RUNNING HEAD: Mechanisms of relapse during abstinence in impulsive smokers

The Role of Impulsivity on Smoking Maintenance

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Abstract

In order to better understand why those higher in impulsivity experience more difficulties during smoking abstinence, the current study examined the possible mechanisms contributing to cigarette smoking relapse. Fifty dependent cigarette smokers completed measures designed to assess tobacco withdrawal severity, craving, and negative affect during 48 hours of nicotine abstinence. Using a series of multilevel models (SAS Proc Mixed Procedure), significant group x time analyses revealed that those higher in trait-impulsivity ($N = 27$) experienced significantly greater increases in tobacco withdrawal symptoms, F (2, 96) = 3.80, $p < .05$, and craving, F (2, 96) = 4.00, $p < .05$, compared to those lower in trait-impulsivity ($N = 23$). These findings indicate that those higher in trait-impulsivity may lack the ability to find an accessible and comparable substitute for cigarette smoking during a period of abstinence. This study also highlights the importance of considering individual differences when treating those who wish to quit smoking.

The Role of Impulsivity on Smoking Maintenance

Despite the well-known health risks associated with cigarette smoking, this behavior remains one of the leading causes of preventable death in the United States (Centers for Disease Control [CDC], 2005). It is estimated that approximately 20.9% (45.1 million) of U.S. adults are current cigarette smokers, with 80.8% (36.5 million) of this group smoking daily (CDC, 2006). Although effective interventions have been developed (United States Department of Health and Human Sciences [USDHHS], 2000) and smoking rates have been on the decline over the last 10 years, a close examination of the percentages of those who report current smoking behavior over the last 2 years appears to indicate that this decline has peaked (CDC, 2006).

The consensus among researchers is that one of the primary obstacles to successful smoking cessation is nicotine withdrawal (Kassel, Stroud, & Paronis, 2003; Niaura et al., 1999; Robinson et al., 1995; West, 1984). In particular, research has shown that during cessation, smokers will experience heightened levels of negative affect (Kassel, Stroud, & Paronis, 2003; Tiffany & Drobes, 1990) in addition to other physical symptoms such as restlessness and decreased heart rate (Hughes & Hatsukami, 1986). Thus, smoking behavior becomes negatively reinforced via attempts to alleviate these symptoms. In fact, previous research has reliably shown that smokers report using cigarettes as a means of relieving negative affect (Gilbert, Sharpe, Ramanaiah, Detwiler, & Anderson, 2000; Wetter et al., 1994). Craving is another important construct that appears to contribute to the maintenance of smoking behavior (Shapiro, Jamner, Davydov, & Porsha, 2002; Shiffman, Paty, Gwalney, & Dang, 2004). Craving, which is currently not considered a symptom of nicotine withdrawal, tends to develop gradually during an abstinence period, rather than increasing sharply post-quit like other withdrawal symptoms

(Hughes et al., 1986; Shiffman et al., 1997). Thus preparing individuals to cope effectively with craving is difficult given its unpredictable nature and what will trigger such feelings.

Other important factors that appear to be related to smoking relapse are personality traits (Gilbert, Crauthers, Mooney, McClernon, & Jensen, 1999; Spielberger & Jacobs, 1982). Impulsivity is one such trait that has been linked to the initiation and maintenance of a variety of substances including, alcohol (Allen, Moeller, Rhoades, & Cherek, 1998), cocaine (Cascella et al., 1994), heroin (Kirby, Petry, & Bickel, 1999), and smoking (Bickel, Odum & Madden, 1999; Mitchell, 1999). Despite the fact that impulsivity has been widely examined in the substance abuse literature, it remains a term that is difficult to define. Reasons for this difficulty include confusion with other terms such as impulse control, self-control, and self-regulation. For the purpose of this study, and consistent with the existing substance abuse literature, trait-impulsivity is defined as a pattern of behaviors predicting a tendency to respond quickly to a given stimulus or to readily available rewards, without forethought of possible negative consequences (Bickel et al., 1999; Mitchell, 1999; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001; Monterosso & Ainslie, 1999).

