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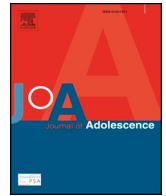
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Risk taking, sensation seeking and personality as related to changes in substance use from adolescence to young adulthood



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ABSTRACT

Introduction: This study examined changes in substance use from adolescence to young adulthood as related to adolescents' risk taking, sensation seeking, antisocial activities, and personality traits.

Methods: Chilean youth ($N = 890$, 52% female) were studied in adolescence (14.5 and 16.2 years) and young adulthood (M age 21.3 years). Risk taking was assessed via a laboratory-based performance task (Balloon Analogue Risk Task), and self-administered questionnaires assessed sensation seeking, antisocial behaviors, personality and substance use.

Results: Frequent involvement in sensation seeking and antisocial activities were associated with increased odds of continued marijuana use from adolescence to young adulthood and of illicit substance use at young adulthood. High risk taking was associated with a reduced likelihood of discontinuing marijuana use at young adulthood, and high agreeableness and conscientiousness were associated with reduced likelihood of new onset marijuana use and illicit substance use at young adulthood.

Conclusions: Results highlight specific risk-taking tendencies and personality characteristics that relate to initiating, continuing, or discontinuing substance use at entry into adulthood. Sensation seeking and involvement in antisocial activities were the two foremost risk factors for continued use, which is a forecaster of drug dependence. Findings suggest potential prevention and intervention targets for abstaining from or discontinuing substance use as youth transition to adulthood.

1. Introduction

The transition from adolescence to young adulthood is a critical period for substance use prevention, as individuals establish habits that are potentially sustained throughout adulthood (Wittchen et al., 2008). Early use of drugs is a well-known risk for continued substance use, and continued use is a marker for substance use dependence and developing drug-related problems (Flory,

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Lynam, Milich, Leukefeld, & Clayton, 2004; Wagner & Anthony, 2002). Existing research shows that early substance use is related to a disposition for risk taking and sensation seeking (Quinn & Harden, 2013; Steinberg, 2004; Zuckerman, 2007) and, to a lesser degree, specific personality traits (Cooper, Wood, Orcutt, & Albino, 2003; Terracciano, Lockenhoff, Crum, Bienvenu, & Costa, 2008). However, it is unclear if such factors reliably predict continuing or discontinuing substance use into young adulthood. The ability to curb substance use, once initiated, is suspected to involve a different set of impulse control components, with different risk factors influencing the various stages of drug use initiation, maintenance, and discontinuation (Wagner & Anthony, 2002; Yamaguchi & Kandel, 1984). The current study investigates the characteristics of adolescents who initiated, continued, or discontinued substance use at young adulthood. We examined risk taking, sensation seeking, antisocial tendencies and personality characteristics as risk factors for transitions into and out of substance use. Understanding what factors predict such transition patterns may help identify intervention and prevention targets. This is important given that substance use, including marijuana use, during young adulthood relates to several health deficits, such as executive functioning impairments, and memory and attention problems (Broyd, van Hell, Beale, Yücel, & Solowij, 2016; LaSpada et al., 2019).

1.1. Risk taking, sensation seeking, antisocial tendencies, and substance use

Risk taking has been defined in various ways, but common themes across definitions involve balancing rewards in the face of high probability of loss (Nigg, 2017). Although dangerous, thrill-seeking activities often involve a high degree of risk, such behaviors are often planned and preceded by a critical analysis of their risk:reward ratio (Skeel, Neudecker, Pilarski, & Pytlak, 2007). This aspect of risk taking involves discounting loss probability given a high possible gain, and is enacted as the inability to resist the pull of a reward when it may lead to loss (Shead & Hodgins, 2009). Various laboratory tasks have operationalized the tendency to avoid loss given the draw of a reward stimulus. For example, Lejuez and colleagues developed a behavioral measure to test this risk-reward processing in the form of a Balloon Analogue Risk Task (BART; Lejuez et al., 2002), which has been shown to relate to several real-world health-risk behaviors, such as alcohol and substance use (Hunt, Hopko, Bare, Lejuez, & Robinson, 2005; Lejuez, Aclin, Zvolensky, & Pedulla, 2003).

