

When Onset Meets Desistance: Cognitive Transformation and Adolescent Marijuana Experimentation

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Abstract

Purpose Desistance scholars primarily focus on changing social roles, cognitive transformations, and shifting identities to understand the cessation of serious crime and illicit drug use in adulthood. In the current study, we move the spotlight away from adulthood and toward adolescence, the developmental stage when the prevalence of offending and substance use peak and desistance from most of these behaviors begins. Our primary hypothesis is that changes in perceived psychic rewards surrounding initial forays into marijuana use strongly predict adolescents' decisions to cease or persist that behavior. In addition, based on social learning expectations, we hypothesize that peer perceptions and behaviors provide mechanisms for perceptual change.

Methods We test these hypotheses using longitudinal data of marijuana use, perceptions, and peer networks from the PROMoting School-community-university Partnerships to Enhance Resilience (PROSPER) study. We estimate hazard models of marijuana initiation and within-person models of perceptual updating for youth from grades 6 to 12 ($n=6154$).

Results We find that changes in marijuana's perceived psychic rewards surrounding initiation differentiated experimenters from persisters. Experimenters had significantly lower updated perceptions of marijuana as a fun behavior compared to persisters, and these perceptions dropped after the initiation wave. In contrast, persisters updated their perceptions in upward directions and maintained more positive perceptions over time. Inconsistent with social learning expectations, initiators' updated perceptions of marijuana as a fun activity were not explained by peer-reported behaviors or attitudes.

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Since Blumstein and colleagues' [10] seminal report to the US National Academy of Sciences, identifying and understanding the dimensions of individual criminal careers have assumed a central place in criminological research. More recently, life course criminologists have focused particular attention on the desistance process, with a multitude of studies attempting to define, model, and explain the deceleration and cessation of criminal offending over age. Building on the work of Sampson and Laub [28–30, 56–59], the majority of desistance researchers have examined the association between adult social role transitions—such as getting married, becoming a parent, joining the military, or getting a full-time job—and decreased offending, arrest, and substance use over time [17, 26, 27, 36, 37, 64, 70, 72]. With increasingly sophisticated methodological designs (e.g., fixed-effects analyses, propensity score matching, and interrupted time series), studies in this vein have documented how social role transitions can serve as “turning points” and lead to reductions in criminal behavior and substance use in adulthood.

Although informative, the scholarly attention to desistance among those who get married, have children, or settle into full-time jobs has meant that researchers generally focus on crime in adulthood (when such transitions are common) and overlook the cessation of less-serious risk behaviors (e.g., substance use, minor delinquency, unprotected sex, and driving under the influence) that occurs earlier in the life course.¹ This omission is unfortunate because, according to the well-established aggregate age-crime distribution, adolescence is the developmental stage when desistance from most risky behaviors begins. Indeed, in their review of the age-crime literature, Loeber and Farrington [33] note the “highest concentration of desistance takes place during late adolescence and early adulthood, irrespective of age of onset.” Stated differently, a vast amount of research has shown that the frequency and prevalence of self-reported offending, particularly for minor offenses, peak sharply in mid-adolescence (at approximately ages 15–16), suggesting that many offenders begin desisting almost immediately after they initiate crime and long before they cohabit, get married, enlist, or obtain career-relevant work [69]. As such, social bonds related to union formation and full-time employment appear insufficient to explain adolescents who experiment or flirt with delinquent behaviors and who do not undergo these more adult-like transitions [16, 48].

Two theories in developmental psychology prioritize adolescent-limited delinquency and provide mechanisms for this behavioral trajectory. In Moffitt's [45] typological theory of crime, individuals with adolescent-limited antisocial behavior (asserted to be the majority of adolescents) commit delinquent acts to overcome a “maturity gap” whereby their biological age is incommensurate with their social age. Thus, they offend to assert autonomy and desist once they reach social maturity. In Steinberg's [67] social neuroscience explanation of adolescent risk taking, the rise and fall of adolescent delinquency primarily result from age-graded changes in brain development.

¹ Indeed, transitions to full-time work, marriage, and childbirth tend to not only be uncommon early in the life course, but some adult roles are correlated with increased crime and delinquency rather than desistance in adolescence, such as when teenagers spend long hours on the job (see [65]).

Accordingly, the decline in risk taking at adolescent's end is due to changes in the brain's cognitive control system that heighten self-regulation.

Although their recognition of the adolescent peak in risk taking is essential for understanding the age-crime curve, both Moffitt's [45] and Steinberg's [67] theories generally over-predict the frequency of offending by average adolescents. The mechanisms that they offer are assumed to operate for most adolescents over an extended age range (e.g., ages 13–18), yet research of adolescent behavioral trajectories across a wide array of samples and behaviors invariably finds that the majority of surveyed respondents are likely to be sporadic, stably low, or rare offenders [24]. If the proposed mechanisms for increased adolescent offending are ever-present during the adolescent life stage, why do not more adolescents increase these behaviors once they initiate them? In other words, as opportunities and the prevalence of risk-taking behaviors among same-age peers increase over adolescence, why do so many adolescents maintain such infrequent and low-level behavioral trajectories?

To address this research question and extend desistance theories, we build on Giordano et al.'s [16, 17] interactionist theory of cognitive transformation, Matza's [41] concept of "drift," and social learning conceptions of peers and perceptual updating to understand cognitive changes at the point of adolescent delinquency initiation. We particularly emphasize changes in perceived rewards (i.e., whether the behavior is perceived as "fun") as critical for understanding when delinquency onset is followed closely by cessation. We then test this model using within-person longitudinal behavioral, perceptual, and peer network data from the PROSPER study. Due to data limitations, we focus our analyses on marijuana use initiation and persistence but propose that similar processes should hold for other minor delinquent behaviors common to adolescent-limited offending. Results from this project will not only help to explain experimentation of risky behaviors that occurs in an important and understudied age range, but also differentiate onset from persistence and potentially help to explain criminal desistance occurring in adulthood.

Background

In their influential life course theory of informal social control, Sampson and Laub [28–30, 56, 58, 59] argue that adult social bonds—including good marriages, stable jobs, and military service—are important for understanding desistance from crime and illicit drug use because these transitions allow individuals to "knife off" criminal opportunities through greater involvement, commitment, and belief in conventional institutions. Supporting this reasoning, research continues to find that adult social role transitions are associated with criminal desistance above and beyond social selection processes [17, 36, 72]. Research in this vein and the longitudinal methods that they employ have solidified the life course approach at the forefront of criminology [32].

In a critique of Sampson and Laub [57], Giordano and colleagues [17] argue that explaining desistance through changes in external controls ignores the "up-front" cognitive work done by actors themselves. Building on the symbolic interactionist tradition of Matza [41] and qualitative desistance research of Maruna [36], Giordano et al. [17] suggest that desistance primarily results from cognitive transformations whereby adults with criminal identities (1) become open to change; (2) are exposed

to environmental stimuli (i.e., “hooks for change”) that are perceived as incompatible with continued criminal behavior; (3) contemplate alternative, non-criminal, identities; and (4) redefine criminal behavior as negative and personally irrelevant. Emphases on the structure-agency link and situationally induced meanings of crime and adult roles most distinguish this cognitive perspective from Sampson and Laub’s [57] original life course theory. Indeed, in subsequent writings, Sampson and Laub [28, 58] acknowledge that they initially overlooked the importance of agency for the behavioral changes observed in their Glueck sample.² The emphasis on active choice to explain the association between adult role transitions and desistance is important because it attends to why some individuals are more likely than others to select themselves into adult transitions, why the transitions themselves are more or less likely to result in behavioral change, and why some individuals desist in the absence of role transitions. The last point, that many offenders desist absent significant adult role transitions, is of particular relevance to the argument that we will lay out.