With regard to the relationship of smoking relapse and impulsivity, Doran, Spring, McChargue, Pergadia, & Richmond (2004) found that smokers with higher levels of trait-impulsivity experienced greater difficulty in maintaining smoking abstinence. Specifically, those participants high in trait-impulsivity were significantly more likely to relapse within 48 hours of completing a one-day smoking cessation workshop compared to their peers with lower levels of this trait. These results map onto previous findings in the cocaine literature, which showed that high impulsive, cocaine-dependent individuals showed greater treatment dropout rates than their counterparts with lower levels of impulsivity (Moeller et al., 2001). However, both of these

studies involved treatment components, which put inherent limitations on answering the question of why these individuals are more likely to relapse. Specifically, Doran and colleagues (2004) suggest that the mood management skills taught during the treatment intervention in their study may have reduced the affective symptoms of nicotine withdrawal in all participants, thereby diminishing any differences that may be present across groups. Such differences are important to better understand how individual differences may impact quit attempts.

Several explanations have been postulated in an attempt to explain why those higher in trait-impulsivity are more likely to use substances of abuse and why these individuals are also more prone to relapse. Specifically, sensation seeking, a trait similar to impulsivity, has been shown to account for a significant portion of the variability in the initiation of risky behaviors, including the use illicit drugs and cigarette smoking (Stephenson, Hoyle, Palmgreen, & Slator, 2003; Zuckerman and Cloninger, 1996). Additionally, there is evidence indicating that impulsivity is higher in adolescent smokers compared to their nonsmoking peers and that smoking progression is mediated by peer influences (Audrain-McGovern et al., 2004). Finally, other studies show that impulsive individuals may experience heightened levels of reward (or heightened expectations of reward) from substances of abuse compared to non-impulsive individuals (Doran, McChargue & Cohen, 2007; Doran et al., 2006; Martin & Potts, 2004; Cascella et al., 1994).

The primary aim of the present study was to examine mechanisms whereby individuals higher in trait-impulsivity relapse more quickly compared to individuals lower in trait-impulsivity during a 48-hour period of smoking abstinence. Specifically, changes in tobacco withdrawal, craving, and negative affect (e.g., anxiety and depression) were examined. It was hypothesized that the decreased reward consumption from not smoking experienced by those

high in impulsivity would be directly related to increases in the abovementioned mechanisms of relapse. Forty-eight hours was chosen as the period of abstinence in order to build upon previous research assessing impulsivity and relapse (Doran et al., 2004) and because tobacco withdrawal mechanisms are believed to peak during the first 48-hours of abstinence (Hughes & Hatsukami, 1986).

Method

Participants

Participants were undergraduate smokers recruited via flyers and listserv announcements seeking individuals between ages 18-40 who smoked at least 16 cigarettes per day for the past six months. Eligible smokers (N = 50: 32% female) had to score a five or greater on the Fagerström Scale of Nicotine Dependence (FTND; Heatherton et al., 1991) and meet the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition -Text Revision (DSM-IV-TR) criteria for Nicotine Dependence (American Psychiatric Association [APA], 2000). On average, participants were almost 23 years of age (M = 22.72, SD =4.8, range = 18-40) and smoked approximately a pack of cigarettes each day (M = 19.44, SD = 3.9, range = 16-35). Potential participants were excluded at screening if they reported current use of psychotropic medications, having a psychiatric diagnosis, were nursing, pregnant, or trying to become pregnant, or experienced a recent event that led to significant fluctuations in their emotional well-being.

Procedure

Interested study candidates were screened by telephone. Eligible participants were asked to come to the laboratory for three consecutive days (either Monday through Wednesday or

Wednesday through Friday). During the first day of the experimental protocol (Baseline), informed consent was obtained and smoking status for each participant was biochemically validated using a carbon monoxide (CO) monitor (Model 2900; Vitalograph, Lenexa, KS., USA) with a value of $\geq$ 10 parts per million (ppm) to ensure that each participant was a regular smoker. Participants were informed that they would be asked to provide a CO measure each day that they participated in the study and it was explained that the information would be used to biologically confirm their self-reported 24- and 48-hour abstinence.

