EXAMINING THE RELATIONSHIPS BETWEEN POSTTRAUMATIC STRESS DISORDER
SYMPTOMS, POSITIVE SMOKING OUTCOME EXPECTANCIES, AND CIGARETTE
SMOKING IN PEOPLE WITH SUBSTANCE USE DISORDERS:
A MULTIPLE MEDIATOR MODEL

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INTRODUCTION

Cigarette smoking is associated with a variety of physical health problems (e.g., pulmonary, cardiovascular, and peripheral vascular disease), and remains one of the most preventable causes of death in the United States (Fagerström, 2002; CDC, 2004).

Although in the general United States population cigarette smoking has decreased substantially in the last 45 years, (CDC, 2011), it is still 2 to 4 times more likely to occur in people with psychopathology (Kalman, Morissette, & George, 2005). Substance use disorders (SUDs) are particularly associated with cigarette smoking: 56.1% of people with alcohol abuse/dependence and 69.7% of people with drug abuse/dependence are current smokers (Lasser et al., 2000). In contrast, 19.3% of people in the general United States population are current smokers (CDC, 2011). This prevalence is notable since people with SUDs experience physical health problems that may be either caused or exacerbated by smoking (Mertens, Lu, Parthasarathy, Moore, & Weisner, 2003). Furthermore, smokers with SUDs are more likely to die from a tobacco-related physical health problem than from a physical health problem resulting from their substance use (Hurt et al., 1996).

Given the high comorbidity rates between SUDs and cigarette smoking, the integration of smoking cessation interventions into addiction treatment protocols has been widely advocated (Baca & Yahne, 2009). Such integrated interventions have demonstrated short-term success; however, long-term smoking cessation has not been as successful (see Prochaska, Delucchi, & Hall, 2004 for a review). One reason for this

failure may be the presence of untreated comorbid anxiety disorders. Among individuals with a current SUD, between 17.7%-35.6% also have a current comorbid anxiety disorder (Grant et al., 2004; Kessler et al., 1996). This comorbidity is noteworthy, given that anxiety disorders are also highly associated with cigarette smoking (see Morissette, Tull, Gulliver, Kamholz, & Zimering, 2007 for review) and thus may contribute to smoking in people with SUDs.

The most common explanation for the association between cigarette smoking and anxiety disorders is the self-medication hypothesis, which maintains that people with anxiety disorders smoke cigarettes in an effort to reduce the negative affect associated with their disorder (Morissette et al., 2007). Indeed, negative affect is often cited by smokers as the prime motivation for engaging in cigarette smoking (for review see Brandon, 1994). In addition, smokers experiencing higher levels of negative affect report more severe nicotine withdrawal symptoms during smoking cessation than smokers with lower levels of negative affect (Piasecki, Jorenby, Smith, Fiore, & Baker, 2003). Furthermore, in individuals who have maintained short-term periods of smoking cessation, higher levels of negative affect have been shown to occur before relapse (Shiffman & Waters, 2004). Given these associations, the presence of untreated comorbid anxiety symptoms in people with SUDs may serve as a source of negative affect contributing to cigarette dependence.

One anxiety disorder in particular that is highly comorbid with SUDs and that may serve as a source of negative affect contributing to cigarette smoking is posttraumatic stress disorder (PTSD). To qualify for a PTSD diagnosis, an individual

must experience an event that involves threat of harm to either themselves or someone else and that evokes a response of intense fear, helplessness, or horror (American Psychiatric Association, 2000). Additionally, individuals exposed to such events must report experiencing symptoms that can be grouped into three categories: reexperiencing symptoms (e.g. reliving the traumatic event and feeling as if it were re-occurring), avoidance symptoms (e.g. avoiding places, situations, or people that are associated with the traumatic event), and hyperarousal symptoms (e.g. feeling jumpy or being overly alert). A PTSD diagnosis is considered when a trauma victim reports the presence of these symptoms for at least 1-month and also experiences functional impairment in one or more domains of life as a result of their trauma symptoms (APA, 2000).

Between 10.9%-41.4%% of people seeking treatment for a SUD also meet criteria for current PTSD (Driessen et al., 2008; Dragan & Lis-Turlejska, 2007; Najavits et al., 2003; Read, Brown, & Kahler, 2004). In addition, PTSD has been consistently associated with greater daily cigarette consumption (Beckham et al., 1997; Buckley, Mozley, Bedard, Dewulf, & Greif, 2004), even after controlling for trauma history and co-occurring depression symptoms (Acierno, Kilpatrick, Resnick, Saunders, & Best, 1996; Op den Velde et al., 2002). Furthermore, PTSD has also been shown to be associated with nicotine dependence after controlling for the presence of comorbid anxiety disorders (Cougle, Zvolensky, Fitch, & Sachs-Ericsson, 2010). Finally, longitudinal research indicates that PTSD increases the risk for subsequent first onset daily cigarette smoking (Breslau, Novak, & Kessler, 2004) as well as first onset cigarette dependence (Breslau, Davis, & Schultz, 2003). Collectively these studies suggest that

PTSD seems to have a specific impact on smoking behavior and may also increase risk for the development of cigarette smoking/dependence.

Research examining smoking in people with PTSD has largely supported the self-medication hypothesis. Motivation to smoke cigarettes in an effort to reduce negative affect has been shown to characterize people with PTSD (Beckham et al., 1997), a relationship that has been observed even after controlling for gender differences and for differences in daily cigarette consumption (Feldner et al., 2007). Stronger evidence for the role of self-medication as an explanation for PTSD-smoking comorbidity comes from experimental research. For example, in response to trauma and stress imagery, smokers with PTSD have been shown to have a greater increase in negative affect as well as a greater increase in cigarette craving compared to smokers without PTSD (Beckham et al., 2007). Furthermore, ambulatory monitoring techniques have revealed that people with PTSD are more likely to smoke in response to negative affect and are more likely to report a reduction in negative affect after smoking a cigarette than are people without PTSD (Beckham et al., 2008).

