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The interactive effect of anxiety sensitivity and frequency of marijuana use in terms of anxious responding to bodily sensations among youth

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Abstract

Marijuana use is associated with anxiety, particularly among those anxiety conditions in which panic is common. It may therefore be that risk factors for panic increase the likelihood that marijuana users will experience problematic anxiety symptoms. The current study investigated the role of one such risk factor, anxiety sensitivity (AS), or the extent to which an individual is frightened of anxiety symptoms. We examined whether AS interacts with frequency of marijuana use to increase anxious responding (using a three-minute voluntary hyperventilation procedure). The sample consisted of 153 adolescents (46.4% female) age 11-17 ($M = 14.92$, $SD = 1.49$). As predicted, AS moderated the link between lifetime marijuana use frequency and both post-challenge physiological anxiety (as indexed by skin conductance) and post-challenge subjective anxiety in female (but not male) adolescents such that those with high AS and more frequent marijuana use demonstrated the highest level of challenge-induced fear response. This effect remained even after controlling for relevant variables (e.g., age, trait anxiety, lifetime alcohol and cigarette use). Present findings suggest AS appears to serve as an important and potentially specific anxiety-related variable that deserves serious attention as a potential vulnerability factor among frequent marijuana-using females.

Keywords

Marijuana; Cannabis; Anxiety; Anxiety Sensitivity; Biological Challenge; Panic

1. Introduction

Empirical evidence indicates a link between anxiety and frequent marijuana use, marijuana-related impairment, and marijuana use disorders (Abel, 1971; Agosti et al., 2002; Buckner et

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al., 2007; Buckner et al., 2006a; Buckner et al., 2006b; Buckner et al., 2008; Oyefeso, 1991; Patton et al., 2002; Zvolensky et al., 2006a). The association between marijuana and anxiety appears strongest among anxiety conditions in which panic is common (e.g., social anxiety, panic disorder). To illustrate, social anxiety disorder (SAD) in adolescence appears to serve as a risk for marijuana dependence in adulthood (Buckner et al., 2008). Further, more frequent marijuana use is prospectively associated with panic attacks and panic disorder (Zvolensky et al., in press) and panic attacks appear to be one of the most common consequences of marijuana use (Thomas, 1996).

Despite the link between marijuana use and certain anxiety states and disorders, little attention has been paid to individual-difference characteristics that may contribute to these relations. Given that marijuana use tends to co-occur with anxiety conditions in which panic commonly occurs, it may be that risk factors for panic increase the likelihood that marijuana users will experience problematic anxiety. One factor relevant to panic is anxiety sensitivity (AS), or the extent to which an individual fears symptoms of anxiety (Reiss and McNally, 1985). To illustrate, an individual high in AS may fear that heart palpitations signal a heart attack whereas someone low in AS may interpret the same sensations as non-threatening. AS has been found to predict panic attacks and panic disorder above and beyond relevant factors such as trait anxiety (Schmidt et al., 1997; Schmidt et al., 1999; Schmidt et al., 2006).

Given that marijuana use can produce bodily sensations such as acute changes in heart rate (O'Leary et al., 2002; Pillard et al., 1974), blood pressure (O'Leary et al., 2002), and respiratory functioning (Nahas and Latour, 1992), high AS individuals may interpret marijuana-related bodily sensations as threatening, thereby increasing the likelihood that they will experience acute anxiety and/or panic. In support of this conceptualization, marijuana use has been found to interact with AS to predict self-reported panic symptoms among young adult tobacco smokers (Zvolensky et al., 2006b). Specifically, high AS marijuana users reported the highest levels of panic symptoms and panic-related cognitions compared to high AS non-users and low AS individuals regardless of marijuana use status.

