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Associations of anxiety sensitivity and emotional symptoms with the subjective effects of alcohol, cigarettes, and cannabis in adolescents

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Abstract

Maladaptive emotional traits (anxiety sensitivity [AS], fear of anxiety-related sensations and consequences) and symptoms (major depressive disorder [MDD] and generalized anxiety disorder [GAD] symptoms) could play a role in altering sensitivity to the subjective effects of drugs of abuse in adolescents. Data were drawn from a longitudinal study of high school students in Los Angeles, CA, USA who completed surveys and reported past six-month use of alcohol ($n=1054$), cigarettes ($n=297$), or cannabis ($n=706$). At each of the four semi-annual waves during mid-adolescence (14–16 years old), students reported positive and negative subjective drug effects experienced in the prior six-months. Controlling for covariates and the simultaneous covariance across the three domains of emotional dysfunction, AS was associated with more positive and

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negative cannabis effects ($\beta = -.09$ – $.16$, $p < .05$), and MDD symptoms were associated with fewer negative cigarette effects ($\beta = -.13$, $p = .04$) and more negative cannabis effects ($\beta = .10$, $p = .004$). The acceleration of positive alcohol and cannabis effects over time was slower among adolescents with higher baseline MDD (MDD $\times$ time: $\beta = -.04$, $p = .044$) and GAD (GAD $\times$ time: $\beta = -.05$, $p = .03$) symptoms, respectively. These findings suggest that emotional dysfunction factors show differential and overlapping effects on subjective drug effects, which may vary across time. Future research should investigate emotional dysfunctions and subjective drug effects in relation to substance use across adolescence and emerging adulthood.

Keywords

anxiety sensitivity; depressive symptoms; anxiety symptoms; alcohol; cigarettes; cannabis; subjective effects

1. Introduction

Emotional dysfunction manifests as psychopathological symptoms and maladaptive traits in adolescence. Among domains of emotional dysfunction, anxiety sensitivity (AS – the fear of anxiety symptoms and their consequences), major depressive disorder (MDD) symptoms, and generalized anxiety disorder (GAD) symptoms have each been shown to be related to adolescent substance use (Frojd, Ranta, Kaltiala-Heino, & Marttunen, 2011; Leventhal, Strong, Sussman, et al., 2015; Pang, Farrahi, Glazier, Sussman, & Leventhal, 2014; Wolitzky-Taylor, et al., 2015). While AS, MDD, and GAD may be part of a common maladaptive expression of negative affect and are intercorrelated, these three factors of emotional dysfunction also are phenomenologically distinct from one another, reflecting concerns about anxiety symptoms, sadness/anhedonia/somatic symptoms, and tension/anxiety/diffuse worry, respectively (American Psychiatric Association, 2013; McNally, 1996). There is some evidence that AS, MDD symptoms, and GAD symptoms may have unique, non-redundant associations with substance use (Ameringer & Leventhal, 2010; Wolitzky-Taylor, et al., 2015).

Individual differences in subjective drug effects is one mechanism implicated in risk of transitioning from drug use experimentation to regular use (de Wit & Phillips, 2012). Following from positive reinforcement models of substance use risk (MacKillop & de Wit, 2013), individuals who have more positive (e.g., relaxation, pleasant) early experiences with alcohol, cigarettes, and cannabis are more likely to continue use of the substance and later develop addiction (Agrawal, Madden, Bucholz, Heath, & Lynskey, 2014; Baggio, et al., 2014; Buchmann, et al., 2013; Zabor, et al., 2013). Theoretically, early negative subjective drug effects should exert a protective effect against continued drug use, but the literature has not found consistent evidence to support this. Negative initial reactions to tobacco and cannabis have been found to increase odds of later cannabis abuse/dependence (Agrawal, et al., 2014), but other studies found no effect on odds of becoming a regular smoker (Baggio, et al., 2014; Zabor, et al., 2013) or future or lifetime use of cannabis (Davidson & Schenk, 1994). Studies have also found that negative alcohol outcome expectancies increase as alcohol consumption increases (Gadon, Bruce, McConnochie, & Jones, 2004) and may be

important for alcohol treatment outcomes (Jones & McMahon, 1994, 1996). Thus, it is also possible that increased negative drug effects may be a consequence of consumption rather than a protective factor against use.