In contrast, sensation seeking is the pursuit of intense, thrilling and novel sensations and experiences (e.g., sky diving, bungee jumping, paragliding) despite significant risk to the individual (Zuckerman, 1994, 2007). The desire to engage in activities that increase sensation and thrill drives its connection to substance use (Dawe, Gullo, & Loxton, 2004; Zuckerman, 2007). Some have also proposed that the novelty-seeking aspect of sensation seeking is a motivating factor for substance use (Wills, Vaccaro, & McNamara, 1994). A few studies have found relations between sensation seeking and increased or continued substance use. For example, Crawford, Pentz, Chou, Li, and Dwyer (2003) found that sensation seeking during middle school predicted both concurrent and high school marijuana use. Quinn and Harden (2013) found that increases in sensation seeking were associated with escalating substance use from mid-adolescence to early adulthood. Similarly, Flory et al. (2004) found that high sensation seeking discriminated between those who had early versus late or no marijuana use. Thus, sensation seeking appears to play a role in early, continued, and increased use of substances.

Antisocial tendencies also have been widely linked with substance use and abuse (Adalbjarnardottir & Rafnsson, 2002; Krueger, Markon, Patrick, Benning, & Kramer, 2007). One conceptualization of this connection is that both antisocial activities, such as violent, delinquent and criminal behaviors, and substance use stem from reduced social restraint and a disregard for social norms (Wood, Dawe, & Gullo, 2013; Zucker, Heitzeg, & Nigg, 2011), with several researchers noting phenotypic similarities between rule-breaking or norm-violating behavior, and substance use (Adalbjarnardottir & Rafnsson, 2002; Krueger et al., 2007). Although antisocial behaviors have been widely linked with drug use, how such behaviors are associated with different stages of substance use has been less studied. Research by Van den Bree and Pickworth (2005) found that engagement in violent and delinquent activities predicted both the initiation of marijuana use at adolescence, and its progression to regular marijuana use one year later. In an earlier study, Yamaguchi and Kandel (1984) found that delinquency predicted initiation of marijuana use at adolescence for males but not for females, and it predicted initiating illicit drug use for both males and females.

1.2. Personality and substance use

Research addressing personality and substance use has typically examined the “Big Five” personality domains (McCrae & Costa, 2008). These include: *conscientiousness*, or being reliable and trustworthy; *agreeableness*, or being easy-going and friendly; *openness to experiences*, which refers to being curious and open-minded; *extraversion*, or being energetic and talkative in social interactions; and *neuroticism*, referring to being anxious, irritable and prone toward experiencing negative emotions (McCrae & Costa, 2008). Several researchers contend that neuroticism predisposes individuals toward using substances as a means to soothe negative emotions (Degenhardt, Hall, & Lynskey, 2001). Others have linked low conscientiousness and low agreeableness with disinhibition, which many have discussed as a risk factor for substance use given the impulsive nature of disinhibition (e.g., Krueger et al., 2007; Zucker et al., 2011). Research applying personality domains to substance use has typically been limited to cross-sectional studies within clinical samples and has focused on substance abuse and substance abuse disorders. Such research finds that high neuroticism, low conscientiousness, low agreeableness, and high openness to new experiences relate to substance use and abuse, and can differentiate abusers from non-abusers (Fridberg, Vollmer, O'Donnell, & Skosnik, 2011; Ketcherside, Jeon-Slaughter, Baine, & Filbey, 2016; Terracciano et al., 2008). Cross-sectional associations between extraversion and substance use are mixed. Ketcherside et al. (2016) and Flory, Lynam, Milich, Leukefeld, and Clayton (2002) found that low extraversion was associated with increased likelihood of marijuana use and later symptoms of marijuana abuse, whereas Raketich et al. (2017) and Dubey, Arora, Gupta, and Kumar (2010)

found that high extraversion was associated with increased opiate dependency among adult women and substance abuse among adults. Although there is considerable research relating personality traits to substance use and abuse, less is known about how personality traits relate to transitions into and out of substance use from adolescence to young adulthood.

1.3. The current study

This study investigated risk factors for substance use patterns between adolescence and young adulthood. The following four patterns were studied: incident use of illicit substances at young adulthood, incident marijuana use at young adulthood, continued marijuana use from adolescence to young adulthood, and discontinued marijuana use from adolescence to young adulthood. We compared the risk taking, sensation-seeking, antisocial tendencies, and personality traits of the above four substance use groups to the reference group of never users. We were particularly interested in factors associated with continued substance use because this category reflects long-term and persistent use and may signify risk for substance use disorder and addiction (Wagner & Anthony, 2002). The study of discontinued substance use is also important as it can identify factors that could apply to drug cessation programs. Investigating the characteristics associated with new onset substance use would also be useful for preventive interventions.

