

Published in final edited form as:

J Drug Issues. 2005 ; 35(2): 255–279.

Trajectories of Marijuana Use During the Transition to Adulthood: The Big Picture Based on National Panel Data

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Abstract

The purposes of this study were to: a) identify trajectory groups of frequent marijuana use during emerging adulthood, b) distinguish among trajectory groups according to demographic and lifestyle characteristics, and c) examine how the trajectory groups relate to behavioral, attitudinal, and social-emotional correlates over time. National panel data from the Monitoring the Future study were used: 18 cohorts of high school seniors (classes of 1977-94) were followed biennially through age 24. Frequent marijuana use was defined as 3+ occasions of use in past month and/or 20 to 40+ occasions in past year. Based on four waves of complete longitudinal data (N=19,952), six frequent marijuana use trajectory groups were identified: chronic, decreased, increased, fling, rare, and abstain. Categorical analyses revealed trajectory group differences in demographic and lifestyle characteristics at senior year and age 24. The trajectory groups varied significantly in longitudinal patterns of other substance use, problem behaviors, and well-being.

Keywords

Marijuana Use; Transition to Adulthood; Developmental Trajectories; Longitudinal Research

The transition from adolescence to adulthood is one of the most critical of normative life transitions because it typically involves pervasive and often simultaneous personal, contextual, and social role changes. During this transition, diversity in life paths increases (Schulenberg, O'Malley, Bachman and Johnston, 2005; Shanahan, 2000), and variability in the timing and content of developmental milestones greatly expands (Cohen, Kasen, Chen, Hartmark, and Gordon, 2003; Elder, 1998). For many, flexibility and self-direction in day-to-day life increases, and geographic mobility is greater in this period than in any other period of life (Arnett, 2000; Shanahan, 2000). In the past few decades, this transition period has lengthened considerably and has become less standardized in terms of normative sequences of adulthood markers relating to work and marriage. These changes led Arnett (2000) to argue that this emerging adulthood period is more than simply a staging ground for adulthood and that it should be viewed as unique and important in its own right. Amidst all this inter-individual variability and the many personal and social role changes, substance use tends to increase, peak, and then subside, a concordance that is not coincidental (Bachman et al., 1997, 2002; Schulenberg, Maggs, and O'Malley, 2003).

In the present study, we are concerned with the course and correlates of marijuana use during the transition to adulthood. Using national panel data spanning this transition, we take a pattern-centered approach to identify and describe common trajectories of marijuana use and to consider static and time-varying correlates of the trajectories.

Trajectories of Marijuana and Other Substance Use During Adolescence and Early Adulthood

Based on epidemiological evidence (Johnston, O'Malley, Bachman, and Schulenberg, 2004), marijuana use at the population level tends to peak during late adolescence and early adulthood. This increase and subsequent decrease are likely due, in part, to changes in freedoms and responsibilities (Bachman et al., 1997, 2002). Leaving home and attending college, for example, is associated with decreased constraints and increased opportunities for substance use. Likewise, through such transitions, one typically encounters more peers in a similar situation and, while not ideal, substance use can serve important developmental task functions regarding peer bonding and identity exploration (Chassin, Pitts, and DeLucia, 1999; Schulenberg and Maggs, 2002). In addition, the role ambiguity and transience characteristic of emerging adulthood (Arnett, 2000) may contribute to substance use by working against commitments to social conventions (e.g., Sampson and Laub, 1990). With the onset of adulthood, however it may be defined, many freedoms recede and new responsibilities regarding family, work, and citizenship emerge (Jessor, Donovan, and Costa, 1991; Masten et al., 1999; Schulenberg and Maggs, 2002; Youniss and Yates, 1997). In particular, "maturing out" of substance use has been found to be a function of getting married (Bachman et al., 1997, 2002; Leonard and Rothbard, 1999).

Embedded within this age-based marijuana use trend are individual trajectories, many of which do not follow the population trend. Given the diversity of life paths and variability in developmental tasks during this time, varying courses of marijuana and other substance use are likely. Over the past decade, efforts to identify and describe different trajectories of substance use during adolescence and emerging adulthood have increased considerably (e.g., Chassin, Presson, Pitts, and Sherman, 2000; Ellickson, Martino, and Collins, 2004; Flory, Lynam, Milich, Leukefeld, and Clayton, 2004; Jackson, Sher, Cooper, and Wood, 2002; Kandel and Chen, 2000; Labouvie and White, 2002; Li, Duncan, and Hops, 2001; Muthén and Muthén, 2000; Schulenberg, Wadsworth, O'Malley, Bachman, and Johnston, 1996; White, Bates, and Buyske, 2001; Windle & Wiesner, 2004). These studies used a variety of strategies for identifying and studying trajectories, including conceptual/logical groupings, cluster analysis, and mixture modeling. As the various studies have shown, there are different longitudinal patterns of substance use, and identifying and distinguishing among them offers important insights into the etiology, course, and consequences of substance use (Curran and Willoughby, 2003; Schulenberg, et al., 2003). These efforts are consistent with a pattern-centered approach to differential change that draws from Magnusson's (1995) individualistic and holistic approach to studying change (see also Cairns, 2000), as well as Elder's (1998) conceptualizations regarding individual coherence and agency across the life course. This pattern-centered approach highlights how variables interrelate within individuals across time and permits the identification of homogenous groups representing distinct patterns of stability and change.

With specific regard to marijuana use, recent longitudinal research has begun to identify trajectory sub-groups spanning adolescence through early adulthood. For example, in a community sample ($N = 481$) of students followed from 6th grade to ages 20 and 22, Flory et al. (2004) identified early and late onset patterns of marijuana use. In a regional sample ($N = 5,833$) of individuals followed from age 13 to 23, Ellickson et al. (2004) found four developmental patterns: early onset with heavy use that decreased with age, light but persistent

use, steady increase from age 13-23, and occasional use. Windle and Wiesner (2004), using a community sample (N=1205) of high school students followed through early adulthood, found five trajectory groups: high chronic, decreasers, increasers, experimental users, and abstainers. In a regional sample (N=708) spanning adolescence through the mid-30s, Kandel and Chen (2000) found four trajectory groups among individuals who had used marijuana at least 10 times in their lifetime: early onset with heavy use, early onset with light use, middle onset with heavy use, and late onset with light use. Most research on trajectories of marijuana use has focused on trajectories starting during early or mid-adolescence, the most common time for initiation of marijuana use (Johnston, et al., 2004). The current study, which begins at an age when most initiation of marijuana use has already occurred, builds on this previous research and extends it by including multi-wave national panel data spanning the end of high school to the beginning of adulthood.