There is reason to hypothesize that adolescents with elevations in emotional dysfunctions may be more sensitive to subjective drug effects. Studies have shown associations between AS and greater accuracy in estimating physiological reactivity among children (Eley, Stirling, Ehlers, Gregory, & Clark, 2004) and young adults (S. H. Stewart, Buffett-Jerrott, & Kokaram, 2001). Similarly, studies have shown that GAD (vs. depressed) patients showed greater accuracy in heartbeat perception (Ehlers & Breuer, 1992). Greater interoceptive awareness in AS and GAD could result in increased awareness of internal sensations produced by the acute pharmacological (e.g., stimulation, arousal enhancement) and sensory (e.g., sensations of inhaling smoke or imbibing alcohol) effects of self-administering drugs of abuse, which could in turn alter the profile of subjective drug effects. Although this hypothesis has not been tested, one study in adult regular smokers found that AS was associated with greater subjective positive effects from acute cigarette administration (Wong, et al., 2013). Additionally, some work in emerging adults has negatively correlated AS with cannabis use, which could theoretically be due to greater negative subjective effects of cannabis in high-AS individuals (S. H. Stewart, Karp, Pihl, & Peterson, 1997; S.H. Stewart, Samoluk, & MacDonald, 1999). Thus, it is plausible that AS and GAD symptoms may differentiate subjective drug effects in adolescents, but further empirical testing is needed.

There is also reason to believe that MDD symptoms may increase positive subjective effects. Depressed vs. non-depressed smokers show greater smoking reward (Audrain-McGovern, Wileyto, Ashare, Cuevas, & Strasser, 2014) and rate the positive aspects of smoking higher (Spring, Pingitore, & McChargue, 2003). Additionally, there is evidence showing an association between depressive symptoms and the use of alcohol (Thornton, et al., 2012) and cigarettes (Audrain-McGovern, et al., 2014) to increase pleasure. Lastly, somatic symptoms are a troublesome factor in MDD (Harshaw, 2015; Tylee & Gandhi, 2005), which may be related to greater negative subjective drug effects.

In the current report, data were drawn from an ongoing longitudinal cohort study involving 4 semi-annual data collections spanning mid-adolescence (Leventhal, Strong, Kirkpatrick, et al., 2015). We examined AS, MDD symptoms, and GAD symptoms measured at baseline in relation to reports of positive and negative subjective effects of alcohol, cigarettes, and cannabis in the prior six-month period across the 4 semi-annual assessments. We hypothesized that emotional dysfunction would associate with stronger positive and negative subjective effects averaged across all time points. Given evidence suggesting that subjective drug effects may change over time (Schuckit & Smith, 2013) and that drug use during adolescence may alter neural systems involved in emotional processing (Lydon, Wilson, Child, & Geier, 2014), we also investigated whether emotional dysfunction interacted with time to predict changes in subjective effects. However, due to the paucity of extant theory or data on changes in subjective drug effects over time in relation to emotional dysfunction, we did not have a priori hypotheses regarding these interactive effects. Additionally, there is some evidence that females compared to males may show stronger associations of emotional symptoms and AS with substance use outcomes (Dahne, Hoffman, & MacPherson, 2015; S.

H. Stewart, et al., 1997). Thus, supplemental analyses investigated gender as a moderator of associations between emotional dysfunction and subjective drug effects.