A number of cognitive-motivational variables have been posited to account for the relationship between PTSD and cigarette smoking. One such variable is smoking outcome expectancies. Smoking outcome expectancies refer to the beliefs that an individual holds concerning the anticipated consequences of smoking cigarettes (Brandon, Juliano, & Copeland, 1999). In the context of addiction research, smoking outcome expectancies have received the most support as mediators of the relationship between addiction risk factors (e.g., family history of SUDs) or relapse risk factors (e.g.,

substance cues, emotional states) and substance dependence (Goldman, Del Boca, & Darkes, 1999; Niaura et al., 1988).

Studies examining the role of smoking outcome expectancies in cigarette smoking support this conceptualization. Positive smoking outcome expectancies (i.e., beliefs that smoking will result in positive outcomes) have been shown to decrease in those participating in smoking cessation treatment (Shadel & Mermelstein, 1993) and this reduction has been shown to characterize smokers who successfully quit smoking (Weinberger, McKee, & George, 2010). Additionally, increases in daily positive smoking outcome expectancies have been shown to precede smoking relapse occurring the following day in smokers attempting to quit (Gwaltney, Shiffman, Balabanis, & Paty, 2005). Finally, research examining the mediation effects of smoking outcome expectancies on the relationship between negative affect and cigarette smoking demonstrates that positive smoking outcome expectancies mediate – but do not moderate – the relationship between negative affect and smoking behavior across time (Cohen, McCarthy, Brown, & Meyers, 2002). Collectively, this research suggests that positive smoking outcome expectancies may play a causal role in cigarette smoking and may also serve as an explanatory mechanism for the relationship between negative affect and cigarette smoking.

Consistent with research demonstrating the role of self-medication in people with PTSD who smoke cigarettes, negative affect reduction expectancies (i.e., beliefs that smoking cigarettes reduces negative affect) have been found to be particularly common in people with PTSD (Marshall et al., 2008) and have been shown to mediate the

relationship between PTSD symptoms and cigarette dependence symptoms in veterans (Carmody et al., 2012). This finding suggests that negative affect reduction expectancies may be an important mechanism for understanding the relationship between PTSD and cigarette smoking. However, other research suggests that many different types of positive smoking outcome expectancies also characterize smokers with PTSD including stimulation-state enhancement expectancies (i.e., beliefs that smoking increases one's energy), taste-sensorimotor manipulation expectancies (i.e., beliefs that smoking produces pleasurable taste sensations), social facilitation expectancies (i.e., beliefs that smoking makes it easier to socialize), and boredom reduction expectancies (i.e., beliefs that smoking relieves feelings of boredom) (Calhoun et al., 2011). Thus, while currently the strongest evidence is for negative affect reduction expectancies serving as a mediator between PTSD and cigarette smoking, a comprehensive model examining the mediating role of many types of positive smoking outcome expectancies has not yet been tested.

A multiple mediator model, in which the mediation effects of multiple types of positive smoking outcome expectancies may be simultaneously considered, is the most appropriate way to examine the importance of positive outcome expectancies. By testing such a model, it is possible to control for the correlations that exist between different types of positive smoking outcome expectancies – yielding a more accurate estimation of the mediation effect associated with each expectancy type. In addition, a multiple mediator model allows for the comparison of the magnitudes of the mediation effects belonging to different mediators (Preacher & Hayes, 2008). Thus, by considering a multiple mediator model that examines the mediation effects of a number of different

types of positive smoking outcome expectancies on the relationship between PTSD symptoms and cigarette smoking, it is possible to determine which expectancies are the largest contributors to smoking in people experiencing PTSD symptoms. Positive smoking outcome expectancies found to be the largest contributors may represent important targets for smoking cessation interventions for people with SUDs who are experiencing PTSD symptoms.

Despite the associations that exist between SUDs, cigarette smoking, and PTSD no research to date has considered (a) whether PTSD symptoms are related to cigarette smoking in people with a SUD and (b) whether positive smoking outcome expectancies may serve as mechanisms for this relationship. The present study addressed these limitations by examining the relationship between PTSD symptoms and cigarette smoking in a sample of people with SUDs seeking detoxification treatment services. Consistent with recommendations, multiple facets of cigarette smoking were considered (Shadel & Shiffman, 2005). Specifically, both the relationship between PTSD symptoms and typical daily cigarette consumption as well as the relationship between PTSD symptoms and cigarette dependence symptoms was examined. In addition, the mediation effects of a number of different positive smoking outcome expectancies on these relationships were tested to determine the contributions of different types of positive smoking outcome expectancies in explaining the relationship between PTSD symptoms and cigarette consumption/cigarette dependence symptoms.

Given the positive relationship between PTSD and cigarette smoking observed within the trauma literature, it was hypothesized that a significant positive relationship

would exist between PTSD symptoms and cigarette consumption/cigarette dependence symptoms, such that greater PTSD symptoms would be associated with greater cigarette consumption/cigarette dependence symptoms (**Hypothesis #1**). Additionally, given evidence for the self-medication hypothesis and the relationship between negative affect and smoking in people with PTSD, it was hypothesized that a significant mediation effect would be observed for negative affect reduction expectancies after controlling for the mediation effects of other positive smoking outcome expectancies (e.g., stimulation-state enhancement, boredom reduction, etc.: **Hypothesis #2**) and that this mediation effect would be larger than any other statistically significant mediation effect observed (**Hypothesis #3**).

METHOD

Participants

Participants included 264 (60.2% male, 88.6% Caucasian) individuals attending a midwestern Alcohol, Drug Addiction, and Mental Health (ADM) Crisis Center. The ADM Crisis Center serves individuals experiencing alcohol or drug addiction. Services provided by the Crisis Center include alcohol/drug addiction assessments and treatment referrals, housing for intoxicated individuals, group counseling, 12-step meetings, and medically-supported detoxification. In the present study, participants consisted of individuals admitted to the ADM Crisis center for inpatient medically-supported detoxification. On average participants were recruited into the study within two days of their admission ($M = 2.05$, $SD = 1.42$).