Although promising, the extant literature linking marijuana use to panic psychopathology is limited in that research to date has been conducted primarily with adults. Yet rates of marijuana use are particularly high among adolescents (Comeau et al., 2001; Johnston et al., 2004; Substance Abuse and Mental Health Services Administration, 2006). Further, the examination of the relations between marijuana use and anxiety among psychologically healthy adolescents (i.e., free from current or past Axis I psychopathology) limits the extent to which findings may be confounded. For instance, if other types of psychopathology common to marijuana use are present in adult samples, observed relations could be due to the presence of psychopathology rather than the predictor variables of interest. Additionally, the use of a young, healthy sample allows for the examination of the relations between marijuana use, AS, and anxious reactivity prior to the point at which marijuana use problems and clinically meaningful AS and/or anxiety could interact to create a vicious cycle of marijuana use leading to increased anxiety leading to increased marijuana use to medicate anxiety reactions (Buckner et al., 2008).

The primary goal of the current study was to further clarify the role of AS in the association between marijuana use and intensity of challenge-induced anxious responding (cognitive and physical). Biological challenges (e.g., hyperventilation) are widely used procedures for the investigation of psychological and neurobiological factors associated with panic and anxiety responses (Zvolensky and Eifert, 2000). Specifically, we sought to test whether AS moderated the relation between marijuana use and anxious reactivity. We extended prior work in several ways. First, we examined challenge-induced anxiety responses (elicited by voluntary hyperventilation). Second, given data suggesting that frequent marijuana use is associated with greater levels of anxiety and panic compared to individuals who use marijuana less frequently

(Oyefeso, 1991; Zvolensky et al., in press), we examined frequency of marijuana use. It was hypothesized that even after controlling for relevant variables (alcohol use, trait anxiety, tobacco use), AS would moderate the association between frequency of marijuana use and challenge response such that individuals with the greatest frequency of marijuana use and highest levels of AS would demonstrate the greatest challenge-induced anxiety relative to frequent marijuana users with low AS and individuals with low levels of marijuana use regardless of AS. Third, in light of data indicating the relations between marijuana and anxiety is specific to females (Buckner et al., 2006a), we examined conducted analyses separately by sex.

2. Method

2.1. Participants

The sample consisted of 153 adolescents (46.4% female) age 11-17 ($M_{age} = 14.92$, $SD = 1.49$) recruited through the general community. Advertising consisted primarily of flyers placed in the community (e.g., arcades, primary care offices, adolescent-oriented community centers). Advertisement booths were also set up in a local well-traveled marketplace on two separate occasions (approximately two months apart). The racial distribution of the sample generally reflected that of the local population: 90.8% Caucasian, 2.0% African American, 0.7% Native Hawaiian, 0.7% Asian, 0.7% American Indian, 2.0% “other,” and 3.3% did not specify race. The study was approved by the University of Vermont Institutional Review Board. Although there are other published reports from this dataset (Leen-Feldner et al., 2005; Leen-Feldner et al., 2006; Leen-Feldner et al., 2007), each focused on a distinct theoretical question.

To determine eligibility, all participants were administered the Anxiety Disorders Interview Schedule for the Diagnostic and Statistical Manual—Fourth Edition [DSM-IV]: Child Version (ADIS-C) (Silverman and Albano, 1996). Research personnel (e.g., doctoral-level graduate students, clinical post-doctoral students) were trained to mastery in the use of the instrument. Training involved intensive didactic sessions, direct observation of administrations, and diagnostic comparison until 100% diagnostic reliability was reached. In addition, ongoing supervision was provided throughout the study. No participant had current or past Axis I psychopathology and no participant met exclusionary criteria for the present study, including: (a) current or past cardiopulmonary (chronic) illness; (b) current acute respiratory illness; (c) current or past psychotropic medication use; (d) suicidality; and (e) limited mental competency and the inability to give informed, written consent/assent. These criteria serve to reduce potential confounds introduced by individual difference factors known to affect responding to the hyperventilation procedure as well as reduce medical complications and risks that might arise from hyperventilation.