2. Method

2.1 Participants

This study comes from an ongoing multi-wave longitudinal school-based study on the association between personality, psychopathology, and substance use. Participants recruited for this study were 9th grade students attending one of 10 Los Angeles area high schools chosen because of their diverse demographic characteristics and proximity. Leventhal et al. (2015a) report characteristics of the 10 schools and other Los Angeles County schools. All 9th grade students at each school were eligible to participate with the exception of those in special education and English as a second language. Of the 4100 eligible participants, 3396 (82.8%) provided parental consent and student assent and were enrolled in the study. Participants remained in the study unless they verbally stated they no longer wished to participate ($n = 9$).

Only participants who have used a particular substance in the past 6 months complete measures of subjective drug effects and participants with data available on AS, MDD symptoms, GAD symptoms and subjective drug effects were included in analytic samples for subjective effects of alcohol (1993 data points from 1054 participants), cigarettes (451 data points from 297 participants) and cannabis (1324 data points from 706 participants).

2.2 Procedure

Students completed paper-and-pencil surveys during 40-minute class periods in Fall 2013 ($N = 3383$), Spring 2014 ($N = 3293$), Fall 2014 ($N = 3282$), and Spring 2015 ($N = 3262$; retention rate by final wave = 96.05%). However, some of the measures included experiences occurring in the 6 months preceding Fall 2013 (see below). Students were told they could skip questions they did not want to answer and that responses would be confidential. The University of Southern California Institutional Review Board approved the study.

2.3 Key Measures

The **Childhood Anxiety Sensitivity Index (CASI)** (Reiss, Peterson, Gursky, & McNally, 1986; Silverman, Fleisig, Rabian, & Peterson, 1991) was administered at the first assessment and measured fearfulness that anxiety symptoms may lead to embarrassment (e.g., I don't want other people to know when I feel afraid), mental incapacitation (e.g., When I am afraid, I worry that I might be crazy), and physical illness (e.g., It scares me when my heart beats fast). Responses included "None" (=1), "Some" (=2), and "A lot" (=3). A mean score from all 18-items was computed. The CASI has been shown to possess adequate reliability and predictive validity in relation to panic/anxiety symptoms (Wright, et al., 2010) and to have short-term stability (Zavos, Rijdsdijk, & Eley, 2012) in adolescent samples.

The **Revised Children's Anxiety and Depression Scale (RCADS)** (Chorpita, Yim, Moffitt, Umemoto, & Francis, 2000) was administered at the first assessment. The 6-item generalized anxiety disorder (GAD; e.g., I worry about things) and 10-item major depressive

disorder (MDD; e.g., I feel sad or empty) subscales were used. Participants rated how often symptoms occurred from “never” (=0) to “always” (=3) and a mean score for each subscale was computed. This measure has been shown to have good reliability, internal consistency, and convergent and discriminant validity in adolescents (Kosters, Chinapaw, Zwaanswijk, van der Wal, & Koot, 2015), and short-term stability in children (Kosters, et al., 2015).

The **Modified Lyons Battery for Subjective Effects (MLBSE)** (Haberstick, et al., 2011; Lyons, et al., 1997) assessed subjective effects of alcohol, cigarettes, and cannabis during past 6-month use. Participants were asked, “over the past 6 months, in the period right after using [specific drug], did it make you feel any of the following ways?” Participants responded with “yes” (=1) or “no” (= 0). Sum scores were computed for two 6-item scales: positive effects (i.e., pleasant/happy, relaxed, energetic, increased sex drive, creative, social) and negative effects (i.e., drowsy, unable to concentrate, dizzy, out of control, lazy, upset stomach). The MLBSE is derived from a questionnaire that was factor analyzed to assess the subjective positive and negative effects of cannabis (Lyons, et al., 1997) and was abbreviated from the original questionnaire via additional factor analysis of subjective cannabis effects (Zeiger, et al., 2010). Positive and negative scales have shown predictive validity for duration and frequency of use, and abuse or dependence of alcohol, tobacco, and cannabis (Lyons, et al., 1997; Zeiger, et al., 2010, 2012). Positive and negative scales have been shown to have acceptable reliability in a large adolescent and young adult sample (Haberstick, et al., 2011).