In subsequent research, Giordano et al. [16] extend their interactionist theory of desistance to the domain of emotions. Here, they argue that adding changing and socially malleable emotions (e.g., excitement, anger, love, and shame) to their earlier neo-Meadian model of cognitive transformation provides a full accounting for why (1) many offenders continue offending in the presence of a role transition (i.e., they do not undergo a substantial change in the emotional self) and (2) many offenders desist from offending in the absence of a role transition (i.e., they undergo diminutions of negative emotional identities and positive emotions connected to crime). The idea that the excitement and thrill of crime diminish over time is of particular salience to our own ideas and provides common ground between our study and Giordano et al.’s [16] influential work.

A contention of Giordano et al.’s [16, 17] theories, and one which we take issue, is that human agency and rational decision-making are more important for behavior in adulthood than adolescence. Giordano and colleagues state ([17]: 998–99) “the somewhat larger social and spatial arena of adulthood presents options that were not available earlier. In addition, adults, compared with children, have greater behavioral leeway, that is, ability to influence the specific course of action they will take.” This assertion that adults are more reflective and agentic than adolescents not only provides the authors room to add cognitive concepts to Sampson and Laub’s theory of adult informal social control, but also implies that one should not look for similar mechanisms to explain juvenile desistance: “Our theoretical emphasis seems well suited to a focus on adult development” (p. 999). We take an opposing view and argue in the next section that cognitive transformation processes are equally, if not more, present during adolescence than adulthood and thus help to explain the rise and fall of adolescent risk taking.

Cognition and Adolescent Experimentation

Compared to childhood, adolescence is the developmental stage when the constraints of parents and teachers increasingly relax and youth are able to exert greater freedom,

² Although recognizing agency as important and an understudied component of desistance, Laub and Sampson [28] continue to emphasize external informal controls and the often arbitrary nature of actors unpredictably stumbling into them, as primary desistance mechanisms (i.e., “desistance by default”; [51]).

explore new identities, and participate in unstructured peer socializing [44, 47, 73]. Indeed, the weakening of family and school bonds during this life course stage is at the heart of Sampson and Laub's [57] age-graded explanation for adolescent delinquency and substance use. As mentioned above, these authors argue that it is only with the accumulation of social bonds in adulthood, such as a strong marriage and job stability, that crime and drug use are expected to decline over age.

But are changes in informal social controls sufficient to explain both the rapid rise and fall of adolescent offending? Here, we look to Matza's [41] concept of drift for assistance. Matza [41] concurs with Cohen and Short's [13] statement, "Delinquency... cannot be assumed to be a potentiality of human nature which automatically erupts when the lid is off," and argues that theories in the social control tradition (e.g., [57]) are incomplete without providing "...an impetus by which the potential for delinquency may be realized" (see also [38]). For Matza, and consistent with the tenets of classical criminology, it is the offender's will, or agency, that is missing from social control and other positivist theories of crime. Matza asserts that the loosening of constraints in adolescence allows individuals greater capacity (although never full freedom) to actively flirt with both criminal and conventional behaviors. Youth therefore drift between available lines of delinquent and non-delinquent actions and are "guided gently" by experiences, norms, and opportunities. In sum, Matza [41] pushes us toward environmentally conditioned decision-making processes to understand the "substantial majority of juvenile delinquents who do not become adult criminals."

Matza's [41] concept of will and his invocation of classical criminology today most closely align with rational choice and subjective expected utility theories of offender decision-making [6, 15]. These perspectives assert that individuals will commit crime if the anticipated benefits from crime exceed its costs, with subjective preferences typically assessed using survey data [43].³ An important consideration for this approach is then identifying the benefits and costs most relevant for criminal decision-making [39]. For adolescent experimentation with minor delinquency, we argue that perceived rewards are particularly salient. Matza and Sykes [40] argued that perceived "excitement, 'thrills,' or 'kicks,'" are central values underlying delinquent behavior. Similarly, Katz [25] suggested that the primary returns of delinquency are its visceral benefits (i.e., excitement and "sneaky thrills"). Empirical analyses also demonstrate that subjective perceptions of delinquency as fun behavior are strong correlates of various types of crimes (see [4] for a review), including auto theft [14], general theft [39, 42], fencing [66], drug use [53], excessive alcohol use [71, 74], and drug selling [42].

Although empirical research demonstrates a clear association between perceived excitement and delinquency, how and why within-individual perceptions change through adolescence remains relatively underexplored. We argue that changes surrounding the point of initiation are particularly useful in understanding delinquency experimentation. The novice has limited experiential bases for establishing baseline perceptions of a behavior's rewards, increasing the likelihood that such perceptions will undergo substantial and rapid change upon the initial experience. The uninitiated teenager must rely on social sources (e.g., peers, family, and the media) to form a preliminary opinion which may be distorted widely from the experience itself. As

³ A typical assumption of these approaches is that rational decision-making is bounded or "constrained by limits of time, ability and the availability of relevant information." ([15]:1).

Matza [41] argues and consistent with social learning expectations [1, 68], adolescent peer groups (i.e., situations of company) are likely primary sources of initial perceptions of delinquency's rewards. Additionally, peers may exaggerate these rewards, particularly if they are inexperienced themselves. Zinberg [77] observed "The beginning user looked for a guide to show him what to do and how to do it correctly and safely...[he] tended to overestimate greatly his more experienced peers' understanding of the drug." Many novices may then downwardly adjust their perceptions of delinquency (but not necessarily their signals to peers) once they experience the behavior and realize that their naïve expectations are unmet or inflated. Alternatively, others may find that the behavior meets or exceeds expectations, increasing the likelihood of behavioral persistence. A between-person divergence in perceptions of delinquency as fun following initiation would then be a strong predictor of persistence vs. short-lived experimentation.

The updating of perceptions upon experiencing delinquency should be shaped by the social contexts of initiation. Howard Becker [8] provides a now classic example of the interactional process surrounding initiation of marijuana smoking. Becker highlights that through interactions with more experienced users, the marijuana novice learns how to effectively smoke the drug as well as recognize the symptoms of being high. In addition, the initiate learns from others how to enjoy the effects. Becker [8] notes "the taste for such experience is a socially acquired one, not different from [other] acquired tastes." Absent-experienced peers, adolescents who initiate delinquent behavior, should be less likely to perceive the event as fun and therefore more likely to avoid or resist future behavioral opportunities. Indeed, Warr [72] and Sweeten et al. [69] found that changes in self-reported delinquent peers were the strongest mediators of the age-crime association.⁴ We interpret these findings as consistent with diverging perceptions of delinquency over age. Adolescents with delinquent peers are more likely to enjoy delinquency, which in turn embeds them further in delinquent networks and increased delinquency over time. However, adolescents who try, but do not enjoy, delinquency are more likely to break their delinquent ties and desist from the behavior. Delinquent peers should therefore both predict initiation and mediate the association between perceptions and desistance.

A second reason why the novice may downwardly adjust his or her excitement perceptions after initiating a delinquent behavior relates to the perceived benefits of novelty itself. For the uninitiated, risk taking should be associated with an anticipatory thrill regardless of the behavior's outcome [5]. By definition, such anticipation should diminish once the behavior is experienced and its mystery is at least partially dispelled. Indeed, one would expect that, over time and with continued criminal involvement, the psychic rewards of crime would necessarily decline as the behavior and its outcomes become better understood and habituated [16]. Research shows that there is a strong correlation between novel stimuli and risk-taking behavior [78]. Thus, even with increasing opportunities and reduced social bonds through the adolescent period, the loss of novelty associated with experiencing delinquency may itself be a turning point toward desistance.

⁴ Although recent research using network-based measures of peer delinquency and sophisticated analyses of longitudinal network data suggest that the magnitude of peer influence effects is less than previously thought (for reviews, see [12], [20], [49], and [76]).