2.2. Measures

2.2.1. Pre-challenge assessment—The 18-item *Childhood Anxiety Sensitivity Index* (CASI) (Silverman et al., 1991) was used to index anxiety sensitivity. Participants rated their perceptions of the aversive nature of anxiety symptoms by endorsing 1 (none), 2 (some), or 3 (a lot) in response to items such as “I don’t want other people to know when I feel afraid”. This psychometrically sound scale ($\alpha = .83$; current sample) was developed for use with youth and evidences satisfactory validity estimates (Silverman et al., 1991). Trait anxiety was measured using the well-validated state-trait anxiety index (STAI) (Spielberger et al., 1983). Substance use behaviors were assessed using items from the Youth Risk Behavior Survey (YRBS) (Division of Adolescent and School Health, 2004). Lifetime frequency of marijuana use was assessed using a 6-point scale ranging from “a” (0 times) to “f” (40 or more times). To evaluate the effects of using other substances, alcohol and tobacco cigarette use were included as covariates. Lifetime alcohol use was assessed on a 7-point scale ranging from “a” (0 days) to

“g” (100 or more days). The YRBS assesses lifetime tobacco cigarette use dichotomously (“yes” or “no”). The YRBS substance items have demonstrated excellent test-retest reliability (Brener et al., 2002).

2.2.2. Challenge assessment—The *Acute Panic Inventory* (API) (Dillon et al., 1987), a 23-item assessment, was used to measure post-challenge panic-relevant responding. Each item on the API represents a DSM-IV defined panic attack symptom (e.g., Do you feel faint?) to which respondents endorse 0 (*not at all*), 1 (*slight*), 2 (*moderate*), or 3 (*severe*), yielding a total intensity score ranging from 0-69. The API has sound psychometric properties ($\alpha = .83$; current sample) and has been successfully employed in previous biological challenge research with children and adolescents (Pine et al., 2000). Consistent with empirical precedent (Zvolensky et al., 2005), we examined the cognitive and physical API items separately.

2.2.3. Challenge—Hyperventilation served as the challenge procedure because it can be safely employed with adolescents, its parametric properties are well studied, and it can reliably produce bodily arousals that mimic panic attack symptoms (Hornsveld et al., 1990). The challenge involved a 3-minute hyperventilation with a breathing rate of 30 respiratory cycles/minute. A J&J Engineering I-330-C2 system was used to digitally record physiological data on-line at a sample rate of 1024 samples per second across all channels using J&J Engineering PhysiLab Software. Raw electrocardiogram data were collected with disposable Ag/AgCl electrodes placed in a standard bilateral configuration on the palmar side of each wrist using adhesive foam patch and pellet, along with Signal Cream conductive cream. Skin conductance levels, converted to microsiemens, were obtained using an RV-5 skin resistance lead connected to SE-35 electrodes placed on the middle finger. In the present study, average heart-rate and skin conductance levels (sampled every .25 s) were computed across the 5-minute quiet period to index baseline physiological responding and for three minutes post-challenge.

2.3. Procedure

Upon arrival to the laboratory, participants and their guardians were told that the purpose of the study was to learn about “adolescent emotions” and that participants had the right to discontinue participation at any time without penalty (no participant withdrew from the study). In regard to the challenge, participants were informed that they would be asked to participate in an exercise that involved breathing in and out at a standard rate for three minutes. Participants also were advised as to the potential side-effects of the procedure. Following completion of the consent/assent forms, trained research staff conducted the psychiatric interview and eligible participants completed the pre-challenge assessments.

For the challenge procedures, participants were seated and electrodes were attached. Participants were instructed to sit as still as possible during the procedures. The experimenter then left the room and participants sat quietly for a five-minute adaptation period. Audiotaped directions then described the hyperventilation procedure and provided breathing instructions. Psychophysiological data indicated the procedure was effective in increasing psychophysiological reactivity (Leen-Feldner et al., 2006).

API ratings were collected directly following the hyperventilation challenge. At the end of the study, participants and their parental guardians were debriefed and compensated \$50.