Participants were then asked to complete the study questionnaires and to abstain from any form of nicotine use for the following 48 hours. Participants were scheduled for appointments the same time for the following two days. To confirm smoking abstinence at both 24 and 48 hours, a CO level of less than 10 (ppm) or at least 50% less than the baseline CO reading had to be obtained at the start of Day 2 (24 hour abstinence) and Day 3 (48 hour abstinence). If participants had CO levels greater than this criterion on either Day 2 or Day 3, they were asked to reschedule all days for the following week. If participants had appropriate CO levels, they were asked to complete the same measures they completed at Baseline. At the end of Day 3, participants were debriefed and any questions related to the study were answered.

Assessments – Screening and Experimental Sessions

Impulsivity. The Barratt Impulsiveness Scale, version 11 (BIS-11; Patton, Stanford, & Barratt, 1995) provides a measure of trait-impulsivity, divided on three impulsiveness subtraits: acting without forethought, being focused on the present rather than the future, and quick cognitive decision making (Patton et al., 1995). The BIS-11 is a 30-item self-report questionnaire that asks participants to rate on a 4-point Likert scale the degree to which a series of statement applies to them from “Rarely/Never” (1) to “Always/Almost Always” (4). Cumulative scores range from

30 (low in trait-impulsivity) to 120 (high in trait-impulsivity). The BIS-11 has three subscales: Nonplanning Impulsiveness, Attentional Impulsiveness, and Motor Impulsiveness. The BIS-11 has been shown to be reliable in both clinical and community samples, with Cronbach's alpha coefficients ranging from .79 to .83 (Patton et al., 1995). The BIS-11 is structured to assess long term patterns of behavior, and has been used to assess trait levels of impulsivity across a variety of populations (e.g., Mitchell, 1999; Moeller et al., 2002; Stanford, Greve, Boudreaux, Mathias, & Brumbelow, 1996).

Nicotine Dependence. The Fagerström Test for Nicotine Dependence was used to assess level of nicotine dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991). The FTND is a brief self-report instrument designed to correlate with physiological measures of nicotine tolerance. The FTND consists of six items rated either from 0 to 1 or from 0 to 3 (depending on the question) that can yield a total score of 10, with higher scores indicating greater nicotine dependence. The FTND has demonstrated adequate internal consistency (Cronbach's alpha = .64; Pomerleau, Carton, Lutzke, & Flessland, 1994) and strong test-retest reliability over time (r = .88, Pomerleau et al., 1994).

Smoking Status. During the screening, participants reported their average daily number of cigarettes smoked. Also, participants' smoking status as well as abstinence from smoking was assessed via a CO monitor (Model 2900;Vitalograph, Lenexa, KS., USA). Carbon Monoxide (CO) measures provide a biological marker to validate smoking status as well as to corroborate self-reported smoking abstinence. According to the guidelines set forth by the Society for Research on Nicotine and Tobacco's Subcommittee on Biochemical Verification (2002) abstinent participants must have CO levels below 10 parts per million (ppm). Due to the fact that some participants may have very high levels at baseline, a second criterion for the verification of

abstinence will be considered. Individuals with initial CO levels above 20 ppm must demonstrate a drop in CO level by at least 50%. This criterion has been used in other studies (Bickel et al., 1991; Tidey, Higgins, Bickel, & Steingard, 1999). Participants' CO level was also used to determine eligibility to complete the study. According to the Subcommittee on Biochemical Verification the optimal cut-off CO level to distinguish a tobacco user from a nonuser is between 8-10 ppm. This study used a cut-off CO level of 10 ppm in an attempt to insure that only regular smokers completed the study.

