



Published in final edited form as:

J Behav Ther Exp Psychiatry. 2011 March ; 42(1): 104–110. doi:10.1016/j.jbtep.2010.07.005.

Marijuana Craving During a Public Speaking Challenge: Understanding Marijuana Use Vulnerability among Women and those with Social Anxiety Disorder

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Abstract

Social anxiety disorder (SAD) is associated with risk for developing marijuana dependence, yet it remains unclear whether urge to use marijuana increases in *anticipation* of social anxiety-provoking situation, *during* the situation, or *afterwards* (to avoid post-event processing). The present study examined the timing of marijuana craving in response to a social anxiety task among 60 (50% female; 33% with SAD) marijuana users randomly assigned to either a speech or reading task. Participants completed ratings of marijuana craving at baseline (prior to being informed of task assignment), before, during, and after task. Among women and participants with SAD, the speech task was associated with greater craving than the reading task. This effect was particularly pronounced *during* the social anxiety induction task. This effect was not observed for men or participants without SAD. Identification of timing of urge to use marijuana has important implications for treatment and relapse prevention of marijuana problems among women and people with SAD (a group at particular risk for marijuana-related problems).

Keywords

Social anxiety disorder; social phobia; marijuana; cannabis; craving; sex differences

1. Introduction

People with social anxiety disorder (SAD), a psychiatric condition characterized by fear of scrutiny in social situations, appear particularly vulnerable to marijuana use disorders (MUD). Findings from the National Comorbidity Study (NCS) indicate that among individuals with SAD, the lifetime prevalence rate of marijuana dependence is 29.0% (Agosti, Nunes, & Levin, 2002) compared to 4.2% in the general population (Anthony, Warner, & Kessler, 1994). Among the anxiety disorders, marijuana dependence and SAD appear to share a specific

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relationship since, in the NCS sample, the rate of marijuana dependence in SAD was more than twice that of any other anxiety disorder (Agosti et al., 2002). Elevated social anxiety and SAD are similarly associated with marijuana-related problems in undergraduate samples (Buckner, Bonn-Miller, Zvolensky, & Schmidt, 2007; Buckner, Mallott, Schmidt, & Taylor, 2006; Buckner & Schmidt, 2008, 2009b; Buckner, Schmidt, Bobadilla, & Taylor, 2006). Moreover, compared to those without SAD, adolescents with SAD show nearly *five times* greater risk of developing adult marijuana dependence even after controlling for a wide array of relevant Axis I psychopathology (Buckner et al., 2008), suggesting social anxiety may be a risk factor for MUD. Multivariate analyses suggest that when accounting for covariance among internalizing disorders, SAD emerges as the only internalizing disorder related to marijuana problems (Buckner, Mallott et al., 2006; Buckner et al., 2008) and the relationship between social anxiety and marijuana problems remains even after controlling for relevant variables such as other substance use, other types of anxiety, and depression (Buckner, Bonn-Miller et al., 2007; Buckner & Schmidt, 2009b; Buckner, Schmidt et al., 2006; Buckner et al., 2008).

The high rate of co-occurrence between SAD and MUD is noteworthy because marijuana use is associated with a variety of substantial problems. For example, smoking marijuana has been found to have a larger effect on respiratory function than tobacco (Sherrill, Krzyzanowski, Bloom, & Lebowitz, 1991), including cellular changes that may increase cancer risk (e.g., Sarafian, Magallanes, Shau, Tashkin, & Roth, 1999). Driving under the influence of marijuana is linked to greater accident risk (Ramaekers, Berghaus, van Laar, & Drummer, 2004) and marijuana use is prospectively related to academic underachievement (Fergusson, Horwood, & Beautrais, 2003). In the U.S., for example, approximately 28% of current marijuana users meet criteria for a MUD and the prevalence of MUD nearly equaled that of the prevalence of all other illicit substance use disorders combined (Substance Abuse and Mental Health Services Administration [SAMHSA], 2006).