Overview of Present Study

There were three purposes of this study: a) to identify common trajectories of marijuana use from the senior year of high school (age 18) through the subsequent six years, focusing on frequent marijuana use (defined as an average of three or more occasions of use per month); b) to characterize the trajectory groups according to demographic and lifestyle characteristics central to the experiences of late adolescence and early adulthood; and c) to examine how the trajectory groups differentially relate to longitudinal patterns of behavioral, attitudinal, and social-emotional correlates. We hypothesize that continued and increased frequent marijuana use - whether a cause, correlate, or effect - links negatively with overall success and adjustment.

Method

This study uses four waves of national panel data from the Monitoring the Future (MTF) project, an ongoing study of adolescents and young adults. The project has used questionnaires administered in classrooms to survey nationally representative samples of 15,000 to over 18,000 high school seniors each year since 1975. Approximately 2,400 individuals are randomly selected from each senior year cohort for biennial follow-up via mailed questionnaires. More detailed descriptions of the study design and procedures can be found in Bachman et al. (2002), in Johnston et al. (2004), and on the study web site (<http://monitoringthefuture.org>).

Sample

The panel sample consisted of 18 cohorts of respondents who were surveyed as high school seniors (Wave 1, modal age 18) in 1977 (when some measures of interest here were first included) through 1994, and who participated in the first three biennial follow-ups (Waves 2-4, at modal ages of 19 and 20, 21 and 22, and 23 and 24, respectively). (The biennial follow-up surveys begin one year post-high school for one random half of each cohort and two years post-high school for the other half; the two random halves were combined for these analyses.)

The trajectory analyses made it desirable to restrict the sample to respondents present at all four waves. Although retention rates for any one follow-up survey averaged 75-80%, this more demanding restriction resulted in a sample size of 21,148 weighted cases¹, representing a four-wave retention rate of nearly 60%. Because of missing data on the marijuana use measures, the final sample was 19,952, representing a four-wave retention rate of 56%. Consistent with findings from previous attrition analyses with similar MTF panel samples (e.g., Schulenberg et al., 1996,2005), we found that compared to those excluded, those retained in the panel sample

¹Because respondents with more frequent senior year illicit drug use were oversampled (by a factor of 3) for follow-up, corrective weighting (.333 for those individuals) was required.

were more likely to be female and White, and to have higher high school GPA and parental education levels, and lower rates of truancy and senior year substance use.

Measures

The measures are described in terms of the three phases of the analyses.

Phase 1: Marijuana use trajectories. The primary construct of interest was marijuana use, which was measured with two items concerning the number of occasions of marijuana use in the past 30 days and the past 12 months. Possible responses for both items ranged from “0 occasions” (1) to “40+ occasions” (7). Previous research has demonstrated the psychometric soundness of these and other measures of substance use in this study (Johnston and O'Malley, 1985; Johnston et al., 2004; O'Malley, Bachman, & and Johnston, 1983).

As detailed in the Results section, the threshold between frequent use and some use was defined as 3 or more occasions of use in the past 30 days and/or 20 to 40+ occasions of use in the past 12 months. This threshold is based on several considerations. First, we included use in both the past 30 days and 12 months because marijuana use may be more intermittent than alcohol and cigarette use, and relying only on use in the past 30 days would miss intermittent but frequent use over the past 12 months. Second, setting the threshold sufficiently high ensures that the distinction between “frequent use” and “some use” is meaningful for the age range. Researchers studying younger adolescents have considered a lower threshold, for example, monthly use (e.g., Brook, Balka, and Whiteman, 1999); however, given that marijuana use tends to peak during the age ranges covered in our study, a higher threshold seemed more appropriate. At the four waves (ages 18, 19-20, 21-22, 23-24), 14.2%, 14.8%, 13.9%, and 11.8%, respectively, of the sample was above the threshold. “Some use” of marijuana was defined as use one or two times in the past 30 days and/or between 1 and 19 times in the past 12 months (excluding frequent users). The rates of “some use” at the four waves were 19.5%, 20.8%, 20.0%, and 17.2%, respectively. Abstinence was defined as no use in the past 30 days and past 12 months (biennial assessments did not allow us to know whether annual abstinence reflected biennial abstinence).

Phase 2: Demographic and lifestyle characteristics of marijuana use trajectory groups. Once the trajectory groups were formed, Phase 2 examined how the trajectory groups varied according to demographic and lifestyle characteristics. We sought to include characteristics that reflected, in broad terms, important pre-transitional statuses and activities, as well as the events, roles, and responsibilities that typify the transition to adulthood. At senior year (Wave 1), these included gender, senior year cohort (1977-82, 1983-89, 1990-94), race/ethnicity (Black, Hispanic, White), parent education (college degree, some college, high school or less; higher level if two parents), religious importance (very and somewhat important v. not), high school GPA (As, Bs, Cs or less), four-year college completion expectations (definitely v. other), truancy (skipped any days in last month v. not), work intensity (no work, 1-15 hrs/wk, 16+ hrs/wk), evenings out with peers (twice a week or more v. less) and dating (once a week or more v. less). At Wave 4 (age 23-24), we included marital status (married v. not), parenthood status (any children v. none), educational attainment (no college, some college, college graduate), financial support (in past year, over 80% of support from self/spouse v. other), unemployment (some unemployment in past year v. none), living arrangements (living with parents or not), and religious importance, evenings out, and dating (all three measured as at Wave 1). Each of these Wave 1 and 4 variables has shown an association with substance use during late adolescence and early adulthood (e.g., Bachman et al., 1997, 2002; Brook, Richter, Whiteman, and Cohen, 1999; Hawkins, Catalano, and Miller, 1992; Jessor et al., 1991; Schulenberg et al., 1996, 2005).

Phase 3: Time varying covariates of marijuana use trajectories. In the third phase, we sought to understand how the trajectories corresponded to longitudinal patterns across the four waves of related behaviors, attitudes, and social-emotional adjustment.² We included two indicators directly relevant to marijuana use. First, we used a “smoking to cope” scale based on the mean of three dichotomous items (to relax or relieve tension, to get away from my problems or troubles, because of anger or frustration; alphas averaged .55 across the waves) (similar to a “drinking to cope” measure we used previously (Schulenberg et al., 1996)). Second, because marijuana use tends to occur in social contexts supportive of such use (e.g., Bachman et al., 2002; Hawkins et al., 1992), we included an item indicating respondent's report on how many friends smoked marijuana or hashish (responses ranged from “none” (0) to “all” (4)).

Because marijuana use is related to use of other substances (e.g., Donovan and Jessor, 1985; Johnston, 2003; Newcomb and Bentler, 1988; Osgood, Johnston, O'Malley, and Bachman, 1988), we included measures of binge drinking and cigarette use. Binge drinking was measured by the frequency of having 5 or more drinks in a row in the past two weeks. A drink was defined as “a glass of wine, bottle of beer, shot glass of liquor, or mixed drink.” Responses ranged from “none” (1) to “10 or more times” (6). Cigarette use was measured as the number of cigarettes smoked daily in the past 30 days; responses ranged from “none” (1) to “2+ packs a day” (7).