The downward adjustment of perceived psychic rewards following behavioral initiation is not necessarily inconsistent with Steinberg's [67] theory of brain development but would amend his argument in influential ways. He argues that the biologically driven remodeling of the brain's dopaminergic pathways at puberty, along with the increased salience of adolescent peer relations, increases adolescents' sensitivity to sensation and novelty-seeking behaviors. Thus, experiencing many new and stimulating situations, rather than repeating a risky behavior multiple times, remains consistent with both our theory and Steinberg's [67] hypothesis. Indeed, initiating a novel behavior could be more rewarding than repeating a previously experienced behavior because (1) uncertainty is itself exciting and the reduction in uncertainty over time makes behavioral repetition less rewarding than the initial experience or (2) pre-initiation perceptions of excitement may exceed post-initiation perceptions, also making the novel behavior more appealing than the repeated behavior. With regard to Steinberg's [67] theory, we would then expect that many adolescents increase the variety of risk-taking behaviors more than the frequency of any given behavior. Although we are unaware of research that looks explicitly at this question, the expectation is consistent with results from latent class trajectories of adolescent risk taking that typically finds large numbers of youth having behavioral trajectories marked by low and sporadic delinquency or risk behaviors. For example, in a comprehensive review of over 100 studies using latent trajectory models for delinquency, aggression, and violence, approximately 90 % placed a majority (i.e., >50 %) of their samples in trajectories labeled low, sporadic, near-zero, rare, non-offender, stable-low, low-risk, or low-level desistor/declining [24].

Although emphasizing perceived psychic rewards (i.e., whether the behavior is fun), we also acknowledge that other benefits and costs contribute to adolescents' offending calculi. A long line of research has focused on the possible deterrent effects of formal sanction perceptions. Several studies document the updating of risk perceptions as predictive of offending over time [3, 31, 39, 54]. Interestingly, studies that compare risk perceptions and anticipated rewards find that perceived rewards are more predictive than perceptions of arrest for theft [39, 42] and drug selling [42], but less predictive of violence [39]. We would argue that these results are consistent with our conception of delinquency's psychic rewards being particularly important for less serious offending (i.e., property offenses and substance use). Additionally, Matsueda et al. [39] found that delinquency's perceived social rewards (i.e., peer status or "coolness") are strongly predictive of both property and violent offending. Perceived coolness is especially salient among adolescent substance users [23, 50]. On the cost side of the equation, McCarthy and Hagan [42] and Grasmick and Bursik [18] document that perceptions of delinquency's moral costs (i.e., perceived "wrongfulness," shame, or guilt) are actually stronger negative correlates of offending than are perceived formal sanctions. In sensitivity analyses for the present study, we include measures of perceived coolness and wrongfulness to isolate the independent effects of perceived psychic rewards on behavioral initiation and persistence.

Data and Measures

Our analyses are based upon data from adolescent participants in the ongoing PROMoting School-community-university Partnerships to Enhance Resilience (PROSPER) longitudinal study [62, 63]. In the fall of 2002 and 2003, two successive

cohorts of sixth-grade students residing in 28 rural communities in Iowa and Pennsylvania were selected to complete confidential surveys focused on their drug use attitudes and behaviors.⁵ Students first completed pencil-and-paper questionnaires administered during school hours in the fall of sixth grade. Enrolled students then completed up to seven follow-up surveys during the spring semester of each school year from the 6th through 12th grade. Across the eight waves, participation rates ranged from 86 to 90 % of enrolled students, and students who participated in the first wave went on to participate in an average of 5 additional in-school surveys ($\bar{x}_{\text{waves}} = 5.90$). There were over 8000 respondents at the first wave.

Our analyses are based upon 6154 youth residing in 27 PROSPER communities who provided data on marijuana use and all covariates in the fall of the sixth grade, completed at least one consecutive follow-up survey,⁶ and attended a school that administered the social network section of the survey necessary for operationalizing peer marijuana use and attitudes.⁷ A small number of respondents ($n = 126$) who had used marijuana prior to the fall of sixth grade were excluded because we lacked marijuana perceptions measured before initiation.

Column 1 of Table 1 lists descriptive statistics for our analytical sample measured at PROSPER wave 1. The majority of the sample is White and from an intact family. Approximately one third of the sample is eligible to receive reduced-cost school lunch. In unlisted analyses, we also compared our analytical sample to other PROSPER respondents. The analytical sample is generally more conventional than the PROSPER sample (i.e., significantly less delinquent, more religious, and stronger bonds with school and family). Our sample also has more girls and Whites than the larger PROSPER sample. These differences are not surprising given that we require our sample to not have used marijuana prior to sixth grade and to have completed at least one consecutive follow-up survey (i.e., be present in school for multiple survey waves). Nevertheless, our sample does include over 1000 marijuana initiators, allowing for a rigorous test of our hypotheses related to adolescent behavioral experimentation and changing risk perceptions.

Dependent Variables: Marijuana Initiation and Persistence

In each wave, respondents were asked if they had used marijuana in the past year. Approximately 16 % ($n = 1009$) of the analytical sample had initiated by spring of the 12th grade, whereas the remaining 84 % ($n = 5145$) did not report marijuana use during the observation period.⁸ Columns 2 and 3 of Table 1 compare variable means (or percentages) measured at wave 1 for marijuana initiators and non-initiators in our

⁵ Each community was selected because it had a public school district with 1300–5200 enrolled students and had at least 15 % of students eligible for reduced-cost lunches.

⁶ For the discrete-time models, a small percentage (~2 %) of person-waves following a missing wave were not included in our analyses, as we lack information about marijuana initiation during the time of the missing survey.

⁷ One of the Pennsylvania schools did not agree to participate in the network portion of the study, resulting in 27 school districts available for our analyses.

⁸ Approximately 36 % of youth in the larger PROSPER sample had ever used marijuana by the spring of the 12th grade. This percentage is only somewhat less than what is reported in the nationally representative Monitoring the Future (MTF) study. For instance, about 42 % of 12th graders in the 2008 and 2009 MTF cohorts have ever used marijuana. The difference between the two samples is likely due to PROSPER consisting of a sample of rural communities in Iowa and Pennsylvania.

Table 1 Descriptive statistics, wave 1

Variables	(1)	(2)	Test ^a	(3)	(4)	(5)
	Analytical sample (<i>n</i> = 6154) Mean/%	Non-initiators (<i>n</i> = 5145) Mean/%		Initiators (<i>n</i> = 1009) Mean/%	Experimenters (<i>n</i> = 236) Mean/%	Persisters (<i>n</i> = 773) Mean/%
Perceptions of MJ as fun	1.16	1.15	***	1.23	1.18	1.24
Number of MJ friends	0.02	0.02	***	0.03	0.05	0.03
Friends' mean fun perceptions	1.19	1.18	**	1.22	1.21	1.22
Friendship nominations received	3.52	3.33	***	4.24	4.39	4.20
Delinquency	0.66	0.56	***	1.03	0.74	* 1.12
Alcohol use	6 %	5 %	***	12 %	10 %	13 %
Risk and sensation seeking	1.89	1.83	***	2.07	1.99	2.10
School adjustment and bonding	4.16	4.20	***	4.05	4.11	4.03
Grades	4.31	4.31		4.30	4.40	* 4.27
Religiosity	2.96	2.99	**	2.91	2.97	2.89
Both biological parents	66 %	67 %	*	64 %	67 %	63 %
Family relations	0.20	0.22	***	0.16	0.20	0.14
Reduced price school lunch	29 %	29 %	*	26 %	21 %	* 28 %
Sex (1 = male)	46 %	46 %		44 %	43 %	44 %
Race (1 = White)	88 %	88 %		90 %	90 %	90 %

* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests)

^a Comparisons were *t* tests for continuous variables and chi-square tests for proportions

sample. Initiators have significantly higher prior delinquency, alcohol use, sensation seeking, marijuana friends, and perceptions of marijuana as fun than non-initiators. Initiators are also less religious, have more friends, are less likely to have intact families, and have poorer family relations than non-initiators.

