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## Developmental Trajectories of Marijuana Use from Adolescence to Adulthood: Personal Predictors

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### Abstract

**Objective**—To investigate the relationship between early adolescent personal characteristics and the developmental trajectories of marijuana use extending from early adolescence to adulthood.

**Design**—This study used a longitudinal design. Data was obtained utilizing structured questionnaires administered by trained interviewers.

**Setting**—Interviews took place in the participants' homes in upstate New York.

**Participants**—Participants were drawn from a randomly selected cohort and studied prospectively since 1975 (T1) at mean age 5 years. The follow-up data used for this study were collected at six points in time when the participants were between the ages of 14 and 37 years, in 1983 (T2), 1985–86 (T3), 1992 (T4), 1997 (T5), 2002 (T6), and 2005–2006 (T7).

**Interventions**—None.

**Main Outcome Measures**—Developmental trajectories of marijuana use.

**Results**—Semiparametric group-based modeling and logistic regression analyses were used to analyze the data. Five distinct trajectories of marijuana use were identified: nonusers/experimenters, occasional users, quitters/decreasers, increasers, and chronic marijuana users. Chronic marijuana users compared with other groups studied (nonusers/experimenters, occasional users, quitters/decreasers, and increasers) reported low self-control, externalizing behavior, and an orientation to sensation seeking.

**Conclusion**—Personal attributes of low self-control, externalizing behavior, and an orientation to sensation seeking have long-term predictive power with regard to distinct trajectories of marijuana use over time. The importance of the findings for prevention and treatment programs are discussed.

### Keywords

Marijuana; Developmental trajectories; Adolescent personal attributes

### Introduction

In our prior research and that of other investigators,<sup>1–5</sup> marijuana use was associated with a number of problem behaviors, such as rebelliousness, delinquency, risky sexual behavior, other substance abuse,<sup>1</sup> poor school performance, low educational aspirations and

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expectations,<sup>2,3</sup> and the postponement of marriage and employment.<sup>4</sup> With some notable exceptions,<sup>5,6</sup> most previous studies of the psychosocial predictors of marijuana use have been either cross-sectional studies, or longitudinal investigations which did not specifically examine different trajectories of marijuana use. The present study is the first, to our knowledge, to examine the personal predictors of the trajectories of marijuana use over a wide age span of 23 years, from early adolescence to adulthood.

As most prior research has not specifically examined the predictors of trajectories of marijuana use, we assessed five personal predictors derived from the literature on the correlates of marijuana use. The significance of intra-individual variables for substance use was emphasized by Tarter,<sup>7</sup> who proposed that personal variables are proximally related to substance use, and that they also serve to mediate the effect of both inherited behavioral propensities and social influences on substance use. The first personal predictor examined in this study, self-control, encompasses the ability to regulate cognition, emotion, and behavior.<sup>8</sup> Wills and Stoolmiller<sup>8</sup> found that limited self-control is related to the rate of increase of substance use. The second personal predictor, externalizing behavior, is a component of neurobehavioral disinhibition,<sup>9</sup> A disturbance of the pre-frontal cortex reflected in affective, behavioral, and cognitive impairments. The authors found that these impairments were predictive of the early onset of substance use disorders. The externalizing behavior problems investigated in this study include rebelliousness, less responsibility, tolerance of deviance, and delinquent and aggressive behaviors. Third, we included a measure assessing the individual's orientation to sensation seeking. Sensation seeking or novelty seeking is defined as an attraction towards the experience of novel situations and stimuli.<sup>10,11</sup> Cloninger<sup>12</sup> theorized that a high level of novelty seeking has a biological basis, and is associated with increased exploratory pursuit to stimuli such as substance use. Higher levels of sensation seeking have been associated with membership in an early-onset substance use trajectory group relative to late-onset and nonuser groups.<sup>6</sup> Fourth, we included internalizing symptoms, which are generally accepted as referring to overlapping symptoms of depression and anxiety.<sup>13</sup> According to Khantzian's Self-Medication Theory, individuals use drugs to deal with internal distress.<sup>14</sup> Higher levels of depressive symptoms have been found to prospectively predict membership in different trajectories of marijuana use through adolescence.<sup>15</sup> Fifth, we included a measure of educational expectations and aspirations as Schulenberg and colleagues found that both high school grades and high expectations of college completion were associated with subsequent trajectories of little or no marijuana use.<sup>16</sup> From a cognitive perspective, adolescents with high aspirations/expectations may be more likely to think of the consequences of substance use on their lives. From a sociological perspective, those with a low education orientation may be more likely to associate with substance using peers and thus use drugs themselves.