Based on the literature reviewed, we hypothesize that high risk taking and frequent sensation seeking and antisocial tendencies in adolescence will be associated with increased likelihood of initiating and continuing substance use into young adulthood, and with lower likelihood of discontinuing marijuana use at young adulthood. Studying these predictors can reveal unique underlying mechanisms leading to substance use. For example, a strong risk-taking propensity (as assessed on the BART) reflects high discounting of risk relative to reward; frequent involvement in sensation seeking activities reflects a desire for intense and exciting experiences; and frequent involvement in antisocial tendencies reflects a disregard for social norms.

Based on the available literature, we hypothesize that the personality traits of high neuroticism, high openness to experiences, low conscientiousness, and low agreeableness will relate to initiating and continuing substance use into young adulthood, and a lower likelihood of discontinuing marijuana use from adolescence to young adulthood. Given the mixed findings in the literature regarding the association between extraversion and substance use, we do not make specific hypotheses for this personality trait.

The current study was conducted in Chile, where substance use rates are relatively high and comparable to those in the U.S. In 2016, past year marijuana use among 12- to 17-year olds was approximately 10% in both the U.S. and Chile, and similar to other countries in North, South, and Central America (Inter-American Drug Abuse Control Commission [CICAD], 2019; Lobato, Sanderman, Pizarro, & Hagedoorn, 2017). However, among 18- to 34-year olds, Chile and the U.S. had the highest rates of all other countries, with past year marijuana use at 28% in Chile and 26.5% in the U.S. (CICAD, 2019). Like the U.S., Chile is a developed upper-middle income country, with a highly literate population (Gitlin & Fuentes, 2012). Thus, the current findings provide an opportunity to corroborate findings from earlier studies, which have been based almost exclusively on U.S. samples. Indeed, replication across cultures and contexts provides insight into the reliability and robustness of associations, and strengthens the interpretation and generalization of findings (Tortolero & Li, 2012).

2. Method

2.1. Sample and study design

Participants were part of the Santiago Longitudinal Study, which began as an iron-deficiency anemia preventive trial and neuromaturation study of 1,790 infants (Lozoff et al., 2003). Healthy, non-anemic 6-month-old infants were recruited from community clinics serving low-to-middle income families in Santiago, Chile (1991–1996). Infants were reassessed at multiple time points, including at 14, 16, and 21 years of age. A total of 1,106 youth completed a substance use questionnaire at adolescence, and, of these, 908 repeated the substance use questionnaire in young adulthood ($M = 21.3$ years). This study's analytic sample includes participants who had substance use data at both time points as well as at least one measured independent variable at adolescence ($n = 890$; Table 1); that is, data on risk taking ($n = 716$), sensation seeking ($n = 814$), antisocial behavior ($n = 850$), or personality ($n = 765$). Participants included in the current analytic sample responded to the substance use survey in adolescence at a mean age of 14.5 years. These individuals completed the personality and BART assessments an average of 1.5 years later (M age = 16.2 years), as part of a separate project that funded an additional follow-up.

The current analytic sample is similar to the original study sample in terms of socioeconomic status, years of maternal education, and ages at the adolescent and young adult evaluations. However, the current study sample had a lower percentage of males (47.9%) compared with the original cohort (53.3%). Sex was adjusted in all analyses.

2.2. Procedure

At the adolescent assessment, signed informed consent was obtained from parents and assent was obtained from adolescents. Signed informed consent was obtained from participants at young adulthood. The study was approved by the authors' university Institutional Review Boards in the U.S. and Chile. Study questionnaires and the laboratory performance measure of risk taking were administered by experienced Chilean psychologists. All study measures were completed in Spanish.

Table 1
Description of participant characteristics and study variables (N = 890).

	N	%	Mean (SD)	Range
Assessment at infancy				
Male sex	890	47.9%		
SES ^a	890		27.1 (6.3)	11–47
Maternal education, yrs	890		9.5 (2.7)	1–17
Assessment at adolescence				
Age at substance use and CHIP, yrs	890		14.5 (1.5)	12–18
Age at BART and NEO, yrs	791		16.2 (0.2)	15–18
BART average adjusted pumps	716		34.4 (11.6)	6–74
BART explosions	715		6.0 (1.9)	1–12
CHIP sensation-seeking	814		2.8 (1.6)	0–11
CHIP antisocial	850		0.8 (1.1)	0–7
NEO conscientiousness	767		34.2 (5.1)	17–45
NEO agreeableness	769		38.8 (5.3)	20–50
NEO openness to experience	765		24.0 (4.0)	10–35
NEO extraversion	770		28.5 (4.0)	14–35
NEO neuroticism	766		24.4 (6.1)	9–42
Never used marijuana by adolescence	760	85.4%		
Ever used marijuana by adolescence	130	14.6%		
Current (past 30d) marijuana use at A	42	4.7%		
Current (past 30d) illicit substance use at A	44	4.9%		
Assessment at young adulthood				
Age, yrs	890		21.3 (0.7)	20–25
Marijuana use	890			
Never used (at A or YA) ^b	236	26.5%		
Ever used (at A or YA) ^c	654	73.5%		
Incident marijuana use at YA ^d	524	58.9%		
Continued marijuana use at YA ^e	100	11.2%		
Discontinued marijuana use at YA ^f	30	3.4%		
Current (past 30d) use at YA	280	31.5%		
Illicit substance use	889			
Never used ^b	619	69.6%		
Ever used ^c	270	30.4%		
Incident illicit substance use at YA ^d	226	25.4%		
Continued illicit substance use at YA ^e	28	3.2%		
Discontinued illicit substance use at YA ^f	16	1.8%		
Current (past 30d) illicit subs use at YA	254	28.5%		