Nicotine Withdrawal and Craving. The Withdrawal Symptoms Checklist (WSC; Hughes & Hatsukami, 1986) is a 12-item self-report measure that is designed to assess the presence of tobacco withdrawal symptoms and the severity of each symptom. The severity scores are based on a 4-point Likert scale, ranging from 0 (not present) to 3 (severe). The instrument has been shown to be valid and reliable. For purposes of this study, the total score on the WSC was calculated by taking the sum of all the items on the measure minus the craving item. We omitted the "craving" item from the total score given it is not currently listed as a nicotine withdrawal symptom in the DSM-IV-TR (APA, 2000). The craving item, however, was used in isolation to assess cigarette craving.

Negative Affect. The Profile of Mood States (POMS; McNair, Lorr & Droppleman, 1971) is a 65-item self-report questionnaire used to assess distinct mood states. The POMS uses an adjective checklist rated on a 5-point Likert scale ranging from (0 = Not at all) to (4= Extremely). The "right now" version was used to determine participants' mood while in the laboratory. Six factors have been derived using factor analysis (McNair et al., 1971) that correspond to the 6 basic moods assessed (Tension-Anxiety, Depression-Dejection, Anger-Hostility, Vigor-Activity, Fatigue-Inertia, and Confusion-Bewilderment). For purposes of this

study, the tension-anxiety and depression-dejection factors were used as the primary measurement of negative affect.

Data Analysis

Tobacco withdrawal, negative affect, and craving were analyzed across the three time-points (baseline, 24-hr, 48-hr) using a series of repeated measures multilevel models analyses using the SAS Proc Mixed Procedure (REF). Using this analysis provided a way to account for variation in the intercepts and slopes across each participant (Littell, Milliken, Stroup, Wofinger, & Schabenberger, 2006). The Proc Mixed method also allows for the ability to specify the covariance structure within a between subjects research design. The covariance structure used for this analysis was the first-order autoregressive, or AR(1) model. This covariance structure was chosen after obtaining estimates of the correlation and covariance among residuals as well as estimates for model fit, as recommended by Littell et. al(2006). This model allows for observations being equally spaced temporally along with the assumption that the correlation structure would not change substantially over time. These models were performed comparing the high trait-impulsives as measured by the BIS-11 (M = 76.3, SD = 8.5) to the low trait-impulsives (M = 56.2, SD = 5.6). Groups were formed using a BIS-11 cutoff value of 67, which was the median BIS-11 score in our sample. This value is similar to previous studies using a nonclinical sample (Doran et al., 1994; Doran et al., 2006). Analyses of variance (ANOVAs) were then used to test for simple main effects.

Results

Demographic characteristics including, number of cigarettes smoked, previous quit attempts, and nicotine dependence were examined using chi-square analyses for categorical

variables or (ANOVAs) for continuous variables. No significant differences were observed across groups (high vs. low impulsives) for any of the demographic variables. Means and standard deviations are presented in Table 1.

<Insert Table 1 about here>

Total Withdrawal

It was hypothesized that relative to those lower in trait-impulsivity, a 48-hour period of smoking abstinence would induce higher levels of tobacco withdrawal, negative affect, and craving among those with higher levels of this trait. Model fit statistics for repeated measures multi-level mixed modeling indicate significant model fit for the model examining the effects of the impulsivity group, time, and the interaction of impulsivity group and time on WSC withdrawal scores, -2 Residual Log Likelihood = 884.6, Null Model Likelihood Ratio Test, χ^2 (1) = 40.20, p <.0001. Inspections of covariance parameter estimates indicate mostly significant Z values for all estimates. Significant parameter estimates indicate significant variability in intercepts and slopes for the model as specified. Analysis of the total scores obtained on the WSC between groups indicated a significant main effect of time, F (2, 96) = 13.51, p < .0001, but only a trend toward significance between groups, F (1, 48) = 3.91, p = .054. As expected, there was a significant time x group interaction, F (2, 96) = 3.80, p < .05, indicating that those higher in trait-impulsivity experienced significantly higher levels of tobacco withdrawal relative to those lower in trait-impulsivity. Figure 1 presents the mean WSC scores for each group across the three time-points.