2.4 Data analytic strategy

Given hypothesized sex differences, analyses were conducted separately for male and female participants. First, zero-order correlations were computed to provide initial examination of the associations between predictor and criterion variables. To control for Type I error, a probability factor of .01 was used to interpret these associations.

To test the hypothesis that AS would moderate the relation between marijuana use frequency and post-challenge anxiety even after controlling for relevant covariates, hierarchical linear regression analyses were performed. This approach ensures that observed effects for the interactions cannot be attributed to shared variance with the variables at lower steps of the model (Cohen and Cohen, 1983). Interaction terms were centered to reduce multicollinearity (Aiken and West, 1991). The criterion variables were post-challenge heart rate, post-challenge skin conductance, and post-challenge API scores (API-physical and API-cognitive). Predictor variables in all regressions were the main effects of AS and marijuana frequency and the interaction of AS $\times$ marijuana frequency. Predictor variables were divided into three steps in the hierarchy: (a) the covariates of baseline heart rate or skin conductance (when applicable), age, trait anxiety, and lifetime alcohol and cigarette quantity were entered at step 1, (b) the main effects of each predictor variable in the interaction were entered at step 2, and (c) the interaction term was entered at step 3 (Baron and Kenny, 1986). The forms of significant interactions were inspected (Cohen and Cohen, 1983) and we conducted post-hoc probing of all significant moderator models (Aiken and West, 1991; Holmbeck, 2002). We also examined whether the observed relations occurred for past-month substance use and found that the nature and magnitude of the findings were similar whether past-month or lifetime indices were utilized. Thus, only analyses concerning lifetime indices are reported.

3. Results

3.1. Relations among predictor and criterion variables

Among females, marijuana use frequency was significantly positively correlated with age and alcohol use frequency, although negatively related to tobacco cigarette use. AS was unrelated to substance use variables. Post-challenge API scales (physical and cognitive) were positively correlated with trait anxiety and demonstrated a trending positive association with marijuana use frequency. AS was positively related to API-cognitive and trended toward a significant positive relation with API-physical. See Table 1.

Among males, lifetime marijuana use frequency was also positively correlated with age and alcohol use frequency, and negatively related to cigarette use. AS was unrelated to substance use. The API-physical scale demonstrated a trending positive relation with AS. See Table 1.

3.2. Moderator analyses controlling for relevant variables

Among females, AS moderated the relation between marijuana use frequency and post-challenge skin conductance even after controlling for relevant variables, $F_{change}(1, 55) = 8.11$, $p = .006$, with a medium effect size as indexed by f^2 (Cohen, 1988) (Table 2). Regression analyses indicated that the predictor variables together predicted 89.6% of the overall variance. After controlling for the covariates, the main effects of AS and marijuana frequency significantly predicted 0.4% of the unique variance in skin conductance. The interaction of AS $\times$ marijuana frequency significantly predicted an additional 1.5% of the total variance. The form of the interaction was examined and, as predicted, high AS and greater frequency of marijuana use were associated with the greatest post-challenge skin conductance (Figure 1). Only the simple slope of the high AS moderator variable was significant ($t = 2.13$, $p < .05$). In other words, post-challenge skin conductance was significantly greater for frequent versus infrequent marijuana users among individuals with high AS. However, among adolescents with low AS, these relations were not significant ($t = -.52$, $p = .61$). AS did not moderate the link between marijuana use frequency and post-challenge heart rate, $F_{change}(1, 55) = .63$, $p = .43$.