Note. BART: Balloon Analogue Risk Task. CHIP: Child Health and Illness Profile. NEO: Neuroticism, Extraversion, Openness Personality Inventory. YA = young adulthood. A = adolescence.

^a Higher scores indicate more socioeconomic disadvantage.

^b No lifetime use at adolescence or young adulthood.

^c Ever lifetime use reported at adolescence or young adulthood.

^d First use reported at young adulthood with no use at or prior to the adolescent evaluation.

^e Ever lifetime use reported at adolescence and current (past 30 days) use reported at young adulthood.

^f Ever lifetime use reported at adolescence but no current (past 30 days) use reported at young adulthood.

2.3. Measures

Adolescent and young adult substance use. Adolescent substance use was assessed via a 16-item self-report questionnaire asking if the participant had ever used any of the following 12 substances (yes = 1; no = 0): marijuana, cocaine, crack, ecstasy, hallucinogens, steroids, inhalants, pasta base (an inexpensive, highly addictive cocaine derivative), or tranquilizers, stimulants, sedatives/barbiturates or analgesics without a prescription. Young adult substance use was evaluated via a similar 16-item self-report questionnaire, asking about ever (lifetime) use and time period for last use (within last 30 days, within last year, more than a year ago).

Substance use groups. Based on the responses outlined above, we defined the following four groups (Table 1): (1) never use was defined as no lifetime use of any substance at both the adolescent and young adult evaluations; (2) incident use included those who first reported use on the young adult survey with no use at or prior to the adolescent evaluation; (3) continued marijuana use involved those who reported marijuana use at or prior to adolescence and within 30 days prior to the young adult assessment; and (4) discontinued marijuana use included those who reported marijuana use at or prior to adolescence but not within the last 30 days prior to the young adult survey. We did not evaluate adolescent-only illicit substance use because only 2 participants had illicit substance use only at adolescence. We were unable to classify four adolescent illicit substance users due to discrepancies between the reported substances assessed at adolescence and young adulthood; these four participants were excluded from analyses. Incident use of illicit substances was determined for the 12 illicit substances listed on both the adolescent and young adult surveys (noted above).

Risk taking. The Balloon Analogue Risk Task (BART) is a validated and reliable measure of risk-taking propensity as conceptualized as risk-reward processing (Hunt et al., 2005; Lejuez et al., 2002; White, Lejuez, & de Wit, 2008). In the task, adolescents

were offered a chance to earn points by inflating a balloon via “pumps” (clicks) on a computer screen. The more pumps the participant made, the more points were earned. At any time in the trial, the participant could stop pumping the balloon and collect their points. However, if the participant inflated the balloon too much, the balloon popped (“exploded”), and all points from that trial were lost. The balloon popped at an unpredictable number of pumps. Participants were given these instructions beforehand and then completed 20 trials of balloon pumping, with each trial ending with either the participant collecting points or the balloon popping. Risk taking in this task is assessed by: (1) the adjusted mean number of pumps, and (2) the number of explosions (Lejuez et al., 2002). More pumps and/or explosions indicate a higher risk-taking propensity.

Sensation seeking and antisocial tendencies. Adolescents completed the Spanish version of the Child Health and Illness Profile-Adolescent Edition (CHIP-AE; Starfield et al., 1993), which asks about engagement in various risky and antisocial behaviors. (Alexander et al., 1990). Engagement in sensation-seeking behaviors involved 11 items assessing a range of health-risk or thrill-seeking behaviors, such as “willingly rode in a car with a dangerous driver” or “did something risky or dangerous on a dare.” Items assessing engagement in antisocial behaviors (7 items) included violent, delinquent, and criminal activity, such as “stealing,” “belonging to a gang,” or “physically attacking someone.” (Items are listed in Supplementary Table 1). Response options were ever (1) or never (0), with positive responses summed, such that higher scores reflect engaging in more sensation-seeking (range 0–11) or antisocial behaviors (range 0–7). The sensation-seeking and antisocial items had good face validity, and the Spanish-version of the CHIP-AE has good reliability and validity (Rajmil et al., 2003). Within the current sample, the Cronbach coefficient alphas were 0.51 and 0.63 for the sensation seeking and antisocial behaviors items, respectively.