Analyses in the current study were restricted to trauma-exposed individuals who self-identified as current smokers. In total, 98.5% ($N=243$) reported being exposed to at least one traumatic event and 92.8% ($N=245$) self-identified as current smokers, while 86.0% ($N=227$) of participants met both of these criteria. Consistent with the demographics of those attending the ADM Crisis Center (66.8% male, 91.6% Caucasian), individuals in the current study were predominantly male (59.9%) Caucasians (89.4%) who were on average 37.1 years old ($SD=11.2$) and had completed 12.1 years of education ($SD=1.8$). Polysubstance abuse/dependence was common, with 70% of

participants having 2 or more SUD diagnoses. A range of SUD diagnoses were represented with 67.8% having opioid abuse/dependence, 59.0% having alcohol abuse/dependence, 43.2% having cannabis abuse/dependence, 23.8% having sedative abuse/dependence, 22.0% having cocaine abuse/dependence, and 5.7% having amphetamine abuse/dependence.

Procedure

Potential participants were approached, given a description of the study, and consented by a researcher. None of those approached declined participation. Consenting participants completed a packet of measures including the Posttraumatic Diagnostic Scale (PDS: Foa, Cashman, Jaycox, & Perry, 1997), the Brief Smoking Consequences Questionnaire for Adults (BSCQ-A: Jeffries et al., 2004), a question asking about typical daily cigarette consumption (Shadel & Shiffman, 2005), and the Cigarette Dependence Scale-12 (CDS-12: Etter, Le Houezec, & Perneger, 2003). Participants' medical charts were reviewed to collect demographic information as well as SUD diagnostic information. Upon completion of the study, participants were given the choice between either a candy bar or a \$5.00 gift card as compensation for their time.

Measures

PTSD symptoms. PTSD was assessed with the 49-item self-report Posttraumatic Diagnostic Scale (PDS: Foa, Cashman, Jaycox, & Perry, 1997). The PDS was used to

obtain both a continuous measure of PTSD symptom severity experienced in the past month (used in the mediational analyses) and a dichotomous probable past month PTSD diagnosis (used for descriptive purposes). Participants were classified as having a probable PTSD diagnosis if they (1) reported experiencing an event meeting Criterion A; (2) had a total symptom severity score of 15 or higher as well as the presence of at least 1 reexperiencing symptom, 3 avoidance symptoms, and 2 hyperarousal symptoms (the frequency with which each symptom was experienced in the past month was rated on a scale ranging from 0 ‘Not at all or only one time’ to 3 ‘5 or more times a week/almost always’; for each item, symptom endorsement was defined as a rating of 1 or higher); (3) reported experiencing these symptoms for at least 1 month; and (4) reported experiencing functional impairment in at least one domain of life due to these symptoms (e.g., school, work, or family) (Foa et al., 1997). Due to a copying error, 5.7% of participants failed to complete the final page of the PDS that asked about functional impairment related to PTSD symptoms. Thus, for these individuals it was not possible to determine probable PTSD diagnostic status, and they were omitted from diagnostic frequency estimates; however, they were included in the mediation analyses given that they had complete PTSD symptom data. Those providing complete PDS data did not differ from those providing incomplete PDS data in terms of age, sex, race, education, PTSD symptoms, or total number of SUD diagnoses (all $ps > 0.05$).

Using the diagnostic algorithm described above, the PDS has been shown to have good sensitivity (0.87-0.92) and specificity (0.56-0.79) (Griffin, Uhlmansiek, Resick, & Mechanic, 2004; Sheeran & Zimmerman, 2002). In addition, internal consistency

analyses in the current study revealed Cronbach's alphas of 0.87 for the reexperiencing subscale, 0.85 for the avoidance subscale, and 0.83 for the hyperarousal subscale (0.92 for the full scale).

Smoking outcome expectancies. Smoking outcome expectancies were measured with the Brief Smoking Consequences Questionnaire for Adults (BSCQ-A: Jeffries et al., 2004). The BSCQ-A is a shortened 30-item version of the Smoking Consequences Questionnaire (Copeland, Brandon, & Quinn, 1995). It consists of 6 subscales representing expectancies that smoking will result in positive outcomes. These subscales include negative affect reduction expectancies (i.e., beliefs that smoking reduces negative affect), stimulation-state enhancement expectancies (i.e., beliefs that smoking energizes behavior), taste-sensorimotor manipulation expectancies (i.e., beliefs that smoking produces pleasurable taste sensations), social facilitation expectancies (i.e., beliefs that smoking makes it easier to socialize), boredom reduction expectancies (i.e., beliefs that smoking reduces boredom), and weight control expectancies (i.e., beliefs that smoking helps to control weight gain). The BSCQ-A also contains three subscales representing expectancies that smoking will result in negative outcomes. However, these subscales were not included in analyses given the connections between PTSD symptoms and positive smoking outcome expectancies observed in the empirical literature. Participants rated how true they thought each consequence was for them if they were to engage in cigarette smoking on a scale ranging from 0 ('Not true at all') to 4 ('Extremely true'). In the current study, Cronbach's alphas ranged between 0.77-0.92 for the subscales representing positive smoking outcome expectancies.

Cigarette consumption. Typical daily cigarette consumption was assessed using a single question modeled after recommendations by Shadel and Shiffman (2005) (i.e., ‘In general, how many cigarettes do you smoke each day?’) using a 5-point Likert scale (i.e., 0 = ‘0-5’; 1 = ‘6-10’; 2 = ‘11-20’; 3 = ‘21-39’; 4 = ‘More than 30’).

