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Substance Use and the Paradox of Good and Bad Attentional Bias

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Habitual substance use is associated with attentional bias for stimuli related to the use. The current study tested whether individuals' substance use can be predicted from their attentional bias for concern-related and substance-related stimuli. Participants (N = 71; 54% male) were selected among university students and the community. The study was conducted in Iran, in which alcohol consumption is illegal. Participants completed a substance use questionnaire and classic, substance-, and concern-related Stroop tests. The results show that after controlling for demographic variables and classic Stroop interference, increases in substance-related but decreases in concern-related reaction times predicted the amount of substances that had been consumed by the participants. Individuals' attentional bias for both substance-related and substance-unrelated goals may be important in predicting substance use behavior. The implication of the findings for treatment prognosis has been discussed.

Keywords: substance use, attentional bias, concern, Stroop test

Evidence based on the motivational model of alcohol use shows that individuals' decisions to consume alcohol increases when they have insufficient alcohol-unrelated goals in their lives to pursue or they have little success in achieving their alcohol-unrelated goals (Cox & Klinger, 1988, 1990; Fadardi & Cox, 2008). Therefore, as far as making decisions to use substances is concerned, the quality and quantity of individuals' goals in their lives matter. People who derive satisfaction from alcohol-unrelated goals generally feel less need to resort to chemicals as a means of regulating their emotions (e.g., Cox & Klinger, 2004b; Klinger, 1977).

Evidence (e.g., Schmuck, 2006) shows that the quality of goals is directly related to people's emotional well-being. For example, compared with those with insignificant, meaningless goals, people with significant, meaningful goals in their lives are more motivated, feel happier, and are less likely to develop emotional disorders (e.g., Cox & Klinger, 2004b; Fadardi, 2003; Fadardi & Cox, 2008; Klinger, 1977; Pintrich & Schunk, 2002), get involved in offending behaviors (e.g., Sellen, McMurran, Cox, Theodosi, & Klinger, 2006), or abuse alcohol or other chemical substances.

When a goal is set, a motivational state begins that is called a *current concern* (Klinger & Cox, 2004). As a hypothetical state of mind, although a current concern is cognitive in nature, it has strong associations with emotions. A current concern exists between two points in time: the time of getting committed to the pursuit of a goal and the time of achieving it or giving it up (e.g., Klinger, 1977; Klinger & Cox, 2004). Therefore, current concerns are *time binding*. This means that a current concern does not disappear when a person is engaged in other activities or when he or she sleeps (e.g., Nikles, Brecht, Klinger, & Bursell, 1998). Although there might be many current concerns at the same time, the person's behavior at any given moment in time may not reflect these concerns. Moreover, when a person has a goal, he or she cannot remain continuously preoccupied with it, and at a *subconscious* level, it continues to have an influence until the person accomplishes the goal or gives it up.

Finally, current concerns are *goal-lurking* entities. A current concern features the psychological processes that are necessary for the goal pursuit. A current concern sensitizes the person to goal-related cues in his or her environment (Klinger & Cox, 2004). Fadardi and Cox (2006) suggested that a current concern causes a circuit of specialized executive cognitive functions that is different from the circuits for other current concerns. Consequently, a current concern is a dynamic entity that, consciously or subconsciously, directs the person's resources toward the underlying goal; this can be achieved by spending more time thinking about the goal, seeking information, or becoming sensitive toward anything that is somehow related to the goal. As stated above, practice increases the automaticality of goal-related activities, including its cognitive processes.

There is empirical evidence in support of the dynamics of current concerns. For example, dream studies have shown that people's content of recall and dreams (Hoelscher, Klinger, & Barta, 1981; Klinger, 1978, 1996) are significantly related to their own current concerns than to those of others. Moreover, evidence from studies of alcohol and

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substance abuse (for reviews, see Cox, Fadardi, & Pothos, 2006; Field & Cox, 2008), anxiety and depression (Williams, Mathews, & MacLeod, 1996), food and dieting (e.g., Tapper, Pothos, Fadardi, & Ziori, 2008), and many other similar studies shows that having an important current concern sensitizes one's attentional resources to cues related to the person's current concerns.