Consistent with problem behavior theory (e.g., Donovan and Jessor, 1985; Jessor et al., 1991), we considered how the marijuana use trajectories related to the course of property damage, interpersonal aggression, risk taking, and well-being. The property damage and interpersonal aggression scales (based on Osgood et al., 1988) concerned frequency of behaviors in the last 12 months, with responses ranging from “not at all” (1) to “five or more times” (5). The property damage scale was the mean of 9 items concerning stealing money or property, trespassing, and damaging property (alphas averaged .71 across waves); the interpersonal aggression scale was the mean of 5 items regarding hitting, fighting, and threatening someone with a weapon (alphas averaged .64 across waves). Risk taking was measured as mean of two items: getting a “kick out of doing things that are a little dangerous,” and testing oneself by “doing something a little risky” (based on Schulenberg et al., 1996). Responses ranged from “disagree” (1) to “agree” (5); alphas averaged .82 across waves. Consistent with how well-being is measured in the adulthood literature (e.g., Ryff and Keyes, 1995), our well-being scale was a composite of three interrelated constructs: self-esteem (8 items, e.g., “I feel I am a person of worth”), self-efficacy (5 items, e.g., “When I make plans I am almost certain that I can make them work”), and social support (6 items, e.g., “There is usually someone I can talk to, if I need to”) (based on Schulenberg et al., 2005). For all items, responses ranged from “disagree” (1) to “agree” (5), with higher scores reflecting higher well-being; alphas averaged .77 across waves.

Analyses and Results

We take a pattern-centered approach to understanding stability and change, grouping individuals according to their marijuana use across the four waves. There were three phases to the analysis: 1) identifying common trajectories of marijuana use during the transition to adulthood; 2) distinguishing among the trajectory groups according to demographic and lifestyle characteristics typical of the transition to adulthood; and 3) examining how the trajectories relate to longitudinal patterns of behavioral, attitudinal, and social-emotional correlates.

²Some measures were included in only one of the five or six MTF questionnaire forms (which were randomly distributed within schools at senior year); thus, analyses involving these variables included only one-fifth or one-sixth of the sample.

Phase 1: Marijuana Use Trajectories

We first formed homogenous groups of individuals representing common trajectories of marijuana use over the four waves of measurement, spanning ages 18 to 24. Based on theoretical perspectives (e.g., Zucker, 1987; Moffitt, 1993), epidemiological evidence regarding peak marijuana use during late adolescence/early adulthood (Johnston et al., 2004; Chen and Kandel, 1995), and previous research on substance use trajectories (e.g., Ellickson et al., 2004; Kandel and Chen, 2000; Schulenberg et al., 1996), we conceptualized six trajectories. Four trajectory groups involved frequent marijuana use, which was defined as 3 or more occasions of use in past 30 days and/or 20 to 40+ (combining responses “20 to 39” and “40 or more”) occasions of use in the past 12 months: Chronic frequent marijuana users (defined by frequent use at every wave), Decreased frequent marijuana users (frequent use at Wave 1, followed by decreasing use over time, with and no or some use by Wave 4), Increased frequent marijuana users (no or infrequent use at Wave 1, followed by increasing use over time, with frequent use by Wave 4), and those who have a “Fling” pattern of frequent marijuana use (no or infrequent use at Waves 1 and 4, and frequent use at Waves 2 and/or 3). The remaining two conceptualized trajectory groups involved no or infrequent marijuana use: Rare marijuana use (i.e., infrequent marijuana use at one or more waves, but no frequent marijuana use at any wave), and those who Abstain from marijuana use (i.e., no use reported – past 30 days and past 12 months – at all four waves).

Consistent with a theory-driven approach to trajectory identification (e.g., Bauer and Curran, 2003), we next statistically confirmed the six conceptual marijuana use trajectory groups using the PROC TRAJ procedure (Nagin, 1999). This procedure identifies clusters of trajectories using a multinomial modeling strategy and allows the testing of the number and shape of trajectories. A six trajectory group model provided a good fit to the data, and all groups but the Fling group were confirmed. The PROC TRAJ procedure distributed members of the Fling group across the Rare group and alternative sixth group. Because the Fling trajectory group was identified in our data, and given its etiological significance, we retained it in the analyses.³

The six trajectory groups are summarized in Table 1, along with sample sizes for the total sample and by gender. The Abstain group contains almost half (47%) of the sample, and another 28% are in the Rare group; thus, between the ages of 18 and 24 about three-quarters of the sample did not use marijuana or used it only infrequently. The remaining one-quarter of the sample includes those who, at some point in their emerging adulthood years, engaged in frequent marijuana use: 5% Chronic, 7% Decreased, 5% Increased, and 6% Fling (the remaining 3% engaged in some frequent use, but their trajectories were unclassifiable; subsequent analyses excluded this group). These small but homogenous groups are etologically significant, indicating that there are distinctive patterns of frequent marijuana use during the transition to adulthood, and that frequent use is concentrated in a relatively small segment of the population.

³We conducted four censored normal models specifying 4 through 7 groups and compared their Bayes information criteria (BIC): the BICs across the four models were -69,908.56, -69,563.05, -69,379.91, and -69,345.14, respectively. The 7 group model BIC was closest to zero, but it was only slightly smaller than the 6 group model BIC, and for parsimony, we retained the 6 group model. The 6 group solution approximately replicated 5 of our conceptualized trajectory groups: Chronic (4%), Decrease (6%), Increase (4%), Rare (20%), and Abstain (56%). A sixth group, not corresponding to our conceptualized trajectories, was characterized by initially moderate marijuana use followed by a rapid decrease in use (8%). Overall about two-thirds of the sample was classified similarly in the two grouping strategies. Note, however, that this confirmation strategy was not ideal because the conceptual grouping was based on both 30 day and 12 month marijuana use and PROC TRAJ was based on 30 day marijuana use only. Consistent with recent perspectives on potential pitfalls of relying exclusively on empirically derived trajectory groups (e.g., Bauer and Curran, 2003), we based this first of our articles on marijuana use trajectories on conceptually-based rather than statistically-based groups.

To illustrate the trajectories, Figure 1 shows mean 30-day marijuana use scores for each trajectory group (excluding Abstain and Remaining groups). Also shown is the trajectory for the total sample; clearly, this mean trajectory, while very useful for some purposes, cannot adequately reflect the various embedded differential change trajectories. Results based on a repeated measures ANOVA revealed significant ($p < .001$) differences fully consistent with the trajectory group definitions. Overall (across all waves), the Chronic group had higher, and the Rare group lower, marijuana use than other groups; trajectory group by time interactions showed that the Decreased group had a greater decrease, the Increased group had a greater increase, and the Fling group had a more negative quadratic trend over time than the other groups.

