935). Studies of interference in serial verbal reaction. *Experimental Psychology, 18,* 643–662.

Tapper, K., Pothos, E. M., Fadardi, J. S., & Ziori, E. (2008). Restraint, disinhibition and food-related processing bias. *Appetite, 51,* 335–338.

Tiffany, S. T. (1990). A cognitive model of drug urges and drug-use behavior: Role of automatic and nonautomatic processes. *Psychological Review, 97,* 147–168.

Tiffany, S. T. (1999). Cognitive concepts of craving. *Alcohol Research & Health: Journal of the National Institute on Alcohol Abuse and Alcoholism, 23,* 215–224.

United Nations Office on Drug and Crime. (UNODC). *World drug report 2005.* Retrieved from http://www.unodc.org/pdf/WDR_2005/volume_1_web.pdf

Verhaeghen, P., & De Meersman, L. (1998). Aging and the Stroop effect, a meta-analysis. *Psychology of Aging, 13,* 120–126.

Wiers, R. W., Cox, W. M., Field, M., Fadardi, J. S., Palfai, T., Schoenmakers, T., & Stacy, A. (2006). The search for new ways to change implicit alcohol-related cognitions in heavy drinkers. *Alcoholism: Clinical and Experimental Research, 30,* 320–331.

Wiers, R. W., & Kummeling, R. H. C. (2004). An experimental test of an alcohol expectancy challenge in mixed gender groups of young heavy drinkers. *Addictive Behaviours, 29,* 215–220.

Wiers, R. W., Stacy, A. W., Ames, S. L., Noll, J. A., Sayette, M. A., Zack, M., & Krank, M. (2002). Implicit and explicit alcohol-related cognitions. *Alcoholism: Clinical and Experimental Research, 26,* 129–137.

Williams, J. M., Mathews, A., & MacLeod, C. (1996). The emotional Stroop task and psychopathology. *Psychological Bulletin, 120,* 3–24.

Received May 19, 2010
Revision received August 23, 2010
Accepted September 17, 2010 ■