As far as substance abuse is concerned, attentional bias for salient, substance-related cues or stimuli has been studied using various paradigms. Examples are artificial grammar learning (e.g., Pothos & Cox, 2002), implicit memory tests (e.g., Bradley, Mogg, & Millar, 1996), dot-probe tests (e.g., MacLeod, Mathews, & Tata, 1986), eyeblink tests (e.g., Amodio, Harmon-Jones, & Devine, 2003), and the addiction Stroop test (see Cox et al., 2006). The general finding of these studies is that substance abusers show greater attentional bias for substance-related stimuli than nonabusers. In fact, Fadardi and Cox (2006) showed that alcohol attentional bias could predict the amount of alcohol that was consumed by a sample of social drinkers. Field and Eastwood (2005) showed that experimental induction of alcohol attentional bias was associated with increased alcohol consumption in a taste test. Shamloo (2007) also showed that experimental reduction in sense of control increased participants' attentional bias for alcohol-related stimuli and their urges to drink.

However, evidence for the relationship between substance use and attentional bias has been largely limited to the study of hypersensitivity for substance-related stimuli. In other words, the relationship between attentional bias for substance-unrelated stimuli (namely, concern-related stimuli) and substance use has not been tested. As stated, those with nonchemical goals and concerns also develop implicit cognitions and attentional bias for concern-related stimuli, which, in turn, should contradict decisions to use chemicals. Therefore, we hypothesized that individuals' attentional bias for concern-related stimuli should adversely predict their decisions to use substances.

Method

Participants

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). Participation in the study was voluntary through advertisements displayed on departmental notice boards. The study was advertised as a project investigating people's reaction times and response precision in reaction to color words that appear on a computer screen. Potential participants were informed that they would also be required to anonymously answer a number of questions regarding the use of unprescribed substances. Of 71 people who participated, 63% were married and 73% had completed their undergraduate studies or a higher education degree. All participants gave informed consent prior to participation in the study. On completion of the experiment, participants were debriefed and thanked for taking part.

Instrument

Substance use questionnaire. In Iran, the classification of Class A, B, and C drugs is similar to many other countries. However, consuming alcohol and many Class C substances is illegal. Moreover, consuming unprescribed substances is highly stigmatized, and there is a great tendency to hide such behavior, especially in situations where perceptions of risk may arise from such reports. Fadardi (2005) developed the Persian Substance Use Questionnaire (P-SUQ) to measure Iranian nonaddicts' frequency of using 11 unprescribed substances. To increase the validity of substance use reports in the Iranian sample, the P-SUQ addresses a variety of chemicals with no overt reference to Class A to C substances. Respondents are required to rate on a Likert scale from 0 (*not at all*) to 7 (*quiet often*) the frequency of using each substance during the past 3 months. The substances indexed on the questionnaire are sedatives, antidepressants, antianxiety drugs, analgesics, psychedelic herbal medicines, tea and coffee, nicotine (smoking tobacco), unusual drinks, unusual drugs, and energizing and hallucinating drugs. In an implicit way, *unusual drinks* refer to alcoholic beverages and *unusual drugs* refer to Class A to C drugs. However, because there is no guarantee that all participants would make consistent implicit inferences about the latter two items (i.e., unusual drinks and unusual drugs), it was not possible to give additional weights to these items, compared with seemingly softer ones (i.e., caffeine vs. unusual drinks). Participants' responses on the P-SQU are summed, yielding a single score of substance use. Despite legal, religious, and cultural prohibitions associated with using alcohol and hard substances in Iran, there is agreement that self-reports of substance consumption (e.g., Cohen & Vinson, 1995; Sobell & Sobell, 1995) are reliable and valid, especially when the anonymity of the participants is assured.

The scale has good internal consistency (Cronbach's alpha = .71), and there is good evidence in support of criterion validity of the questionnaire. Fadardi, Shamloo, and Yazdi (2008) reported positive correlations between the P-SUQ and depression ($r = .44$, $p < .01$) and Shapiro's (1994) Negative Sense of Control ($r = .23$, $p = .001$) but negative correlations between the P-SUQ and Satisfaction With Life ($r = -.23$, $p < .05$), Intrinsic Motivation ($r = -.31$, $p < .01$), Positive Sense of Control ($r = -.30$, $p < .01$), and Shapiro's (1994) Overall Sense of Control ($r = -.33$, $p < .01$).