In regard to self-reported intensity of panic symptoms, AS moderated only the association between frequency of lifetime marijuana use and API-cognitive scores after controlling for relevant covariates, $F_{change}(1, 58) = 9.78$, $p = .003$, with a medium effect size as indexed by

f^2 (Table 2). Regression analyses suggest that the predictor variables together predicted 50.9% of the overall variance. After controlling for relevant variables, the main effects of AS and marijuana frequency significantly predicted 13.1% of the unique variance in marijuana symptoms. The interaction of AS $\times$ marijuana frequency significantly predicted an additional 8.3% of the total variance. The form of the interaction was examined and, as predicted, high AS and greater frequency of marijuana use were associated with the greatest post-challenge API-cognitive scores (Figure 2). Only the simple slope of the high AS moderator variable was significant ($t = 3.96, p < .001$). In other words, the relationship between frequency of marijuana use and post-challenge API-cognitive scores was significantly different for individuals with high AS but not individuals with low AS ($t = .89, p = .38$). AS did not moderate the link between marijuana use frequency and post-challenge API-physical scores, $F_{change} (1, 57) = .01, p = .91$.

Due to limitations of conducting moderator analyses using cross-sectional data, one method of increasing confidence in observed effects is to conduct additional regressions after reversing the proposed moderator with the independent variable. This strategy allows for the examination of the competing hypothesis that high AS adolescents are hyper-reactive and use marijuana to self-medicate. Frequency of marijuana use served as the dependent variable in two additional hierarchical regression models. Predictor variables included the main effects of centered AS and post-challenge reactivity (skin conductance or API-cognitive score) and their interaction. Predictors were divided into three steps in the hierarchy: (a) covariates were entered at step 1, (b) the main effects of each interaction term were entered at step 2, and (c) the interaction term was entered at step 3. Neither model was significant (post-challenge skin conductance $F_{change} (1, 55) = 2.46, p = .12$; API-Cognitive $F_{change} (1, 55) = .01, p = .92$). In other words, these models failed to account for the data thereby increasing confidence in the original models' moderational effects.

Among male participants, AS did not moderate the relation between marijuana use frequency and any post-challenge measure, $F_{change}'s < .44, p's > .51$.

To examine the specificity of AS as a moderator, we examined whether trait anxiety demonstrated a similar moderational effect. Trait anxiety did not moderate the link between marijuana use frequency and any post-challenge measure (biological indices and API subscales) for female adolescents, $F_{change}'s < 1.09, p's > .30$, or for male adolescents, $F_{change} < 1.53, p's > .20$.

4. Discussion

Overall, findings from the present study suggest that female adolescents who have frequently used marijuana throughout their lives may be particularly vulnerable to increased anxious responding if they possess high levels of the trait-like quality AS. Interestingly, our data suggest that marijuana use may not increase anxious responding among those with low AS. These findings are consistent with prior work suggesting that AS moderates the association between marijuana use and self-reported panic-relevant indices among adults (Zvolensky et al., 2006b). We built upon prior work by examining whether these relations were evident on behavioral measures of anxiety (i.e., response to hyperventilation challenge). Although the additional variance explained by the interaction term was small, given the magnitude of variance accounted for at earlier steps for each model (e.g., 88%), it is noteworthy that the interaction of AS and marijuana use frequency enhanced the model's predictive power at all (Abelson, 1985) and future study is necessary to evaluate the practical utility of this finding. Importantly, the observed effects were not attributable to other factors related to marijuana use and AS (e.g., lifetime alcohol and tobacco cigarette use, trait anxiety, age). It is also of note

that trait anxiety did not demonstrate a moderator effect, providing further support that AS may serve a specific role in anxious responding among marijuana users.

An alternative explanation of the current data is that high AS female adolescents are vulnerable to anxious responding and therefore use marijuana to dampen anxious arousal. This interpretation is consistent with the self-medication hypothesis that has received at least partial support in prior reports (e.g., Carrigan and Randall, 2003). Although the cross-sectional nature of our research design does not allow us to speak to temporal ordering of these associations, we attempted to rule out this alternative explanation by evaluating whether AS and anxious responding interacted to predict frequency of lifetime marijuana use. This model was not significant for either psychophysiological or self-reported post-challenge response, strengthening confidence in our contention that frequent marijuana use among high AS individuals may place them at risk for increased anxious arousal. However, prospective work will be a critical next step in demarcating temporal sequencing of these relations.