Cigarette dependence symptoms. Cigarette dependence symptoms were assessed with the Cigarette Dependence Scale-12 (CDS-12: Etter, Le Houezec, & Perneger, 2003). The CDS-12 is a 12-item self-report measure designed to assess symptoms of nicotine dependence experienced in the past month as described in the DSM-IV and the ICD-10. For each item, respondents were asked to provide responses on a scale ranging from 1 to 5; however, the anchors associated with this scale varied depending upon the item in question. For example, question 1 asked respondents to rate their addiction to cigarettes on a scale from 0-100, with a score of 1 corresponding to ‘0-20’ and a score of 5 corresponding to ‘81-100’. On the other hand, question 3 asked respondents how long it takes after waking up until they smoke a cigarette with a score of 1 corresponding to ‘0-5 minutes’ and a score of 5 corresponding to ‘More than 61 minutes.’ The psychometric properties of the CDS-12 are strong and have been shown to be superior to other commonly used measures of nicotine dependence including the Fagerström test for nicotine dependence and the heaviness of smoking index (Etter, 2005, 2008). Cronbach’s alpha was 0.92 in the current study.

Depression symptoms. Depression symptoms were measured with the Center for Epidemiologic Studies Depression scale (CES-D) (Radloff, 1977). The CES-D is a 20-item self-report measure assessing depression symptoms experienced in the past month.

For each item, respondents indicate how often they have experienced the symptom described on a scale ranging from 0 ('Rarely or none of the time/less than 1 day') to 3 ('Most or all of the time/5-7 days'). The CES-D has been shown to be a valid and reliable measure of major depression symptoms (Clark, Mahoney, Clark, & Ericksen, 2002; Knight, Williams, McGee, & Olaman, 1997). In the current study Cronbach's alpha was 0.88.

Polysubstance use. Polysubstance use was assessed by chart review.

Specifically, the number of SUD diagnoses were summed for each participant to yield a total number.

DATA ANALYSIS

All analyses were conducted using SPSS 19.0 for Windows (SPSS Inc., 2010). Given evidence that post-traumatic psychopathology is best represented as falling along a continuum (Stein, Walker, Hazen, & Forde, 1997; Marshall et al., 2001), as well as the anticipation of diagnostic changes implemented in the DSM 5, a continuous rather than dichotomous measure of PTSD was used in all mediational analyses. Two multiple mediator models were of primary interest in testing the study's hypotheses. In one model, typical daily cigarette consumption served as the outcome variable and in the other cigarette dependence symptoms served as the outcome variable. In both models tested, PTSD symptoms served as the focal predictor variable and positive smoking outcome expectancies served as the mediating variables. Finally, given the relationships between polysubstance use, PTSD symptoms, and depression symptoms (Neighbors, Kempton, & Forehand, 1992; Ullman, Townshend, Starzynski, & Long, 2006) – as well as the co-occurrence of PTSD and depression (Breslau, Davis, Peterson, & Schultz, 2000), both models were retested with depression symptoms and polysubstance use included as covariates and compared to the models that did not include these covariates (see Figure 1).

According to Kenny (2012), in order for the inferences drawn from the proposed mediation models to be valid, three major conditions must be met: 1) the mediators should be relatively free of measurement error; 2) chances of model misspecification

should be minimized such that efforts are made to ensure that important variables that should be included in the model are not omitted; and 3) alternative mediation models specifying different relationships between the variables of interest must be examined to determine if the proposed model represents the only model that can explain the relationships between PTSD symptoms, positive smoking outcome expectancies, and cigarette consumption/cigarette dependence symptoms.

As described above, the Cronbach's alphas associated with each of the positive smoking outcome expectancy subscales ranged between 0.77-0.92 indicating that the assumption of minimal error variance in the mediators was met. In addition, one of the core strengths of the current study is that multiple types of positive smoking outcome expectancies are being included in the primary mediation models in order to ensure that important variables are not omitted, thereby obtaining accurate estimates of the potential mediating relationships of these variables and reducing the chances of model misspecification. Finally, in the present study, it is proposed that experiencing PTSD symptoms plays a causal role in cigarette consumption and in the experience of cigarette dependence symptoms consistent with research demonstrating this relationship in people with PTSD (Breslau et al., 2003; Breslau et al., 2004). Furthermore, given that PTSD is a source of negative affect, it is proposed that experiencing PTSD symptoms increases the saliency of negative affect reduction expectancies held by a person (Niaura et al., 1988), which in turn is posited to cause a person to engage in cigarette smoking and to experience cigarette dependence symptoms (Shadel & Mermelstein, 1993; Gwaltney et al., 2005; Weinberger et al., 2010) even after controlling for the potential mediation

Figure 1. (a) Primary mediation models examining the total effect of PTSD symptoms on cigarette smoking (hypothesis #1) as well as (b) the mediation effect of negative affect reduction expectancies after controlling for other positive smoking outcome expectancies on the relationship between these variables (hypothesis #2) and the magnitude of the mediation effect associated with negative affect reduction expectancies in relation to other positive smoking outcome expectancies (hypothesis #3). Separate models examining cigarette consumption and cigarette dependence symptoms as outcome variables were analyzed; additionally, each model was examined with vs. without controlling for depression symptoms and polysubstance use.

effects of other positive smoking outcome expectancies. Thus, negative affect reduction expectancies are proposed to be an important intervening variable in explaining the relationship between PTSD symptoms and cigarette smoking/cigarette dependence symptoms even after controlling for other potential mediation effects.

However, two alternative mediation models may also appropriately describe the relationships between these variables. First, it is also appropriate to test a mediation model in which PTSD symptoms serve as the predictor, cigarette consumption/cigarette dependence symptoms serve as mediators, and negative affect reduction expectancies serve as the outcome. More specifically, in this model it is proposed that PTSD symptoms serve as a source of negative affect making salient negative affect reduction expectancies; in addition, PTSD symptoms are also proposed to cause cigarette consumption/cigarette dependence symptoms, and in turn, cigarette consumption/cigarette dependence symptoms may reinforce negative affect reduction expectancies if it is perceived that cigarette smoking has the expected effect of reducing the negative affect experienced.