Stroop Tests

Five types of words were used to devise the Stroop tests used in this study. Congruent (e.g., *red* in red ink) and incongruent (e.g., *red* in blue ink) color words were used for the classic Stroop test (Stroop, 1935), which is a measure of general executive cognitive functions. Participants' reaction times and accuracy of responses on a computerized test have been shown to covary with their general executive cognitive functions (Fadardi & Cox, 2006). Four color words appeared 4 times (with an ink color consistent with

their meaning) to make 16 color-congruent color words; the set was repeated 3 times. The same color words appeared 3 times each (skipping the congruent stimulus for each color) to make 12 color-incongruent words; the set repeated 4 times.

The third type consisted of words related to substance use. There were seven substance-related words (i.e., *crystal, opium, heroin, tablet, syringe, straw, lighter*), each of which appeared in four colors (i.e., blue, green, yellow, red). Prior to finalizing the list of substance-related words for the addiction Stroop test, a long list of substance-related words in Persian was first compiled and rated in terms of their substance use relatedness by two pilot samples of 20 substance abusers and 20 nonabusers. Only words rated as highly related to substance use by the two samples were selected as candidate words to be included in the test. Similarly, a list of potential concern-related words was also rated by the pilot samples in terms of their relevance to people's common daily goals (i.e., *health, family, love, home, study, job, clothing*).

To calculate an index of attentional bias for substance- and concern-related words, it is always necessary to include a category of control words that are emotionally neutral (not salient) to the respondents. Again, a list of potentially neutral words was shown to the pilot samples, and the words that were rated the most irrelevant to people's goals or substance use were considered as candidate words. All control words were related to building items (i.e., *door, window, stair, fence, cupboard, key, ceiling*). Finally, seven words from each control, substance-, and concern-related lists were selected to be included in the Stroop test. The lists were also balanced for the number of letters, syllables, and semantic relatedness. It was not possible to control for the words' frequency of usage in written and spoken language because of lack of such a reference in Persian.

It has to be noted that, theoretically, composing individualized lists of stimuli to be included in the Stroop test could be preferable and even lead to stronger interference effects; however, this is not always possible because of various reasons such as problems with the lexical comparability of the world lists and programming issues. Moreover, the bulk of research in the field of addiction Stroop (see Cox et al., 2006) shows that common lists of stimuli can produce reliable and valid results. Moreover, Fadardi and Cox (2009) showed that a generic list of concern-related words based on descriptions of heavy drinkers' personal concerns can be reliably used to detect attentional bias for common goals.

Apparatus

The software used to make the computerized Stroop tests was SuperLab Pro SKD (Cedrus-Corporation, 1999). All stimuli were presented via a PC on a 17-in. display that was located 40–55 cm away from the participant's eyes. A standard keyboard was used as the response input device. On the keyboard, four keys (?, the *less than* [<] key, *C*, and *Z*) were tagged with different colored dots to indicate response choices.

Procedure

On giving informed consent and prior to starting the Stroop tests, all participants were given 50 practices with color patches to familiarize participants with the computerized test. On the actual test, each word was presented at the center of the display for a maximum of 3 s, after which or on pressing a key a cross appeared for 500 ms prior to presentation of the next stimulus word. The order in which words from each category were presented was randomly determined. 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

Independent samples *t* tests were conducted on men's and women's age, education, and the P-SUQ single items. The total score showed that the two genders were different only on years of education, with women having 1.8 years more education than men (M = 14.25 years), $t(69) = 2.31$, $p = .024$. The results of two multivariate analyses of variance showed that, compared with men, women had faster reaction times (RTs) to substance words, $F(1, 71) = 6.73$, $p = .012$, and to control words, $F(1, 71) = 4.87$, $p = .031$. Moreover, women made fewer errors than men when responding to (a) incongruent words, $F(1, 71) = 8.10$, $p = .006$; (b) substance-related words, $F(1, 71) = 5.15$, $p = .026$; and (c) concern-related words, $F(1, 71) = 5.60$, $p = .021$.

Participants' mean percentages of errors were 1.58% on the congruent category, 2.35% on the incongruent category, 0.70% on the substance category, 0.84% on the concern category, and 0.56% on the neutral category. The numbers of errors made were not considerable; therefore, further analyses on the number of errors were deemed unnecessary.