Personality. At adolescence, participants completed the Neuroticism, Extraversion, Openness Personality-Five-Factor Inventory (NEO-FFI) (Costa & McCrae, 1992), which is a 60-item self-report measure of personality, assessing the “Big Five” personality domains of: conscientiousness, agreeableness, openness to experiences, extraversion, and neuroticism. The personality domains were assessed using 12 items each, with a 5-point Likert scale response option (1 = strongly disagree to 5 = strongly agree). We performed a reliability analysis and removed items to improve internal consistency of each scale. The final five scales each consisted of 7–10 items, with the following Cronbach coefficient alphas: conscientiousness (9 items; $\alpha = 0.80$); agreeableness (10 items; $\alpha = 0.72$); openness to experience (7 items; $\alpha = 0.62$); extraversion (7 items; $\alpha = 0.74$); and neuroticism (9 items; $\alpha = 0.75$) (See Supplementary Table 2 for the items per scale).

2.4. Covariates

Multivariable analyses adjusted for the following variables: sex, socioeconomic status (SES), and age at each assessment. SES was assessed using the Graffar social class index, with higher scores indicating more socioeconomic disadvantage (Graffar, 1956).

2.5. Analytic strategy

Data analysis was conducted with SAS version 9.4 software. Participant characteristics were summarized using means (continuous variables) and frequencies (categorical variables). We used PROC LOGISTIC to estimate multinomial logistic regression models (link = ‘glogit’) to assess associations among the study variables and substance use. The outcome in each model was a four-level substance use variable (never use, incident use, continued use, discontinued use), with never use coded as the reference category. Predictor variables were entered in separate models as continuous variables. In Table 2, we report the odds ratio for a one standard

Table 2
Multinomial logistic regression models analyzing odds of substance use associated with risk taking, sensation seeking, antisocial behaviors, and personality.

Predictors	Incident illicit substance use at YA ^a (n = 226)	Incident marijuana use at YA ^a (n = 524)	Continued marijuana use ^b (n = 100)	Discontinued marijuana use ^c (n = 30)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
BART average adjusted pumps	1.08 (0.91, 1.29)	1.13 (0.94, 1.35)	1.06 (0.78, 1.45)	0.58 (0.33, 1.01)
BART explosions	1.10 (0.92, 1.31)	1.17 (0.98, 1.41)	1.05 (0.77, 1.44)	0.52 (0.29, 0.91)
CHIP sensation seeking	1.49 (1.27, 1.78)	1.53 (1.26, 1.86)	3.15 (2.36, 4.21)	2.60 (1.71, 3.96)
CHIP antisocial	2.90 (1.98, 4.26)	1.94 (1.51, 2.50)	3.89 (2.82, 5.29)	3.04 (2.03, 4.56)
NEO conscientiousness	0.66 (0.55, 0.79)	0.72 (0.60, 0.85)	0.56 (0.41, 0.75)	0.72 (0.45, 1.14)
NEO agreeableness	0.65 (0.54, 0.78)	0.76 (0.64, 0.90)	0.52 (0.39, 0.70)	0.79 (0.50, 1.24)
NEO openness	0.87 (0.73, 1.03)	0.82 (0.69, 0.97)	0.81 (0.61, 1.07)	0.86 (0.55, 1.34)
NEO extraversion	0.56 (0.33, 0.94)	0.96 (0.81, 1.14)	0.75 (0.57, 0.99)	1.00 (0.64, 1.56)
NEO neuroticism	1.33 (1.10, 1.59)	1.20 (1.01, 1.43)	1.41 (1.04, 1.90)	1.01 (0.63, 1.62)

Note. All four models compare the group of interest to the reference group of never users (n = 236). Bold values indicate statistical significance at $p < .05$. Associations are adjusted for age, sex, and socioeconomic status. Associations are listed for a one-standard deviation increase in the exposure. BART: Balloon Analogue Risk Task. CHIP: Child Health and Illness Profile. NEO: Neuroticism, Extraversion, Openness Personality Inventory. OR: odds ratio. CI: confidence interval.

^a First use reported at young adulthood with no use at or prior to the adolescent evaluation.