Phase 2: Demographic and Lifestyle Characteristics of Marijuana Use Trajectory Groups

The second phase of the analysis focused on describing the six marijuana use trajectory groups according to demographic and lifestyle characteristics at Wave 1 (18 years old, senior year of high school) and Wave 4 (23-24 years old). Because many characteristics were categorical and the others could be converted to meaningful categories, we conducted categorical analyses. Cramer's V indicated significant ($p < .001$) bivariate associations between each of the Wave 1 and 4 demographic and lifestyle characteristics and the six-group trajectory variable, controlling for unequal cell sizes. Post hoc chi-square analyses of all 2 by 2 comparisons (e.g., Chronic group membership by gender) revealed the significant differences ($p < .01$ or better) summarized in Tables 2 and 3; the main findings are highlighted below. Gender and cohort by predictor interactions were considered at Waves 1 and 4, and only three were significant.⁴

Wave 1 differences. Men were overrepresented in the Chronic and Increased groups and underrepresented in the Rare and Abstain groups. Because we included senior year cohorts 1977-94, years of clear and often large historical trends in marijuana use (Johnston et al., 2004), it was important to consider variations in the prevalence of each trajectory group as a function of senior year cohort. We included three categories, roughly representative of major historical shifts (1977-82, 1983-89, and 1990-94). While there were some complexities in the findings, those in the earliest cohorts (1977-82) were clearly overrepresented in the Chronic and Decreased groups and underrepresented in the Abstain group. Compared to African Americans, Whites were overrepresented in the Chronic, Decreased, Fling, and Rare groups, and underrepresented in the Abstain group. Compared to Hispanics, Whites were overrepresented in the Chronic and Decreased groups, and underrepresented in the Abstain group. Trajectory membership differed by parental education level: compared to the college graduate group, the high school or less group was overrepresented in the Decreased and Abstain groups and underrepresented in the Increased, Fling, and Rare groups; compared to the some college group, the high school or less group was underrepresented in the Fling group. Students for whom religion was important were overrepresented in the Abstain group and underrepresented in all other groups.

Students with higher high school grades (As and Bs) were overrepresented in the Abstain group and underrepresented in the Chronic and Decreased groups. Compared to students with As, those with Bs and C-Ds were overrepresented in the Increased and Rare groups. Those who said that they “definitely will” complete 4 years of college were overrepresented in the Rare and Abstain groups and underrepresented in the Chronic and Decreased groups. Students who

⁴At Wave 1, gender interacted significantly with race/ethnicity and dating. Based on post-hoc multinomial logistic regressions, White males were generally more likely than other groups to be in the Chronic and Increased marijuana use trajectory groups, and less likely to be in the Abstain trajectory group. For dating, among those who dated more than once a week, males are more likely to be in the Fling group than females. For females, those who dated less than once a week, compared to those who dated more, were less likely to be in the Chronic group and more likely to be Fling group. At Wave 2, the cohort by marital status interaction was significant. In general, the earlier cohorts and unmarried respondents were more likely to be in the Chronic, Decreased, and Increased groups, and less likely to be in the Rare group.

skipped school were underrepresented in the Abstain group and overrepresented in all other groups. Those working 16 or more hours per week were underrepresented in the Abstain group and overrepresented in the Chronic and Decreased groups. Compared to students working 1-15 hours per week, students not working at all were underrepresented in the Rare group. Students who went out with friends once a week or less, compared to students who went out more, were overrepresented in the Abstain group and underrepresented in all other groups. Likewise, those who dated less than once a week, compared to those who dated more, were overrepresented in the Abstain group and underrepresented in Chronic, Decreased, and Rare groups.

Wave 4 differences. At age 23-24, compared to single respondents (including those engaged, separated, or divorced), married respondents were overrepresented in the Decreased and Abstain groups and underrepresented in all other groups. Respondents who were parents by Wave 4 were overrepresented in the Decreased and Abstain groups and underrepresented in the Chronic and Increased groups. Respondents who attained college degrees by Wave 4 were overrepresented in the Rare and Abstain groups and underrepresented in the Chronic and Decreased groups. In terms of financial independence, the complex picture that emerges suggests that this task had different timetables and meanings across the trajectory groups. Respondents who received more than 80% of their financial support from self/spouse, compared to others, were overrepresented in the Decreased group and underrepresented in the Abstain group. Respondents with no recent unemployment, compared to those who did, were overrepresented in the Abstain group and underrepresented in the Chronic and Increased groups. Respondents who lived away from their parents, compared to those who lived with one or both parents, were overrepresented in the Increased and Rare groups and underrepresented in the Abstain group.

Similar to what was found at Wave 1, respondents for whom religion was important at Wave 4 were overrepresented in the Abstain group and underrepresented in the other groups. Finally, regarding social life, young adults who went out with friends once a week or less, compared to those who went out more, were overrepresented in the Abstain group and underrepresented in the Chronic, Increased, Fling, and Rare, groups. Similarly, those who dated (including with spouse) less than once a week, compared to those who dated more, were overrepresented in the Abstain group and underrepresented in the Decreased and Rare groups.

Phase 3: Relating the Trajectories to Behavioral, Attitudinal, and Social-Emotional Correlates

Phase 3 analyses involved placing the trajectories in the context of longitudinal patterns in measures of related behaviors and attitudes. Figures 2a-h illustrate these measures by the six marijuana use trajectory groups, and as shown, the longitudinal patterns of the various measures generally corresponded closely with the marijuana use trajectories. Repeated Measures ANOVAs were conducted to consider the statistical significance of the relationships illustrated in Figures 2a-h. The behavioral/attitudinal measures at the four waves were outcomes. Marijuana use trajectory group (6 levels) was a between-subjects predictor. Time (4 levels) was a within-subjects predictor; time effects were partitioned into orthogonal polynomial contrasts to test for linear, quadratic, and cubic effects. Trajectory group by time interactions were included to consider differential change in the outcomes as a function of marijuana use trajectory groups. Table 4 provides a summary of the ANOVA results, and below we highlight the main findings.⁵

Trajectory Main Effects. The trajectory main effects (collapsed across time) were significant for all measures except well-being. The Chronic group was highest on smoking to cope, friends' use of marijuana, binge drinking, cigarette use, theft/property damage, interpersonal aggression, and risk taking. In contrast, the Abstain group was lowest on each of these measures (except smoking to cope, which was not asked of this group).

Time Main Effects. Overall time effects were significant for all outcomes. It was found that during emerging adulthood, respondents on average experienced significant decreases in number of friends who use marijuana, theft and property damage, interpersonal aggression, and risk taking; they experienced significant increases in cigarette use and well being; and they experienced increases then decreases in smoking marijuana to cope and heavy drinking.