Each participant's RT to the color-congruent words on the classic Stroop test was subtracted from that participant's mean RT to the color-incongruent words. The resulting interference score was used as an index of participants' inhibitory processes and cognitive flexibility. Substance-interference scores (SA) were calculated as participants' mean RT to the substance-related words minus their mean RT to the neutral words. Concern-interference scores (CA) were calculated as participants' mean RT to the concern-related words minus their mean RT to the neutral words. RTs on trials on which errors were made (i.e., incorrect or no response) were not included in the calculations, nor were RTs that were either unrealistically fast (i.e., < 400 ms) or slow RTs (i.e., > 2,000 ms). Women and men did not differ from each other on either of the interference scores.

Table 1 shows intercorrelations among substance use, gender, marital status, age, education, and interference scores for classic, substance-, and concern-related Stroop tests. As the table shows, substance use was correlated

Table 1
Intercorrelations Among Substance Use, Gender, Marital Status, Age, Education, and Interference Scores for Classic, Substance-, and Concern-Related Stroop Tests

Variable	Substance use	Gender	Marital status	Age	Education	Cl St Int	Sub Att bias
Gender	−.15						
Marital status	.14	−.042					
Age	.20*	−.098	.76**				
Education	−.28*	.26*	−.47**	−.41**			
Cl St Int	−.16	.010	.22*	−.001	.11		
Sub Att bias	.043	−.094	.084	.050	−.099	−.006	
Conc Att bias	−.16	.067	.035	−.010	−.13	.012	.75**

Note. Cl St Int = classic Stroop interference; Sub Att bias = substance-related attentional bias; Conc Att bias = concern-related attentional bias. Gender: male = 1; Marital status: single = 1.
* $p < .05$. ** $p < .001$.

positively with age and negatively with education. There was also a significant positive correlation between CA and SA.

A multiple hierarchical regression analysis was conducted to test whether substance use can be predicted from SA and CA. In the model, substance use was entered as an outcome variable. Gender, marital status, age, education, and classic Stroop interference scores (as a measure of executive cognitive function) were entered into the first step of the model; SA and CA were entered into the second step. The adequacy of the regression analysis was ensured by checking the model's a priori and a posteriori assumptions (Miles & Shevlin, 2001).

As Table 2 shows, the first step of the model did not produce a significant increase in the model's variance, $F(5, 71) = 1.69$, $p = .14$. However, the addition of SA and CA on the second step led to a significant increase in the variance of the model, $F(2, 71) = 2.34$, $p = .033$, with the two predictors working in opposite directions to each other in predicting substance use. That is, increases in SA, but decreases in CA, significantly predicted the frequency of substance use reported by nondependent users after controlling for demographic variables and executive cognitive function.

Discussion and Conclusions

The results of the current study show for the first time that participants' attentional bias for SA was positively associated with the amount of substances that they had reportedly used, whereas their attentional bias for CA was negatively associated with the amount of substances that they had reportedly used. This finding supports claims made by the theory of current concerns in predicting attentional bias for emotionally salient stimuli and its role in people's substance use behaviors. The relationship between substance use and developing attentional bias for substance-related stimuli has already been discussed. As stated above, when SA develops, it contributes to the person's decisions to use substances by increasing the person's awareness of the substances in the environment and its role in initiating an automatic, appetitive chain of substance use decisions and behaviors (e.g., Bechara, 2005; Fadardi & Cox, 2008; Robinson & Berridge, 2008; Wiers et al., 2006). Cox, Pothos, and Hosier (2007) reported that alcohol attentional bias was inversely related to abusive drinkers' ability to reduce their alcohol intake; those with low alcohol attentional bias reported more reductions in their alcohol consumption than those with high alcohol attentional bias.

As the results of a review by Kalivas and Volkow (2005) also suggest, abusing substances may cause pathological changes in the neurochemistry of the brain (e.g., in the excitatory neural pathways of the prefrontal cortex and nucleus accumbens); such changes reduce the brain's capacity to respond naturally to biological rewards and to exercise control over substance-seeking behaviors in response to substance-related stimuli. However, the extent to

Table 2
Hierarchical Regression Predicting Frequency of Substance Use From Substance- and Concern-Related Attentional Bias After Controlling for Demographic Variables and Classic Stroop Interference