Among sampled youth who initiated marijuana, 77 % ($n = 773$) reported using marijuana more than twice in the initiation wave or at least once in the next wave and were classified as persisters.⁹ The remaining 23 % ($n = 236$) reported using marijuana only once or twice in the wave that they initiated and no use in the subsequent wave and were classified as experimenters. Columns 4 and 5 of Table 1 compare variable means (or percentages) at wave 1 by marijuana use category. There are relatively few observed differences between the two groups, with persisters reporting significantly more prior delinquency, lower grades, and more receipt of reduced price school lunch than experimenters.

⁹ As we lack the post-initiation wave for those respondents who initiate in wave 8, we relied on their initiation year marijuana use to classify persistence. In unlisted analyses, we restricted analyses to waves 1–7 and found results virtually identical to those reported.

Focal Predictor Variable: Perceptions of Marijuana as Fun

A unique feature of the PROSPER study is that youth were asked each year to self-report the risk and rewards of marijuana use. *Perceptions of MJ as fun* is a time-varying measure capturing responses to the survey item, “Smoking marijuana (pot) lets you have more fun.” Possible responses ranged from “1” (strongly disagree) to “5” (strongly agree), and in the fall of the sixth grade, the average student strongly disagreed that smoking marijuana is a fun activity (sample mean_{wave1} = 1.16).

Time-Varying and Time-Invariant Controls

Our models include controls for several time-varying factors that might render spurious any observed association between perceived rewards and marijuana onset and/or persistence. At each wave, students nominated up to seven best or close friends in the same school grade. Friendship nominations were collected using an open name generator where students wrote the first and last names of each friend on the survey form, which were then matched to student rosters. Names were matched 80 % of the time. We used this peer nomination data to create a peer-reported measure of the *number of friends who use marijuana* (ranging from 0 to 7), *friends’ mean fun perceptions* from marijuana use (see above), and the *number of friendship nominations* (ranging from 0 to 20) that respondents received at each survey wave (i.e., indegree or peer acceptance). *Delinquency* at each wave is operationalized as a variety scale indicating whether respondents committed 12 self-reported delinquent behaviors in the past year (ranging from 0 to 12). *Alcohol use* at each wave is derived from the item, “During the past month, how many times have you had beer, wine, wine coolers, or other liquor?” (coded 1 = “1 or more times”; 0 = “not at all”). *Risk and sensation seeking* is the mean of three items ($\alpha=0.77$), respondent (1) does what feels good, regardless of consequences, (2) does something dangerous on a dare, and (3) does crazy things just to see the effect on others, rated on a scale of 1 (“definitely would not”) to 5 (“definitely would”). *School adjustment and bonding* is the mean of eight items ($\alpha=0.80$), which students rated on a scale of 1 (“never true”) to 5 (“always true”). These items asked whether students liked school, got along with their teachers, and felt like that they belonged at school. We also include measures of self-reported *grades* at each wave based upon the question “What grades do you generally get in school?” Responses ranged from (1) “mostly lower than Ds” to (5) “mostly As.” *Religiosity* is derived from responses to the question “How often do you go to church or religious services?” which ranged from (1) “never” to (4) “more than once a week.” Respondents also reported at each wave whether they currently resided with *both biological parents* (1 = yes) and their *family relations*, assessing child-parent affective quality (12 items), joint activities (6 items), parental monitoring (5 items), inductive reasoning (3 items), and family cohesion (7 items). Finally, we controlled for sociodemographic background by including measures of *gender* (1 = male), *race/ethnicity* (1 = White), and whether the child reported receiving a *reduced price lunch* (1 = yes in the past year), as well as age and cohort trends by including seven dummy variables for survey wave and 53 dummy variables for community and cohort (i.e., 2 cohorts * 27 communities – 1 community cohort that did not participate in network portion of study).

In sensitivity analyses, we also include in our models additional measures of respondents’ and friends’ perceived rewards and costs of marijuana use. Each year,

students reported their perceived wrongfulness of marijuana use (“How wrong do you think it is for someone your age to use marijuana or pot?”), with responses ranging from 1 (“not at all wrong”) to 4 (“very wrong”). Respondents were also asked whether they gained *social rewards* from using marijuana (“smoking marijuana (pot) makes you look cool”), with responses ranging from 1 (“strongly disagree”) to 5 (“strongly agree”). We include these perceptual variables in sensitivity analyses because (1) changes in the perceived psychic rewards of marijuana may result in changes in marijuana’s perceived wrongfulness, thus complicating the temporal ordering of concepts, and (2) the correlation between perceived psychic rewards and social rewards is quite high ($r = .78$), leaving little independent variation to distinguish the two measures.¹⁰

Analyses

Using the longitudinal data, the analysis strategy proceeded in three steps: First, we examine unadjusted mean value fluctuations in the perceptions of marijuana as fun use over the waves among youth who never used marijuana as well as those who initiated and then either persisted or desisted. Second, we used discrete-time logit (hazard) models for event history analysis to assess whether perceptions that marijuana use is fun, along with other covariates theoretically related to marijuana use, increase the risk of time to initiation [9, 60]. Discrete-time logit models are advantageous over models predicting marijuana initiation at particular end dates (i.e., by the end of high school) because the models allow for time-varying covariates (i.e., perceptions, friends who use marijuana, family relations, etc.) to be entered into the model and appropriately adjust for the right-hand censoring of children who were lost to attrition, who were no longer enrolled in the school district, or who did not initiate by the end of the 6-year observation period. The estimated hazard of initiation will be generated from 6154 children who have been followed 23,297 person-years. We will test if the predicted probability of initiation increases when youth perceive the drug as fun, controlling for other risk and protective factors. Finally, limiting the analysis sample to 1009 youth who had initiated by end of high school and were not missing data on the predictor variables, in a series of logistic regression models, we estimated the factors influencing who persisted or desisted.¹¹ These analyses will allow us to assess the predictive power of changes in perceived psychic rewards from the other risk factors as well as whether peer marijuana use mediates the perceived reward-persistence association.

Results

In Fig. 1, we first longitudinally compare mean values for marijuana’s perceived psychic rewards between non-initiators, persisters, and experimenters. For the initiating

¹⁰ Due to prior theory and research, we chose to focus analyses on perceived psychic rewards as a primary independent variable rather than perceived social rewards or a latent measure combining the two measures.

¹¹ In supplemental logistic regression models (not shown but available upon request), we used multiple imputation to retain youth who had initiated but had missing data on at least one of the predictor variables. The results from models based upon the imputed data did not substantially differ from those shown in Table 3.

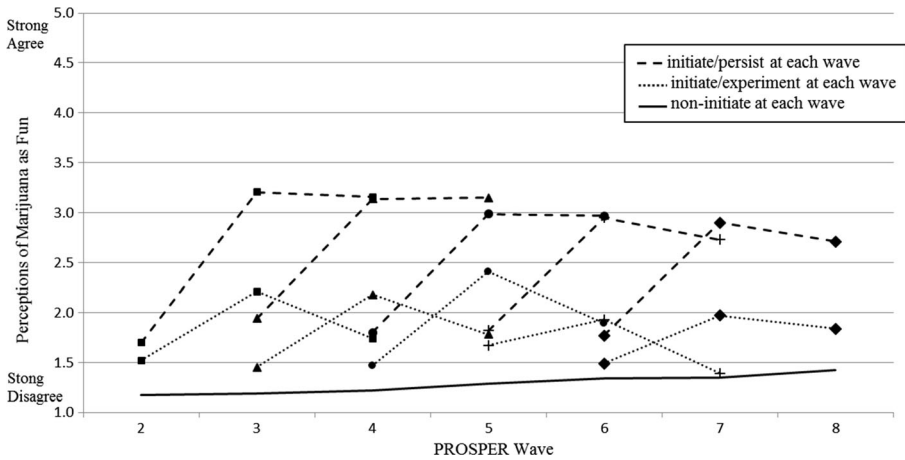


Fig. 1 Mean perceptions of marijuana as fun by initiation wave and persistence vs. experimentation status

