



Full length article

## Psychopathology and tobacco demand

Samantha G. Farris<sup>a,b,c,\*</sup>, Elizabeth R. Aston<sup>d</sup>, Michael J. Zvolensky<sup>e,f</sup>, Ana M. Abrantes<sup>a,c</sup>, Jane Metrik<sup>a,d,g</sup><sup>a</sup> Alpert Medical School of Brown University, Department of Psychiatry and Human Behavior, 345 Blackstone Blvd., Providence, RI 02906, USA<sup>b</sup> The Miriam Hospital, Centers for Behavioral and Preventative Medicine, 164 Summit St., Providence, RI 02906, USA<sup>c</sup> Butler Hospital, 345 Blackstone Blvd, Providence, RI 02906, USA<sup>d</sup> Brown University School of Public Health, Center for Alcohol and Addiction Studies, Box G-S121-5, Providence, RI 02912, USA<sup>e</sup> University of Houston, Department of Psychology, 126 Fred J. Heyne Building, Houston, TX 77204, USA<sup>f</sup> The University of Texas MD Anderson Cancer Center, Department of Behavioral Science, 1155 Pressler St., Houston, TX 77230, USA<sup>g</sup> Providence Veterans Affairs Medical Center, 830 Chalkstone Ave, Providence, RI 02908, USA

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## ABSTRACT

**Introduction:** Behavioral economic measurement of the relative value of tobacco (Cigarette Purchase Task; CPT) is used to examine individual differences in motivation for tobacco under certain contexts. Smokers with psychopathology, relative to those without, may demonstrate stronger demand for tobacco following a period of smoking deprivation, which could account for disparate rates of smoking and cessation among this subgroup.

**Method:** Participants (n = 111) were community-recruited adult daily smokers who completed the CPT after a deprivation period of approximately 60 min. Presence of psychopathology was assessed via clinical interview; 40.5% (n = 45) of the sample met criteria for past-year psychological diagnosis. Specifically, 31.5% (n = 35) had an emotional disorder (anxiety/depressive disorder), 17.1% (n = 19) had a substance use disorder, and 19.1% of the sample had more than one disorder.

**Results:** Smokers with any psychopathology showed significantly higher intensity (demand at unrestricted cost; \$0) and  $O_{max}$  (peak expenditure for a drug) relative to smokers with no psychopathology. Intensity was significantly higher among smokers with an emotional disorder compared to those without. Smokers with a substance use disorder showed significantly higher intensity and  $O_{max}$ , and lower elasticity, reflecting greater insensitivity to price increases. Having  $\geq 2$  disorders was associated with higher intensity relative to having 1 or no disorders.

**Discussion:** Findings suggest that presence of psychopathology may be associated with greater and more persistent motivation to smoke. Future work is needed to explore the mechanism linking psychopathology to tobacco demand.

## 1. Introduction

Although population-based smoking rates have declined over the past several decades (US Department of Health and Human Services [USDHHS], 2014), cigarette use remains high among those with psychopathology relative to those without (34.3% vs. 16.7%; Centers for Disease Control and Prevention [CDCP], 2013; Morris et al., 2014). It is estimated that 30.9% of all cigarettes smoked by adults between 2009 and 2011 were by individuals with a history of a psychiatric disorder (CDCP, 2013). Smokers with a history of psychopathology are also significantly less likely to quit smoking successfully relative to

those with no such history (34.7% vs. 53.4% quit rate; CDCP, 2013). Various psychiatric disorders are linked to poor smoking cessation outcomes, including depressive disorders (Hitsman et al., 2003; Zvolensky et al., 2015), schizophrenia (Lasser et al., 2000), anxiety disorders (Piper et al., 2010, 2011), posttraumatic stress disorder (Beckham et al., 2013; Zvolensky et al., 2015), and co-morbid substance use problems (Goodwin et al., 2014a, 2014b; Humfleet et al., 1999). Additionally, the prevalence of several anxiety disorders and dysthymia among current smokers appears to have increased over the past decade (Goodwin et al., 2014a,b). Therefore, understanding smoking maintenance factors among individuals with psychopathology

\* Corresponding author at: Alpert Medical School of Brown University, Department of Psychiatry and Human Behavior, 345 Blackstone Blvd, Butler Hospital, Providence, RI 02906, USA.