Trajectory Group by Time Interactions. As shown in Table 4, each marijuana use trajectory group by time interaction was significant, revealing significant linear differences in each measure and significant quadratic differences in all but the well-being measure as a function of the trajectory groups (none of the cubic interaction effects was significant). Consistent with what is shown in Figure 2a, smoking to cope increased significantly more than average for the Increased marijuana use trajectory group, decreased significantly more than average for the Decreased group, and followed a significantly more negative quadratic pattern for the Fling group. As Figure 2b shows, friends' marijuana use corresponded to one's own level of marijuana use; most noteworthy again was that the decrease in friends' use was greatest for the Decreased group and least for the Increased group, and the quadratic effect was greatest for the Fling group.

The changes in binge drinking mirrored the marijuana use trajectories, as shown in Figure 2c. For the Decreased, Increased, and Fling marijuana trajectory groups, binge drinking significantly decreased more, increased more, and was more strongly quadratic than average, respectively. Likewise, as illustrated in Figure 2d, the increase in cigarette smoking was greatest for the Increased marijuana trajectory group, and least for the Decreased group.

As illustrated in Figures 2e and 2f, for both theft/property damage and interpersonal aggression, the decrease was significantly greatest for the Decreased and Chronic marijuana trajectory groups; the decrease was significantly less for the Increased group. For interpersonal aggression only (Figure 2f), the decrease was less than average for the Fling group. Risk taking decreased significantly less for the Chronic and Increased marijuana trajectory groups, decreased more for the Decreased group, and was more negatively quadratic for the Fling group (see Figure 2g). Finally, for overall well-being, the increase over time was greatest for the Decreased marijuana trajectory group and least for the Increased group (see Figure 2h).

Discussion

Marijuana use is illegal, and its health and psychosocial consequences can be serious. So it is troublesome that over half of the population in recent years engaged in at least some marijuana use and a quarter engaged in frequent marijuana use during their emerging adulthood years. Yet for many young people, some or even frequent marijuana use appears to be developmentally limited and not associated with difficulties with the transition to adulthood.

Overall, the two extreme groups, Chronic and Abstainer, were found to be distinct from each other in nearly every characteristic considered. Comparatively, the Chronic group was more likely to include men, those from earlier cohorts, and Whites; in high school they had lower

⁵We recognize the probable causal reciprocity between the marijuana use trajectories and the behaviors/attitudes. Furthermore, in conducting the ANOVAs, we were unable to avoid violating some assumptions of this procedure. We maintained our use of ANOVAs because they tend to be robust to the violations we encountered, and because the ANOVA strategy provided the most straightforward way to address the third purpose of this study. In terms of assumption violations, the normal distribution of outcomes assumption was not always met, but the ANOVA is robust to violation of this assumption (e.g., Stevens, 1986). Second, the homogeneity of variance across groups assumption was not always met for the outcomes, with the variances being larger for the smaller trajectory groups. This may contribute to the actual p level exceeding the nominal p level, suggesting a slightly increased chance of Type I errors for effects involving these outcomes (Stevens, 1986). Nevertheless, the vast majority of relevant significant F-tests and change coefficients were significant at the .001 level (and all at least at the .01 level), suggesting that the slightly inflated chance of Type I errors had no substantive impact on the results.

grades and college aspirations, skipped more school, worked more hours, spent more evenings out with friends, and dated more frequently; in early adulthood (age 23-24), they were less likely to be married, have children, and to have graduated from college, were more likely to experience unemployment, spent more evenings out with friends, and dated more frequently. Similarly, these two groups were typically at the opposite ends in terms of the longitudinal course of other problem behaviors and socio-emotional adjustment during the transition.

Interestingly, the Decreased group, which had similar levels of marijuana use as the Chronic group at Wave 1, resembled the Chronic group in many characteristics at Wave 1 but was quite different by Wave 4 in terms of marriage, parenthood, employment, and financial independence. Typically, this group showed the greatest declines during the transition in the use of marijuana for coping, friends' use of marijuana, the use of other substances, delinquency, and risk taking; similarly, they had the greatest increase in well-being. Clearly, this group is moving on in adulthood, leaving behind the excesses and problem behaviors of their adolescence.

The Rare and Abstain groups, the two groups defined by no frequent marijuana use, were similar in many demographic and school related characteristics at Wave 1, but distinct in religious importance and social life characteristics at Wave 1, as well as at Wave 4 in family life (Abstain group was more likely to be married and to be parents), financial independence (greater for Rare group), and social life characteristics (Rare group spent more time with friends and in dating). In regard to time varying covariates, these two groups were not very distinct. Overall, to the extent that the Rare pattern reflects occasional or experimental use, such use seems to be associated with less religiosity and more social activity compared to the individuals who abstain from marijuana use during emerging adulthood.

Finally, the Fling and Increased groups (both of which start with infrequent use and increase their use by Wave 2 – see Figure 1), were quite similar to each other in Wave 1 demographic and lifestyle characteristics, and then differed from each other by Wave 4 in terms of education, employment, and financial independence (the Increased group showed less success in these tasks). These two groups also typically showed the greatest increase in using marijuana to cope, friends' marijuana use, other substance use, delinquency, and risk taking between Waves 1 and 2; but then the Fling group declined in these correlates, and by Wave 4, they looked quite similar to the Rare group. Overall, the Fling group experienced some difficulties in the few years following high school before they gained a more salutary path; the Increased group followed a troublesome path to adulthood, one in which marijuana appeared to be used frequently to cope with difficulties with various normative tasks. In future analyses, especially for intervention implications, it will be important to attempt to distinguish these Increased and Fling groups, focusing on pre-transitional and transitional characteristics and experiences.

Strengths, Limitations, and Future Directions

An important strength of this study is the use of national panel data spanning a six-year age interval between late adolescence and early adulthood. The use of national multi-wave panel data to construct and study trajectory groups represents a powerful approach to understanding course, etiology, and consequences of substance use, reflecting an important integration of large scale survey research and developmental science (Schulenberg et al., 2003). Of course, such large-scale efforts must be complemented with more intensive efforts (e.g., in-depth interviews) to provide a fuller understanding of the etiology of substance use and abuse.