^b Ever lifetime marijuana use reported at adolescence and current (past 30 days) use reported at young adulthood.

^c Ever lifetime marijuana use reported at adolescence, but no current (past 30 days) use reported at young adulthood.

Table 3

Associations between risk taking, sensation seeking, antisocial behaviors, and personality and odds of marijuana use at adolescence and young adulthood.

Predictors	Current (past 30 days) young adult marijuana use					
	Used marijuana at or prior to adolescence (<i>n</i> = 130) ^a		Among those who never used marijuana by adolescence (<i>n</i> = 760) ^b		Among those who used marijuana at or prior to adolescence (<i>n</i> = 130) ^c	
	OR	95%CI	OR	95% CI	OR	95%CI
BART average adjusted pumps	1.16	(0.89, 1.51)	1.12	(0.94, 1.34)	1.30	(0.78, 2.16)
BART number explosions	1.23	(0.94, 1.60)	1.17	(0.98, 1.40)	1.35	(0.79, 2.29)
CHIP sensation seeking	2.23	(1.78, 2.80)	1.24	(1.05, 1.47)	1.48	(0.97, 2.27)
CHIP antisocial	2.21	(1.79, 2.72)	1.21	(1.04, 1.43)	1.12	(0.74, 1.70)
NEO conscientious-ness	0.74	(0.57, 0.95)	0.84	(0.71, 1.00)	0.76	(0.49, 1.18)
NEO agreeableness	0.67	(0.53, 0.86)	0.93	(0.78, 1.11)	0.75	(0.49, 1.16)
NEO openness	0.94	(0.74, 1.20)	0.86	(0.72, 1.03)	0.91	(0.60, 1.39)
NEO extraversion	0.99	(0.77, 1.26)	1.05	(0.88, 1.26)	0.97	(0.63, 1.50)
NEO neuroticism	1.12	(0.91, 1.50)	0.99	(0.83, 1.20)	0.97	(0.63, 1.51)

Note: Bold values indicate statistical significance at *p* < .05. Associations are listed for a one-standard deviation increase in the exposure. Associations are adjusted for age, sex, and socioeconomic status. BART: Balloon Analogue Risk Task.

CHIP: Child Health and Illness Profile. NEO: Neuroticism, Extraversion, Openness Personality Inventory. OR: odds ratio.

CI: confidence interval.

^a Example interpretation: Every SD increase in the predictor is associated with X odds increase in ever use of marijuana as reported at adolescence.

^b Example interpretation: Among participants who did not use marijuana by adolescence, every SD increase in the predictor is associated with X odds increase in current (past 30 days) marijuana use at young adulthood.

^c Example interpretation: Among participants who ever used marijuana by adolescence, every SD increase in the predictor is associated with X odds increase in current (past 30 days) marijuana use at young adulthood.

deviation increase in the predictor variable for each substance use group versus the never use group. In additional analyses, we conducted binary logistic regression models (PROC LOGISTIC), modeling use of marijuana at or prior to adolescence, and separately, current (past 30 days) marijuana use at young adulthood as a function of each independent variable and the covariates (Table 3). The young adult models were stratified by ever or never use at adolescence.

3. Results

Within the current sample, 73.5% of participants reported ever using marijuana (at either adolescence or young adulthood; *n* = 654), and 30.4% reported ever using an illicit substance (*n* = 270, Table 1). Many participants first used marijuana at young adulthood (58.9%, *n* = 524), while 11.2% reported marijuana use at both adolescence and young adulthood (*n* = 100). Approximately 14% of the sample reported marijuana use at or prior to adolescence (14.6%, *n* = 130). However, most of the illicit drug users within the sample reported first using illicit substances at young adulthood (25.4%, *n* = 226).

3.1. Relations between risk taking, sensation seeking, antisocial tendencies and substance use group

Results of the multinomial regressions indicated that sensation-seeking and antisocial behavior (as measured on the CHIP-AE) were significantly higher in all four substance use groups than among never-users (Table 2). For each standard deviation increase on the sensation-seeking scale, the odds of initiating illicit substance use in young adulthood increased by 49% (95% confidence interval [95%CI]: 1.27, 1.78), and the odds of initiating marijuana use in young adulthood increased by 53% (95%CI: 1.26, 1.86). A standard deviation increase in sensation-seeking was associated with over three times the odds of continued marijuana use (odds ratio (OR) = 3.15, 95%CI: 2.36, 4.21), and 2.60 times the odds of marijuana use at adolescence but discontinuing use at young adulthood (OR = 2.60, 95%CI: 1.71, 3.96). A similar pattern was found for antisocial behaviors, such that a one standard deviation increase predicted: an increase in the odds of initiating illicit substance use in young adulthood (OR = 2.90, 95%CI: 1.98, 4.26); an increase in the odds of initiating marijuana use in young adulthood (OR = 1.94, 95%CI: 1.51, 2.50); an increase in the odds of continuing marijuana use into young adulthood (OR = 3.89, 95%CI: 2.82, 5.29); and an increase in the odds of discontinuing use after adolescence (OR = 3.04, 95%CI: 2.03, 4.56).