<Insert Figure 1 about here>

Craving

Model fit statistics for repeated measures multi-level mixed modeling indicate significant model fit for the model examining the effects of the impulsivity group, time, and the interaction of impulsivity group and time on WSC craving scores, -2 Residual Log Likelihood = 339.1, Null Model Likelihood Ratio Test, χ^2 (1) = 6.92, p <.01. Inspections of covariance parameter estimates indicate mostly significant Z values for all estimates. Significant parameter estimates indicate significant variability in intercepts and slopes for the model as specified. The role of craving during the cessation period indicated a significant main effect for time on the pattern of craving scores, F (2, 96) = 19.37, p < .0001, but no significant main effect for group. There was a significant time x group interaction, F (2, 96) = 4.00, p < .05, which reflected higher levels of craving for cigarettes over the 48 hours of cessation among those higher in trait-impulsivity. Figure 2 presents the mean WSC craving scores for each group across the three different time-points.

<Insert Figure 2 about here>

Negative Affect

The study hypotheses related to impulsivity and negative affect revealed mixed results. For anxiety, model fit statistics for repeated measures multi-level mixed modeling indicated significant model fit for the model examining the effects of the impulsivity group, time, and the interaction of impulsivity group and time on the POMS anxiety scores, -2 Residual Log Likelihood = 849.2, Null Model Likelihood Ratio Test, χ^2 (1) = 46.75, p <.0001. Inspections of covariance parameter estimates indicate mostly significant Z values for all estimates. Significant parameter estimates indicate significant variability in intercepts and slopes for the model as

specified. Analyses revealed a main effect for time, F (2, 96) = 11.02, $p < .0001$, as well as for group, F (1, 48) = 15.65, $p < .001$. However, contrary to expectations, only a trend toward a significance was observed in the time x group interaction, F (2, 96) = 2.99, $p = .055$. These results appear to reflect a distinction between the levels of anxiety experienced at the onset of the cessation period and over time. Follow-up (ANOVAs) revealed that those higher in trait-impulsivity had significantly higher group means at baseline, F (1, 49) = 4.26, $p < .05$, 24-hrs of abstinence, F (1, 49) = 13.41, $p < .01$, and 48-hrs of abstinence, F (1, 49) = 15.51, $p < .001$. Figure 3 presents the mean POMS anxiety-tension factor scores for each group across the three different time-points.

<Insert Figure 3 about here>

For depression, model fit statistics for repeated measures multi-level mixed modeling indicated significant model fit for the model examining the effects of the impulsivity group, time, and the interaction of impulsivity group and time on the POMS depression scores, -2 Residual Log Likelihood = 866.2, Null Model Likelihood Ratio Test, χ^2 (1) = 71.71, $p <.0001$. Inspections of covariance parameter estimates indicate mostly significant Z values for all estimates. Significant parameter estimates indicate significant variability in intercepts and slopes for the model as specified. Analyses revealed a a main effect for group, F (2, 96) = 4.63, $p < .05$, however there was not a significant main effect for time, F (2, 96) = 1.51, $p = n.s.$, nor was there a significant interaction, F (2, 96) = 0.59, $p = n.s.$ Follow-up one-way ANOVAs revealed that individuals with higher levels of trait-impulsivity had significantly higher levels of POMS depression-dejection scores at the 24-hr, F (1, 49) = 4.60, $p < .05$, and 48-hr, F (1, 49) = 7.37, $p < .05$, time-points.

Discussion

The present study examined the effect of a 48-hr period of abstinence in an attempt to clarify the role of impulsivity on smoking behavior. The primary aim was to examine the possible mechanisms of relapse that may explain why those higher in trait-impulsivity appear to relapse more quickly during a period of smoking abstinence. For this project, repeated measurements of tobacco withdrawal, craving, and negative affect were measured. As expected, those with higher levels of trait-impulsivity experienced significantly greater increases in nicotine withdrawal and craving from baseline to 48-hrs of abstinence. Results were mixed, however, with respect to negative affect. Specifically, a trend towards significance was observed for anxiety, but no association was found for depression. These results indicate anxiety may be a better predictor of relapse in those with higher levels of trait-impulsivity than depression or more general negative affect.