2.4 Covariates

Demographics—We included gender (0 = female, 1 = male) as a planned covariate as there is evidence of gender differences in emotional dysfunction in children and adolescents (Salk, Petersen, Abramson, & Hyde, 2016; Walsh, Stewart, McLaughlin, & Comeau, 2004). Given that BMI can affect pharmacological metabolism (Maudens, et al., 2014), we included BMI as a planned covariate.

Substance use—Items assessing substance use were derived from the Youth Behavior Risk Surveillance (Eaton, et al., 2010) and Monitoring the Future (Johnston, O’Malley, Miech, Bachman, & Schulenberg, 2015). Individuals endorsing any lifetime use of alcohol, a whole cigarette, or cannabis were asked about their age when they first used the substance (i.e., 8=8, 9 – 10=9.5, 11 – 12=11.5, 13–14=13.5, 15–16=15.5, 17 =17). Participants also reported past 6-month substance use and how many days they used [specific substance] over the past 30 days (coded as 0=0 days and 1= one or more days of use). We included onset age and recent use as planned covariates because longer and/or more frequent use of a substance can produce tolerance (Lewinsohn, Rohde, & Seeley, 1996). There is some evidence for cross drug associations in subjective effects (Zeiger, et al., 2012) so polysubstance use over the past six-month period (range 1–3) was included as a covariate.

2.5 Data Analysis

Preliminary analyses involved reporting descriptive statistics, bivariate associations, and internal consistency reliability estimates for study variables separately for the samples that

used alcohol, cigarettes, or cannabis, in the prior six months during at least one wave. Linear regression models were used to investigate multicollinearity for primary models.

Primary analyses utilized individual generalized estimating equations (GEE; Zeger, Liang, & Albert, 1988), which allow for subjects to differ in the number of observations available for analysis and take into account the clustering of data within subjects, to examine associations between AS, RCADS MDD, and RCADS GAD (predictors) and subjective drug effects (outcomes) controlling for gender, BMI, past 30 day use of substance, age of first use of substance, polysubstance use, and time. Time (i.e., Waves 1–4) was modeled as a continuous variable to yield parameter estimates reflecting linear slopes of subjective drug effects across the four waves of data collection. Three sets of GEE models (i.e., alcohol, cigarettes, and cannabis) were tested for each respective drug outcome in subsamples reporting past six-month use of the substance during at least one wave. We then added the interaction term of predictor (i.e., AS, RCADS MDD, RCADS GAD) $\times$ time to the adjusted model to examine whether baseline emotional disorder symptoms or AS predicted changes in subjective effects across time. Supplemental analyses used individual predictor models to investigate whether gender moderated associations between RCADS MDD, RCADS GAD, and CASI in predicting subjective effects.

We used a first order autoregressive AR1 structure to model the correlation across time. To avoid listwise deletion of participant-level data due to missing covariate data, the missing indicator method (MIM) was used (Groenwold, et al., 2012). Data was analyzed using IBM SPSS Statistics version 22, and continuous variables were standardized resulting in standardized parameter estimates (β). Significance was set at .05 for all analyses.

3. Results

3.1 Preliminary results

See Table 1 for sample descriptives. CASI, RCADS MDD, and RCADS GAD all had adequate internal consistency (Cronbach's $\alpha > .87$), and were correlated ($r_s = .46-.64$, $p < .001$) which suggests convergent validity of these measures. Internal reliabilities for the MLBSE (KR-20s $> .56$) and descriptives are reported in Table 2. Tolerance was greater than .52 and VIFs were lower than 1.92 in linear regression models, which suggest that multicollinearity did not bias parameter estimates (Marquardt, 1970; Menard, 1995).

3.2 Primary results

Time invariant associations of each emotional dysfunction variable with drug effects—Controlling for relevant covariates, CASI was significantly associated with more positive and negative cannabis effects, and RCADS MDD was significantly associated with fewer negative cigarette effects and more negative cannabis effects (Table 3).