Model	Variable	*B*	*SE*	β	*t*	ΔR^2
1	(Constant)	14.03	5.42		2.58*	.12
	Gender	−1.07	1.48	−.088	−0.72	
	Marital status	−0.16	2.55	−.013	−0.062	
	Age	0.089	0.14	.12	0.66	
	Education	−0.36	0.25	−.19	−1.40	
	Cl St Int	−0.010	0.009	−.14	−1.08	
2	Sub Att bias	0.023	0.011	.37	2.11*	.091*
	Conc Att bias	−0.031	0.011	−.48	−2.68**	

Note. Cl St Int = classic Stroop interference; Sub Att bias = substance-related attentional bias; Conc Att bias = concern-related attentional bias.
* $p < .05$. ** $p < .001$.

which such brain changes are responsible for substance use behaviors in nondependent users is not yet clear.

One culturally relevant reason that may fortify the salience of substance-related stimuli compared with the reduced salience of concern-related stimuli could be the fact that in Iran alcohol and other illicit drugs are associated with stigma and threat. As suggested by some researchers (e.g., Algom, Chajut, & Lev, 2004; McKenna & Sharma, 1995, 2004), in an emotional Stroop test, perceptions of threat may interact with the self-relevance of the stimuli in producing attentional bias. However, there is no evidence comparing the degree to which variations in self-relevance versus threat features of the stimuli may be responsible for RT latencies in addiction Stroop studies.

The negative relationship between CA and substance use reported in the present study needs to be elaborated. One may argue that many substance abusers have various substance-unrelated goals also. Although it seems that having a number of important, substance-unrelated goals is paradoxical to decisions to use substances, the relationship is not that simple. There are various factors that contribute to the quality of goals and the degree to which a person can successfully pursue them.

For instance, intrinsic goals lead to better mental health consequences than extrinsic goals (e.g., Elliot et al., 2000; Milkulincer, 1994; Spruijt-Metz, 1995). There is a general consensus that extrinsic goals (such as devoting one's life to wealth and fame) reduce the meaningfulness of a person's life and are unhealthy and dysfunctional (Kasser & Ryan, 1993, 1996; Klinger, 1975; Ryan et al., 1999; Sheldon & Kasser, 1998). In contrast, people with more altruistic goals are healthier than those with more self-centered goals, and those who are optimistic in achieving their goals are emotionally healthier than those who are rather pessimistic (e.g., Martinez & Sewell, 2000; Martin-Krumm, Sarrazin, Pererson, & Famose, 2003). Research within the framework of motivational structure (see Cox & Klinger, 2004a) shows that an appetitive goal (e.g., studying for a favorite degree) is usually associated with higher levels of motivation and joy, whereas an aversive goal (e.g., studying for a boring subject) may cause lethargy and resentment.

Unresolved goals can be a significant, continuous source of negative emotions, such as anxiety, stress, frustration, and depression, which in turn might lead an individual to resort to maladaptive coping mechanisms (e.g., substance use, alcohol abuse; Cooper, Agocha, & Sheldon, 2000; Cooper, Frone, Russell, & Mudar,1995; Cox & Klinger, 1988; Klinger, 1977; Kushner, Sher, Wood, & Wood, 1994; Willinger et al., 2002). Cox, Hogan, Kristian, and Race (2002) showed that inpatient alcohol abusers who showed high distraction for concern-related stimuli at treatment admission were more likely to quit their treatment than those with little distraction. This finding suggests that strong current concerns about unfinished businesses may have interfered with the patients' detoxification goal.

Therefore, goal pursuit strategies that people use have important consequences because they determine one's success in achieving goals, thereby affecting one's emotional well-being. Cox and Klinger (2002, 2004b) proposed the construct of motivational structure to formulate the role of various factors that individually, or in their unique relations with each other, determine people's success or failure in pursuing their goals. A rational, adaptive pattern of relations among these factors increases one's chances of success, whereas a maladaptive pattern of relations will reduce one's chances of success. For example, a maladaptive motivational structure will exist if one's goals are mainly aversive with a low sense of control in achieving them, little knowledge about how to achieve one's goals, or disproportional emotional involvement with one's goal-seeking activities (Klinger & Cox, 2004). There is evidence that maladaptive motivation is associated with excessive drinking (e.g., Beckman, 1980; Cox & Klinger, 2004b; Deaton, 1975; Fadardi & Cox, 2008), marital dissatisfaction (Soleimanian, Navabinezhad, & Farzad, 2006), and offending behaviors (Sellen et al., 2006).

