Published in final edited form as:
Addict Behav. 2008 September ; 33(9): 1154–1161. doi:10.1016/j.addbeh.2008.04.016.

Children taking risks: The association with cocaine and other drug use by young adulthood

Carlos F. Ríos-Bedoya[1], **Holly C. Wilcox**[2], **Marina Piazza**[3], and **James C. Anthony**[1]

1*Carlos F. Ríos-Bedoya, M.P.H., Sc.D., Assistant Professor, Michigan State University, B-108 Clinical Center, East Lansing, Michigan 48824, Phone: 517-884-0436, Fax: 517-355-7700, email: carlos.rios@hc.msu.edu*

2*Holly C. Wilcox, Ph.D., Assistant Professor, Johns Hopkins School of Medicine, The Johns Hopkins Hospital, CMSC 346, 600 N. Wolfe Street, Baltimore, MD 21287, email: hwilcox1@jhmi.edu*

3*Marina Piazza, MPH, Sc.D., Professor, Universidad Peruana Cayetano Heredia, School of Public Health, 430 Honorio Delgado Ave., Urb. Ingeniería, S.M.P., Lima, Perú, email: mpiazza@upch.edu.pe*

1*James C. Anthony, Ph.D., Professor and Chairman, Michigan State University, West Fee Hall B-601, East Lansing, Michigan 48824, Phone: 517-353-8623 ext. 100, Fax: 517-432-1130, email: janthony@msu.edu*

Abstract

In this report from a longitudinal study, the main aim was to evaluate the long-term predictive strength of a novel cartoon-based risk-taking trait assessment, which might prove to have utility in future research on mechanisms leading toward illegal drug involvement. The study population originated as 2,311 first-graders entering 19 elementary schools during two successive school years. The assessments started when the children were midway through primary school in the same school system. The key response variable was participants' use of cocaine by the time of a young adult assessment. We found that for each standard deviation increase in the risk-taking scale there was a two fold increase in the risk of becoming a cocaine user by young adulthood (estimated relative risk, RR = 1.9; 95% confidence interval, CI = 1.3, 2.7). Independently, onset of cannabis use by young adulthood also was predicted by risk-taking scale values, but use of legal drugs (alcohol and tobacco) was not. These long-span associations provide support for new research on very early risk-taking mechanisms that lead toward illegal drug involvement.

Keywords

risk-taking; cocaine; cannabis; children; longitudinal; drug initiation

1. INTRODUCTION

In this study the main aim is to estimate the strength of a suspected developmental association that links risk-taking traits with later drug involvement. The risk-taking trait has been measured via a novel cartoon-based assessment, originally devised and implemented in an epidemiological sample survey of pre-adolescent children (8–10 years old) having limited reading comprehension. In this evaluation, we estimate the degree of association that links the

childhood risk-taking trait as measured during or right after the primary school years to a multivariate profile of drug involvement responses by the time of follow-up assessments completed after the children had become young adults, age 20–24. A specific focus is onset of cocaine use by the young adult years, with other drug use constructs taken into account for comparative purposes.

Whereas the focal point of this study is onset of cocaine use by young adulthood, there is a rationale for studying other drug taking constructs that might be less well discriminated by a measure of children taking risks. For example, cumulative occurrence of cocaine use is at present statistically non-normative in the young adult population of the United States (US); by age 18–25, fewer than 20% have tried cocaine (United States, 2004). In contrast, a history of cannabis smoking is more frequent at slightly more than 50% prevalence (United States, 2004). A history of tobacco smoking occurs about 1.3 times more often than a history of cannabis smoking, with cumulative occurrence of tobacco smoking (at least one cigarette) at a level just above 70% (United States, 2004). Moreover, by age 18 an estimated 85% to 90% have consumed alcoholic beverages on at least one occasion (United States, 2004). On this basis, we can frame a hypothesis that onset of cocaine use by young adulthood might be more strongly linked to early risk-taking traits, with weaker or null associations for the legal drugs used in young adulthood. Zuckerman (1979) made similar statements regarding sensation seeking that have been confirmed in more recent studies (Crawford et al., 2003). However, quantification of strength of association can depend upon the choice of statistical approaches, many of which are margin sensitive. For this reason, we have chosen to use the odds ratio (OR) as the primary index of association. As explained by Bishop et al. (1975), the odds ratio, as a measure of association, is not margin sensitive. In this context, the size of the OR does not depend upon the marginal lower occurrence of cocaine use versus the marginal higher occurrence of alcohol use by the young adult years.