To our knowledge, the present study was the first to assess the mechanisms of relapse in those higher in trait-impulsivity without the use of a treatment paradigm. Contrary to prior findings in the literature (Doran et al., 2004), results from this study indicate that the intensity of nicotine withdrawal and craving increase at a significantly greater rate for those with higher levels of trait-impulsivity. These findings are consistent with previous research examining other substances of abuse showing that impulsivity was related to increases in withdrawal during an abstinence period (Moeller et al., 2001). The non-significant findings with respect to negative affect and impulsivity are not entirely surprising given that previous studies have been unable to show a consistent relationship (Doran et al., 1994). In this sample however, those higher in trait-impulsivity showed heightened baseline levels of anxiety and depression, along with increases at both the 24-hr and 48-hr timepoints. These results replicate previous research (Emmons &

Diener, 1986) suggesting that those higher in impulsivity may be more prone to affective disturbances than others.

Significantly greater increases in both nicotine withdrawal and craving over a 48 hour period of abstinence among those higher in trait-impulsivity may account for the higher levels of relapse observed among this population. These data are particularly interesting given the current sample was not prepared in advance to effectively cope with the withdrawal symptoms experienced during the abstinence period. These findings lend support to previous speculation that those higher in trait-impulsivity have more difficulty finding appropriate and comparable substitutes during an abstinence period (Kreudelbach, McCormick, Schulz, & Grueneich, 1993). The possible implication of this finding is that these individuals are more likely to relapse, due to the fact that they find cigarettes more rewarding compared to their peers with lower levels of trait-impulsivity.

Important limitations do need to be observed when interpreting or generalizing from the present study. For instance, while the participants were dependent smokers, they were generally college-aged (e.g., 18-24). This population may be more prone to increased cues in their environment which could lead to increased levels of craving and nicotine withdrawal. However, estimates indicate that up to 25% of adult smokers initiated smoking after entering college (Everett et al., 1999) and that nicotine abuse peaks during this time of emerging adulthood (Chen & Kendel, 1995). Adults ages 18-24 also have the highest prevalence rates of those who currently smoke (CDC, 2006), so developing a better understanding of the mechanisms of relapse within this age group is an important endeavor. A second limitation is that the current sample was primarily Caucasian and male, making gender and ethnic group comparisons impossible. Additionally, those who participated were current smokers who were not planning to

quit smoking. The results therefore, could be different if these individuals were not planning to resume smoking after 48 hours.

In summary, the present study suggests that those higher in trait-impulsivity experience greater levels of craving and tobacco withdrawal during a period of abstinence. Additionally, differences in baseline levels of anxiety and depression along with significant mean differences over time suggest that dependent cigarette smokers higher in trait-impulsivity may experience more difficulties when not smoking, compared to their lower impulsive peers. The current study builds on previous research in this area by examining the mechanisms of relapse without the use of a treatment package as part of the experimental protocol. Future research is needed to compare the effect of different cessation tools, that are both accessible and rewarding, to those higher in trait-impulsivity. Additionally, because those with higher levels of trait-impulsivity may be more susceptible to cues in their environment, using an ecological momentary assessment (EMA) paradigm during an abstinence period may provide valuable information to the possible immediate antecedents of continued smoking behavior.

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Table 1. Demographic Characteristics (N = 50)

	High Impulsives (n=27)	Low Impulsives (n=23)
Age (*M, SD*)	21.9 (4.4)	23.6 (5.1)
Gender (% female)	29.6	34.8
Fagerström (*M, SD*)	6.2 (1.4)	6.2 (1.1)
Cigs. smoked per day (*M, SD*)	19.8 (4.7)	19.0 (2.8)
Prev. quit attempts (*M, SD*)	3.1 (2.7)	4.4 (4.3)
Ethnicity (%)		
African-American	3.7	4.3
Asian/Pacific Islander	0	4.4
Caucasian	96.3	73.9
Hispanic	0	4.4
Multi-ethnic	0	8.7
Native American	0	4.3

Note: No significant group differences were found at $p < .05$.