E-mail addresses: [Samantha.farris@brown.edu](mailto:Samantha.farris@brown.edu) (S.G. Farris), [Elizabeth.aston@brown.edu](mailto:Elizabeth.aston@brown.edu) (E.R. Aston), [mjzvolen@central.uh.edu](mailto:mjzvolen@central.uh.edu) (M.J. Zvolensky), [ana\\_abrantes@brown.edu](mailto:ana_abrantes@brown.edu) (A.M. Abrantes), [jane\\_metrik@brown.edu](mailto:jane_metrik@brown.edu) (J. Metrik).

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is a pressing public health priority (Aubin et al., 2012).

Behavioral economic theories and principles provide a useful framework for examining the appeal of a given substance, or the relative value, despite negative consequences of use (Bickel et al., 2014). The relative reinforcing value of, or demand for, a given drug has been assessed via self-reported hypothetical purchase tasks wherein participants indicate how much of a drug they would purchase at a range of prices (MacKillop et al., 2008; Murphy and MacKillop, 2006). These tasks yield data indicating the strength of motivation to obtain the drug, and can provide meaningful information about individual differences in motivational salience for drugs (i.e., the extent to which an individual values a drug under certain contexts). Five key behavioral economic indices of substance demand can be obtained from assessment of purchase task performance: intensity (amount of drug consumed at zero cost),  $P_{\max}$  (price at maximum expenditure for a drug),  $O_{\max}$  (peak expenditure for a drug), breakpoint (cost whereby drug consumption is suppressed to zero), and elasticity of demand (the degree to which consumption decreases with increasing price). Purchase tasks have been used successfully to assess demand for several substances including tobacco (Acker and MacKillop, 2013; MacKillop et al., 2012a,b 2008; MacKillop and Tidey, 2011), alcohol (Amlung et al., 2012; MacKillop et al., 2014, 2010; MacKillop and Murphy, 2007; Murphy et al., 2013; Murphy and MacKillop, 2006), and marijuana (Aston et al., 2015; Collins et al., 2014; Metrik et al., 2016). Data generally indicate that purchase behavior reflects an inverted U-shaped curve, such that expenditures for hypothetical substances are low when price value is low, increase with moderate prices, and are suppressed at high prices (Hursh and Silberberg, 2008; Jacobs and Bickel, 1999; Murphy et al., 2011). Specific to the Cigarette Purchase Task, tobacco demand indices generally tend to be associated with indicators of tobacco dependence and smoking rate (MacKillop et al., 2008; Murphy et al., 2011), are sensitive to nicotine deprivation and cue-induced craving (MacKillop et al., 2012a,b), and certain demand indices are associated with lower motivation for smoking cessation (Murphy et al., 2011).

Limited work to date has examined tobacco demand as a function of psychopathology. Theoretically, smokers with emotional disorders (e.g., anxiety and mood disorders, posttraumatic stress disorder), which are largely characterized by high levels of negative affect, dysregulated mood states, and avoidance, may expect a reduction in distress states following consumption of cigarettes (McCarthy et al., 2010). Negative reinforcement smoking may, in turn, increase demand for tobacco for these individuals. For example, one study found that among trauma-exposed heavy drinkers, more severe posttraumatic stress symptoms were associated with greater demand intensity and peak expenditure for alcohol ( $O_{\max}$ ), and lower sensitivity to increasing price of alcohol (elasticity; Murphy et al., 2013). Moreover, intensity and elasticity of alcohol demand explained, in part, the link between posttraumatic stress symptoms and consequences related to drinking (Tripp et al., 2015). Laboratory-based studies have also found that regular drinkers respond with greater alcohol demand (intensity,  $O_{\max}$ ,  $P_{\max}$ ) following acute stress induction (Amlung et al., 2013), a finding also observed among heavy drinkers (Owens et al., 2015).