In sum, the present longitudinal study uses a growth mixture model (GMM)<sup>17</sup> to identify rates and direction of change of marijuana use in different subgroups assessed at six time points from early adolescence to adulthood. Based on previous research conducted by our group and others,<sup>5,6,16,18,19</sup> we hypothesized that there will be several trajectories of marijuana use, including a group of chronic users, a group of nonusers, and a group of quitters. As regards the personal and behavioral predictors of trajectories of marijuana use, we hypothesized that most of the personal risk factors (e.g., externalizing behavior, internalizing behavior, and sensation seeking) and lower scores on personal protective factors (e.g., low self-control, low educational expectations and aspirations) are associated with 1) being members of the chronic marijuana use group as compared with being members of other trajectory groups and 2) being members of the other marijuana use groups as compared with being members of the nonuser group.

## Method

### Participants and Procedure

Participants were drawn from a randomly selected cohort studied prospectively since 1975 (T1). The original sample was representative of the population of children in the 1970s in upstate New York with respect to ethnicity, gender, family intactness, family income, and education. Six follow-up waves of data were collected in the participants' homes. The mean ages (SDs) of the participants for the various waves were 14.1 (2.8) in 1983 (T2), 16.3 (2.8) in 1985–1986 (T3), 22.3 (2.8) in 1992 (T4), 27.0 (2.8) in 1997 (T5), 31.9 (2.8) in 2002 (T6), and 36.6 (2.8) in 2005–2006 (T7). The trajectory analyses for the current study were based on those participants who participated in the study at least at two points in time from T2 through T7 (N=806). Those participants (N=11) who participated in the study at only one point in time were excluded from the current analyses. There were no appreciable differences in terms of gender and ethnicity between those who were included and those who were excluded from the study. The sample used in the present study was 92% white and 54% female.

Written informed consent was obtained from the mothers of the participants in 1975, from the participants and their mothers at T2–T4, and from the participants only at T5–T7. The Institutional Review Board of the New York University School of Medicine approved this study. A Certificate of Confidentiality was issued by the National Institutes of Health. Additional information regarding the study methodology, including interview procedures, is available in prior publications.<sup>20</sup>

### Measures

**Marijuana Use**—At each time wave (T2–T7), questions about marijuana use (adapted from the Monitoring the Future study<sup>21</sup>) were included. In order to measure the lifetime quantity and frequency of marijuana use from childhood to the mid-thirties, at each time wave the questions asked about the frequency of marijuana use during the period from the last time wave through the current time wave. Specifically, the questions used were the frequency and quantity of marijuana use in childhood and early adolescence for T2 (prior to and at T2), during the past two years in adolescence for T3 (T2–T3), during the past five years in the early twenties for T4 (T3–T4), during the past five years in the late twenties for T5 (T4–T5), during the past five years in the late twenties and early thirties for T6 (T5–T6), and during the past five years in the mid-thirties for T7 (T6–T7). The marijuana use measure at each point in time had a scale coded as none (0), a few times a year or less (1), once a month (2), several times a month (3), once a week (4), several times a week (5), and daily (6).

**Early Adolescent Personal Attributes**—For early adolescent personal attributes (mean age 14), we included a measure of self-control (7 items,  $\alpha=0.62$ , e.g., “I generally rely on careful reasoning in making up my mind,” “I feel like losing my temper at people”<sup>20</sup>) a measure of sensation seeking (5 items,  $\alpha=0.52$ , e.g., “I like ‘wild’ uninhibited parties,”<sup>10</sup>) and a measure of educational expectations and aspirations (2 items, e.g., “How far do you hope you will go in school?”<sup>21</sup>). In addition, we included a measure of externalizing behavior ( $\alpha=0.81$ ), which consisted of: a) 8 items assessing tolerance of deviance (e.g., “How wrong do you think it is to fake an excuse from home?”<sup>22</sup>); b) 8 items assessing rebellion (e.g., “When rules and regulations get in the way, I sometimes ignore them.”<sup>23</sup>); c) 6 items assessing responsibility (e.g., “If I get too much change in a store, I always give it back.”<sup>24</sup>); d) 3 items assessing aggression (e.g., “I often make people angry by teasing them.”<sup>21</sup>); and e) 5 items assessing delinquency (e.g., “How often have you gotten into a serious fight at school?”<sup>21</sup>). We also included a measure of early adolescent