Despite the high rates of co-occurrence between social anxiety and marijuana problems and emerging evidence that there may be a relatively specific relationship between them (Buckner, Bonn-Miller et al., 2007; Buckner, Mallott et al., 2006; Buckner & Schmidt, 2009b; Buckner, Schmidt et al., 2006; Buckner et al., 2008), little empirical work has focused on elucidation of the functional relationship between social anxiety and marijuana problems. A variety of substance use models including the tension-reduction model (Conger, 1956) and motivational models (e.g., Simons, Correia, Carey, & Borsari, 1998) posit that the use of substances to manage negative affect increases risk of substance use and substance-related problems. It follows that people with SAD may use marijuana in an attempt to manage negative affect experienced in response to social situations. In fact, socially anxious marijuana users endorse greater rates of coping motives (i.e., using marijuana to cope with negative affect) and this motive mediated the relationship between marijuana problems and social anxiety among marijuana users (Buckner, Bonn-Miller et al., 2007).

Alternatively, people with SAD may use marijuana to help manage the impression they make on others during social situations. Consistent with the self-handicapping theory of substance use (Jones & Berglas, 1978), individuals with elevated social anxiety may be vulnerable to craving marijuana in anticipation of or during a social event because they believe others will attribute any deficits in social functioning to the effects of marijuana rather than to lack of ability. In support of this theory, elevated subclinical social anxiety and SAD are associated with the expectation that marijuana use will produce cognitive and behavioral impairment (Buckner & Schmidt, 2008, 2009b).

Yet another possibility is that people with SAD may be motivated to use marijuana after a social event to avoid memories of embarrassing moments during social situations. Relative to individuals with less social anxiety, individuals with elevated social anxiety engage in more

post-event processing (i.e., detailed review of one's performance during a social situation), particularly after social anxiety-provoking situations (for review see Brozovich & Heimberg, 2008). Higher social anxiety appears to be particularly related to negative rumination after a social situation and such negatively valenced post-event processing is thought to perpetuate and even exacerbate social anxiety in future social situations (Brozovich & Heimberg, 2008). It therefore follows that people with SAD may use marijuana in an attempt to manage the negative affect brought on by post-event processing.

In reviewing the associations between social anxiety and marijuana use behaviors, it is noteworthy that emerging data suggest that women may be particularly vulnerable to using substances such as marijuana to manage social anxiety. To illustrate, women who use substances exhibit higher rates of anxiety and mood disorders than male users (for review see Zilberman, Tavares, Blume, & el-Guebaly, 2003), suggesting women may be particularly vulnerable to using substances to manage negative affect. Girls with marijuana dependence have been found to exhibit higher anxiety (but not depression or borderline personality symptoms) compared to boys with marijuana dependence (Chabrol, Ducongé, Casas, Roura, & Carey, 2005). In one of the few studies to examine the relations between symptoms of SAD and MUD separately by sex, we found SAD and MUD symptoms were positively related among women but not men (Buckner, Schmidt et al., 2006). These data suggest it is important to consider possible sex differences when examining the impact state social anxiety may have on marijuana use variables.

One way to test whether state social anxiety increases marijuana use risk among those with SAD is to experimentally manipulate state social anxiety to examine whether increases in state anxiety are associated with greater marijuana craving. Further, the experimental manipulation of social anxiety in a controlled laboratory environment can provide information about whether the phase of the social situation (i.e., before, during, after) affects marijuana craving. The present study examined whether laboratory-induced state social anxiety would be related to greater self-reported marijuana craving. Participants were randomly assigned to either a social anxiety induction task (i.e., speech task) or a socially neutral task (i.e., reading task). Participants rated their state anxiety and marijuana craving at baseline (before being informed of task assignment), immediately prior to task, during task, and immediately after task. In line with the notion that state social anxiety can increase marijuana craving, it was predicted that, compared to those in the reading condition, participants in the speech condition would report greater state anxiety and marijuana craving before, during, and after the task. Consistent with the notion that women and people with SAD are particularly vulnerable to using marijuana to manage their social anxiety, it was hypothesized that observed effects would be especially evident for these participants. The sample was comprised of marijuana-using undergraduates with and without SAD, given college students and young adults generally are at risk for marijuana problems (SAMHSA, 2006; Caldeira, Arria, O'Grady, Vincent, & Wish, 2008).