Emotional dysfunction variables as moderators of changes in drug effects over time—Adding the time interaction to adjusted models predicting positive alcohol effects yielded a significant interaction for RCADS MDD ($\beta = -.04$; $p = .04$). Simple slopes analyses showed those with low (vs. high) MDD symptom level showed a greater increase in positive alcohol effects across time (Figure 1). Adding the time interaction to the adjusted

model predicting positive cannabis effects yielded a significant interaction for RCADS GAD ($\beta = -.06$; $p = .02$). Simple slopes analyses showed that adolescents with low compared to high GAD symptom levels have greater increases in positive cannabis effects across time (Figure 1).

3.3 Supplemental Analyses

Moderation of the association of emotional dysfunction with drug effects by gender—There were no interactions between any of the three emotional dysfunction variables and gender, nor were there any three-way interactions between any emotional dysfunction variables $\times$ gender $\times$ time on any of the subjective effects outcomes (β s ranged from $-.07$ to $.07$; all p s $> .05$).

4. Discussion

AS was the only emotional dysfunction that showed a time-invariant association with more positive effects of cannabis. AS and MDD symptoms were associated with more negative effects of cannabis. The subjective effects profile of cannabis is broad (Green, Kavanagh, & Young, 2003; Hunault, et al., 2014) and includes several positive and negative effects. Pending replication, the hypersensitivity of adolescents with high AS and MDD symptoms in relation to cannabis effects could have multiple implications for understanding the abuse potential and possible therapeutic value of different formulations and strains of cannabis products. For example, in a mixed patient sample (i.e., multiple sclerosis, chronic pain, nausea, cancer, psychological problems) there is evidence of acute anxiety after cannabis administration with higher vs. lower THC levels (Brunt, van Genugten, Honer-Snoeken, van de Velde, & Niesink, 2014). Given that most cannabis sold is high THC, which can be anxiogenic (Crippa, et al., 2009), it is plausible that adolescents with emotional dysfunction may be hyper-responsive to the negative effects of these formulations. In light of these findings it is important that applications of cannabinoid products for therapeutic effects, including anxiety disorders, consider how product and user characteristics might interact in the case of AS and other emotional traits.

Depressive symptoms were associated with fewer negative cigarette effects, which may account for high comorbidity between depression and tobacco dependence (Dierker, et al., 2015). At first glance this may seem to contrast with the finding that depressive symptoms were associated with more negative cannabis effects. However, it is possible that the negative effects of cigarettes vs. cannabis are more stimulant vs. depressive in nature; thus, there may be some blunting vs. amplification of subjective drug response in depressed individuals depending on the basic class of drug. Future studies can test this hypothesis by investigating whether depressive symptoms associate with different arousal-related subjective effects of cannabis and tobacco.

This study also found that subjective drug effects trajectories over time may differ depending on emotional disorders symptoms. We found that individuals with higher compared to lower GAD symptoms initially report more positive cannabis effects, but have a slower increase in these effects across time. Similarly, positive alcohol effects increased over time to a greater extent in individuals with low (vs. high) depressive symptoms. Heightened reward reactivity

is thought to be a part of normal adolescent development (Gilbert, 2012). Across normal adolescent development, individuals with higher MDD and GAD symptoms have been shown to have dampened positive emotion and altered emotional regulation (Eisner, Johnson, & Carver, 2009), which could result in blunting of positive drug effects across time.

This study is correlational and cannot determine causality and used self-report measures, which can be subject to reporting bias. As an observational study, the doses and formulations that adolescents self-administered were variable and we did not ask about frequency/intensity of use over the 6-month period that subjective effects were assessed. However, these limitations are balanced with the heightened ecological validity of this naturalistic observational design. Additionally, this study addressed only a period of mid-adolescence and may not generalize to those with problematic or dependent use of these substances or to other age ranges. We also included outcomes from Wave 1, which means the study is not entirely prospective, to minimize self-selection bias of removing participants reporting use in Wave 1 only (Alcohol $n = 90$; Cigarettes $n = 36$; Cannabis $n = 43$). Concerns about lack of prospective analysis for Wave 1 are offset by the short-term stability of the predictors in adolescents (Zavos, et al., 2012).