internalizing behavior ( $\alpha=0.79$ ), which consisted of: a) 5 items assessing depression (e.g., “Over the last few years, how much were you bothered by feeling low in energy or slowed down?”<sup>25</sup>); b) 4 items assessing anxiety (e.g., “Over the last few years, how much were you bothered by feeling anxious?”<sup>25</sup>); and c) 6 items assessing interpersonal difficulties (e.g., “Over the last few years, how much were you bothered by feeling easily annoyed or fearful?”<sup>25</sup>). These measures have been found to predict drug use, delinquency, and psychopathology.<sup>20,26</sup>

**Control Variables**—Demographic characteristics assessed included gender, age, and socioeconomic status (i.e., family income and highest level of parental education at T2).

## Analysis

Using the Mplus software<sup>27</sup>, we conducted GMM analyses to identify the developmental trajectories of marijuana use. We treated the dependent variable (marijuana use at each time point) as a censored normal variable. We applied the full information maximum likelihood (FIML) approach<sup>28</sup> for the missing data in the analysis. We set each of the trajectory polynomials to be cubic. We used the minimum Bayesian Information Criterion (BIC) to determine the number of trajectory groups ( $G$ ). We did not consider groups with fewer than 5% of the sample because some investigators<sup>29</sup> have cautioned against over-extraction of latent classes due to the presence of non-normal data. After extracting latent classes, we assigned each participant to the trajectory group with the largest Bayesian posterior probability (BPP). For each of the trajectory groups, we created an indicator variable, which had a value of 1 if the participant had the largest BPP for that group and 0 otherwise. The observed trajectory for a group was the average of marijuana use at each time point for participants assigned to the group (see Figure 1 and Table 1).

We computed the mean and standard deviation for each of the personal/behavioral factors by each of the trajectory groups. We then performed multivariate logistic regression analyses to separately examine the associations between each of the personal/behavioral factors and the participants' trajectory group memberships. For example, in the five logistic regressions of  $G_1$  versus  $G_2$ , we set the  $G_2$  group as the reference group. The dependent variable was an indicator variable of being  $G_1$  users. The independent variable was one of the five T2 personal factors (i.e., self control, externalizing behavior, sensation seeking, internalizing behavior, and educational expectations and aspirations), and the control variables consisted of gender, age, family income, and parental educational level. To facilitate interpretation of the adjusted odds ratios (A.O.R.), the independent variables were converted to standardized scores. Thus, the odds ratios associated with these variables were computed for one standard deviation of change.

## Results

### Trajectories of Marijuana Use

The mean (SD) of the marijuana use scores at each time point were 0.56 (1.19), 0.75 (1.35), 1.00 (1.37), 0.94 (1.43), 0.72 (1.37), and 0.60 (1.23) for T2–T7 respectively. The percentage of marijuana users peaked at T4 (mean age=22).

We calculated solutions for the three-group trajectory (Likelihood Value = -4982; BIC = 10098), the four-group trajectory (Likelihood Value = -4937; BIC = 10042), the five-group trajectory (Likelihood Value = -4883; BIC = 9967), and the six-group trajectory (Likelihood Value = -4843; BIC = 9921). Even though the BIC value for the six-group trajectory was lower than that for the five-group trajectory, we did not consider the six-group solution, because there was one trajectory group with fewer than 3% of the sample.

Participants were then assigned to the marijuana trajectory group that best depicted their marijuana use over time. The average classification probabilities for group membership ranged from 0.81 to 0.88, which indicate a satisfactory classification.