2. Method

2.1. Participants

Participants were recruited based on responses to a mass screening administered from September 2006 to January 2008. Of the 3,200 undergraduates screened, 1,412 reported using marijuana during the past 1–3 months and were invited via email to participate in a “Linguistics Study” for research credit. To oversample those with SAD, the *Social Interaction Anxiety Scale* (Mattick & Clarke, 1998) was administered and the 448 marijuana users who evinced elevated social anxiety were sent an additional study invitation email.

To isolate the effects of the social anxiety manipulation on marijuana craving, time since last marijuana use was held constant by asking participants to refrain from marijuana use for three

days prior to their appointment. This timeframe was chosen because abstinence was verified using oral tetrahydrocannabinol (THC) testing, which can detect THC that has been consumed up to three days prior to test administration (Cone et al., 2002). Although 93 marijuana users scheduled an appointment, 22 cancelled or no-showed. Of the 71 who attended their appointment, 5 were excluded because they reported never using marijuana during the clinical interview. Of the 66 that completed the study protocol, 3 tested positive for THC and 3 provided THC samples that were of insufficient volume for testing. These 6 participants were excluded from analyses.

Thus, the final sample was comprised of 60 (50.0% female) students, one-third of whom met DSM-IV criteria for SAD. Ages ranged from 18–22 ($M=19.07$, $SD = 1.63$). The racial/ethnic composition of the sample was: 3.3% African American, 3.3% Asian American, 1.7% American Indian, 85.0% Caucasian, and 6.7% Hispanic/Latino. See Table 1 for additional demographic information.

2.2. Measures

2.2.1. Clinical interviews—Diagnostic status was determined via clinical interview using the *Anxiety Disorders Interview Schedule-IV-L* (ADIS-IV; DiNardo, Brown, & Barlow, 1994). Percent agreement between clinical interviewers in our laboratory using the ADIS has been found to be over 80% (Buckner & Schmidt, 2009a).

2.2.2. Oral THC Testing—Oral THC testing was chosen because oral tests demonstrate superior ability to detect recent THC administration (Niedbala et al., 2001). Specimens were collected on the day of the experiment with the Intercept Oral Specimen Collection Device (OraSure Technologies, Bethlehem, PA) according to manufacturer's instruction. The device consists of a treated cotton fiber pad attached to a nylon stick and preservative solution (0.8 mL). The collection pad was placed between the lower gum and cheek for approximately 2 minutes then placed in the preservative solution. Approximately 0.4 mL of saliva was collected per participant. Specimens were analyzed with the Intercept MICRO-PLATE Enzyme Immunoassay (OraSure Technologies, Bethlehem, PA) by LabOne (Lenexa, KS) according to manufacturer's procedures. The ability of Intercept to detect THC using saliva specimens has been confirmed in previous studies (e.g., Cone et al., 2002).

2.2.3. Marijuana use—The Marijuana Use Form (MUF) is a self-report instrument used to assess marijuana use (Buckner, Bonn-Miller et al., 2007). Lifetime frequency was assessed using a 0 (*never*) to 6 (*once or more every day*) rating scale. Past-month frequency was assessed using a 0 (*once per month or less*) to 9 (*at least 21 times per week*) rating scale. This questionnaire has successfully assessed marijuana use behaviors (Buckner, Bonn-Miller et al., 2007; Buckner & Schmidt, 2008, 2009b).