Conceptually, personality traits might influence preference or susceptibility for certain type of drugs. Cloninger biosocial model (Cloninger et al, 1993) postulates that an individual's preference for a specific type of drug is determined by the hypothesized combination of genetic and neurological bases of personality interacting with learning and environmental factors. Using this model as their framework Le bon and colleagues (2004) compared novelty seeking levels among controls, alcoholics and heroin addicts. Their findings indicate that both, alcoholics and heroin addicts, showed more novelty seeking than the controls. However, subdimension analysis found that heroin addicts were much higher on exploratory excitability (a concept more related to sensation seeking) than alcoholics. Their data support the hypothesis that certain personality traits have differential predisposition for specific classes of substances of abuse.

Prior studies of risk taking traits and drug involvement generally have been hampered by cross-sectional designs, which make it possible for drug-taking to influence levels of risk-taking propensities. Nonetheless, there is prospective research on several fronts, as illustrated in the work of Donohew and colleagues (1999), Brook and colleagues (1999), and Morojele and Brook (2001). Nevertheless, the prospective record of evidence that links risk-taking to later drug involvement generally has not started with measures of risk taking in childhood, nor has it extended to young adult use of cocaine.

When primary school samples have been studied, the resulting base of evidence is of limited scope and character—almost always cross-sectional and with small samples, rarely developmental, or even longitudinal. For example, Kennedy and Lipsitt (1998) studied risk-taking behavior among 74 preschool-age children from various ethnic backgrounds using standardized assessment instruments (i.e., the Injury Behavior Checklist), and found cross-sectionally that children who described themselves as high in risk-taking had higher levels of

accident and injury experiences. In a systematic replication using a sample of 45 Hispanic preschoolers, Kennedy and Rodríguez (1999) found that injury behaviors were not associated with the child's self-report of risk taking and daring behaviors.

At the time our research group was designing the present prospective study in the mid-1980s, we searched for brief standardized field survey measurements of risk taking traits that might be useful in large sample epidemiological research on children in middle primary school, most of whom had just started to read and to gain literacy. We found no suitable measure, which led us to devise a cartoon-based approach as depicted in Figure 1. The notes accompanying the figure provide the specifications we gave to our team of field survey interviewers. As shown, for this protocol, each child (during a private face-to-face interview) is asked to select a position on the wall from which he or she would jump to the ground. In 1990, when the children were age 9–10 years old, 17% selected position E on the wall, and 46% selected position A.

2. MATERIALS AND METHODS

This study builds from a program of epidemiology and prevention research initiated by Professors Sheppard Kellam, James C. Anthony, and colleagues at the Prevention Research Center of Johns Hopkins University School of Hygiene and Public Health, with research design and methods as described by Kellam & Anthony (1998), Kellam et al. (1991), and later collaborators who joined the research team (e.g., Chilcoat et al., 1995; Hunter et al., 1998; Ialongo et al., 1999; Storr et al., 2004a, 2004b, Wilcox & Anthony, 2004).

The basic design is that of a prospective and longitudinal study, with multiple waves of follow-up assessments after initial recruitment of an epidemiologically credible sample of children as they entered primary school in a single metropolitan area. Here, we focus upon the risk-taking traits measured midway through primary school (or shortly after primary school) as our key predictive or explanatory construct of interest, with other first grade constructs as control covariates (e.g., levels of child misbehavior as rated by first grade teachers).

The study population base was designated to include 2,311 first-graders entering 19 public elementary schools of a single school system during two successive school years (Cohort 1 entering in 1985 and Cohort 2 entering in 1986). All of these first-graders were residents of urban neighborhoods within the catchment area of this school system, which is located in the mid-Atlantic region of the United States. There was no sub-sampling: efforts were made to recruit all entering first-graders in these 19 schools.

Throughout primary school and middle school, assessors on the study team returned to this school system to secure an annual or biannual trace of teacher ratings and school achievement test scores for all children still growing up and going to school in the same school system. During the 1988–89 school year, when possible, face-to-face interviews were completed with each participating child. The risk-taking measure was administered during the second of these face-to-face interviews (Spring 1990), and during each subsequent face to face interview completed between 1990 and 1994.