One important question remains: Can motivational structure be improved, and if so, can such improvement reduce one's attentional bias for substance-related stimuli? There is limited empirical evidence to answer this question. However, evidence from studies on sense of control seems promising. People's feelings of sense of control appear to be the key to their success (Shapiro & Astin, 1998) and mental health (Lachman, Ziff, & Sapiro, 1994; Ziff, Conrad, & Lachman, 1995). Frequent failures in a given situation may cause a person to conclude that there is no point in struggling to control the situation (e.g., one gets an electric shock regardless of what he or she does); *learned helplessness* has negative consequences on people's feelings of success in their lives and on their mental health (Seligman, 1975, 1994; Maier, Peterson, & Schwartz, 2000).

The only empirical study showing the direct relationship between motivational indices and attentional bias is that of Shamloo (2007), who showed that increasing excessive drinkers' sense of control and their intrinsic motivation might help them to counteract negative feelings that underlie their desire to drink and actual drinking. In an experimental study, she randomly assigned participants into one of three groups: a control group and a high and a low sense of control group. Using two experimental tasks, she manipulated the experimental groups' sense of control. The results showed that, at posttest assessment, participants in the low sense of control group showed significantly higher attentional bias for alcohol-related stimuli than controls, but an opposite pattern was found with the high sense of control group. The results also support the notion that improvements in people's motivation can reduce the chances that they will make decisions to use substances (Cox, Blount, Bair, & Hosier, 2000; Cox et al., 2002; Cox & Klinger, 2002, 2004b).

Finally, we would like to address potential limitations of the current study. First, one may argue that the results cannot be readily generalized because the participants were selected from a wider community, that is, not restricted to university students. Although some authors (e.g., Cole, 1979) argue in favor of homogeneity of samples as a reason for increasing their representativeness, others (e.g., Spilker, 1991) believe that generalizability of findings is related to

the external validity, and a heterogeneous sample is a better representative of the outer world. Therefore, it seems that there is no general consensus about the relationship between homogeneity and heterogeneity with generalizability (e.g., Fienstein, 1983; Mook, 1983) of the findings. Second, in regards to the P-SUQ, although it is possible that different participants may interpret items related to unusual drinks (to indicate alcohol consumption) and drugs (to indicate hard drugs) in different ways, the implication of the items is rather clear for Iranian participants. However, we admit that when non-Iranian cultures are concerned, individual items of the P-SUQ should be scrutinized separately; otherwise, there is the risk that heavy use of legal substances such as tea and coffee could be equated with illegal and harmful drugs such as hallucinogens.

To summarize, it seems that having an attentional bias for goals that are unrelated to substance use is contrary to getting distracted by cues related to substances. It means that having current concerns about other, substance-unrelated goals requires that sufficient attentional resources be allocated to them, which means that there will be fewer attentional resources available to be allocated to the substances. Moreover, substance-unrelated current concerns may mean that such a person is enjoying his or her life in a safe and productive way, that is, the person is emotionally satisfied and is not motivated to resort to chemicals to compensate for his or her lack of joy and satisfaction.

The current tendency to focus on substance-related cognitions has diverted researchers from paying attention to the role of substance-unrelated cognitions in substance use behavior. Results presented in the current study suggest that such cognitions may be equally important in diagnostic and therapeutic procedures in addictive behaviors.

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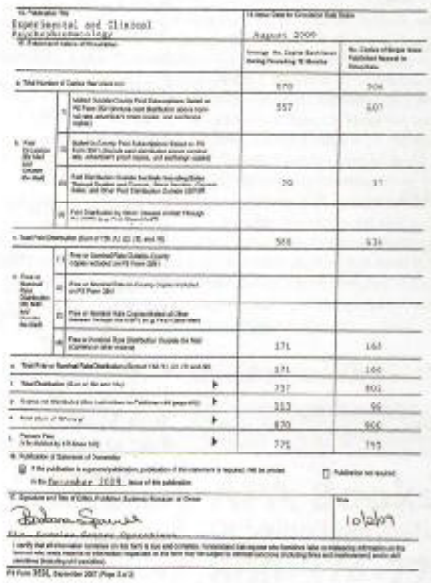

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