It is of note that AS moderated the marijuana use-anxious responding link while participants were ostensibly not under the influence of marijuana. This finding indicates there may be long-term effects of marijuana use on high AS female adolescents, such that high AS females who use marijuana are more likely to experience greater anxiety even when not intoxicated.

The present study is the first known investigation of the relations between marijuana use, AS, and anxious responding by sex and it is notable that lifetime frequency of marijuana use was related to some forms of anxiety (trait anxiety, post-challenge API) in female (but not male) adolescents. It is also noteworthy that AS increased post-challenge anxiety response only among female adolescents. These data are in line with emerging literature indicating that marijuana-related problems are related to anxiety among female (but not male) college students (Buckner et al., 2006a) and marijuana use is more strongly related to the development of depression and anxiety among female than male adolescents (Patton et al., 2002).

Yet what accounts for higher rates of anxiety among *female* marijuana users? Differential motivations for marijuana use may be at least partially responsible. Although females are more likely to use marijuana to cope with negative affect (Simons et al., 1998), male adolescents are more likely to use marijuana to enhance sociability and positive affect than females (Newcomb et al., 1988). It may therefore be that if males use marijuana and experience anxiety, they are less likely to subsequently use marijuana (as its use produced negative, not positive affect).

The present study should be considered in light of limitations that point to further work in this area. First, the cross-sectional nature of the study hinders our ability to draw causal inferences. Second, the present study examined a non-referred group of adolescents rather than a treatment-seeking sample. Although these data are thereby generalizable to our population of interest, 70% of participants were non-users and future study is necessary to determine whether the observed relations generalize to more severe marijuana-using populations. Third, panic symptoms were evaluated by administering the API following the hyperventilation challenge thereby providing information regarding the overall magnitude of panic responding. Future work is thus necessary to evaluate change in panic symptoms before and after challenge engagement. Fourth, given the lack of significant findings for male adolescents, replication using a multi-modal, multi-informant approach would strengthen confidence in the present findings.

Overall, the present investigation represents an important step toward the delineation of mechanisms that may contribute to the high rates of co-occurring marijuana use and anxiety pathology. The results suggest that AS plays an important role in some types of anxious responding among frequent marijuana using female adolescents. Future work is necessary to

determine the temporal relations among marijuana use, AS, and anxiety as such work will have important implications for the prevention and treatment of this high-risk population.

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Figure 1. Post-challenge skin conductance among high and low marijuana users based on AS (female adolescents).

Figure 2. Post-challenge API-Cognitive scores among high and low marijuana users based on AS (female adolescents).

Table 1

Correlations between age, anxiety, lifetime substance use, and post-challenge measures by sex

	1	2	3	4	5	6	7	8	9	10	Mean (SD)
1. Age	-										14.80 (1.44)
2. Anxiety sensitivity	.22 ^{**}	.18	.12 ^{**}	.39 ^{**}	.48 ^{**}	.18	-.19	-.18	-.14	-.18	14.80 (1.44)
3. Trait anxiety	.47 ^{**}	-.63 ^{**}	.49 ^{**}	-.02	.01	.18	-.17	-.02	.26 [*]	.12	23.58 (4.18)
4. Marijuana use frequency	.35 ^{**}	.06	.25 [*]	.00	-.00	.02	.06	.09	.31 ^{**}	.18	29.08 (6.74)
5. Alcohol use frequency	.39 ^{**}	.07	.32 ^{**}	-	.69 ^{**}	-.59 ^{**}	-.06	-.13	-.02	-.03	
6. Cigarette use	.21 [*]	-.12	.29 [*]	.80 ^{**}	-	-.56 ^{**}	-.09	.04	-.02	-.15	
7. Post-challenge heart rate	-.33 ^{**}	.11	-.29 [*]	-.75 ^{**}	-.66 ^{**}	-	-.12	-.02	.02	.08	
8. Post-challenge skin conductance	-.09	.04	-.09	-.01	.04	-.05	-	.06	-.02	.10	77.79 (10.26)
9. API: Physical	.13	.30 [*]	.42 ^{**}	-.12	-.03	-.06	.18	-	.12	.26 [*]	5.68 (2.30)
10. API: Cognitive	.11	.50 ^{**}	.49 ^{**}	.26 [*]	.16	-.29 [*]	-.14	-.03	-	.40 ^{**}	7.82 (5.49)
Mean (SD)	15.04 (1.56)	24.69 (5.11)	31.10 (6.64)	.29 [*]	.16	-.26 [*]	.02	.04	.72 ^{**}	-	1.48 (2.95)
							77.40 (10.30)	4.97 (1.89)	8.49 (6.76)	1.56 (2.47)	