Figure 1. Changes in tobacco withdrawal over 48-hrs of abstinence

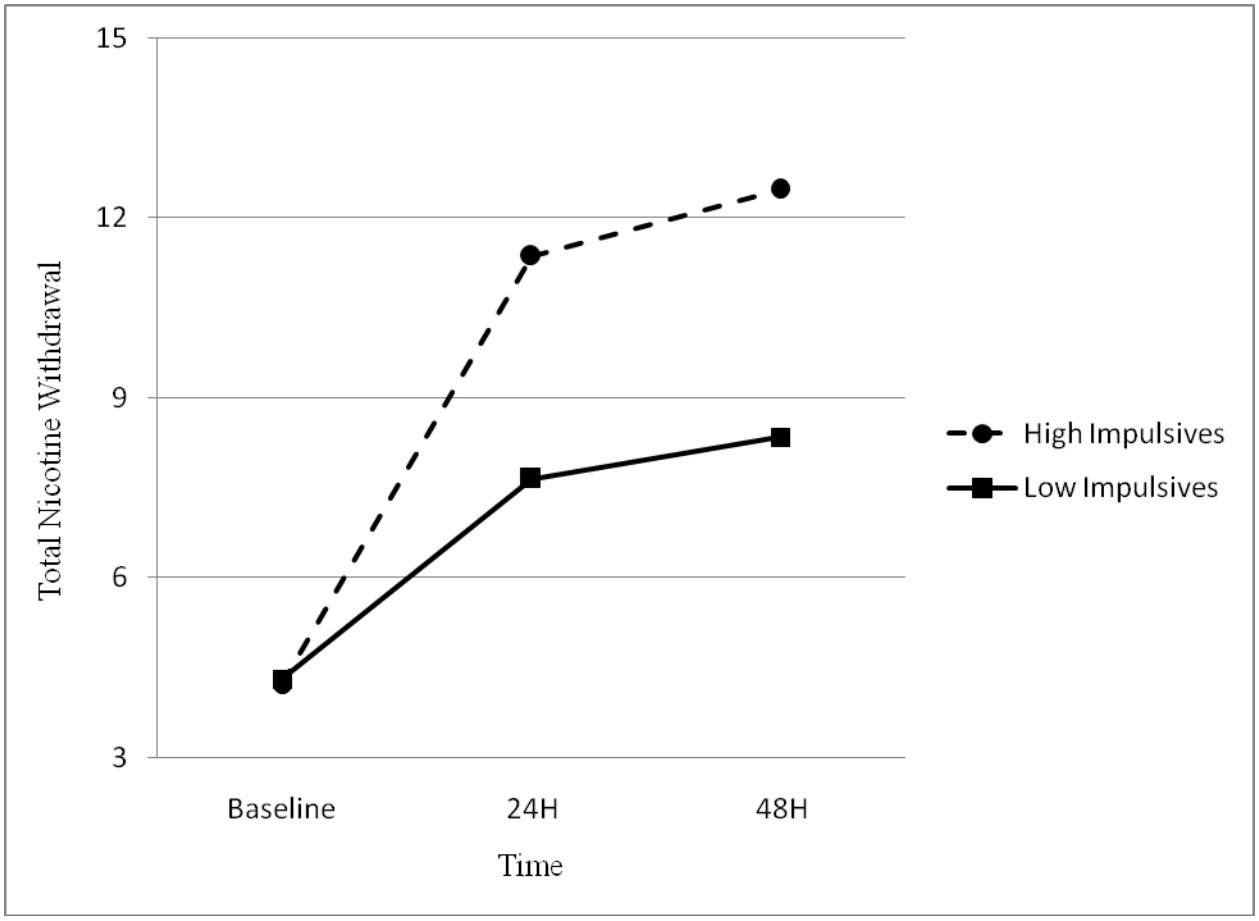

Figure 2. Craving for a cigarette