In the second alternative mediation model, cigarette consumption/cigarette dependence symptoms serve as predictors, PTSD symptoms serve as the mediator, and negative affect reduction expectancies serve as the outcome. According to this model, cigarette consumption/cigarette dependence symptoms reinforce negative affect reduction expectancies if cigarette smoking is perceived to reduce negative affect. Additionally, cigarette consumption/cigarette dependence symptoms are proposed to cause/exacerbate PTSD symptoms, a possibility given that the stimulatory effects of nicotine may

contribute to the hyperarousal symptoms of PTSD. Finally, PTSD symptoms are proposed to make salient negative affect reduction expectancies. Given the plausibility of these alternative mediation models, they were each examined in addition to the primary mediation models proposed.

Primary Mediation Analysis

Traditionally, researchers examining mediation models have relied on the *causal steps approach* as described by Baron & Kenny (1986). According to this approach, mediation is present only if a stringent set of criteria is satisfied. Specifically, it must be demonstrated that (1) the predictor variable X is associated with the outcome variable Y (path c), (2) the predictor variable X is associated with the mediator M (path a), (3) the mediator M must be associated with the outcome variable Y while controlling for the effects of the predictor variable X (path b), and (4) the association between the predictor variable X and the outcome variable Y must be reduced when the mediator is included as a predictor of Y (path c'). However, this approach has a number of flaws. Perhaps most notably, it fails to *directly quantify* the mediation effect and test its significance. Instead, the causal steps approach merely *infers* the presence of the mediation effect based upon the significance of a series of tests. This is particularly problematic given that it is possible for a mediation effect to be statistically significant despite the non-significance of one or more of the paths tested by the causal steps approach (e.g., paths c or c') (Hayes, 2009). Given this limitation, current recommendations for testing mediation are to use the *product-of-coefficients* approach to obtain a bootstrapped estimate of the

mediation effect represented by paths a and b (Mackinnon, Lockwood, Hoffman, West, & Sheets, 2002; MacKinnon, Lockwood, & Williams, 2004). Such an approach is superior to the causal steps approach to testing mediation in that it yields a direct test of the mediation effect.

In the current study, the supplemental macro ‘indirect’ created by Preacher and Hayes (2008) was used to test the total effect (i.e., path c) of PTSD symptoms on cigarette consumption/cigarette dependence symptoms (**Hypothesis #1**). It was also used to obtain a bootstrapped estimate of the product term formed by multiplying paths a and b associated with each mediator (Preacher & Hayes, 2008). This approach was used to test the significance of the mediation effect associated with negative affect reduction expectancies after controlling for the mediation effects of other positive smoking outcome expectancies (**Hypothesis #2**). For each mediation effect, a sample was drawn with replacement from the observed sample in the present study and the mediation effect was computed. This procedure was repeated 5,000 times and the resulting 5,000 estimates for each mediation effect were averaged to yield an overall point estimate. Because confidence intervals based upon bootstrapped estimates are asymmetrically distributed (Efron, 1987), bias-corrected and accelerated 95% confidence intervals (BCa 95% CIs) were computed. Finally, to test whether the mediation effect associated with negative affect reduction expectancies was statistically larger than any of the other observed mediation effects, pairwise contrasts comparing the magnitude of the mediation effects were estimated (**Hypothesis #3**).

Missing Data

Given that only 3.5% of the data included in the present analyses were missing, mean substitution was used to impute missing data.

Power Analysis

Given that the mediation analysis in the current study represented the most sophisticated statistical analysis, the present study was designed so that it would have sufficient power to test hypothesis #2 with the recognition that the other hypotheses would be sufficiently powered if this analysis was adequately powered. According to a simulation study conducted by Fritz & MacKinnon (2007), if we conservatively assume a small-medium effect size associated with the a and b paths of the mediation effect of negative affect reduction expectancies after controlling for the mediation effects of other positive smoking outcome expectancies, then to achieve 80% power with an $\alpha = 0.05$ a sample size of $N = 162$ is required. Thus, the present sample size of $N = 227$ was sufficient to test hypothesis #2.

RESULTS

Descriptive Statistics

Means, standard deviations, and zero-order correlations among the study variables are presented in Table 1. The mean number of traumas reported by participants was 4.23 ($SD = 2.40$), with interpersonal traumas being the most commonly endorsed. More specifically, 78.4% of the sample reported experiencing one or more interpersonal traumas including sexual contact when under age 18 with someone at least 5 years older (43.6%); physical assault by a stranger (48.9%); physical assault by a family member or someone they knew (39.6%); sexual assault by a family member or someone they knew (27.8%); sexual assault by a stranger (18.9%); torture (11.9%); or military combat (8.8%). Overall, 38.3% of the sample met criteria for a probable PTSD diagnosis. This is consistent with existing research demonstrating that addiction treatment-seeking individuals with SUDs are a highly traumatized population (Dore, Mills, Murray, Teesson, & Farrugia, 2012; Hien, Nunes, Levin, & Fraser, 2000; Wasserman, Havassy, & Boles, 1997).

Table 1. Means, Standard Deviations, and Correlations Among the Major Study Variables

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	M	SD
1. Cigarette Consumption	-										2.17	0.96
2. Cigarette Dependence Symptoms	0.58***	-									47.49	10.27
3. PTSD Symptoms	-0.07	0.01	-								21.48	12.38
4. Negative Affect	0.31***	0.52***	0.22**	-							10.44	4.51
5. Reduction Stimulation State	0.26***	0.37***	0.15*	0.59***	-						4.50	3.07
6. Taste-Enhancement Sensorimotor Manipulation	0.27***	0.45***	0.11	0.61***	0.61***	-					5.99	3.55
7. Social Facilitation	0.23***	0.34***	0.18**	0.53***	0.73***	0.57***	-				4.80	4.15
8. Boredom Reduction	0.28***	0.46***	0.21**	0.63***	0.62***	0.57***	0.59***	-			6.97	3.39
9. Weight Control	0.10	0.16*	0.18**	0.35***	0.42***	0.37***	0.46***	0.31***	-		3.82	3.45
10. Depression symptoms	-0.01	0.11	0.50**	0.20**	0.09	0.02	0.13*	0.19**	0.06	-	32.05	10.52
11. Polysubstance Use	0.03	-0.05	-0.04	-0.06	-0.10	-0.05	-0.24***	-0.11	-0.11	0.02	1.64	1.10