Another potential limitation of the current study is the use of the MLBSE, which only measures whether an individual experiences a specific effect and cannot address differences in intensity or frequency of subjective effects. Additionally, the positive effects mainly pertain to positive reinforcement (e.g., pleasant/happy, energetic) with only one negative reinforcement item (i.e., relaxed). Studies in adolescent and adult samples report positive associations between AS and coping motives and outcome expectancies for alcohol (Novak, Burgess, Clark, Zvolensky, & Brown, 2003), cigarettes (Battista, et al., 2008), and cannabis (Zvolensky, et al., 2009). Thus, more associations between emotional dysfunction and positive subjective effects may have been found with a measure that included more negative reinforcement related positive effects. Lastly, some of the internal reliabilities for the MLBSE were slightly below the recommended range for short scales (Widaman, Little, Preacher, & Sawalani, 2011). This may be due to items tapping a broad construct of effects (e.g., 'energetic' - high arousal positive reinforcement vs. 'relaxed' - low arousal negative reinforcement).

5. Conclusions

In summary, findings suggest that high-AS adolescents may be more reactive to certain internal changes caused by cannabis intoxication. As heightened positive effects of cannabis may lead to problematic use (Agrawal, et al., 2014; Davidson & Schenk, 1994), it is possible that high-AS adolescents may be at greater risk for cannabis problems. However, increased negative effects in high-AS adolescents may temper this increased risk. It will be important to understand how the balance of positive and negative effects contributes to susceptibility of use and/or misuse. Additionally, this study found depressive symptoms associated with more negative cannabis effects, but fewer negative cigarette effects. It is possible that the quality of negative effects differs between these two substances, which may cause hypersensitivity to cannabis but blunting of negative cigarette effects. Lastly, there was some evidence that

across time those with low emotional symptoms may have greater increases in positive subjective drug effects. It is possible that these differences in positive subjective drug effects across time may reflect differences in development of positive emotion and emotion regulation. However, future research is needed to address the interactive and directional effects of emotional symptoms, substance use, and subjective drug effects over a longer period of time into emerging adulthood.

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Highlights

- Anxiety sensitivity associated with more positive and negative cannabis effects
- Depressive symptoms (DS) associated with more negative cannabis effects
- DS associated with fewer negative cigarette effects
- DS associated with fewer increases in positive alcohol effects over time
- Anxiety associated with fewer increases in positive cannabis effects over time

a)

b)

Figure 1.

Note. Predicted values for positive alcohol effects (a) and positive cannabis effects (b) illustrating the interaction of time RCADS MDD (a) and RCADS GAD (b) at values that are one standard deviation above and one standard deviation below the mean.