The study protocol was reviewed and approved by the cognizant institutional review board (IRB) for protection of human subjects in research at Johns Hopkins. In addition, there was a school system ethics review and many principal-teacher-parent meetings to review the details of the protocol prior to its implementation. Ninety five percent of the parents consented to allow participation of their children (Kellam & Hunter, 1990). Once the children became young adults, our protocol for obtaining their verbal assent in childhood was converted to a protocol for securing signed consent, as per IRB stipulation. The result was some degree of sample attrition, discussed below.

Roughly 15 years after first grade assessments, during 2000–2002, nearly 75% of the surviving youths were traced and re-recruited. As stipulated by the IRB, signed informed consent was obtained for follow-up assessments of 1,692 participants in young adulthood, including 154 incarcerated participants. In quantitative terms, the main reasons we were unable to include all 2,311 first graders in the analysis sample for the present investigation were as follows: (1) it was not possible to locate the participant for follow-up assessment of cannabis involvement (n = 310), (2) the participant was located but was unwilling to sign an additional consent form and declined to be interviewed in young adulthood (n = 142), and (3) the participant was located but was living overseas (e.g., military posting) or too far away for completion of the face-to-face interview (n = 135). Through the National Death Index, we were able to confirm that 32 of the original 2,311 participants had died by the time of the young adult follow-up assessments completed in calendar years 2000–2002.

The key response variable in this study is a binary indicator for whether surviving participants had started to use cocaine by the time of the young adult assessments, which we also have termed onset of cocaine use. During each young adult assessment (approximately one year apart), participating youths were asked the following question “How old were you the first time you tried cocaine?” The response variable is coded as 1 for young adults who had tried at least one time, and is coded as 0 for never users. Analogous measures and coding approaches have been used to express the other three responses; onset of cannabis, tobacco, and alcohol use by the time of young adult assessment. Cocaine use tends to be highly interdependent with respect to cannabis, alcohol, and tobacco use (e.g., see Wagner & Anthony, 2002; Lynskey et al., 2004), as it is in this sample. This interdependency motivated us to turn to the GLM/GEE approach in our analysis plan.

The suspected causal determinant or covariate of central interest is risk taking behavior prior to the onset of legal and/or illegal drug use, as measured via our cartoon-based measure. There were 124 children who completed the risk-taking assessment on just one occasion, and an additional 1,539 children who completed the risk-taking assessment on more than one occasion (from 1990–1994). For those with more than one risk-taking assessment, we borrow information across the repeated risk-taking values in order to place each child on an underlying dimension of risk-taking, standardized to have a mean of 0 and a standard deviation of 1.0. The resulting risk-taking trait score has a 0.98 correlation with the factor score from a principal components analysis constrained to a single factor after casewise deletion. For those 124 children measured only one time on the risk-taking assessment, we have used that standardized measurement value in our analyses, in an effort to reduce missing values.

The initial guiding conceptual model was one in which the key response variable of interest — namely, the occurrence of the youth's first use of cocaine — was expressed as a function of the level of the primary school risk taking scale value, with statistical adjustment for several covariates, including male sex, age, and race of the youth at the time of entry into primary school, free or subsidized school lunch upon entry into first grade as a socioeconomic indicator, and first grade teachers’ ratings of childhood rule-breaking and misbehavior in the classroom, as described in Kellam & Anthony (1998). The choice of covariates for our conceptual model was guided by previous work in the area of youthful drug involvement (e.g., see Kellam & Anthony, 1998; Storr et al., 2004a; Wilcox & Anthony, 2004). Within the framework of this conceptual model, the youth's risk-taking trait value is conceptualized as a developmental forerunner with respect to onset of cocaine use and other drug use by young adulthood.

In order to complement the cocaine analysis, and to bring into play the multivariate conceptualization described in the study introduction, we re-estimated the strength of association that links childhood risk-taking level to onset of use of (a) cocaine, (b) cannabis, (c) tobacco, and (d) alcohol. As explained in the introduction, our expectation was that the

strength of association would be stronger in relation to illegal drug use (especially for cocaine) and weaker for tobacco and alcohol, even with the analyses based on an estimation approach that takes advantage of the odds ratio's margin-insensitive quality.