categories (i.e., persisters and experimenters), 3-year means are presented for those who initiated in waves 3–8 (i.e., grades 7–12). For example, the dashed line with a square at each wave corresponds to the mean psychic rewards for marijuana persisters in the wave before they initiated (i.e., wave 2) and two waves after they initiated marijuana (i.e., waves 3–4). As expected, those adolescents who never used marijuana in the observation period had low perceptions of the drug as fun across all waves, although these perceptions do increase somewhat over time. Marijuana initiators who continued using the drug more than one or two times (i.e., persisters) had a large increase in perceived fun between their pre- and post-initiation waves, and this difference was fairly similar regardless of the age at which they initiated. In contrast, initiators who ceased use after one or two times saw smaller increases in perceived psychic rewards than persisters in the wave after initiation, followed by a decrease in the next wave. For experimenters who initiated marijuana in wave 6 (i.e., tenth grade), their post-initiation perceptions were not significantly different from the non-user category. This is in line with previous findings that show that experimenters and abstainers closely resemble one another in their attitudes toward drugs [50]. It is also worth noting that pre-initiation perceptions for the persisting group were always significantly higher than the non-using group and significantly higher than the experimenting group in wave 3. The pre-initiation values for the experimenting group were also significantly different from non-users in waves 2 through 5. In total, the descriptive comparison of perceived psychic rewards suggests that marijuana initiators update their perceptions of marijuana in a positive direction upon first use and that the updated perceptions are larger and more stable for persisters than experimenters. It is also interesting that, prior to initiation, none of the categories have impressions of marijuana as a fun activity (i.e., the mean is always under two on a five-point scale), and even after initiation, the highest group's perceptions only approximate the mid-point on the scale.

We next estimate a discrete-time model of marijuana initiation between waves 2 and 8. Table 2 lists coefficients and standard errors for lagged (i.e., $t-1$) independent variables included in the model. The large amount of power obtained from 23,297 person-waves results in precise coefficients that, for the most part, are in theoretically expected directions. Of most importance for the current paper, the

Table 2 Discrete-time logistic regression of marijuana initiation

Variable	<i>b</i>	SE
Time varying covariates (<i>t</i> - 1):		
Perceptions of MJ as fun	0.29***	0.04
Number of MJ friends	0.16**	0.06
Friends' mean fun perceptions	0.30***	0.06
Friendship nominations received	0.06***	0.01
Delinquency	0.14***	0.02
Alcohol use	0.99***	0.08
Risk and sensation seeking	0.27***	0.04
School adjustment and bonding	-0.16**	0.06
Grades	-0.19***	0.05
Religiosity	-0.05	0.03
Family relations	-0.25**	0.09
Both biological parents	-0.32***	0.07
Reduced price school lunch	0.02	0.09
Time-stable covariates:		
Sex (1 = male)	-0.19**	0.07
Race (1 = White)	-0.16	0.11
Wave:		
2 (6th grade)	-5.01***	0.45
3 (7th grade)	-4.16***	0.44
4 (8th grade)	-3.65***	0.44
5 (9th grade)	-3.47***	0.44
6 (10th grade)	-3.49***	0.447
7 (11th grade)	-3.21***	0.44
8 (12th grade)	-2.96***	0.44

Models include fixed effects for 53 community cohorts (not shown). $n = 23,297$ person-waves, 6154 persons
 * $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests)

positive and statistically significant ($p < .001$) estimate for perceived psychic rewards ($OR = 1.34$; 95 % $CI = 1.24-1.44$) suggests that adolescents with higher pre-initiation perceptions of marijuana as a fun activity were at greater risk of subsequently initiating marijuana during our observation period. This finding is consistent with results from Fig. 1 and suggests that marijuana initiators were exposed to more favorable messages of marijuana use prior to using the drug themselves.

The other estimates provide few surprises. Having friends who use marijuana increases the risk of marijuana initiation, as does those friends' perceptions of marijuana as a fun experience, prior delinquency, alcohol use, and risk and sensation seeking. Respondents who initiated marijuana also had higher peer acceptance (i.e., more received friendship nominations) than non-initiating youth. Consistent with social control theory ([21] [1969]), school bonding, higher grades, stronger family relations, and residing with both biological parents reduce the risk

of marijuana initiation. Males are also less likely to initiate marijuana than are females. Finally, the negative and close to monotonically decreasing estimates for wave mean that the risk of marijuana initiation is low at earlier waves but increases over time.

Table 3 lists estimates from four stepwise models of marijuana persistence among our PROSPER sample who initiated marijuana between waves 2 and 8 (i.e., 7th and 12th grade). Model 1 lists coefficients for time-stable covariates and, for time-varying covariates, estimates for the lagged (i.e., $t-1$) period capturing baseline differences between marijuana persisters and experimenters. Only two variables in the model have significant associations with marijuana persistence. First, persisters receive greater numbers of friendship nominations prior to initiation than do experimenters. Each additional friend corresponds to a 5 % increase in the odds ($OR=1.05$; 95 % $CI=1.00-1.10$) of persisting vs. desisting marijuana use. Second, the significant estimate for wave of initiation means that persisters are more likely to initiate marijuana at younger ages than are experimenters. Of interest to our study, pre-initiation perceptions of marijuana as fun do not differentiate persisters and experimenters at standard (i.e., $p < .05$) levels of significance.

Model 2 adds a change measure (i.e., the difference between the initiation wave [t] and pre-initiation wave [$t-1$]) of perceived psychic rewards to model 1. The positive and significant association between this measure and persistence suggests that marijuana initiators who increase their perceptions of marijuana as a fun activity are more likely to persist than are those who do not update their perceptions in a positive direction. An increase of one point between the pre-initiation and post-initiation waves is expected to increase the odds of persistence by just over 50 % ($OR=1.51$; 95 % $CI=1.31-1.74$). Additionally, including the change measure of perceived psychic rewards into the model increases the estimate and significance of the baseline measure of perceived fun. Net of changes in perceptions, persisters have higher baseline perceptions of marijuana as a fun behavior.

Model 3 tests if changes in peer contexts explain the association between changes in marijuana perceptions and continued use by including covariates for (1) change in number of marijuana-using friends, (2) change in friends' perceptions, and (3) change in incoming friendship nominations to model 2. Although increase in marijuana-using friends is a significant positive correlate of persistence, the perceived psychic reward estimate in model 3 remains very similar to model 2. Change in friends' perceptions neither predicts persistence nor attenuates the association between changes in respondents' perceived psychic rewards and marijuana persistence. Inconsistent with our social learning hypothesis, our network measure of peer marijuana use appears to explain little of the association between changing perceptions of marijuana as fun and marijuana persistence.

Finally, model 4 adds change measures for our other time-varying covariates to model 3. Of these, only increases in alcohol between the pre-initiation and post-initiation waves significantly predict marijuana persistence. Initiating alcohol consumption between the pre-initiation and post-initiation waves increases the odds of persistence by almost 50 % ($OR=1.50$; 95 % $CI=1.06-2.12$). Model 4 does not, however, attenuate much of the estimate for changes in perceived psychic rewards. This variable remains a strong and significant predictor of marijuana persistence ($OR=1.44$; 95 % $CI=1.24-1.68$).