Table 1

Sample descriptives

	Alcohol Users ^a		Cigarette Smokers ^b		Cannabis Users ^c	
	<i>n</i>	<i>M(SD)</i> or %	<i>n</i>	<i>M(SD)</i> or %	<i>n</i>	<i>M(SD)</i> or %
Demographics						
Gender (% female)	1054	61.1%	297	54.2%	706	55.5%
Ethnicity						
Hispanic/Latino	575	55.6%	139	48.3%	390	56.7%
White	172	16.7%	51	17.7%	102	14.8%
Asian	90	8.7%	25	8.7%	47	6.8%
Black/African American	34	3.3%	8	2.8%	34	4.9%
Native Hawaiian or Pacific Islander	39	3.8%	15	5.2%	26	3.8%
Multiracial	46	4.4%	21	7.3%	41	5.9%
Other	77	7.5%	29	10.0%	48	7.0%
W1 Age	377	14.64 (0.42)	77	14.71 (0.43)	216	14.67 (0.42)
W2 Age	483	15.13 (0.40)	105	15.16 (0.46)	322	15.12 (0.42)
W3 Age	537	15.52 (0.76)	126	15.58 (0.45)	349	15.51 (0.89)
W4 Age	574	16.12 (0.39)	137	16.13 (0.42)	414	16.14 (0.42)
W1 BMI	316	22.33 (4.68)	60	21.47 (4.33)	176	22.30 (4.29)
W2 BMI	434	22.46 (4.11)	92	22.45 (4.75)	284	22.86 (4.19)
W3 BMI	492	22.62 (4.47)	117	22.32 (3.93)	317	22.77 (4.60)
W4 BMI	485	21.84 (4.07)	117	21.32 (3.97)	359	22.25 (4.34)
Interpersonal Factors						
CASI	1054	1.74 (0.41)	297	1.72 (0.42)	706	1.71 (0.42)
RCADS MDD	1054	0.96 (0.77)	297	1.12 (0.87)	706	0.98 (0.80)
RCADS GAD	1054	1.52 (0.79)	297	1.60 (0.83)	706	1.51 (0.82)
Substance use						
Age first use	1050	13.65 (1.58)	295	13.53 (1.97)	706	13.78 (1.56)
W1 % no use last 30 days	375	31.2%	77	44.2%	216	23.6%
W2 % no use last 30 days	492	21.7%	107	32.7%	331	25.7%
W3 % no use last 30 days	545	23.7%	127	29.1%	354	22.6%

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	Alcohol Users ^a		Cigarette Smokers ^b		Cannabis Users ^c	
	<i>n</i>	<i>M(SD)</i> or %	<i>n</i>	<i>M(SD)</i> or %	<i>n</i>	<i>M(SD)</i> or %
W4 % no use last 30 days	574	23.5%	137	29.9%	409	24.3%
W1 Polysubstance	377	1.54 (0.69)	77	2.41 (0.69)	216	1.90 (0.70)
W2 Polysubstance	495	1.75 (0.77)	108	2.56 (0.71)	337	2.06 (0.71)
W3 Polysubstance	546	1.75 (0.74)	129	2.58 (0.65)	356	2.09 (0.67)
W4 Polysubstance	575	1.79 (0.75)	137	2.54 (0.75)	415	2.03 (0.70)

Note. W1 = Wave 1; W2 = Wave 2; W3 = Wave 3; W4 = Wave 4; BMI = Body Mass Index; RCADS = Revised Children's Anxiety and Depression Scale; GAD = General Anxiety Disorder subscale; MDD = Major Depressive Disorder subscale; CASI = Children's Anxiety Sensitivity Scale. Gender coded 0=female, 1 = male. Substance use coded 0 = no use past 30 days, 1 = one or more days of use in past 30 days. Sample sizes ranged due to missing data and number of participants reporting past 6 month use of the substance at each wave (i.e., time varying variables only include participants reporting past 6 month use of that substance during the wave).

Table 2

Descriptives and reliability of the subjective effects by wave

	W1		W2		W3		W4	
	<i>M</i> (<i>SD</i>)	KR 20	<i>M</i> (<i>SD</i>)	KR 20	<i>M</i> (<i>SD</i>)	KR 20	<i>M</i> (<i>SD</i>)	KR 20
<i>Alcohol^a</i>								
Positive	3.23 (1.62)	0.61	3.63 (1.61)	0.63	3.74 (1.51)	0.57	3.82 (1.61)	0.65
Negative	1.90 (1.62)	0.62	1.89 (1.68)	0.67	2.01 (1.75)	0.70	2.16 (1.80)	0.69
<i>Cigarettes^b</i>								
Positive	1.70 (1.47)	0.66	1.75 (1.58)	0.70	2.04 (1.66)	0.73	2.04 (1.55)	0.70
Negative	1.18 (1.56)	0.75	1.22 (1.61)	0.76	1.00 (1.48)	0.77	1.09 (1.46)	0.75
<i>Cannabis^c</i>								
Positive	4.04 (1.37)	0.56	4.12 (1.51)	0.66	4.28 (1.43)	0.63	4.23 (1.52)	0.67
Negative	1.92 (1.47)	0.59	1.91 (1.61)	0.69	2.03 (1.55)	0.64	2.06 (1.61)	0.69

Note. KR 20 = Kuder-Richardson 20. Sample sizes ranged due to missing data and number of participants reporting past 6 month use of the substance at each wave:

^a *n*=364–575;

^b *n*=74–137;

^c *n*=205–415.