*** $p < 0.01$. ** $p < 0.001$

Primary Mediation Models

To test hypothesis #1, the total effect (c) of PTSD symptoms on cigarette consumption and cigarette dependence symptoms was considered. Contrary to predictions, a non-significant relationship was found between PTSD symptoms and cigarette consumption ($B = -0.006$, $SE = 0.005$, $p = 0.277$). A non-significant relationship was also found for the relationship between PTSD symptoms and cigarette dependence symptoms ($B = 0.006$, $SE = 0.055$, $p = 0.917$). When controlling for depression symptoms and polysubstance use, similar non-significant relationships were found between PTSD symptoms and cigarette consumption ($B = -0.007$, $SE = 0.006$, $p = 0.240$) as well as between PTSD symptoms and cigarette dependence symptoms ($B = -0.053$, $SE = 0.064$, $p = 0.406$).

Table 2 contains the statistics associated with the specific mediation effects of positive smoking outcome expectancies on the relationship between PTSD symptoms and cigarette consumption/cigarette dependence symptoms. Consistent with hypothesis #2, the mediation effect associated with negative affect reduction expectancies ($B = 0.003$, $SE = 0.002$, BCa 95% CI = 0.001, 0.008) was the only significant mediation effect on the relationship between PTSD symptoms and cigarette consumption, after controlling for the mediation effects of the other positive smoking outcome expectancies. More specifically, it was found that higher PTSD symptom levels were associated with greater negative affect reduction expectancies ($B = 0.080$, $SE = 0.024$, $p < 0.001$) and that greater negative affect reduction expectancies were associated with greater cigarette consumption ($B = 0.788$, $SE = 0.183$, $p < 0.001$).

Table 2. *Primary Mediation Models: Mediation Effects of Positive Smoking Outcome Expectancies on the Relationship Between PTSD Symptoms and**Cigarette Smoking*

Predictor = PTSD Symptoms	Bootstrapped Point estimate	SE	BCa 95% CI	Bootstrapped Point estimate	SE	BCa 95% CI
<i>Mediation effects</i>						
Cigarette Consumption				Cigarette Consumption: Depression Symptoms & Polysubstance Use Covariates		
Negative affect reduction (NAR)	0.003*	0.002	0.001	0.008	0.002	0.001
Simulation state enhancement (SSE)	0.001	0.001	-0.002	0.003	0.001	-0.002
Taste-sensorimotor manipulation (TSM)	0.001	0.001	-0.001	0.003	0.001	-0.001
Social facilitation (SF)	0.001	0.002	-0.002	0.004	0.001	-0.001
Boredom reduction (BR)	0.002	0.002	-0.001	0.006	0.001	-0.001
Weight control (WC)	-0.001	0.001	-0.003	0.001	0.001	-0.004
<i>Pairwise contrasts</i>						
NAR vs. TSM	-	-	-	-	-	-
NAR vs. BR	-	-	-	-	-	-
TSM vs. BR	-	-	-	-	-	-
Predictor = PTSD Symptoms						
Cigarette Dependence Symptoms				Cigarette Dependence Symptoms: Depression Symptoms & Polysubstance Use Covariates		
Negative affect reduction (NAR)	0.062*	0.034	0.024	0.121	0.041*	0.029
Simulation state enhancement (SSE)	-0.004	0.025	-0.031	0.018	-0.002	-0.031
Taste-sensorimotor manipulation (TSM)	0.017*	0.012	0.001	0.051	0.023*	0.001
Social facilitation (SF)	0.004	0.013	-0.021	0.033	0.002	-0.020
Boredom reduction (BR)	0.032*	0.017	0.008	0.077	0.020*	0.001
Weight Control (WC)	-0.010	0.010	-0.036	0.003	-0.010	-0.040
<i>Pairwise contrasts</i>						
NAR vs. TSM	0.045*	0.046	0.003	0.103	0.019	-0.021
NAR vs. BR	0.030	0.031	-0.017	0.092	0.021	-0.017
TSM vs. BR	-0.015	0.016	-0.056	0.019	0.002	-0.034
Note. BCa 95% CI: biased corrected and accelerated 95% confidence intervals						
p < 0.05						

Note. BCa 95% CI: biased corrected and accelerated 95% confidence intervals

* $p < 0.05$

In contrast, negative affect reduction ($B = 0.062$, $SE = 0.034$, BCa 95% CI = 0.024, 0.121), boredom reduction ($B = 0.032$, $SE = 0.017$, BCa 95% CI = 0.008, 0.077), and taste-sensorimotor manipulation expectancies ($B = 0.017$, $SE = 0.012$, BCa 95% CI = 0.001, 0.051) were all found to be significant mediation effects for the relationship between PTSD symptoms and cigarette dependence symptoms. Specifically, higher PTSD symptoms were associated with greater negative affect reduction ($B = 0.056$, $SE = 0.027$, $p = 0.04$), boredom reduction ($B = 0.039$, $SE = 0.021$, $p = 0.06$) and taste-sensorimotor manipulation ($B = 0.042$, $SE = 0.022$, $p = 0.06$) expectancies. Additionally, greater negative affect reduction ($B = 0.764$, $SE = 0.186$, $p = 0.001$), boredom reduction ($B = 0.517$, $SE = 0.248$, $p = 0.04$), and taste-sensorimotor manipulation ($B = 0.565$, $SE = 0.233$, $p = 0.02$) expectancies were associated with greater cigarette dependence symptoms.