Figure 1 presents the five observed marijuana use trajectories. Table 1 presents the mean (SD) of marijuana use (T2–T7) by the five trajectory groups. The trajectory groups were named: chronic users (10.7%), quitters/decreasers (22.9%), increasing users (5.7%), occasional users (20.6%), and nonusers/experimenters (40.1%). As noted in Figure 1 and Table 1, the chronic users started early, achieved the maximum level of use on a weekly basis in late adolescence, and then tapered off gradually to a lower level. Quitters/decreasers started early, then tapered off from late adolescence/emerging adulthood into adulthood. Increasing users started late, increased use from late adolescence/emerging adulthood to the early thirties (several times a week or daily), and then stayed at that level through the late thirties. Occasional users started late and used marijuana less than on a monthly basis.

### **Risk and Protective Factors as Predictors of Marijuana Group Membership**

Table 2 presents the mean (SD) for each of the T2 risk and protective factors by the five marijuana use trajectory groups. Table 3 presents the results from the separate logistic regression analyses. As noted in Table 3, as compared with the nonusers/experimenters: 1) low self-control and more externalizing behavior were significantly associated with an increased likelihood of being a member of each of the marijuana use trajectory groups, i.e. the chronic users, the quitters/decreasers, the increasers, or the occasional users; 2) greater sensation seeking and more internalizing behavior were significantly associated with an increased likelihood of being a chronic user or a quitter/decreaser; and 3) low educational expectations and aspirations were associated with an increased likelihood of being a chronic user. We also noted that all of the personal/behavioral factors significantly distinguished the chronic users from the nonusers/experimenters. In addition, low self-control, more externalizing behavior, and greater sensation seeking were significantly associated with an increased likelihood of being a chronic user as opposed to being a quitter/decreaser. More externalizing behavior was significantly associated with an increased likelihood of being a chronic user as opposed to being an increaser. Low self-control, more externalizing behavior, greater sensation seeking, and low educational expectations and aspirations were significantly associated with an increased likelihood of being a chronic user as opposed to being an occasional user. A Bonferroni correction was applied to these comparisons. There were more significant results than expected by chance, and the results were consistent with the hypotheses. We did not hypothesize how the remaining groups, noted above, would differ from one another. Nevertheless, we found that more externalizing behavior significantly differentiated a quitter/decreaser from an occasional user or an increaser. As compared with occasional users, low educational expectations and aspirations were associated with an increased likelihood of being quitter/decreasers.

### **Discussion**

This longitudinal study provides contributions to the research literature on the development of marijuana use. First, using latent growth mixture modeling, we have identified five different trajectories of marijuana use across a wide age range extending from age 14 to 37. Second, we examined a wide range of personal attributes associated with each of the trajectories of marijuana use, which were assessed at six points in time. These personal attributes include major dimensions of self-control, response to societal demands (i.e., externalizing behavior), susceptibility to environmental arousal and stimuli (i.e., sensation seeking) and internal distress (i.e., anxiety and depression). Third, we have controlled for the important background factors (i.e., gender, age, family income, and parental education) related to the personal attributes and/or the trajectories of marijuana use. To our knowledge,

this is the first longitudinal study to include the personal predictors of the trajectories of marijuana use spanning so many important developmental periods.

Using latent growth mixture modeling, five trajectory groups were identified over a period extending from age 14 to 37, namely chronic users, quitters/decreasers, increasing users, occasional users, and nonusers/experimenters. The trajectories identified adequately accounted for individual variations in long-term marijuana use. The trajectory group approach used in this study suggests that there was considerable change within the individual's marijuana use between early adolescence and the thirties. Thus, our focus on changes in marijuana use over time revealed information that studying absolute levels of marijuana use could not reveal.

Our trajectories cover a longer period of time than has been employed in prior studies assessing marijuana use trajectories.<sup>5,16,18,19</sup> Nevertheless, the trajectories of marijuana use in the current study corresponded broadly, with slight differences in some cases, to the trajectories we have found in our prior work (conducted on a different sample),<sup>18</sup> as well as those obtained by other investigators.<sup>5,19</sup> However, in contrast to our findings, Schulenberg et al.<sup>16</sup> did identify a “fling” group of individuals demonstrating intermittent, heavy use of marijuana (5.7% of their sample).