In an exploratory analysis, it has been possible for us to look into whether the observed association between risk-taking and occurrence of drug use might depend upon a possibly correlated trait — namely, a tendency to give socially desirable responses. This exploratory elaboration of our conceptual model was made possible because 1,305 of the participating youths completed an adapted version of the Paulhus socially desirable responding scale when they were 12–14 years old (Paulhus, 1984). This scale yields two factors, one for impression management (IM) and one for self-deception (SD). Cronbach alpha estimates for the IM and SD subscales were 0.5 and 0.7, respectively. The IM and SD subscales were standardized, divided in tertiles, and included as covariates in the full model.

In order to estimate the prospectively derived association between performance on this risk-taking measure and onset of cocaine use up to 12 years later, with comparisons to risk of onset of other drugs, we drew upon the generalized linear model and the generalized estimating equations (GLM/GEE). The response profile is multivariate, with allowances for interdependencies among binary indicators for cumulative occurrence with respect to four drugs: cocaine, cannabis, tobacco, and alcohol. The GLM/GEE approach addresses the interdependencies among the binary response variables with fewer parametric assumptions and other qualities that are superior to ANOVA and MANOVA when responses are binary (e.g., see Diggle et al., 2002). Via the logit link, this statistical approach yields the margin-insensitive odds ratio as an estimate of the strength of the association. The initial specification was for an exchangeable correlation matrix, but with robust variance estimation procedures that accommodate model mis-specifications. In subsequent exploratory analysis steps, the statistical approach involved refining and fitting terms for covariate adjustment as well as an effort to determine whether more than one slope might be required to summarize subgroup variation. For example, we also have evaluated whether the strength of association linking the youthful risk taking scale value to the occurrence of the first use of cocaine might vary across sub-groups of the study population (e.g., in relation to male-female differences in the strength of this association). This GLM/GEE approach has been described in a series of prior papers (e.g., see Andrade et al., 1994; Johnson et al., 2002; Chen & Anthony, 2003). All the analyses were done using STATA software, version 8.2 (Stata Corp, 2004)

In this work, p-values have not been applied as tests of statistical significance or for hypothesis-testing. Rather, we present and interpret the width of the 95% confidence intervals and the actual p-values as gauges for statistical uncertainty of the study evidence. Readers with a frequentist orientation may wish to pay more attention when p-values are below 0.05 and less attention when p-values are 0.05 or greater. These readers also may appreciate that a statistical power analysis shows that the study sample had at least 85% statistical power to detect quite modest relative risk estimates of size 1.25 or greater for binary covariates, with alpha set at 0.05.

3. RESULTS

Table 1 offers a description of the study sample. Racial/ethnic subgroups (mainly African-American) predominate in this sample, as is true for the school system as a whole. With respect to socioeconomic status, more than 50% of the sample qualified for free or subsidized lunch at entry to primary school. The mean age of the study sample was 8–9 years in 1989 and 13–14 years in 1994, with generally balanced male-female and cohort ratios.

We also found an excess risk for males of becoming a cocaine user or cannabis user or tobacco user by young adulthood (no male excess for alcohol). Race/ethnic group membership (being of Caucasian heritage) was associated with an increased risk of onset of all drugs by young adulthood. Receiving subsidized/free lunch in first grade was inversely associated with becoming a future user of cocaine, tobacco, and alcohol but no association was found for future cannabis usage. Finally, first grade teachers' ratings of rule-breaking and misbehavior in the classroom helped account for future onset of cocaine use, cannabis use, and tobacco use, but not for future alcohol use (Table 2).

The overall crude summary regression slope estimate, linking standardized levels of the child risk-taking trait to onset of cocaine use by young adulthood, conveys the impression of an association (estimated log odds ratio, $\beta = 0.9$; 95% CI = 0.5, 1.2; $p < 0.001$). Re-expressed as a relative risk estimate in Table 3, this slope value indicates that for each standard deviation increase on the risk-taking trait dimension, there is a corresponding 2.4 fold increased risk for onset of cocaine use by the young adult years (i.e., estimated relative risk, RR = 2.4; 95% CI = 1.7, 3.4; $p < 0.001$). There was some attenuation of this RR estimate when the regression model was extended to include covariate adjustment for sex, race, socioeconomic status, age, and teachers' ratings misbehavior in first grade (RR = 1.9; 95% CI = 1.3, 2.7; $p < 0.001$). A contrast of children draw from different tails of the risk-taking distribution indicates that for each 3.5 standard deviation separation between children, there was an estimated nine-fold excess odds of cocaine onset by young adulthood (adjusted RR = 8.9; 95% CI = 2.6, 30.5; $p < 0.001$).