The number of pumps on the BART was not related to incident or continued substance use. However, more explosions on the BART, signifying higher risk-taking propensity, was related to a decreased likelihood of discontinuing marijuana use at young adulthood (OR = 0.52, 95%CI: 0.29, 0.91).

3.2. Relations between personality and substance use group

The multinomial logistic regression models for the NEO personality scores indicated that both high conscientiousness and agreeableness were each associated with reduced odds of initiating marijuana or illicit substance use at young adulthood, as well as reduced odds of continued marijuana use into young adulthood (Table 2). High neuroticism was associated with increased odds of incident illicit substance use (OR = 1.33, 95%CI: 1.10, 1.59), incident marijuana use (OR = 1.20, 95%CI: 1.01, 1.43), and continued marijuana use (OR = 1.41, 95%CI: 1.04, 1.90). The personality trait of extraversion was associated with reduced odds of continuing marijuana use from adolescence to young adulthood (OR = 0.75, 95%CI: 0.57, 0.99).

3.3. Associations with marijuana use at adolescence and young adulthood

The results of binary logistic regression models predicting marijuana use at adolescence and, separately, marijuana use at young adulthood conditional on adolescent use, are shown in Table 3. Frequent sensation seeking and antisocial behaviors were associated with increased odds of marijuana use at adolescence (OR = 2.23, 95%CI: 1.78, 2.80 and OR = 2.21, 95%CI: 1.79, 2.72, respectively), whereas high conscientiousness and agreeableness were associated with reduced odds of adolescent marijuana use (OR = 0.74, 95%CI: 0.57, 0.95 and OR = 0.67, 95%CI: 0.53, 0.86, respectively). Frequent sensation-seeking and antisocial behaviors were also related to increased odds of marijuana use at young adulthood among those who reported no lifetime use of marijuana at adolescence (OR = 1.24, 95%CI: 1.05, 1.47 and OR = 1.21, 95%CI: 1.04, 1.43, respectively), while high conscientiousness was associated with reduced odds of marijuana use at young adulthood among those who had never used marijuana at or prior to adolescence (OR = 0.84, 95%CI: 0.71, 1.00).

4. Discussion

Using data from a relatively large cohort of Chileans, this study found several associations among adolescents' risk and personality characteristics and changes in their substance use patterns from adolescence to young adulthood. Results indicate four primary findings. First, frequent sensation-seeking and antisocial behaviors were significantly associated with incident use of illicit substances and marijuana at young adulthood, and with an increased likelihood of continuing marijuana use into young adulthood. Thus, these two factors are particularly important risks, as continued substance use is a significant marker for substance use disorder and progression to poly-substance use (Trull, Waudby, & Sher, 2004; Wagner & Anthony, 2002). The continued use category in the current study reflects use during at least two time points over a 7-year period, possibly reflecting regular-persistent use or drug dependence (Wittchen et al., 2008). The excitement- and thrill-seeking aspects of sensation seeking could be driving the need for increased sensations and pleasures (such as those experienced with drug use), and the disregard for social norms associated with antisocial-delinquent activities could be a catalyst for long-term use (Krueger et al., 2007; Sher & Trull, 1994). The current results corroborate previous findings linking sensation-seeking and antisocial tendencies to substance use (Cooper et al., 2003), and extend such work to indicate that these tendencies present a significant risk for long-term marijuana use into young adulthood.

Second, results indicated that risk-taking behavior — as measured on the performance-based Balloon Analogue Risk Task (BART) — was associated with a lower likelihood of discontinuing marijuana use at young adulthood. Given that high risk taking on the BART indicates high discounting of risks, the relation between high explosions on the BART and failure to discontinue marijuana use might reflect discounting (disbelieving) the harms associated with continued use. There is some indication that deficits in risk-reward processing are related to weak working memory, which can limit the ability to consider the long-term consequences of behaviors (Romer et al., 2011). This interpretation is consistent with interventions that find that enhancing sensitivity to risks and reducing sensitivity to rewards lead to less risky behaviors (Scott-Parker & Weston, 2017; Singer & Schensul, 2011). Efforts to improve adolescents' awareness of the risks involved in prolonged substance use might lead to greater success at discontinuing substance use into young adulthood.