2.2.4. Other substance use measures—Alcohol use frequency and use-related problems were assessed with the *Alcohol Use Disorders Identification Test* (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). Current tobacco cigarette use was assessed with an item from the *Smoking History Questionnaire* concerning number of cigarettes smoked on an average day in the past week. This measure has been successfully used in previous smoking studies (e.g., Brown, Lejuez, Kahler, & Strong, 2002). Marijuana use-related problems were assessed with the *Marijuana Problems Scale* (MPS; Stephens, Roffman, & Curtin, 2000), a 19-item list of negative social, occupational, physical, and personal consequences associated with past 90 day marijuana use. Problems were rated on a 0–2 scale (0=*no problem*, 1=*minor problem*, 2=*serious problem*). This measure has demonstrated good reliability (Buckner, Keough, & Schmidt, 2007; Buckner & Schmidt, 2008; Stephens et al., 2004).

2.2.5. State Marijuana Craving and Social Anxiety—Participants rated marijuana craving using a visual analog scale (VAS) that read: “Please indicate how much you are craving marijuana RIGHT NOW” on an 11-point (0 to 10) scale. VAS scales have been used in other experimental studies of marijuana craving (Gray, LaRowe, & Upadhyaya, 2008). In the present study, baseline VAS craving was positively, strongly correlated with the four factors of Marijuana Craving Questionnaire (MCQ; Heishman, Singleton, & Liguori, 2001), compulsivity ($r=.51, p<.001$), emotionality ($r=.50, p<.001$), expectancy ($r=.65, p<.001$), and purposefulness ($r=.66, p<.001$). State anxiety was assessed using a *Subjective Units of Distress* (SUDS; Wolpe, 1968) in which participants were asked to “Please indicate your current level of anxiety by circling the number that best corresponds with the way you are feeling RIGHT NOW” on a scale of 0–10. Similar SUDs have been used in other experimental studies of social anxiety (e.g., Hofmann, Gerlach, Wender, & Roth, 1997). In the present study, baseline SUDS was positively, strongly correlated with the 20-item state portion of the Spielberger State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983), $r=.55, p<.001$.

2.3. Experimental Conditions

2.3.1. Speech Task—A public speaking task was designed to increase state social anxiety given this manipulation has reliably produced marked increases in self-reported social anxiety in prior reports (e.g., Kidorf & Lang, 1999). Participants in this condition gave a 5-min speech concerning “their most undesirable characteristic”. Participants were informed that the speech would be videotaped and evaluated by a small group of faculty and students.

2.3.2. Reading Task—A reading task designed to have no effect on state social anxiety was used as the control procedure. Participants in this condition were told their task was to silently read a *Popular Mechanics* magazine at their own pace for 5 minutes. Reading tasks have been shown to produce significantly less anxiety than social anxiety challenges (e.g., Abrams, Kushner, Medina, & Voight, 2002).

2.4. Procedures

On the day of the appointment, the participant met individually with a trained clinical interviewer. Prior to data collection, the interviewer obtained informed consent. Participants were randomly assigned to one of the two conditions: speech task ($n=30$) and reading task ($n=30$).

After the clinical interview, eligible participants met with an undergraduate research assistant who obtained the oral THC sample. Participants completed computerized versions of the self-report measures using a secure, on-line data collection website. Computerized and paper-and-pencil versions of self-report measures produce equivalent scores and are highly correlated (Gwaltney, Shields, & Shiffman, 2008). There are several advantages of computerized versions including that missing data can be reduced by making items required to answer before moving on to the next item and effort and error associated with data entry can be reduced because there is no manual entering of data by research assistants (Gwaltney et al., 2008). Participants were next informed of the task to which they were randomized (speech or reading task). Craving and state anxiety were assessed four times: at baseline (prior to knowledge of condition assignment), immediately prior to task initiation (after being informed of condition assignment; i.e., the anticipation phase), 2.5 minutes into the task (i.e., the during phase), and immediately after the task (i.e., the after phase). After completing study task and measures, all participants were debriefed and given a list of community treatment options.