To compare the magnitudes of the statistically significant mediation effects associated with negative affect reduction, boredom reduction, and taste-sensorimotor manipulation smoking expectancies, pairwise contrasts were estimated. Partially consistent with hypothesis #3, results indicated that the mediation effect associated with negative affect reduction expectancies was statistically larger than the mediation effect associated with taste-sensorimotor manipulation expectancies ($B = 0.045$, $SE = 0.046$, BCa 95% CI = 0.003, 0.103); however, the mediation effects associated with negative affect reduction expectancies and boredom reduction expectancies were not significantly different from one another ($B = 0.030$, $SE = 0.031$, BCa 95% CI = -0.017, 0.092). When both primary mediation models were retested with depression symptoms and

polysubstance use included as covariates, results remained largely the same; however, the pairwise contrasts associated with negative affect reduction, boredom reduction, and taste-sensorimotor manipulation smoking expectancies were found to be non-significant indicating that the magnitudes of these mediation effects were comparable (See Table 2).

Alternative Mediation Model #1

Table 3 contains the results of alternative mediation model #1, which considered the mediation effect of cigarette consumption/cigarette dependence symptoms on the relationship between PTSD symptoms and negative affect reduction expectancies. The mediation effects associated with cigarette consumption ($B = -0.008$, $SE = 0.009$, BCa 95% CI = -0.027, 0.006) as well as with cigarette dependence symptoms ($B = 0.001$, $SE = 0.013$, BCa 95% CI = -0.024, 0.028) were found to be statistically non-significant. Similar relationships were observed when controlling for depression symptoms and polysubstance use (see Table 3). Collectively, these results did not lend support to alternative mediation model #1.

Alternative Mediation Model #2

Table 4 contains the results of alternative mediation model #2, which considered the mediation effect of PTSD symptoms on the relationship between both cigarette consumption/cigarette dependence symptoms and negative affect reduction expectancies. The mediation effects associated with PTSD symptoms when cigarette consumption ($B =$

-0.085, $SE = 0.079$, BCa 95% CI = -0.264, 0.055) as well as when cigarette dependence symptoms ($B = 0.001$, $SE = 0.007$, BCa 95% CI = -0.012, 0.015) served as predictors were found to be statistically non-significant. Similar relationships were observed when controlling for depression symptoms and polysubstance use (see Table 4). Collectively, these results did not lend support to alternative mediation model #2.

Table 3. *Alternative Mediation Model #1: Mediation Effect of Cigarette Smoking on the Relationship Between PTSD Symptoms and Negative Affect*

Reduction Expectancies

Predictor = PTSD symptoms	Bootstrapped Point estimate	SE	BCa 95% CI	Bootstrapped Point estimate	SE	BCa 95% CI
<div> <div>Negative Affect Reduction Expectancies</div> <div>Negative Affect Reduction Expectancies: Depression Symptoms & Polysubstance Use Covariates</div> </div>						
Mediation effect Cigarette consumption	-0.008	0.009	-0.027 0.006	-0.010	0.010	-0.034 0.006
Predictor = PTSD symptoms	Bootstrapped Point estimate	SE	BCa 95% CI	Bootstrapped Point estimate	SE	BCa 95% CI
<div> <div>Negative Affect Reduction Expectancies</div> <div>Negative Affect Reduction Expectancies: Depression Symptoms & Polysubstance Use Covariates</div> </div>						
Mediation effect Cigarette dependence symptoms	0.001	0.013	-0.024 0.028	-0.012	0.016	-0.042 0.020

Note. BCa 95% CI: biased corrected and accelerated 95% confidence intervals

* $p < 0.05$

Table 4. *Alternative Mediation Model#2: Mediation Effect of PTSD Symptoms on the Relationship Between Cigarette Smoking and Negative Affect Reduction Expectancies*

Predictor = Cigarette consumption	Bootstrapped Point estimate	SE	BCa 95% CI	Bootstrapped Point estimate	SE	BCa 95% CI
<div> <div>Negative Affect Reduction Expectancies</div> <div>Negative Affect Reduction Expectancies: Depression Symptoms & Polysubstance Use Covariates</div> </div>						
Mediation effect PTSD symptoms	-0.085	0.079	-0.264 0.055	-0.055	0.058	-0.224 0.024
Predictor = Cigarette dependence symptoms	Bootstrapped Point estimate	SE	BCa 95% CI	Bootstrapped Point estimate	SE	BCa 95% CI
<div> <div>Negative Affect Reduction Expectancies</div> <div>Negative Affect Reduction Expectancies: Depression Symptoms & Polysubstance Use Covariates</div> </div>						
Mediation effect PTSD symptoms	0.001	0.007	-0.012 0.015	-0.004	0.006	-0.018 0.005

Note. BCa 95% CI: biased corrected and accelerated 95% confidence intervals

* $p < 0.05$

DISCUSSION

Cigarette smoking is highly prevalent in people with SUDs and is associated with significant physical health problems. PTSD is also common in people with SUDs, is associated with cigarette smoking, and may represent a barrier to long-term smoking cessation in traumatized individuals with SUDs. Positive smoking outcome expectancies have been shown to be related to smoking in people with PTSD and may represent treatment targets in smokers with SUDs experiencing PTSD symptoms. Despite these relationships, no research to date has considered the relationship between PTSD symptoms and cigarette smoking in people with SUDs. In addition, no attention has been given to the potential role of positive smoking outcome expectancies in contributing to cigarette smoking in people with SUDs who may be experiencing PTSD symptoms. Thus, the current study considered the relationship between PTSD symptoms and cigarette consumption/dependence symptoms in a sample of people with SUDs seeking detoxification treatment who reported experiencing trauma and being a current smoker. In addition, the impact of multiple types of positive smoking outcome expectancies on the relationship between PTSD symptoms and cigarette consumption/cigarette dependence symptoms was examined.

Contrary to expectations, PTSD symptoms were not found to be associated with either cigarette consumption or cigarette dependence symptoms. This is surprising given the consistent relationship that has typically been found between PTSD symptoms and

cigarette smoking (e.g., Beckham et al., 1997; Breslau et al., 2003; Cougle et al., 2010). However, this inconsistency may be explained by characteristics of the present sample. The sample in the current study consisted of participants seeking treatment for one or more SUDs – which are highly related to cigarette smoking apart from any comorbid psychopathology (Kalman et al., 2005), and the incidence of smoking was very high. Thus, the impact of SUD on cigarette smoking may have contributed to a ceiling effect and masked any relationship between PTSD symptoms and cigarette smoking.