Because the sample included only those who graduated from high school, generalizability to those who dropped out of high school may be limited. Similarly, the differential attrition likely imposed some limits on the generalizability of the findings; we probably underestimated rates and effects of problematic marijuana use trajectories. Although the use of multi-wave panel

data represents an important strength, the two-year lag between the waves suggests some lack of precision in specifying the marijuana use trajectories. Some measures available in the data set also limited the analyses, a common and perhaps forgivable limitation of long-term national panel studies (Brooks-Gunn, Phelps, and Elder, 1991). The transition to adulthood is multifaceted, a quality not fully captured in the characteristics we selected to reflect statuses and experiences typical of this transition. A more comprehensive consideration of transitional tasks and experiences may yield stronger links with changes in marijuana use. As Arnett (2000) makes clear, this period in life is especially given to historical variation, and the same is true for marijuana and other substance use (Johnston et al., 2004) indicating the need to consider the historical context. Future research in this area would do well to start earlier in adolescence to gain a better “before” picture, and to consider a longer, less normative time-frame for assumption of adulthood roles. Finally, identifying trajectory groups conceptually and logically involves some potential inaccuracies, as do more statistical strategies (Bauer and Curran, 2003), suggesting the importance of ongoing comparisons of different strategies.

Summary and Conclusions

We found that during emerging adulthood, there was continuity of marijuana use/non-use for most (i.e., 80%), reflected in continuous non-use (Abstainer group, which was 47% of the sample), infrequent use (Rare group, 28%), and frequent use (Chronic group, 5%). For others, frequent marijuana use showed important discontinuities in terms of decreased use (Decreased group, 7%), increased use (Increased group, 5%), and increased then decreased use (Fling group, 6%), and this discontinuity related to corresponding changes in several attitudinal, behavioral, and social-emotional correlates. Overall, it appears that extensive use in high school (reflected in the Chronic and Decreased trajectory groups) relates to a quicker transition to adulthood in terms of faster entry into the world of work, parental independence, and (for the Decreased group only) marriage. Increased use, going from no or infrequent use in high school to frequent use by age 23-24, relates to a range of adjustment difficulties at the beginning of adulthood; in contrast, while following a Fling pattern relates to similar initial adjustment difficulties, there appear few if any long-term difficulties. Documenting trajectories of marijuana and other substance use in the general population across the transition to adulthood, and major life transitions in general, provides an essential backdrop for more in-depth understanding about the course, correlates, consequences, and prevention of substance abuse across the life course. In particular, attending to extreme cases that are often small portions of the population (e.g., chronic frequent marijuana users) allows for a fuller understanding of the range of pathways reflecting the etiology of experimental and problematic substance use (Cicchetti, 1999; Schulenberg and Maggs, 2002), and of psychopathology more generally (Curran and Willoughby, 2003). This fuller understanding of various pathways provides the needed foundation for effective interventions.

Acknowledgments

This study was supported in part by a grant from the National Institute on Drug Abuse (DA01411). This paper was based in part on presentations by the first author at a workshop on Substance Abuse During Emerging Adulthood, sponsored by the National Institute on Drug Abuse, Washington, DC, January 2004, and at the 10th Biennial Meetings of the Society for Research on Adolescence, Baltimore, MD, March 2004.

The authors thank Lisa Crockett and Jennifer Maggs for helpful comments and suggestions, and Tanya Hart and Deborah Kloska for assistance with the preparation of this paper.

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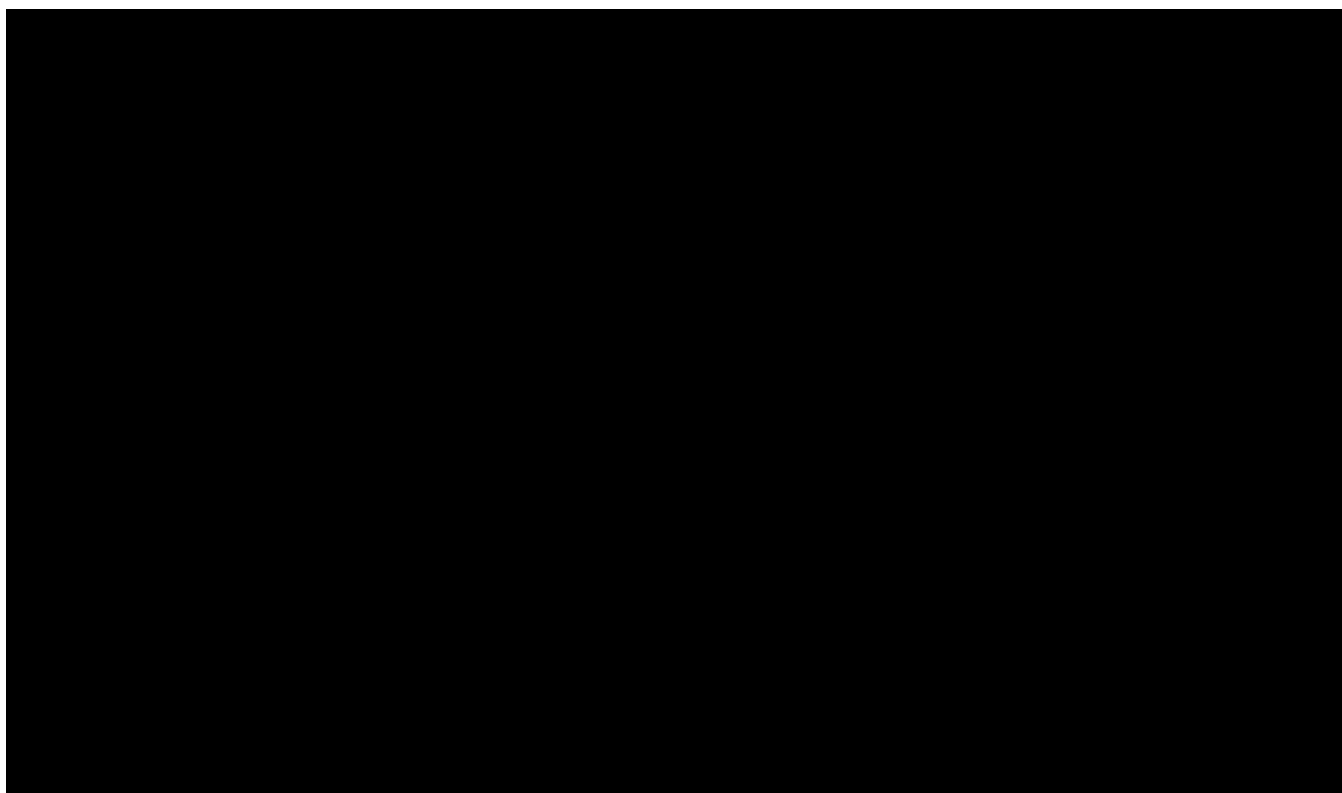


Figure 1.
Mean scores for 30-day marijuana use by marijuana use trajectory groups.