3. Results

3.1. Sample Characteristics

To ensure conditions did not differ on demographic and other relevant variables, one-way analyses of variance (ANOVAs) were conducted for continuous variables and χ^2 analyses were performed for dichotomous variables. Bonferroni corrections were used ($p=.05/16=.003$). The conditions did not differ on SAD or MUD diagnostic status, anxiety treatment history, frequency of marijuana use, marijuana-related problems, or demographic variables (Table 1). However, randomization resulted in a slightly greater percentage of women in the speech condition ($.003 < p < .05$). Therefore, to provide a conservative test of study hypotheses that ensured observed effects were not due to sex, sex was included as a covariate in data analyses when appropriate.

3.2. Substance Use

In this sample, 93.2% reported past-month marijuana use, 65.0% reported at least weekly use, and 16.7% indicated daily use. Participants reported average lifetime marijuana use in the 1–4 times per week range since marijuana initiation (MUF $M=3.71$, $SD = 1.16$). Regarding past-month use, participants reported average use in the twice per week range (MUF $M=4.05$, $SD = 2.60$).

Regarding alcohol use, only 1.7% reported no alcohol use, 5.0% reported monthly use or less, 21.7% reported drinking 2–4 times per month, 66.7% reported drinking 2–3 times per week, and 5.0% reported drinking 4+ times per week. As for tobacco cigarette use, 68.3% reported using cigarettes. Of those, the mean number of cigarettes smoked per day in the past week was 2.15 ($SD=4.37$, range: 0–15).

3.3. Manipulation Check

To evaluate the success of the experimental manipulation of anxiety, a 4 (Time: baseline, anticipation, during, after) X 2 (Condition: Reading vs Speech) repeated measures analysis of covariance (ANCOVA)¹ was conducted with sex as the covariate. Following the recommendations of Olejnik and Algina (2000), effect size was measured using ω^2 to determine whether effect of the interaction was small ($\omega^2 = .01$), medium ($\omega^2 = .06$), or large ($\omega^2 = .14$). The interaction was significant, $F(2.01, 106.77) = 11.89$, $p < .001$, $\omega^2 = .05$. Although the two conditions did not significantly differ on anxiety at baseline, participants in the speech task reported significantly greater anxiety during and after the task (Table 2). There was a trend for participants in the speech condition to report greater anxiety in anticipation of their task.

3.4. Effects of Speech Stressor on Craving by Sex

To examine whether experimental conditions differed as a function of sex on average craving ratings over time, a 2 (Condition) X 2 (Sex: Male vs Female) X 4 (Time) repeated measures ANCOVA¹ was conducted with daily marijuana use status and daily tobacco smoking status included as covariates. Time was the within subjects factor and experimental condition and sex were between-subjects factors. This three-way interaction was significant, $F(2.30, 75.84) = 4.52$, $p = .001$. To probe this interaction, we conducted follow-up 2 (Condition) X 4 (Time) repeated measures ANCOVAs¹ separately by sex, given our a priori hypothesis that female participants may be especially vulnerable to marijuana craving in response to the speech versus reading task. Among women, this interaction was significant, $F(1.63, 21.18) = 5.88$, $p = .013$, $\omega^2 = .03$ (Figure 1a). Follow-up analyses revealed that the two conditions did not differ on craving at baseline ($F(1, 17) = .01$, $p = .912$, $d = .35$), in anticipation of the task ($F(1, 17) = .$

¹Greenhouse-Geisser corrections were applied to all repeated measures ANCOVA analyses when appropriate.

1.29, $p = .277$, $d = 1.24$), or after the task ($F(1, 17) = .90$, $p = .362$, $d = 1.43$). They did, however, differ during the task such that women in the speech task reported greater craving than those in the reading task, $F(1, 17) = 17.66$, $p = .001$, $d = 2.88$. A significant interaction contrast suggests that the rate of change in craving from baseline to during the task was significantly greater for women in the speech task relative to women in the reading task, $F(1, 13) = 19.07$, $p = .001$. However, among men, the 2 (Condition) by 4 (Time) repeated measures ANCOVA¹ was not significant, $F(1.26, 22.67) = .14$, $p = .768$, $\omega^2 = .00$ (Figure 1b).