Third, regarding the personality domains, results indicated that high neuroticism was associated with increased likelihood of illicit and marijuana use at young adulthood and of continued marijuana use from adolescence into young adulthood. This is consistent with the assertion that illicit substance use serves to soothe the negative emotions that characterize those with neurotic tendencies, such as being anxious, irritable, or distressed. In contrast, high conscientiousness, agreeableness, and openness were each associated with a reduced likelihood to initiate substance use at young adulthood. High agreeableness, as measured on the NEO personality inventory, does not encompass a vulnerability to succumb to peer pressure as its name might imply, but rather, captures an easy-going and adaptive capacity, reflecting the positive personality capabilities of compassion, altruism, and trust (McCrae & Costa, 2008). Similarly, conscientiousness is aligned with several positive health behaviors reflective of personal responsibility, reliability, and diligence (McCrae & Costa, 2008), which may explain its inverse relationship with substance use. In addition, the openness items used in this study highlight an artistic and intellectual curiosity, rather than an interest in experimenting with psychoactive substances as a new experience.

There were a few counter-intuitive findings. For example, both frequent sensation seeking and involvement in antisocial activities related to an increased likelihood of discontinuing marijuana use at young adulthood. This association, however, might reflect use at adolescence, as the odds ratios involved comparing those who used marijuana at adolescence and discontinued use at young adulthood to those who had never used marijuana (at either adolescence or young adulthood). Thus, the higher odds ratios may reflect the higher sensation seeking and antisocial tendencies among the adolescent users in that grouping. This was the case (as seen in Table 3), with frequent sensation seeking and antisocial activities significantly related to marijuana use at adolescence. The finding

that neuroticism did not play a role in marijuana use at adolescence (Table 3) was also somewhat surprising, given its central role in substance use at young adulthood (Table 2). Perhaps marijuana use at young adulthood is more strongly linked to the anxiety, anger, and depression that co-occur with neuroticism than with marijuana use at adolescence (Terracciano et al., 2008). This is consistent with research finding that continued marijuana use into young adulthood signifies general maladjustment issues (Kandel & Logan, 1984; Trull et al., 2004).

4.1. Study limitations and strengths

This study's limitations should be considered when interpreting its findings. In the current study sample, relatively few individuals discontinued marijuana use from adolescence into young adulthood (3.4% or 30 participants). However, the individuals who discontinued marijuana use at this developmental juncture are an important group, as they provide insight into characteristics associated with ceasing drug use (Kulis, Nieri, Yabiku, Stromwall, & Marsiglia, 2007). Another limitation is the somewhat low internal consistency reliabilities of the sensation seeking and openness to experience items. This may have hampered our ability to detect associations between these characteristics and substance use patterns. In addition, relatively few relations emerged with scores from the BART. We attribute this to the fact that the BART, as implemented in the current study, involved a computer game scenario involving 'points,' without connection to a tangible reward. Most administrations of the BART involve a monetary reward or gift card (Lejuez et al., 2002, 2003). In the absence of a tangible reward, participants' strategies may not reflect true risk-taking tendencies. Additionally, the study variables, to the exclusion of substance use, were measured only once—at the adolescent assessment. This precluded us from investigating whether changes in the personological factors studied contribute to changes in substance use over time.

Strengths of this study include the relatively large sample that was followed longitudinally across a critical developmental period. The majority of substance use research has focused on cross-sectional associations, with limited attention given to transitions into and out of drug use. Past research has also largely involved clinical samples of adult substance users, rather than non-clinical samples of adolescents and young adults that our study investigated. As such, the current findings may be more generalizable to youth in the general population. In addition, this study took place in Chile, a setting where both marijuana and illicit substance use prevalence are relatively high and similar to that in the U.S., thereby providing a different yet comparable context to study developmental changes in substance use patterns. Our findings also showed relations between several personological characteristics and substance use several years after the initial survey administration, or between 5 and 7 years later. This longitudinal study design represents a step forward for understanding factors related to substance use initiation, continuation, and discontinuation during the transition to adulthood. Study of these groups are of interest for prevention and intervention efforts, as findings indicate factors associated with starting and stopping drug use at the onset of adulthood—a critical time when actions can have serious long-term consequences (e.g., driving while under the influence of substances, risky sexual behaviors, etc.). The initiation of substance use at young adulthood is the most common trajectory of substance use (Substance Abuse and Mental Health Services Administration, 2017). Therefore, understanding the factors that co-occur with initiating substances at this juncture has widespread implications.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.adolescence.2020.04.011>.

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