The main risk estimates for the other drugs examined in this study also are presented in Table 3, based on the GLM/GEE statistical approach described in the methods section of this paper. The unadjusted RR estimates for cannabis, tobacco, and alcohol are as follows (cannabis RR = 1.9; 95% CI = 1.6, 2.2; $p < 0.001$; tobacco RR = 1.5; 95% CI = 1.3, 1.7; $p < 0.001$; alcohol RR = 1.4; 95% CI = 1.0, 2.0; $p = 0.07$). After covariate adjustment, there is some attenuation in all of these RR estimates. Furthermore, with covariates in the model, the tobacco and alcohol RR estimates become null by conventional frequentist standards (i.e., $p > 0.05$).

Another approach is to contrast the drug use experiences of children who consistently had placed themselves at position 'E' of the wall figure relative to those who had consistently placed themselves at position 'A'. Using this approach, and with the GLM/GEE model, we found that youths with consistent 'E' values, in all five assessments, were an estimated nine times more likely to try cocaine by young adulthood as compared to youths who consistently placed themselves at the lower end ('A' position) of the wall values (estimated relative risk, RR = 9.2; 95% CI = 3.7, 22.9; $p < 0.001$). This relative risk estimate was somewhat attenuated with covariate adjustment for sex, race, socioeconomic status, age at entry to primary school, and teachers' ratings of childhood misbehavior in first grade (RR = 5.2; 95% CI = 2.1, 12.9; $p < 0.001$; data not shown in a table). For cannabis onset by young adulthood, the corresponding unadjusted excess risk estimate is five-fold (RR = 5.2; 95% CI = 3.4, 7.8; $p < 0.001$; data not shown in a table). The following are the estimated relative risks for tobacco and alcohol (tobacco RR = 2.8; 95% CI = 1.9, 4.2; $p < 0.001$; alcohol RR = 2.3; 95% CI = 0.9, 5.9; $p = 0.07$; data not shown in a table).

In an exploratory analysis, we took into account the Paulhus socially desirable response standardized subscales in order to evaluate their possible influence on our observed association linking early risk-taking trait values to drug involvement by young adulthood. Social desirable responding (SDR) did not have a major impact on the strength of our association linking early risk-taking trait and drug involvement by young adulthood. For example, after covariate adjustment for SDR, the estimated RR estimate for cocaine use was 1.8 ($p = 0.001$) and the cannabis RR estimate was 1.5 ($p < 0.001$).

Exploratory analyses with respect to subgroup variation disclosed no appreciable male-female variation in the strength of association linking earlier levels of risk taking behavior to later risk of cocaine onset and cannabis onset, although males had larger risk-taking scores than females. For example, with respect to the risk-taking slope for cocaine onset, the observed 2.1 relative risk estimate derived for males in the sample was not appreciably different from the 1.9 relative risk estimate derived for females in the sample (95% CI = 1.3, 3.2 and 1.2, 3.8, for males and females, respectively). With respect to cannabis, for males in the sample, the observed relative risk estimate of 1.1 was very close to the 1.2 relative risk estimate derived for females in the sample. Virtually identical and null relative risk estimates for males and females were found when the response variables were coded for tobacco use and alcohol use (RR = 1.1 and RR = 1.0, respectively).

The final set of exploratory analyses (e.g., regression diagnostics, model selection) disclosed that the observed main study estimates were robust. For example, there were no overly influential observations. Similarly, our model selection was supported by several goodness of fit tests and model comparisons.

4. DISCUSSION

The main findings of this study may be summarized succinctly. First, as hypothesized, earlier levels of risk taking behavior, as measured by the cartoon-based risk-taking task, were associated robustly with later increased risk for onset of cocaine and cannabis by young adulthood. We speculate that the risk-taking measure may be more useful in future research on illegal or non-normative drug-taking behavior (cocaine, cannabis), less useful in research on legal or more normative drug-taking behavior in the young adult years. In this study, the prospective link from early risk-taking to later onset of tobacco and alcohol use was not statistically robust in the context of covariate adjustment, and the alcohol association might well be null ($p = 0.07$).