3.5. Effects of Speech Stressor on Craving by Social Anxiety Disorder Status

To evaluate whether experimental conditions differed as a function of SAD status on craving over time, a 4 (Time) X 2 (Condition) X 2 (SAD status: SAD+ vs SAD-) repeated measures ANCOVA¹ was conducted with craving as the dependent variable. Daily marijuana use status, daily tobacco use status, and sex were included as covariates. This three-way interaction was not significant, $F(2.32, 74.14) = 1.78$, $p = .170$. Given our a priori hypothesis that the Time X Condition interaction may be significant among participants with SAD, we next conducted separate Time X Condition ANCOVAs¹ for those with and without SAD.

Among participants with SAD, the Time X Condition interaction approached significance, $F(3, 15) = 3.07$, $p = .060$, $\omega^2 = .06$. Because the lack of significant interaction does not preclude the possibility that the conditions can differ at specific time points or that specific time points may experience significantly different rates of change (Maxwell & Delaney, 2004) combined with the finding that the interaction was associated with a medium effect size, we conducted follow-up analyses examining point comparisons and interaction contrasts among SAD participants (Figure 2a). Follow-up analyses revealed that the two conditions did not differ on craving at baseline ($F(1, 10) = .05$, $p = .829$, $d = .26$), in anticipation of the task ($F(1, 10) = 1.39$, $p = .304$, $d = .64$), or after the task ($F(1, 10) = .12$, $p = .749$, $d = .70$). They did, however, differ during the task such that participants with SAD in the speech task reported greater craving than those in the reading task, $F(1, 10) = 9.15$, $p = .039$, $d = 1.66$. The “baseline” to “during” interaction contrast was significant, $F(1, 5) = 11.57$, $p = .019$, indicating that craving in the speech condition increased at a greater rate during the speech task than it did during the reading task. Among participants without SAD, the Time X Condition interaction was not significant, $F(1.65, 39.61) = .50$, $p = .598$, $\omega^2 = .00$ (Figure 2b).

4. Discussion

This study is the first to examine whether increased state social anxiety is related to marijuana craving to further elucidate the nature of observed relations between marijuana use and its disorders and elevated social anxiety (Agosti et al., 2002; Buckner, Bonn-Miller et al., 2007; Buckner, Mallott et al., 2006; Buckner & Schmidt, 2008, 2009b; Buckner et al., 2008). These data contribute to our understanding of the social anxiety-marijuana relationship in several ways. First, this study supports prior work suggesting that social anxiety may be particularly related to marijuana-related behaviors among *women* (Buckner, Schmidt et al., 2006). Second, data from the present report support the contention that social anxiety can temporally precede marijuana-related behaviors (Buckner et al., 2008) given that increases in state social anxiety were associated with greater average cravings among women and people with SAD. The present study extends prior work by demonstrating that state social anxiety experienced *during* a social anxiety-provoking situation may be particularly implicated in marijuana use among women and people with SAD.

The specificity of the increased desire to use marijuana specifically *during* a social situation among women and those with SAD provides novel insight into marijuana use vulnerability among these groups. Our finding that women were particularly vulnerable to wanting to use marijuana during a social anxiety-provoking situation (but not before or afterwards) is

interesting when considered in light of prior research. Specifically, our finding suggests that women may be particularly vulnerable to wanting to use marijuana during the situation (when state anxiety was highest) in an attempt to decrease their state anxiety. However, prior work has found gender to be unrelated to coping motives for marijuana use (Buckner, Bonn-Miller et al., 2007; Simons et al., 1998). On the other hand, coping motives have been found to interact with gender to predict marijuana use such that there appears to be a stronger relationship between coping motives and marijuana use among women compared to men (Simons et al., 1998). Also, the magnitude of the difference between women in the speech versus control condition in anticipation of the task and after the task, although not statistically significant, was large (Cohen, 1988). This finding suggests replication with larger samples of women marijuana users may be an important next step in this line of work. Clearly more research is necessary to determine whether women are particularly vulnerable to wanting to use marijuana specifically during social anxiety-provoking situations to help them cope with unpleasant anxiety reactions or whether they are motivated to use marijuana during these situations for other reasons. Such information could go a long way toward improving treatment efforts among women suffering from MUD.