With regard to the personal risk factors, as noted earlier, externalizing behaviors (i.e., more rebelliousness, tolerance of deviance, delinquency, and aggressive behaviors) reflect difficulty in meeting environmental demands. Greater antisocial behavior (as reflected in externalizing behavior) distinguished the chronic users from all other subgroups (i.e., quitters/decreasers, increasers, occasional users, and nonusers/experimenters). Since chronic users display higher levels of marijuana use at an early age, this finding is in accord with the results of Tarter et al.,<sup>9</sup> who maintain that neurobehavioral disinhibition predicts early onset of substance use disorders. It may be that externalizing personality attributes reflect unconventional values and behaviors as well as an acceptance of norm-violating activities consistent with marijuana use, and that they serve to weaken internal personal controls against using marijuana (e.g., Newcomb and McGee<sup>30</sup>). As noted earlier, sensation seeking represents a propensity toward novel experiences, which is consistent with experimentation with marijuana use. With the exception of the increasers, a propensity toward novel experiences (i.e., an orientation to sensation seeking) distinguished the chronic users from the other subgroups. These findings are consistent with those of Flory et al.<sup>6</sup> in their study of adolescents and young adults. They reported that sensation seeking predicted heavy marijuana use. In general, our findings provide some support for Cloninger's theory<sup>12</sup> that neurobiological differences may account for variations in substance use habits among different groups of people. Chronic users were also more likely to have lower educational expectations and aspirations. From a cognitive perspective, low expectations/aspirations may have prevented chronic users from thinking of the consequences of substance use on their lives. From a sociological perspective, low expectations/aspirations may have provided chronic users more opportunity to associate with substance using peers who encouraged their marijuana use. Furthermore, low scores on our measure of self-control indicated less impulse control, resulting in actions such as losing one's temper, swearing, and becoming distracted. Such lack of self-control increased the likelihood of being a chronic user compared with a quitter/decreaser, an occasional user, or a nonuser/experimenter. In a related vein, Wills and Stoolmiller,<sup>8</sup> found that poor self-control was related to a higher initial level of use and increased rate of growth of substance use in early adolescence. They further suggest that poor self-control may influence substance use via a failure to meet expectations, a failure to consider the consequences of substance use, and a failure to form positive social relationships, and that these factors, in turn, increase the likelihood of persistent substance use.

Nonusers/experimenters, in comparison with chronic users, quitters/decreasers, increasers, or occasional users, manifested less externalizing behavior and the highest levels of the personal protective factors such as higher self-control. These findings are in accord with those of several investigators who have reported that non-users of marijuana tend to be less likely to engage in externalizing behavior.<sup>2,31</sup> Our findings add to the literature by demonstrating that the results of previous investigations (e.g., Brook et al.<sup>2</sup>; Bryant and Zimmerman<sup>31</sup>) can be applied to a description of the long-term trajectories of marijuana use.

Our measure of internalizing behavior, which included symptoms of depression and anxiety as well as interpersonal difficulty, differentiated the chronic users and quitters from the nonusers. It did not, however, distinguish among the different trajectories of marijuana users (i.e., among chronic users, quitters/decreasers, increasers, and occasional users) (see also Windle and Wiesner<sup>15</sup>). In general, the literature indicates that compared to externalizing characteristics, the link between emotional difficulties (internalizing behavior) and marijuana use is less strong.<sup>32</sup>

The findings of the present research have several limitations. First, we did not control for possible familial or peer variables that may be associated with the development of risk and protective personality factors for substance use.<sup>33</sup> Second, only adolescent personal risk factors studied at one point in time were included in this research in order to discriminate the different trajectories of marijuana use. There is the possibility that the predictor variables that we examined are not stable over time, which then may alter the marijuana trajectories. Future research should focus on those risk and protective factors which vary over time, so that the developmental interactions between risk and protective factors and marijuana use may be better understood.