Some readers may be interested in subsidiary findings. For example, among the illegal and legal drug users, there were more males than females across all types of drugs except alcohol. Nonminorities (Caucasians), those ineligible for free or reduced lunch, and those with higher childhood misbehavior ratings were at generally increased risk for the onset of drug use by the young adult years.

Before detailed discussion of these results, several of the more important study limitations merit attention. First and of central concern are issues pertinent to follow-up and tracking, which always represent problems in longitudinal research within the United States, particularly when the human subjects committee stipulates a signed consent at each assessment visit. The response rate of nearly 75% by young adulthood is respectable when compared to other longitudinal studies in the U.S. and some other countries. However, we must acknowledge that incomplete participation in young adulthood might be associated with underlying predispositions or susceptibility factors of the type under study.

We also acknowledge the possibility of measurement error in relation to the key response variables, legal and illegal drug use, assessed via standardized self report interview measures under confidential (but not anonymous) conditions. Bioassays might have been used to validate self-report of recent drug use in adult community samples (e.g., see Colon, Robles & Sahai, 2001), but these assays were neither feasible nor affordable in this large sample longitudinal study. In addition, the chance of a false positive test might be larger than the prevalence of cocaine or cannabis in our study sample (Wells, Halperin & Thun, 1988).

Finally, we are the first to recognize that the term risk-taking trait is similar to what is often referred to as sensation seeking, novelty seeking, or risk seeking. Our cartoon-like

measurement with all likelihood is one behavior, among many, in which individuals high in this trait might engage. We are by no means trying to infer that our measurement of this complex construct is comprehensive or exhaustive. Furthermore, we are not making any claims about the reliability or validity of this single measurement of risk-taking behavior. Nevertheless, we think that our findings regarding this novel measurement deserve attention and more research is needed to either confirm or reject our results considering the potential clinical and preventive implications of our findings. In addition, it was suggested that an analysis focused upon age at onset of drug use might be a useful continuation of this line of research. We agree with this suggestion and a multivariate response survival analysis model is on our future research agenda.

Notwithstanding limitations such as these, the present study also possesses a number of counterbalanced strengths. For example, the epidemiologically credible sample and longitudinal study design help to constrain sources of bias and error that otherwise can complicate cross-sectional research on highly selected samples. The risk-taking trait always was measured at least six years before the young adult assessment of drug use, and the research team (and participants) were not aware that this association would be studied. The multivariate statistical methods used in this paper were used to derive modest but robust relative risk estimates and their respective confidence intervals.

Eligibility for free or subsidized lunch at the time of entry into first grade was included in this study's models as a control variable, but it was not expected to be a strong predictor of the occurrence of drug-taking among young adults in this study. First, this variable is a rather crude index of socioeconomic advantage (SES). Second, there was a long lag time from entry into first grade to the young adult assessment, with many opportunities and years for the socioeconomic status of the young people and their families to change as they progressed from first grade through the primary school and later years. Third, most of the literature about relationships between drug use and young adult SES is based upon the SES of the young adult and not the SES of the young adult at the time of entry into first grade. As such, we had not anticipated the observed association that links lack of eligibility for free or subsidized lunch (i.e., higher SES) with greater occurrence of drug use by young adulthood in this sample. This is an unexpected relationship that might prove to be a statistical fluke. Alternately, if replicated and confirmed by other research groups now conducting long-span longitudinal research in this same area of the country, it may be an indication of local area variation in longitudinal SES-drug use relationships, which might prove to be of interest from the sociological perspective.

By way of discussion, we note that we may never have complete knowledge of the complex underlying traits that might confound relationships of the type found in this study. In future randomized trials, it may be possible to manipulate risk taking levels experimentally, and then to assess impact of the hypothesized trait-modifying experimental intervention with respect to illegal drug involvement by young adulthood. Certainly, it is possible that interventions to reduce risk taking behavior might prevent or delay onset of drug use by young adulthood. For instance, the intervention might have a temporary effect on the timing of the first drug use, delaying that event until later years of adulthood. This delay may be of public health importance since earlier-onset of drug use has been linked to transitions to other drugs and to a more rapid progression to drug dependence (e.g., see Anthony & Petronis, 1995; Chen & Anthony, 2003; Wagner et al., 2005). Examples of randomized trials of this type, directed toward early conduct problems and misbehavior, have been reported by Kellam and Anthony (1998), Furr-Holden et al., (2004), Storr and colleagues (2004a), among others.