Consistent with predictions, negative affect reduction expectancies were found to have a significant mediation effect between PTSD symptoms and cigarette consumption after controlling for the mediation effects of other positive smoking outcome expectancies. When cigarette dependence symptoms served as the outcome of interest, this finding was also observed; however, boredom reduction and taste-sensorimotor manipulation expectancies were also found to have significant mediation effects. Partially consistent with predictions, negative affect reduction expectancies had a statistically larger mediation effect compared with taste-sensorimotor manipulation expectancies, while the mediation effects associated with negative affect reduction and boredom reduction expectancies were similar in magnitude. However, these results were not observed when depression symptoms and polysubstance use were included as covariates – a finding likely attributable to the large correlation observed between PTSD and depression symptoms in the current study. Despite these statistically non-significant findings when controlling for depression symptoms and polysubstance use, results from the current study still lend the most support to the primary mediation models, as the

findings associated with both alternative mediation models #1 and #2 were non-significant both with vs. without covariates.

Both negative affect reduction and boredom reduction expectancies reflect beliefs that smoking cigarettes will help to alleviate negative affective experiences. This is consistent with research demonstrating that PTSD and PTSD symptoms are associated with deficits in emotion regulation (Ehring & Quack, 2010; McDermott, Tull, Gratz, Daughters, & Lejuez, 2009) and indicates that smoking may represent a coping behavior used to manage negative affect by people with SUDs experiencing PTSD symptoms.

Interestingly, while cigarette smoking may stem from beliefs that smoking cigarettes will reduce negative affect, research suggests that the act of smoking following the induction of anxiety *actually increases* the experience of physiological arousal, contributing to the physical state that accompanies anxiety in people with PTSD (Buckley, Holohan, Mozley, Walsh, & Kassel, 2007; Calhoun et al., 2011). Thus, there may be a discrepancy between the *expected* effect that cigarette smoking has on one's affective experience and the *actual* effect that cigarette smoking has in people with PTSD.

The present results suggest that targeting negative affect reduction and boredom reduction expectancies might be critical components in smoking cessation programs. More specifically, such programs may benefit smokers with SUDs experiencing PTSD symptoms by having them identify their expectancies for smoking on their emotional experiences. Biofeedback could be implemented as a way to demonstrate how cigarette smoking may actually produce physiological effects that are counter to the expected

negative affect-reducing effects associated with cigarette smoking. Identification of alternative coping behaviors that could be used to manage negative affect should also be incorporated into treatment regimens.

Although taste-sensorimotor manipulation expectancies had a smaller significant mediation effect on cigarette smoking, augmenting the above approaches with nicotine fading may be an effective component in a smoking cessation program for people with SUDs experiencing PTSD symptoms. Nicotine fading involves gradually reducing nicotine intake by switching cigarette brands over a sustained period of time (Foxx & Brown, 1979). Nicotine fading has been shown to be effective in reducing cigarette consumption because it breaks the association between the gustatory cues associated with smoking and the delivery of a nicotine “high” (Zacny & Stitzer, 1988). This in turn increases self-efficacy for quitting smoking altogether (Dodgen, 2005). Thus, implementing such a procedure with people with SUDs experiencing PTSD symptoms may reduce taste-sensorimotor manipulation expectancies while simultaneously increasing confidence in one’s ability to quit smoking.

Interpretations of the findings from the current study are constrained by a number of limitations. First, all constructs were assessed via self-report and thus are constrained by the methodological limitations associated with this type of measurement (i.e., memory errors, shared method variance, etc.). Thus, future studies should seek to replicate the present findings using alternative types of measurement. For example, structured clinical interviews could be used to assess the minimum number of cigarettes smoked per day – in addition to typical daily cigarette consumption – or carbon monoxide readings could

be implemented as a physiological measure of cigarette consumption. Second, results in the present study were constrained by the cross-sectional design. Given that PTSD symptoms, positive smoking outcome expectancies, and cigarette consumption/cigarette dependence symptoms were measured concurrently, the temporal relationships between these variables are unclear. Prior research has demonstrated that positive smoking outcome expectancies predict subsequent smoking behavior in smokers from the community (Cohen et al., 2002), suggesting that the model tested in the present study is consistent with the temporal relationships typically observed. However, the evidence for the temporal relationship between these variables would have been strengthened if we had assessed the age at which participants first experienced their trauma, as well as the age at which they first engaged in cigarette smoking in order to establish which occurred first. Alternatively, the temporal relationships between PTSD symptoms, positive smoking outcome expectancies, and cigarette smoking could be tested by using experience sampling methodology (Scollon, Kim-Prieto, & Diener, 2009). Such a design would allow for the examination of the relationships between PTSD symptoms, positive smoking outcome expectancies, and cigarette smoking in real-time – a major strength given that smokers experience difficulty with retrospectively reporting their smoking behavior in an accurate manner (Shiffman et al., 1997).

Finally, it should be noted that the results of the current study may be constrained by the nature of the sample, which consisted of individuals with SUDs seeking addiction treatment. High rates of cigarette smoking have been noted in this population, with recent estimates indicating that smoking among those with SUDs seeking addiction

treatment exceeds that observed in those with SUDs who are not seeking addiction treatment (see Guydish et al., 2011 for review). However, given the paucity of research considering the relationships between smoking, PTSD, and positive smoking outcome expectancies in people with SUDs, this limitation also represents a strength of the current study. Even so, future research should seek to replicate our results among those with SUDs who are not seeking addiction treatment.

Despite these limitations, the current study indicates that negative affect reduction, boredom reduction, and taste-sensorimotor manipulation expectancies are potentially important targets for smoking cessation treatments performed with individuals with SUDs experiencing PTSD symptoms. Given the substantial medical comorbidity associated with smoking in people with SUDs, interventions that use the findings reported here may help to curtail the costs imposed on smokers with co-occurring SUDs and PTSD symptoms.

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