To our knowledge, this is the first research study to identify the personal predictors of multiple trajectories of marijuana use extending from early adolescence to the thirties. In previous research we have found that family factors predict marijuana use<sup>20</sup>; however, personal factors have emerged as mediating factors. Taken together, the findings of the present study showed that the personal dimensions included in these analyses predicted chronic marijuana use fourteen years later. Early intervention aimed at reducing the level of these personal risk factors may have a positive effect on reducing the likelihood of chronic use of marijuana over time. Moffitt and Caspi<sup>34</sup> found that pediatricians were able to identify risk factors for childhood delinquency. Pediatricians should also take particular note when their young patients demonstrate the personal risk factors for chronic marijuana use (i.e., low self-control, externalizing behavior, sensation seeking, educational aspirations/expectations, and internalizing symptoms). The significant risk and protective factors identified in this study warrant further research for their potential integration into marijuana prevention and treatment programs.

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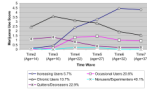
## References

1. Degenhardt L, Hall W, Lynskey MT. The relationship between cannabis use and other substance use in the general population. *Drug Alcohol Depend* 2001;64:319–327. [PubMed: 11672946]

2. Brook JS, Adams RE, Balka EB, Johnson E. Early adolescent marijuana use: Risks for the transition to young adulthood. *Psychol Med* 2002;32:79–91. [PubMed: 11883732]
3. Brook JS, Balka EB, Whiteman M. The risks for late adolescence of early adolescent marijuana use. *Am J Public Health* 1999;89:1549–1554. [PubMed: 10511838]
4. Brook JS, Richter L, Whiteman M, Cohen P. Consequences of adolescent marijuana use: Incompatibility with the assumption of adult roles. *Genet Soc Gen Psychol Monogr* 1999;125:193–207. [PubMed: 10363351]
5. Ellickson PL, Martin SC, Collins RL. Marijuana use from adolescence to young adulthood: Multiple developmental trajectories and their associated outcomes. *Dev Psychopathol* 2004;16:193–213. [PubMed: 15115071]
6. Flory K, Lynam D, Milich R, Leukefeld C, Clayton R. Early adolescent through young adult alcohol and marijuana use trajectories: Early predictors, young adult outcomes, and predictive utility. *Dev Psychopathol* 2004;16:193–213. [PubMed: 15115071]
7. Tarter RE. Are there inherited behavioral traits that predispose to substance abuse? *J Consult Clin Psychol* 1988;56:189–196. [PubMed: 3286703]
8. Wills TA, Stoolmiller M. The role of self-control in early escalation of substance use: A time-varying analysis. *J Consult Clin Psychol* 2002;70:986–997. [PubMed: 12182282]
9. Tarter RE, Kirisci L, Mezzich A, et al. Neurobehavioral disinhibition in childhood predicts early age at onset of substance use disorder. *Am J Psychiatry* 2003;160:1078–1085. [PubMed: 12777265]
10. Zuckerman M, Eysenck S, Eysenck HJ. Sensation seeking in England and America: Crosscultural, age, and sex comparisons. *J Consult Clin Psychol* 1978;46:139–149. [PubMed: 627648]
11. Wills TA, Windle M, Cleary SD. Temperament and novelty seeking in adolescent substance use: Convergence of dimensions of temperament with constructs from Cloninger's theory. *J Pers Soc Psychol* 1998;74:387–406. [PubMed: 9491584]
12. Cloninger CR. Neurogenetic adaptive mechanisms in alcoholism. *Science* 1987;236:410–416. [PubMed: 2882604]
13. Achenbach, TM. Integrative Guide for the 1991 CBCL/4–18, YSR and TRF Profiles. Burlington, VT: University of Vermont, Department of Psychiatry; 1991.
14. Khantzian EJ. The self-medication hypothesis of substance use disorders: A reconsideration and recent applications. *Harv Rev Psychiatry* 1997;4:231–244. [PubMed: 9385000]
15. Windle M, Wiesner M. Trajectories of marijuana use from adolescence to young adulthood: Predictors and outcomes. *Dev Psychopathol* 2004;16:1007–1027. [PubMed: 15704825]
16. Schulenberg JE, Merline AC, Johnston LD, et al. Trajectories of marijuana use during the transition to adulthood: The big picture based on national panel data. *J Drug Issues* 2005;35:255–279. [PubMed: 16534532]
17. Nagin DS. Analyzing developmental trajectories: A semiparametric, group-based approach. *Psychol Methods* 1999;4:139–157.
18. Brook JS, Lee JY, Finch SJ, Brown EN. Course of comorbidity of tobacco and marijuana use: Psychosocial risk factors. *Nicotine Tob Res*. In press.
19. Jackson KM, Sher KJ, Schulenberg JE. Conjoint developmental trajectories of young adult substance use. *Alcohol Clin Exp Res* 2008;32:723–737. [PubMed: 18331376]
20. Brook JS, Brook DW, Gordon AS, Whiteman M, Cohen P. The psychosocial etiology of adolescent drug use: A family interactional approach. *Genet Soc Gen Psychol Monogr* 1990;116:111–267. [PubMed: 2376323]
21. Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future National Survey Results on Drug Use, 1975–2005: Volume I, Secondary School Students (NIH Publication No. 06-5883). Bethesda, MD: National Institute on Drug Abuse; 2006.
22. Jessor, R.; Graves, TD.; Hanson, RC.; Jessor, SL. *Society, Personality, and Deviant Behavior: A Study of a Tri-ethnic Community*. New York: Holt, Rinehart, & Winson; 1968.
23. Smith, GE.; Fogg, CP. *Research in Community and Mental Health: An Annual Compilation of Research*. Greenwich, CT: JAI Press; 1979. Psychological antecedents of teen-age drug use.
24. Gough, HG. *The California Psychological Inventory*. Palo Alto, CA: Consulting Psychological Press; 1957.