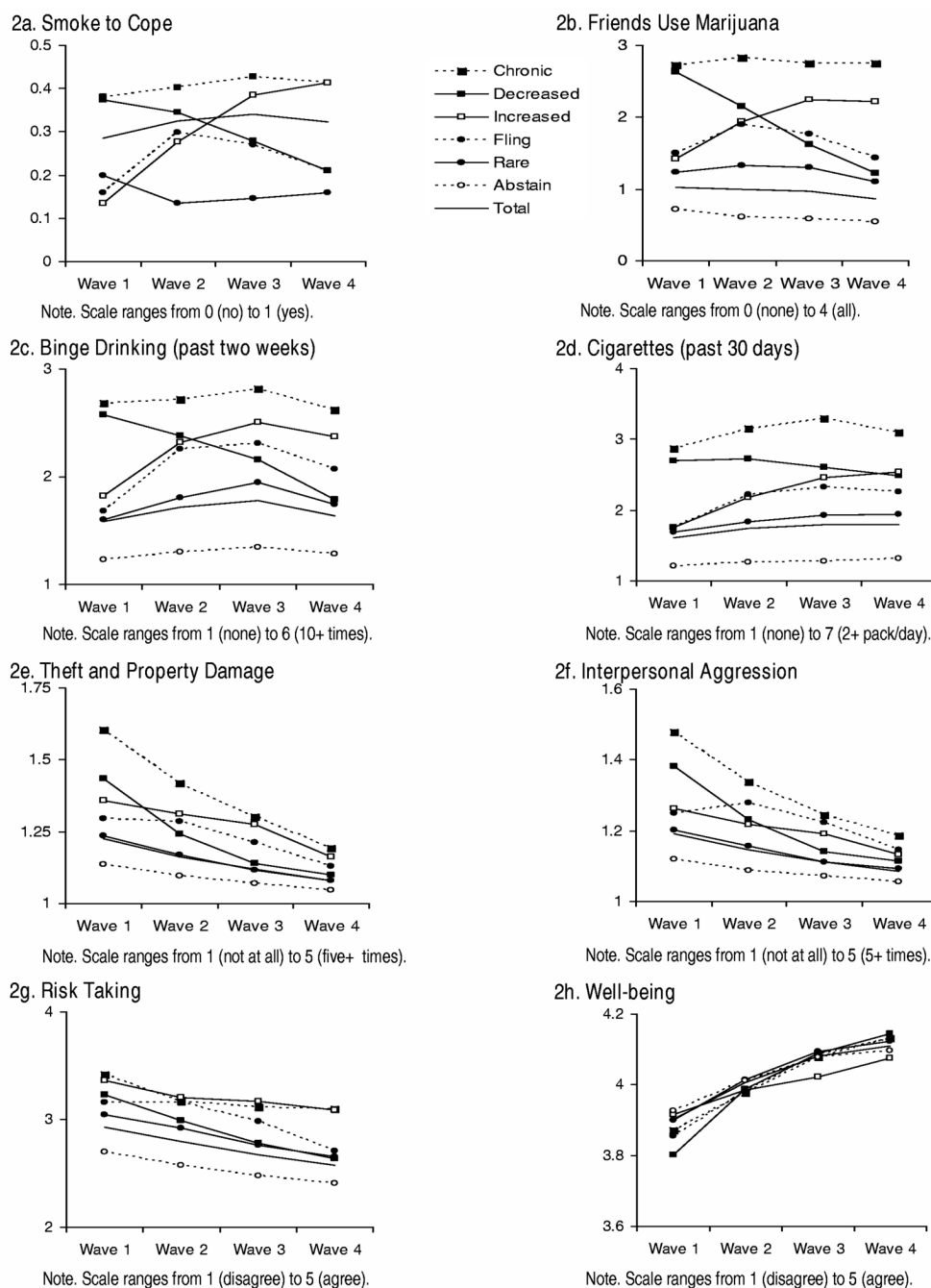


Figure 2.
 Change in behaviors, attitudes and social-emotional correlates as a function of marijuana use trajectory groups.

Table 1
Marijuana use trajectory groups: Sub-sample sizes and percentages by gender, and for total sample

Trajectory	Description	Men		Women		Total	
		n	%	N	%	n	%
Chronic	Frequent use (3 or more times past month and/or 20-40+ times past 12 months) at all four waves	583	6.9	336	2.9	919	4.6
Decreased	Frequent use (3 or more times past month and/or 20-40+ times past 12 months) at Wave 1, followed by no or some use (<3 times past month and <20-40 past 12 months) by Wave 4	589	7.0	847	7.4	1436	7.2
Increased	No or some use (<3 times past month and <20-40 past 12 months) at Wave 1, followed by frequent use (3 or more times past month and/or 20-40+ times past 12 months) by Wave 4	525	6.3	476	4.1	1001	5.0
Fling	No or some use (<3 times past month and <20-40 past 12 months) at Waves 1 and 4, with frequent use (3 or more times past month and/or 20-40+ times past 12 months) at Waves 2 and/or 3	499	5.9	644	5.6	1143	5.7
Rare	Some use but not frequent use at any wave (<3 times past month and <20-40 past 12 months)	2223	26.5	3289	28.6	5512	27.7
Abstain	No use past month or past 12 months at any wave	3702	44.1	5635	49.0	9337	46.9
Remaining	Some marijuana use, but pattern does not correspond to any of the categories above	278	3.3	277	2.4	555	2.8
Total		8399	100	11504	100	19903	100

Table 2
Marijuana Use Trajectory Group Percentages by Wave 1 Demographic and Lifestyle Characteristics