Table 3 Logistic regressions of marijuana persistence

Variables	Model 1		Model 2		Model 3		Model 4					
	<i>b</i>	SE	<i>b</i>	SE	<i>b</i>	SE	<i>b</i>	SE				
Time-varying covariates (<i>t</i> - 1):												
Perceptions of MJ as fun	0.17	0.11	0.49	***	0.12	0.48	***	0.12	0.49	***	0.11	
Number of MJ friends	-0.02	0.16	0.01		0.16	0.28		0.19	0.31		0.20	
Friends' mean fun perceptions	0.17	0.16	0.17		0.17	0.03		0.19	0.01		0.19	
Friendship nominations received	0.05	*	0.02	0.05	*	0.03	0.04	0.03	0.04		0.03	
Delinquency	0.02	0.04	0.02		0.04	0.02		0.04	0.04		0.04	
Alcohol use	0.08	0.18	0.06		0.18	0.02		0.18	0.35		0.23	
Risk and sensation seeking	0.12	0.07	0.07		0.08	0.06		0.07	0.09		0.10	
School adjustment and bonding	-0.17	0.13	-0.09		0.15	-0.12		0.15	0.06		0.16	
Grades	-0.11	0.10	-0.14		0.10	-0.14		0.10	-0.27		0.14	
Religiosity	-0.02	0.08	-0.05		0.08	-0.05		0.08	-0.09		0.09	
Both biological parents	-0.20	0.20	-0.15		0.20	-0.15		0.20	-0.09		0.21	
Family relations	-0.14	0.22	-0.09		0.23	-0.08		0.23	-0.21		0.26	
Reduced price school lunch	-0.03	0.23	0.03		0.24	0.05		0.23	0.14		0.28	
Wave	-0.22	***	0.06	-0.21	***	0.06	-0.22	***	0.06	-0.21	***	0.06
Time-stable covariates:												
Sex (1 = male)	-0.07	0.19	-0.10		0.19	-0.09		0.19	-0.08		0.20	
Race (1 = White)	0.04	0.25	0.15		0.24	0.12		0.26	0.19		0.25	
Time-varying covariates (<i>t</i> - [<i>t</i> - 1]):												
Δ Perceptions of MJ as fun			0.14	***	0.07	0.41	***	0.07	0.37	***	0.08	
Δ Number of MJ friends						0.34	**	0.11	0.36	**	0.10	
Δ Friends' mean fun perceptions						-0.13		0.11	-0.16		0.11	
Δ Friendship nominations received						0.01		0.04	0.01		0.04	
Δ Delinquency								0.06			0.04	
Δ Alcohol use								0.41	*		0.18	
Δ Risk and sensation seeking								0.06			0.12	
Δ School adjustment and bonding								0.25			0.17	
Δ Grades									-0.31		0.16	
Δ Religiosity									-0.10		0.08	
Δ Both biological parents									-0.04		0.42	
Δ Family relations									-0.45		0.27	
Δ Reduced price school lunch									0.20		0.33	
Constant	2.40	**	0.70	1.39	0.82	1.74	*	0.85	1.11		0.93	
Wald χ^2 , <i>df</i>	85.14,16	***	33.59,1	***	11.57,3	**	25.33,9	**				

Robust standard errors adjust for 53 community cohorts. *n* = 1009

p* < .05; *p* < .01; ****p* < .001 (two-tailed test)

Predicting Changes in Perceptions of Fun

To better understand the lack of mediation observed in our models of marijuana persistence, we estimated ordinary least squares models with changes in marijuana perceptions as the outcome and present coefficients and robust standard errors for these models in [Appendix A](#). Model specification closely parallels that of [Table 3](#). Model 1 shows that, of the background measures, respondents with higher prior perceived fun showed less change in perceptions over time. Those who were risk and sensation seekers had increased perceived fun over time, as did those with high religiosity. Those who were bonded to school saw decreases in perceived fun over time.

Our primary interest relates to model 2, which adds measures for changing peer contexts, including changes in marijuana-using friends, friends' mean perceptions, and number of friendship nominations received. None of these estimates approached statistical significance. It thus appears that strong, network-based measures of peer behavior and perceptions do not predict changes in perceived fun of marijuana from the pre-initiation to post-initiation waves. In contrast, model 3 shows that increases in delinquency, alcohol use, and risk and sensation seeking and decreases in grades all predict increased perceptions of marijuana as a fun activity.

Adding Other Rewards and Costs

Two additional appendices display results from models including measures of respondents' and their friends' perceived social rewards (coolness) and moral costs (wrongfulness) of marijuana. [Appendix B](#) adds these variables to the discrete-time model of marijuana initiation listed in [Table 2](#). There is a significant negative odds ratio for perceived wrongfulness, indicating that the risk of initiation was reduced when respondents felt that marijuana use was wrong. Net of other covariates, perceived social rewards were not associated with marijuana initiation, nor were the perceptions of social and moral costs from friends. Including all additional perceptual measures attenuated approximately 10 % of the perceived fun coefficient from [Table 2](#), but this estimate remained significant. Thus, even after accounting for those who perceived marijuana as morally wrong, adolescents who viewed marijuana as a fun behavior were more likely to initiate the drug than those who did not.

Finally, [Appendix C](#) adds baseline (i.e., $t-1$) and change score (i.e., $t-[t-1]$) measures of respondents' and friends' perceived social rewards and perceived wrongfulness of marijuana to model 4 of [Table 3](#). Adolescent respondents who perceived marijuana as "wrong" prior to initiation or who increased their perceptions of wrongfulness or coolness after initiation were significantly less likely to persist using the drug. The change in social reward finding must be interpreted in light of the high correlation between perceived fun and coolness. With the fun variables (i.e., baseline and change score) removed from the model (not shown), change in coolness remains a (non)significant positive predictor of marijuana persistence. Regardless, adding the other perceptual measures of marijuana's costs and rewards attenuates none of the baseline or change score estimates of perceived fun from model 4 ([Table 3](#)).

Discussion

Over the past 20 years, the study of desistance has taken a central place in criminological discourse. Scholars have forwarded a number of theories purporting to explain desistance from serious crime. Notably, theories have emphasized that important life events, such as a “good” marriage and stable employment, are embedded in the desistance process and that these events serve as turning points in adult criminal trajectories [57]. Alternatively, theories of cognitive transformations [16, 17] and identity change [51] place emphasis on the cognitive processes associated with leaving behind a life of crime. Although extremely informative, extant accounts of the desistance process focus on adult processes. Specifically, Sampson and Laub [57] note: “our major thesis is that... turning points are important concepts in understanding processes of change in the adult life course.” Yet, the sharp peak in the prevalence of delinquency commonly observed in mid to late adolescence suggests that, for most individuals, the deceleration or cessation of offending and risk taking occurs earlier in the life course and that the majority of offenders stop the behavior shortly after they initiate [33]. This leads to a gap between the criminological emphasis on desistance in adulthood and the fact that most individuals desist prior to entering their adult years. The current study sought to fill some of this gap by forwarding a theory of adolescent experimentation.

A salient theme in the desistance literature surrounds the timing of turning points or hooks for change. For example, some scholars suggest that structural factors can initiate the desistance process [57], whereas other scholars argue that structural factors operate in tandem with the cognitive processes of change [17]. Still, others forward that agentic changes in an offender identity predate both desistance and life course transitions [51]. The commonality among extant desistance theories is their emphasis on explaining the behaviors of established, or serious, offenders. Such emphasis is perhaps warranted, as it has long been understood that a small minority of serious offenders are responsible for a large proportion of crime [75]. However, shifting the spotlight to this small population misses potentially different mechanisms for the desistance process among the majority of less-serious offenders. Moreover, understanding desistance that occurs among adolescent experimenters may also contribute to understanding desistance occurring among more serious and chronic offenders, as well as point to potential interventions to reduce minor delinquency, prevent early commitment to criminal lines of action, and thus have a larger societal impact (i.e., see the prevention paradox; [55]). The current study thus shifted focus away from established offenders and toward adolescent desistance that occurred shortly after behavioral onset.