25. Derogatis LR, Lipman RS, Richels K, Uhlenhuth EH, Covi L. The Hopkins Symptom Checklist (HSCL): A self-report symptom inventory. *Behav Sci* 1974;19:1–15. [PubMed: 4808738]
26. Cohen, P.; Cohen, J. *Life Values and Adolescent Mental Health*. Mahwah, NJ: Lawrence Erlbaum; 1996.
27. Muthén, LK.; Muthén, BO. *Mplus User's Guide*. 4. Los Angeles, CA: 2007.
28. Schaefer JL, Graham J. Missing data: Our view of the state of the art. *Psychol Methods* 2002;7(2): 147–177. [PubMed: 12090408]
29. Bauer DJ, Curran PJ. Distributional assumptions of growth mixture models: Implications for overextraction of latent trajectory classes. *Psychol Methods* 2003;8:338–363. [PubMed: 14596495]
30. Newcomb MD, McGee L. Influences of sensation-seeking on general deviance and specific behavior. *J Pers Soc Psychol* 1991;61:614–628. [PubMed: 1960653]
31. Bryant AL, Zimmerman MA. Examining the effects of academic belief and behaviors on changes in substance abuse among urban adolescents. *J Educ Psychol* 2002;94:621–637.
32. Brook, JS.; Brook, DW.; Pahl, K. The developmental context for adolescent substance abuse intervention. In: Liddle, HA.; Rowe, CA., editors. *Adolescent Substance Abuse: Research and Clinical Advantages*. New York: Cambridge University Press; 2006. p. 25-51.
33. Tarter RE, Vanyukov M. Alcoholism: A developmental disorder. *J Consult Clinical Psychol* 1994;62:1096–1107. [PubMed: 7860808]
34. Moffitt TE, Caspi A. Childhood predictors differentiate life-course persistent and adolescent-limited antisocial pathways among males and females. *Dev Psychopathol* 2001;13:355–375. [PubMed: 11393651]



**Figure 1.**  
 Developmental Trajectories of Marijuana Use Extending From Adolescence to Age 37  
**Note:** The marijuana use score refers to the following: 0 = none; 1 = a few times a year or less; 2 = once a month; 3 = several times a month; 4 = once a week; 5 = several times a week, and 6 = every day.

**Table 1**

Mean (SD) of Marijuana Use (T2–T7) by Marijuana Trajectories.