over 48-hrs of abstinence

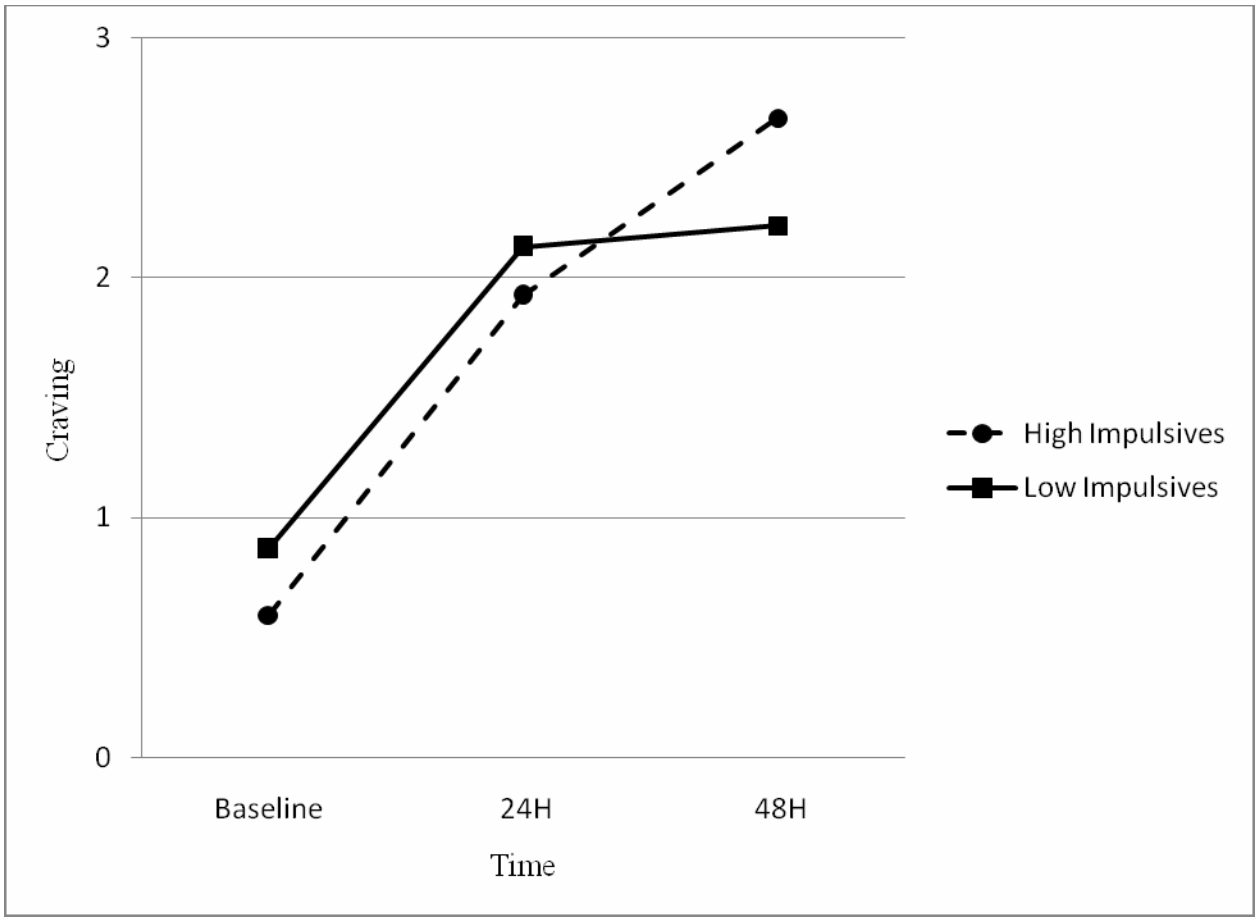

Figure 3. Levels of Self-Reported Anxiety over 48-hrs of abstinence