Using longitudinal data from 1009 teenagers who had initiated marijuana use, we found that, prior to initiation, perceptions of marijuana as a fun behavior were similar among those youth who subsequently persisted and those who stopped their use. Indeed, the average marijuana user did not expect the drug to be exciting, regardless of whether they continued use or not. Upon initiation, however, there was a clear distinction in perceptions between those who stopped the behavior and those who persisted. Marijuana experimenters had significantly lower perceptions of the drug as fun compared to persisters, eventually settling to levels that were little different from non-users. In contrast, persisters updated their perceptions in an upward direction and maintained more positive perceptions over time, thus departing dramatically from both experimenters and non-users. These patterns suggest that the experience of marijuana

itself strongly predicts subsequent perceptions, which in turn are strongly correlated with continued use. The observed patterns thus document important variation in the perceptual updating process applied to a health risk behavior.

Our results have several implications for dominant life course and criminological theories. First, our results challenge the hypothesis, drawn from Becker's [7] seminal work, that marijuana persistence is conditional on the peer contexts of initiation. Using network-derived measures of peer marijuana use and perceptions, we found little mediation of the association between perceptions of marijuana as a fun activity and continued marijuana use. Indeed, in supplementary analyses, we found these peer variables uncorrelated with changes in marijuana perceptions. It thus appeared that peers were unnecessary for marijuana initiators to update their perceptions of their first marijuana experience. If peers are not the mechanisms for such perceptual change, who or what are? One possibility is that individuals are able to experience the effects of marijuana without strong peer guidance, because the act is not as complicated as Becker originally hypothesized. In fact, in the preface to the recent re-release of his earlier work, Becker [7] commented that today's drug culture incorporates widely shared knowledge of the techniques and subjective effects of marijuana that can inform and enhance neophytes' initial marijuana experiences. This knowledge is also able to spread widely through social media and internet sources, further reducing the need for situational definitions provided directly by peers. Simultaneously, Becker [7] recognized that the level of marijuana's active ingredient, THC, is higher today than when he originally proposed his theory and therefore does not require perfect technique to experience the drug's physiological effects (see also [19]). Similarly, marijuana initiators may be able to come to their own conclusions of the marijuana experience without peer advice. For example, novices may be unconvinced by peers that marijuana's "high" is rewarding or may enjoy the feeling even if experienced users are not present. Our results thus implicate variable definitions of situations that might accompany novel experiences as the primary drivers of perceptual change surrounding marijuana initiation.

Second, the temporal proximity of onset and desistance found among marijuana experimenters also qualifies developmental explanations of adolescent risk taking that typically rely on mechanisms that are less malleable to changing environmental circumstances. For example, Moffitt [45] argues that the cessation of adolescent-limited risk taking should coincide with reductions in the maturity gap that accompany the transition to adulthood. Given the young age of this sample, it is unlikely that the adolescent experimenters that we observed in this study stopped using marijuana because they felt more adult. Similarly, onset followed by cessation appears inconsistent with Steinberg's [67] theory of brain development; unless as mentioned earlier, novelty seeking is itself the dominant reward and many adolescents move from one risk-taking behavior to another. Future research should examine these possibilities using other longitudinal adolescent samples.

Third, given that cognitive changes surrounding behavioral initiation strongly predict persistence, identity transformation may not be a necessary condition for desistance, at least during this life stage. Indeed, we would argue that it is the absence of a stable identity that facilitates behavioral cessation so close to the point of initiation. We lack identity measures and therefore cannot directly test this hypothesis, but future research should examine whether an unsettled identity during adolescence increases

delinquent experimentation. A related question is whether cognitive transformations similar to what we observe can occur during adulthood without a contemporaneous shift in identity. It is plausible that the accumulation of crime's physical, monetary, emotional, and social costs and simultaneous decay in its rewards are enough to alter an individual's behavioral trajectory. It could then be this agentic movement away from crime that results in identity transformation and paves the way for other conventional role transitions, such as employment, marriage, and parenthood. We would therefore expect that changes in criminal behavioral could occur even in the absence of life course transitions but remain consistent with Giordano et al. [16, 17] and link cognitive transformations with symbolic interaction processes. Our thesis also departs from Giordano et al. and Paternoster and Bushway [51] in asserting that cognitive transformation precedes identity transformation and directly influences future behaviors, at least among adolescent-limited delinquents.

Our study also has implications for a now dormant criminal career debate. Criminal career researchers have long argued that various dimensions of the criminal career, such as onset and persistence, might require separate explanatory models and therefore justify the criminal career perspective. However, empirical evidence has generally shown that behavioral prevalence, onset, or initiation, and persistence can be explained by similar factors [46, 52, 61], such as delinquent peers and gender. Since studies in this vein have not found support for the need to use separate explanatory models for initiation and persistence, scholars have largely abandoned the endeavor. Results from this study potentially re-open this debate. In models of marijuana initiation, we find significant correlations for the "usual suspects" from criminological theory, including prior delinquency, school and parental bonds, impulsivity, and gender. However, we also found that these correlates were often much less consequential in distinguishing between experimentation and persistence. Instead, consistent with the concept of cognitive transformation, we found strong evidence that changes in perceptions of marijuana as fun differentiated the two behavioral trajectories. In light of our results, we postulate that criminal career research has been hindered by inattention to factors that change at the point of behavioral onset, when situations of substantial uncertainty are re-evaluated given new information. Given our findings, we urge scholars to revisit the criminal career proposition with a focus on situationally specific cognitive processes surrounding initial offending experiences.

Although we focused our analysis on marijuana use, we posit that similar cognitive processes operate for other minor delinquent behaviors, all of which incorporate some sensual element of thrill, danger, or adventure [25, 35, 39]. Although substance use differs in important ways from other forms of delinquency (e.g., substances directly impact a person's physiology and drug use typically peaks in early adulthood versus adolescence), we argue that initial experiences with both behaviors are situationally defined and result in substantial cognitive transformations and strong potential for desistance. In other words, regardless of form, most adolescents experiment with problem behaviors and many do not continue after their initial exploration. Moreover, perceived psychic costs and rewards, whether they be thrill, pain, fear, or boredom, apply to all risky behaviors and likely vary substantially between individuals and over time. We expect that our findings are applicable across adolescent problem behaviors.

A limitation of our analyses is that it is unclear how representative our results are to all adolescents. PROSPER collects data only from predominantly White rural

communities, and our sample is generally more conventional than the broader PROSPER sample, complicating generalizability. However, it should be kept in mind that our theoretical interest is not on serious delinquents (who would likely be under-represented in our sample), but rather minor- and adolescent-limited delinquents, of which there are adequate numbers in our sample. Moreover, there is little reason to suspect that the processes that we examine, such as proximal marijuana perceptions and individual decisions to continue marijuana use over time, should vary dramatically by social context. We encourage further studies to replicate our findings across different samples but suspect that the patterns that we observe will be robust to such contextual variations.

Though the PROSPER study follows respondents over an extended age range, the variables that we are most interested in were only collected through the end of high school. This right censoring raises the issue that many of the adolescents that we label as “experimenters” may actually return to the behavior after the observation window. Although a valid concern, it is likely that such behavioral reuptake will be sporadic or intermittent rather than continuous use, resulting in respondent profiles that are closer to non-users than chronic or frequent users (Bushway and Paternoster 2013). Moreover, by focusing on the peak age range of initiation (and desistance), we are able to measure the pre- and post-initiation perceptions central to our cognitive thesis and generally unavailable to other researchers.

Data limitations require us to operationalize perceived psychic rewards with a single item. Ideally, we would want more detailed measures of marijuana’s psychopharmacological effects—such as euphoria, paranoia, laughter, hunger, and dizziness ([7] [1953])—and the emotions individuals attached to those experiences. We feel confident that our measure captures global perceptions of the marijuana experience, but future research would benefit from finer-grained measurement of marijuana perceptions before and after initiation.

It is also important to acknowledge that, over time and repeated use, addictive substances such as marijuana may result in neurological adaptations and the usurpation of the brain’s reward centers (i.e., tolerance and dependence) that predict continued use in the absence of perceptions of the substance as fun, “thrilling”, or “exciting” [22, 34]. Indeed, one of the criteria for a substance use disorder according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5: [2]) is “continued substance use despite having persistent or recurrent social or interpersonal problems caused or exacerbated by the effects of the substance.” Our argument is not that substance use is *forever* perceived as fun for persistent users, but rather that persistent users are more likely than experimenters to perceive *early use* as a fun activity.