That participants with SAD did not report wanting to use marijuana after the social event to manage negative affect associated with post-event processing suggests people with SAD may want to use marijuana not necessarily to cope with unpleasant physical sensations associated with anxiety (as they would experience anxiety during post-event processing), but rather to manage their anxiety during the social situation in particular. This hypothesis is consistent with recent theory that people with SAD may use marijuana as a means to manage the impression they make on others —so that others will attribute any deficit in social skills to the use of marijuana rather than to the individual (Buckner & Schmidt, 2008, 2009b). In fact, social anxiety has been linked to other self-handicapping strategies thought to play a role in impressions management (e.g., Snyder, Smith, Augelli, & Ingram, 1985). Future work directly testing the theory that people with SAD use marijuana to self-handicap in social situations will be an important next step in this line of work.

Given that anxiety is related to post-treatment marijuana use and relapse (Arendt, Rosenberg, Foldager, Perto, & Munk-Jorgensen, 2007; Bonn-Miller & Moos, 2009; Buckner & Carroll, in press), our novel data have implications for the prevention and treatment of the high rates of marijuana problems among those with SAD. Increases in state social anxiety may be a trigger for marijuana use among SAD patients more so than patients without SAD. In particular, marijuana users with SAD appear especially vulnerable to wanting to use marijuana during social anxiety-provoking tasks (and less so in anticipation of or after a social event). Thus, clinicians may consider including assessment of specific phase of social situation (anticipation, during, after) as possible triggers for marijuana use during functional analyses with marijuana using patients with SAD. These patients may also benefit from learning strategies specifically developed to cope with cravings in anticipation of and during social situations to help reduce marijuana use during treatment and to prevent relapse.

The present study should be considered in light of limitations that suggest the need for additional work in this area. First, randomization resulted in unequal numbers of men and women in each experimental condition. Thus, although the present study is an important first step in understanding the relationships between sex, social anxiety, and marijuana craving, additional work is necessary. Second, randomization resulted in a greater (although non-significant) percent of women in the speech condition. Although SAD analyses statistically controlled for sex, replication without this sex difference will be an important next step. Third, the effects of the speech task on craving were not as large as those obtained in studies that included *in vivo* marijuana cues (Gray et al., 2008) and future work may include such cues to examine whether these cues work synergistically with state social anxiety to elicit craving.

Fourth, state craving and anxiety were assessed with single-item measures. The single items assessing state craving and anxiety correlated with longer measures of craving (MCQ; Heishman et al., 2001) and anxiety (STAI; Spielberger et al., 1983), respectively, with magnitudes considered to be large effects by Cohen (1988). However future work could benefit from the use of more comprehensive measures of craving and anxiety. Fifth, the sample was comprised of undergraduates. Although this sampling strategy was chosen to target individuals at risk for marijuana problems (e.g., young adults, college students) (SAMHSA, 2006; Caldeira et al., 2008), future research is necessary to determine whether the observed relations generalize to other marijuana-using populations (e.g., adolescents, older adults, young adults who do not attend university). Sixth, future work would benefit from examination of actual marijuana use to determine whether women and people with SAD are in fact more likely to use marijuana during a social situation.

In conclusion, the present study provides the first known experimental evidence suggesting that state social anxiety may increase desire to use marijuana among current marijuana users, particularly women and people with SAD. Results suggest that these groups of marijuana users may be particularly vulnerable to wanting to use marijuana during social anxiety-provoking situations. Future work is necessary to elucidate the reasons these individuals are motivated to use marijuana during social situations, as such information could go a long way toward improving marijuana treatment and prevention efforts for this vulnerable population.