Wave 1 Predictors	Marijuana Use Trajectory Groups (n)					
	Chronic (919)	Decreased (1436)	IncreAsed (1001)	Fling (1143)	Rare (5512)	Abstain (9337)
Gender						
Male	7.2% [*]	7.3%	6.5% [*]	6.1%	27.4% [*]	45.6% [*]
Female	3.0	7.5	4.2	5.7	29.3	50.2
Cohort						
1 1977-1982	8.1, ^{ab}	11.4, ^{ab}	5.9 ^a	7.2, ^{ab}	29.2 ^b	38.3, ^{ab}
2 1983-1989	2.7 ^a	6.8, ^{ac}	4.0 ^a	4.8 ^a	30.6 ^c	51.0, ^{ac}
3 1990-1994	2.3 ^b	3.1, ^{bc}	4.9	5.4 ^b	25.1, ^{bc}	59.2, ^{bc}
Race/Ethnicity						
1 White	5.0, ^{ab}	7.8, ^{ab}	5.3	6.2 ^a	29.2 ^a	46.3, ^{ab}
2 Black	3.2 ^a	4.7 ^a	4.5	4.1 ^a	25.9 ^a	57.6 ^a
3 Hispanic	2.5 ^b	4.6 ^b	4.1	4.6	25.2	59.0 ^b
Parent Education						
1 ≤ High school	4.5	8.4 ^b	4.4 ^b	5.0, ^{ab}	26.9 ^b	50.7, ^{ab}
2 Some college	4.3	7.2	5.3	6.5 ^a	28.9	47.8 ^a
3 College grad +	5.1	6.7 ^b	5.7 ^b	6.5 ^b	30.1 ^b	45.9 ^b
Religious Importance						
Important	3.0 [*]	5.7 [*]	4.2 [*]	5.1 [*]	26.7 [*]	55.2 [*]
Not important	7.4	10.1	6.7	7.1	31.3	37.4
High School Grades						
1 As	2.1, ^{ab}	3.9, ^{ab}	4.0, ^{ab}	5.5	26.5, ^{ab}	57.9, ^{ab}
2 Bs	4.8, ^{ac}	7.5, ^{ac}	5.4 ^a	6.1	29.4 ^a	46.7, ^{ac}
3 Cs-Ds	7.8, ^{bc}	12.2, ^{bc}	6.1 ^b	6.0	29.0 ^b	39.0, ^{bc}
4 yr College Intention						
Definitely will	3.1 [*]	5.1 [*]	5.5	6.1	29.9 [*]	50.4 [*]
< Definitely will	5.9	9.3	5.0	5.8	27.4	46.5
Truancy						
1+ days skipped	10.3 [*]	14.6 [*]	6.3 [*]	7.3 [*]	31.0 [*]	30.4 [*]
No days skipped	2.8	5.0	4.7	5.3	27.7	54.5
Work Intensity						
1 None	3.7 ^b	6.4 ^b	5.4	5.5	26.3, ^{ab}	52.6 ^b
2 1-15 hours/wk	3.7 ^c	5.5 ^c	4.9	5.8	28.8 ^a	51.3 ^c
3 16+ hours/wk	5.9, ^{bc}	9.3, ^{bc}	5.3	6.2	29.5 ^b	43.8, ^{bc}
Evenings Out						
≤ Once a week	1.1 [*]	2.8 [*]	3.9 [*]	4.6 [*]	23.5 [*]	64.0 [*]
Twice a week +	5.7	8.7	5.6	6.3	30.1	43.7
Dating						
< Once a week	3.9 [*]	5.5 [*]	5.1	5.9	27.2 [*]	52.4 [*]
Once a week +	5.4	9.4	5.4	5.9	30.1	43.7

Note. Row percents sum to 100% within rounding error. Cramer's Vs for each individual predictor by trajectory model were significant ($p < .01$). Significance ($p < .01$) based on chisquare post-hoc comparisons. Significant differences with two-level predictors indicated by

* significant differences with three level predictors indicated as follows:

^a compares level 1 to level 2,

^b compares level 1 to level 3, and

^c compares level 2 to level 3.

Table 3
 Marijuana Use Trajectory Group Percentages by Wave 4 Demographic and Lifestyle Characteristics

Wave 4 Predictors	Chronic (919)	Marijuana Use Trajectory Groups (n)				Abstain (9337)
		Decreased (1436)	Increased (1001)	Fling (1143)	Rare (5512)	
Marital Status						
Married	3.2% [*]	8.4% [*]	3.0% [*]	4.6% [*]	25.6% [*]	55.3% [*]
Not Married	5.4	7.0	6.1	6.5	29.7	45.2
Parenting						
No children	4.9 [*]	6.9 [*]	5.5 [*]	6.1	28.8	47.7 [*]
Any children	3.9	9.6	3.6	5.3	27.2	50.4
Degree Attained						
1 No college	7.1, ^{ab}	10.5, ^{ab}	4.3 ^a	5.3	25.9, ^{ab}	46.9 ^b
2 Some college	5.0, ^{ac}	7.5, ^{ac}	5.9 ^a	6.2	28.5 ^a	46.8 ^c
3 College degree	2.7, ^{bc}	5.1, ^{bc}	5.0	6.1	30.4 ^b	50.8, ^{bc}
Financial Support						
Self/spouse	5.1	8.1 [*]	5.1	5.9	29.2	46.5 [*]
Others	4.3	6.6	5.1	5.7	27.5	50.8
Unemployment						
None	4.2 [*]	7.3	4.5 [*]	5.7	28.0	50.3 [*]
1 week +	6.4	7.8	7.2	6.3	29.9	42.4
Living Arrangement						
With parents	4.7	6.8	4.3 [*]	5.7	26.9 [*]	51.6 [*]
Away from parents	4.8	7.7	5.5	6.0	29.2	46.8
Religious Importance						
Important	3.2 [*]	6.6 [*]	3.6 [*]	5.0 [*]	26.8 [*]	54.7 [*]
Not important	7.3	8.8	7.8	7.3	31.2	37.5
Evenings Out						
≤ Once a week	3.1 [*]	7.6	3.2 [*]	5.2 [*]	26.8 [*]	54.0 [*]
Twice a week +	5.9	7.3	6.6	6.4	29.6	44.2
Dating						
< Once a week	4.5	6.9 [*]	4.9	5.6	27.6 [*]	50.6 [*]
Once a week +	5.0	8.1	5.6	6.3	29.6	45.3

Note. Row percents sum to 100% within rounding error. Cramer's Vs for each individual predictor by trajectory model were significant ($p < .01$). Significance ($p < .01$) based on chisquare post-hoc comparisons. Significant differences with two-level predictors indicated by

* significant differences with three level predictors indicated as follows:

^a compares level 1 to level 2,

^b compares level 1 to level 3, and

^c compares level 2 to level 3.

Table 4

Summary of Repeated Measures ANOVAS: F statistics (based on Wilks Lambda) for longitudinal patterns in behavioral/attitudinal measures as a function of marijuana use trajectory groups.

Effects	Smoke to Cope	Friends' Use of Marijuana	Binge Drinking	Cigarette Use	Theft and Property Damage	Interpersonal Aggression	Risk Taking	Well-being
Trajectory group	18.68***	131.23***	203.50***	164.86***	134.21***	104.61***	46.72***	0.29***
Time	3.38*	5.62***	34.59***	54.49***	289.59***	162.45***	69.34***	90.67***
Linear	3.5	6.22*	3.71	91.51***	807.97***	473.50***	207.57***	264.15***
Quadratic	7.56**	8.70**	99.57***	78.11***	5.73*	5.14*	1.28	15.12***
Cubic	0.01	0.25	1.3	0.04	0.06	0.04	0.15	0.03
Trajectory group × Time	7.56***	6.24***	15.08***	10.55**	20.62***	13.94***	2.92***	1.90*
Linear	20.65***	14.10***	35.54***	21.05***	51.55***	34.47***	5.28***	5.00***
Quadratic	3.19*	2.24***	9.98***	10.94***	10.96***	9.66***	3.02*	0.67
Cubic	0.5	0.37	1.1	0.59	0.92	0.98	0.38	0.18

* p < .05,

** p < .01,

*** p < .001