Finally, regarding policy, our results suggest that interventions aimed at helping adolescents to downwardly adjust definitions of deviant behavior as they begin experimentation may be particularly promising. Although differences in the perceived rewards between persisters, experimenters, and non-users become substantial over time, the average adolescent in all of these categories is at most ambivalent about marijuana’s psychic rewards (i.e., even the average persister is not sure that marijuana use is fun). This means that there is an opening to redefine the behavior in a way that de-glamorizes the drug and further erodes its perceived rewards. The experimenter, who has experienced the drug and found it wanting, would be a strong ally in helping lower expectations among non-users and those at risk of persisting. Experimenters can

not only acknowledge their own preconceived notions and the attractiveness of experiencing a new behavior and taking risks, but also present the experience as anti-climactic and less interesting over time. A strategy focused on realistic perceptions of the drug's physiological and social consequences would then treat adolescents as agents capable of weighing the risks and rewards to make their own behavioral decisions. Lowering expectations for other first-time users, or those at risk of using, could alter perceptual trajectories in ways that keep use to short-lived experimentation.

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Appendix A

OLS regressions of change in perceptions of marijuana as fun

Variables	Model 1		Model 2		Model 3				
	<i>b</i>	SE	<i>b</i>	SE	<i>b</i>	SE			
Time-varying covariates ($t - 1$):									
Perceptions of MJ as fun	-0.77	***	0.04	-0.77	***	0.04	-0.74	***	0.04
Number of MJ friends	-0.05		0.06	0.02		0.07	0.02		0.07
Friends' mean fun perceptions	0.04		0.07	0.08		0.09	0.10		0.09
Friendship nominations received	-0.01		0.01	0.00		0.06	0.00		0.02
Delinquency	0.02		0.02	0.02		0.02	0.03		0.02
Alcohol use	0.05		0.09	0.04		0.09	0.25	*	0.10
Risk and sensation seeking	0.15	**	0.05	0.14	**	0.05	0.23	***	0.06
School adjustment and bonding	-0.21	*	0.09	-0.21	*	0.09	-0.21		0.11
Grades	0.06		0.05	0.07		0.05	0.04		0.06
Religiosity	0.07	*	0.03	0.07	*	0.03	0.06		0.04
Both biological parents	-0.14		0.09	-0.14		0.09	-0.13		0.09
Family relations	-0.15		0.12	-0.14		0.12	-0.10		0.12
Reduced price school lunch	-0.20		0.12	-0.19		0.12	-0.10		0.12
Wave	-0.04		0.03	-0.04		0.03	0.01		0.03
Time-stable covariates:									
Sex (1 = male)	0.06		0.09	0.06		0.09	0.04		0.09
Race (1 = White)	-0.23		0.14	-0.26		0.14	-0.24	*	0.11
Time-varying covariates ($t - [t - 1]$):									
Δ Number of MJ friends				0.08		0.05	0.08		0.05
Δ Friends' mean fun perceptions				0.07		0.06	0.06		0.06
Δ Friendship nominations received				0.02		0.02	0.02		0.02
Δ Delinquency							0.04	*	0.02

(continued)

Variables	Model 1		Model 2		Model 3	
	<i>b</i>	SE	<i>b</i>	SE	<i>b</i>	SE
Δ Alcohol use					0.23	** 0.08
Δ Risk and sensation seeking					0.18	** 0.05
Δ School adjustment and bonding					-0.16	0.09
Δ Grades					-0.14	* 0.06
Δ Religiosity					-0.04	0.05
Δ Both biological parents					-0.23	0.17
Δ Family relations					-0.04	0.13
Δ Reduced price school lunch					0.20	0.15
Constant	2.70	**	0.40	2.56	***	0.42
<i>F</i> value, <i>df</i>	43.97,16	***		2.69,3		11.42,9

Robust standard errors adjust for 53 community cohorts. $n = 1009$

* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests)

Appendix B

Discrete-time logistic regression of marijuana initiation with social rewards and moral costs

Variable	<i>b</i>		SE
Time-varying covariates ($t - 1$):			
Perceptions of MJ as fun	0.02	**	0.07
Social rewards	0.03		0.08
Moral costs	-0.28	***	0.05
Number of MJ friends	0.14	*	0.06
Friends' mean fun perceptions	0.32	***	0.09
Friends' mean social rewards	-0.11		0.10
Friends' mean moral costs	-0.07		0.08
Friendship nominations received	0.06	***	0.01
Delinquency	0.13	***	0.02
Alcohol use	1.00	***	0.08
Risk and sensation seeking	0.26	***	0.04
School adjustment and bonding	-0.13	*	0.06
Grades	-0.19	***	0.05
Religiosity	-0.05		0.03
Family relations	-0.23	**	0.09
Both biological parents	-0.32	***	0.07
Reduced price school lunch	0.03		0.09
Time-stable covariates:			
Sex (1 = male)	-0.18	*	0.07
Race (1 = White)	-0.14		0.11

(continued)

Variable	<i>b</i>		SE
Wave:			
2 (6th grade)	-3.57	***	0.61
3 (7th grade)	-2.70	***	0.60
4 (8th grade)	-2.20	***	0.60
5 (9th grade)	-2.01	**	0.60
6 (10th grade)	-2.09	***	0.59
7 (11th grade)	-1.81	**	0.59
8 (12th grade)	-1.61	**	0.58

Models include fixed effects for 53 community cohorts (not shown). $n = 23,169$ person-waves, 6146 persons
 $*p < .05$; $**p < .01$; $***p < .001$ (two-tailed tests)

Appendix C

Logistic regression of marijuana persistence with social rewards and moral costs

Variable	<i>b</i>		SE
Time-varying covariates ($t - 1$):			
Perceptions of MJ as fun	0.36	*	0.16
Social rewards	0.02		0.19
Moral costs	-0.35	**	0.12
Number of MJ friends	0.03		0.20
Friends' mean fun perceptions	0.02		0.29
Friends' mean social rewards	0.02		0.38
Friends' mean moral costs	0.05		0.25
Friendship nominations received	0.04		0.03
Delinquency	0.04		0.04
Alcohol use	0.30		0.23
Risk and sensation seeking	0.07		0.11
School adjustment and bonding	0.07		0.15
Grades	-0.27		0.09
Religiosity	-0.07		0.09
Both biological parents	-0.08		0.22
Family relations	-0.16		0.28
Reduced price school lunch	0.19		0.28
Wave	-0.26	***	0.07
Time-stable covariates:			
Sex (1 = male)	-0.06		0.20
Race (1 = White)	0.29		0.26
Time-varying covariates ($t - [t - 1]$):			
Δ Perceptions of MJ as fun	0.39	***	0.10
Δ Social rewards	-0.22	*	0.11

(continued)

Variable	<i>b</i>		SE
Δ Moral costs	-0.39	***	0.10
Δ Number of MJ friends	0.35	**	0.11
Δ Friends' mean intrinsic rewards	-0.15		0.16
Δ Friends' mean social rewards	-0.09		0.22
Δ Friendship moral costs	-0.06		0.21
Δ Friendship nominations received	0.01		0.04
Δ Delinquency	0.05		0.04
Δ Alcohol use	0.31		0.17
Δ Risk and sensation seeking	0.06		0.13
Δ School adjustment and bonding	0.29		0.19
Δ Grades	-0.31		0.16
Δ Religiosity	-0.11		0.07
Δ Both biological parents	0.25		0.38
Δ Family relations	-0.39		0.28
Δ Reduced price school lunch	0.27		0.34
Constant	2.26		1.39

Robust standard errors adjust for 53 community cohorts. $n = 997$ (12 cases lost due to missing data on social rewards and moral costs)

* $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed tests)

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