Variables	C 10.7% Mean (SD)	Q 22.9% Mean (SD)	I 5.7% Mean (SD)	O 20.6% Mean (SD)	N 40.1% Mean (SD)
Marijuana Use at T2	2.43 (2.04)	1.13 (1.17)	.1 (.37)	0 (0)	.08 (.3)
Marijuana Use at T3	3.57 (1.42)	1.32 (1.14)	.37 (.58)	.14 (.38)	0 (0)
Marijuana Use at T4	3.13 (1.76)	.08 (.83)	2.35 (1.69)	1.29 (1.25)	.21 (.43)
Marijuana Use at T5	2.83 (1.69)	.34 (.56)	3.24 (1.83)	1.43 (1.34)	.2 (.46)
Marijuana Use at T6	1.93 (1.73)	.22 (.44)	4.43 (1.3)	1.01 (.99)	0 (0)
Marijuana Use at T7	1.55 (1.66)	.21 (.47)	4.29 (1.19)	.91 (.81)	0 (0)

Note: C=Chronic user; Q=Quitter/Decreaser; I=Increasing User; O=Occasional user; N=Non/experimental user.

**Table 2**

Mean (SD) of Personal Predictors by Marijuana Trajectories.

Variables	C Mean (SD)	Q Mean (SD)	I Mean (SD)	O Mean (SD)	N Mean (SD)
Self control (High)	-.48 (1.03)	-.21 (.93)	-.22 (1.19)	.07 (1)	.24 (.93)
Externalizing Behavior	1.09 (.91)	.51 (.92)	-.10 (.93)	-.29 (.82)	-.42 (.8)
Sensation Seeking	.28 (.63)	-.04 (.8)	.19 (1.23)	.14 (1.07)	-.15 (1.08)
Internalizing Behavior	.03 (.94)	.16 (1.03)	.13 (1.1)	-.01 (1.01)	-.11 (.97)
Educational Expectations & Aspirations (High)	-.30 (1.01)	-.12 (1.02)	.07 (.94)	.18 (.91)	.04 (1.02)

Note: C=Chronic user; Q=Quitter/Decreaser; I=Increasing User; O=Occasional user; N=Non/experimental user.

**Table 3**

Logistic regression of risk and protective personal/behavioral factors associated with the trajectories of marijuana use over time: Adjusted odds ratio (A.O.R.) adjusted for gender, age, family income, and parental educational level.

Independent Variables	C vs. N A.O.R. (95% C.I.)	C vs. O A.O.R. (95% C.I.)	C vs. I A.O.R. (95% C.I.)	C vs. Q A.O.R. (95% C.I.)	Q vs. N A.O.R. (95% C.I.)	Q vs. O A.O.R. (95% C.I.)	Q vs. I A.O.R. (95% C.I.)	I vs. N A.O.R. (95% C.I.)	I vs. O A.O.R. (95% C.I.)	O vs. N A.O.R. (95% C.I.)
Self-control (High)	.35*** (.25-.49)	.52** (.35-.77)	N.S.	.67** (.50-.91)	.53*** (.42-.67)	N.S.	N.S.	.54*** (.38-.76)	N.S.	.78* (.63-.96)
Externalizing Behavior	6.13*** (3.95-9.52)	3.52*** (2.10-5.87)	2.82*** (1.60-4.94)	1.93*** (1.41-2.63)	3.02*** (2.28-4.00)	1.81*** (1.27-2.58)	1.75* (1.10-2.80)	1.68* (1.12-2.53)	N.S.	1.54** (1.19-2.02)
Sensation Seeking	2.18*** (1.65-2.88)	1.62* (1.11-2.38)	N.S.	1.78** (1.23-2.58)	1.62*** (1.31-2.01)	N.S.	N.S.	N.S.	N.S.	N.S.
Internalizing Behavior	1.41* (1.06-1.88)	N.S.	N.S.	N.S.	1.54*** (1.24-1.91)	N.S.	N.S.	N.S.	N.S.	N.S.
Educational Expectations & Aspirations (High)	.72* (.54-.97)	.51** (.34-.76)	N.S.	N.S.	N.S.	.63** (.46-.87)	N.S.	N.S.	N.S.	N.S.

\* p<.05;

\*\* p<.01;

\*\*\* p<.001 (two-tailed tests);

Each of the independent variables was continuous and standardized;

C=Chronic user; Q=Quitter/Decreaser; I=Increasing User; O=Occasional user; N=Non/experimental user.