Acknowledgments

This research was supported in part by National Institute on Drug Abuse (NIDA) grant F31 DA021457 (awarded to Julia D. Buckner). NIDA had no further role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the paper for publication. The authors wish to thank Rebecca A. Bernert, L. Rose Hunter, Meghan E. Keough, José Silgado, and Kiara R. Timpano for conducting clinical interviews.

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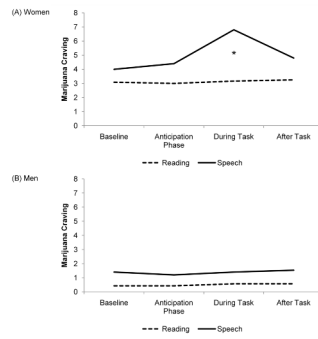


Figure 1. (A) Time X Condition Interactions for Female Participants, (B) Time X Condition Interactions for Male Participants.

Note. Means presented are estimated marginal means controlling for daily marijuana and tobacco use statuses.

* Difference between condition means statistically significant ($p < .05$).

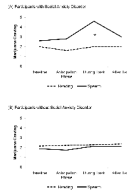


Figure 2.

(A) Time X Condition Interactions for Participants with Social Anxiety Disorder, (B) Time X Condition Interactions for Participants without Social Anxiety Disorder.

Note. Means presented are estimated marginal means controlling for sex and daily marijuana and tobacco use statuses.

* Difference between condition means statistically significant ($p < .05$).

Table 1
Demographic Characteristics of Randomized Sample for Total Sample and by Experimental Condition

Dependent Variable	Total N=60	Reading n = 30	Speech n = 30	χ^2	F	p
Age	19.9 (1.16)	18.90 (1.09)	19.23 (1.22)	1.24		.27
Gender (Female)	50.0%	66.7%	33.3%	6.67		.01
Race (Caucasian)	85.0%	76.7%	93.3%	3.27		.07
Employed	25.0%	23.3%	26.7%	.09		.77
Anxiety treatment history	8.5%	10.0%	6.9%	.18		.67
SAD	33.3%	36.7%	30.0%	.30		.58
MUD	40.0%	36.7%	43.3%	.28		.60
Marijuana Abuse	26.7%	26.7%	26.7%	.00		1.00
Marijuana Dependence	13.3%	10.0%	16.7%	.58		.45
Weekly marijuana use	65.0%	60.0%	70.0%	.66		.42
Age first marijuana use	15.66 (1.94)	16.00 (2.07)	15.31 (1.78)	1.86		.179
Daily marijuana use	16.7%	16.7%	16.7%	.00		1.00
Marijuana Problems	3.68 (3.56)	3.72 (3.99)	3.63 (3.17)	.01		.92
Depression	7.97 (78.62)	9.18 (8.47)	6.83 (6.69)	1.38		.25
Social anxiety	25.21 (15.45)	25.25 (15.82)	25.21 (15.37)	.00		.98

Note. Chi-square and ANOVAs conducted to determine whether experimental conditions differed. Numbers presented are means and standard deviations for the total sample and each condition unless noted otherwise.

Table 2

State social anxiety at each time point by experimental condition.

	Reading (<i>n</i> =30)		Speech (<i>n</i> =30)					
	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)	<i>F</i>	<i>df</i>	<i>p</i>	<i>d</i>
Baseline	1.86	(1.58)	1.32	(.95)	1.17	1, 54	.284	.43
Anticipatory phase	2.18	(1.96)	2.86	(2.07)	3.52	1, 55	.066	.35
During task	2.18	(2.07)	4.04	(2.60)	12.02	1, 55	.001	.85
After task	2.14	(2.10)	3.61	(2.78)	6.63	1, 55	.013	.64

Note. Sex (0=male, 1=female) was included as a covariate.