Correlations for male participants are presented above the diagonal. Correlations for female participants are presented below the diagonal. Lifetime tobacco cigarette use was dummy coded (1 = Yes, 2 = No). Given that substance use variables are categorical, means are not reported.

* $p < .05$,

** $p < .01$.

Table 2

Individual variable contributions predicting post-challenge outcomes (female adolescents)

	ΔR^2	T	β	f^2	p
Dependent Variable: Post-Challenge Heart Rate					
Step 1: Covariates	.772				
Baseline heart rate		12.32	.83	2.62	<.001
Age		-2.36	-.18	0.10	<.001
Trait anxiety		1.53	.11	0.04	.02
Alcohol frequency		.86	.08	0.01	.13
Cigarette use		.42	.04	0.00	.39
Step 2: Main Effects	.014				.68
Anxiety sensitivity		1.70	.14	0.05	.18
Marijuana frequency		-.86	-.11	0.01	.10
Step 3: Interaction Effect	.002				.40
Anxiety sensitivity $\times$ Marijuana frequency		-.79	-.05	0.01	.43
Dependent Variable: Post-Challenge Skin Conductance					
Step 1: Covariates	.877				
Baseline skin conductance		19.97	.05	6.89	<.001
Age		.87	-.06	0.01	<.001
Trait anxiety		-1.09	-.05	0.02	.39
Alcohol frequency		-.70	.04	0.01	.28
Cigarette frequency		-1.32	-.08	0.03	.49
Step 2: Main Effects	.004				.19
Anxiety sensitivity		.86	.05	0.01	.36
Marijuana frequency		1.11	.11	0.02	.39
Step 3: Interaction Effect	.015				.27
Anxiety sensitivity $\times$ Marijuana frequency		2.85	.13	0.15	.006
Dependent Variable: Post-Challenge API-Physical					
Step 1: Covariates	.221				
Age		-.96	-.13	0.02	<.01
Trait anxiety		3.23	.44	0.17	.34
Alcohol frequency		-.71	-.11	0.01	.002
Cigarette frequency		-1.63	-.25	0.04	.48
Step 2: Main Effects	.027				.11
Anxiety sensitivity		.35	.05	0.00	.35
Marijuana frequency		1.41	.32	0.03	.73
Step 3: Interaction Effect	.000				.16
Anxiety sensitivity $\times$ Marijuana frequency		.11	.01	0.00	.91
Dependent Variable: Post-Challenge API-Cognitive					
Step 1: Covariates	.295				
Age		-1.53	-.20	0.04	<.001
Trait anxiety		4.30	.55	0.30	.18
Alcohol frequency		-.67	-.10	0.01	<.001
Cigarette frequency		-1.37	-.20	0.03	.25
Step 2: Main Effects	.131				.98
Anxiety sensitivity		2.40	.31	0.10	.002
Marijuana frequency		2.71	.54	0.12	.03
Step 3: Interaction Effect	.083				.001
Anxiety sensitivity $\times$ Marijuana frequency		3.13	.29	0.17	.003

API=Acute Panic Inventory. Anxiety sensitivity was measured using the Childhood Anxiety Sensitivity Index (CASI), trait anxiety was measured using the Spielberger Trait Anxiety Inventory (STAI). β = standardized beta weight provided for multiple regression.