It is also possible that smokers with comorbid substance use disorders, relative to those without, may demonstrate stronger and more persistent motivation to consume cigarettes. One study of heavy drinking college students found cigarette smokers, relative to non-smokers, reported greater intensity,  $O_{\max}$ ,  $P_{\max}$ , and lower sensitivity to increasing price of alcohol (Yurasek et al., 2013). Impulsivity, a dispositional individual difference factor associated with externalizing behavior and disorders, has also been associated with greater alcohol demand among college student drinkers (Amlung et al., 2013) and cigarette smokers who also reported past-year alcohol use (Gray and MacKillop, 2014).

The bulk of the existing data to date on psychopathology and substance demand have been specific to alcohol, as reviewed above (e.g., Murphy et al., 2013; Tripp et al., 2015). We are aware of only one existing published study of psychopathology and tobacco demand, which found that smokers with schizophrenia, relative to healthy controls, had higher intensity of demand (MacKillop and Tidey, 2011). This work has not yet been extended to broader forms of psychopathology which is important given (a) heterogeneity in psychopathology and (b) differences in smoking lapse behavior across different disorder groups (e.g., anxiety versus substance use disorders; Piper et al., 2010). Additionally, given that comorbid psychopathology is associated with poorer smoking cessation outcomes (Cougle et al., 2010; Piper et al., 2010), it is important to understand how tobacco demand may differ as a function of number of diagnoses.

Thus, the current study examined the association between various forms of psychopathology and situational tobacco demand in a sample of community-recruited daily smokers. We examined the effect of having any past-year diagnosis, relative to not, in terms of tobacco demand, as indexed via performance on a state-version of the Cigarette Purchase Task (CPT; MacKillop et al., 2008) following approximately 60 min of smoking deprivation. This assessment window allowed for the onset of tobacco craving, which can occur within 30 min of not smoking (Hendricks et al., 2006). Additionally, we tested the unique patterning of effects of having an emotional disorder (anxiety/depressive disorder), comorbid (non-tobacco) substance use disorder, and the number of psychological diagnoses in terms of CPT performance. It was hypothesized that smokers with any psychopathology, relative to none, would demonstrate greater tobacco demand following deprivation, and that these differences would be present in smokers with emotional disorders and those with substance use disorders. It was also hypothesized that smokers with more disorders (having two or more diagnoses) would demonstrate greater tobacco demand relative to individuals with one or no diagnosis.

## 2. Material and methods

### 2.1. Participants

Non-treatment seeking adult daily smokers were recruited for an experimental study on smoking behavior (Farris and Zvolensky, 2016). Community-recruited individuals who were between 18 and 65 years of age, reported smoking 10 or more cigarettes per day for at least one year and smoked within the first 30 min of waking in the morning, were invited for a baseline assessment to determine eligibility for the experimental study (described in Farris and Zvolensky, 2016). Participants were excluded from participation during an initial telephone screen if they reported heavy/frequent drinking ( $\geq 9$  standard drinks/week), illicit drug use ( $\geq 3$  days/week), unstable medical conditions, or current psychotic symptoms. The current study is a secondary analysis of data from participants who completed the baseline assessment including the CPT ( $n = 126$ ), regardless of whether or not they were deemed eligible for the experimental phase of the study. Several cases ( $n = 11$ ) showed evidence of inconsistent responding across prices (i.e., had  $\geq 3$  reversals), and 4 cases exhibited constant demand, suggesting low effort during this task; these cases were excluded from subsequent analysis.

Participants ( $n = 111$ ;  $M_{age} = 43.8$ ;  $SD = 9.8$ ; 55.8% male) identified race as Black/African-American (59.5%), white (33.3%), American Indian/Alaska Native (1.8%), Asian (1.0%), or other (4.5%), and 5.4% of participants identified ethnicity as Hispanic. Approximately half of the sample completed at least some college (57.5%). Participants were single (47.7%), divorced/separated (35.1%), married/co-habiting (12.6%), and widowed (4.5%). Employment status was reported as unemployed (38.7%), employed full time (24.3%), employed part time

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