Table 3

Associations of emotional symptoms and anxiety sensitivity with positive and negative subjective effects of alcohol, cigarettes, and cannabis

	Positive Effects β [95% CI]	Negative Effects β [95% CI]
Alcohol ^a		
CASI	0.03 [-0.04, 0.09]	0.04 [-0.02, 0.11]
RCADS MDD	-0.04 [-0.11, 0.02]	0.06 [0.00, 0.13]
RCADS GAD	0.01 [-0.06, 0.08]	0.06 [0.00, 0.13]
Gender	0.00 [-0.06, 0.05]	-0.04 [-0.10, 0.01]
BMI	-0.01 [-0.02, 0.01]	-0.01 [-0.03, 0.00] *
Recent alcohol use (past 30 days)	0.12 [0.08, 0.17] ***	0.00 [-0.04, 0.04]
Age first use of alcohol	-0.03 [-0.08, 0.03]	0.02 [-0.03, 0.08]
Polysubstance	0.14 [0.09, 0.18] ***	0.20 [0.15, 0.24] ***
Time	0.10 [0.06, 0.14] ***	0.04 [0.00, 0.08]
Cigarettes ^b		
CASI	0.00 [-0.13, 0.12]	0.08 [-0.04, 0.20]
RCADS MDD	0.07 [-0.05, 0.19]	-0.13 [-0.24, -0.01] *
RCADS GAD	0.11 [-0.01, 0.24]	0.11 [-0.02, 0.24]
Gender	0.08 [-0.03, 0.19]	0.09 [-0.02, 0.19]
BMI	-0.01 [-0.04, 0.01]	0.00 [-0.02, 0.02]
Recent cigarette use (past 30 days)	0.17 [0.08, 0.26] ***	-0.03 [-0.13, 0.08]
Age first use of cigarettes	-0.03 [-0.14, 0.08]	-0.06 [-0.16, 0.04]
Polysubstance	-0.05 [-0.15, 0.04]	0.05 [-0.04, 0.15]
Time	0.07 [-0.01, 0.16]	-0.02 [-0.10, 0.07]
Cannabis ^c		
CASI	0.09 [0.00, 0.17] *	0.16 [0.08, 0.25] ***
RCADS MDD	-0.08 [-0.15, 0.00]	0.10 [0.03, 0.18] **
RCADS GAD	0.01 [-0.07, 0.09]	-0.04 [-0.12, 0.04]
Gender	0.19 [0.13, 0.26] ***	0.01 [-0.05, 0.08]
BMI	0.01 [0.00, 0.03] *	0.00 [-0.01, 0.02]
Recent cannabis use (past 30 days)	0.17 [0.11, 0.22] ***	-0.01 [-0.07, 0.04]
Age first use of cannabis	-0.13 [-0.20, -0.06] ***	0.03 [-0.03, 0.10]
Polysubstance	0.10 [0.04, 0.15] ***	0.05 [0.00, 0.11]
Time	0.07 [0.02, 0.12] **	0.03 [-0.03, 0.08]

Note. BMI = Body Mass Index; RCADS = Revised Children's Anxiety and Depression Scale; GAD = General Anxiety Disorder; MDD = Major Depressive Disorder; CASI = Children's Anxiety Sensitivity Scale. Gender coded 0=female, 1 = male. Recent substance use coded 0 = no use past 30 days, 1 = one or more days of use in past 30 days

^a n = 1993 data points from 1054 subjects;

^b
 $n=451$ data points from 297 subjects;

^c
 $n=1324$ data points from 706 subjects.

*
 $p<.05$,

**
 $p<.01$,

 $p<.001$.

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