In conclusion, we found new evidence that a novel approach to measure risk-taking traits in primary school may help account for the occurrence of illegal drug use by young adulthood, with evidence of a less solid link from earlier risk-taking to later legal drug involvement. Future

experimental research can be used to probe the developmental and longitudinal facets of the long-term associations found in this research.

ACKNOWLEDGEMENTS

The authors wish to acknowledge generous support of this research program over a span of 20 years, including NIDA Grants K05DA015799, R01DA09897, R01DA04392, and T32DA007292, as well as NIMH grants R01MH042968 and P50MH038725, and FIC training award 5D43TW005819 which provided research support and training support. We would like to thank the children, families, and school system personnel who have participated in this study over the years. We also acknowledge collaboration of the Epidemiology & Biostatistical Core Program of the Ponce School of Medicine, (NIH Grant 2G12RR03050-18).

REFERENCES

1. Andrade L, Eaton WW, Chilcoat H. Lifetime comorbidity of panic attacks and major depression in a population-based study. Symptom profiles. British Journal of Psychiatry 1994;165:363–369. [PubMed: 7994507]
2. Anthony JC, Petronis KR. Early-onset drug use and risk of later drug problems. Drug and Alcohol Dependence 1995;40:9–15. [PubMed: 8746919]
3. Bishop, YMM.; Fienberg, SE.; Holland, PW. Discrete multivariate analysis: Theory and practice. Cambridge: MIT Press; 1975. p. 281-298.
4. Brook JS, Kessler RC, Cohen P. The onset of marijuana use from preadolescence and early adolescence to young adulthood. Developmental Psychopathology 1999;11:901–914.
5. Chen CY, Anthony JC. Possible age-associated bias in reporting clinical features of drug dependence: epidemiological evidence on adolescent-onset marijuana use. Addiction 2003;98:71–82. [PubMed: 12492757]
6. Chilcoat HD, Dishion TJ, Anthony JC. Parent monitoring and the incidence of drug sampling in urban elementary school children. American Journal of Epidemiology 1995;141:25–31. [PubMed: 7801962]
7. Cloninger CR, Svrakic DM, Przybeck TR. A psychobiological model of temperament and character. Arch. Gen. Psychiatry 1993;50:975–990. [PubMed: 8250684]
8. Colón HM, Rafaela RR, Sahai H. The validity of drug use responses in a household survey in Puerto Rico: comparison of survey responses of cocaine and heroin use with hair tests. International Journal of Epidemiology 2001;30:1042–1049. [PubMed: 11689520]
9. Crawford AM, Pentz MA, Chou CP, Li C, Dwyer JH. Parallel developmental trajectories of sensation seeking and regular substance use in adolescents. Psychology of Addictive Behaviors 2003;17:179–192. [PubMed: 14498812]
10. Diggle, P.; Heagerty, P.; Liang, KY.; Zeger, S. Analysis of Longitudinal Data. 2nd Ed.. New York: Oxford University Press; 2002. p. 142-159.
11. Donohew RL, Hoyle RH, Clayton RR, Skinner WF, Colon SE, et al. Sensation seeking and drug use adolescents and their friends: models for marijuana and alcohol. Journal of Studies on Alcohol 1999;60:622–631. [PubMed: 10487731]
12. Furr-Holden CDM, Ialongo NS, Anthony JC, Petras H, Kellam SG. Developmentally inspired drug prevention: middle school outcomes in a school-based randomized prevention trial. Drug and Alcohol Dependence 2004;73:149–158. [PubMed: 14725954]
13. Hunter AG, Pearson JL, Ialongo NS, Kellam SG. Parenting alone to multiple caregivers: child care and parenting arrangements in Black and White urban families. Family Relations 1998;47:343–353.
14. Ialongo NS, Werthamer L, Kellam SG, Brown CH, Wang S, et al. Proximal impact of two first-grade preventive interventions on the early risk behaviors for later substance abuse, depression, and antisocial behavior. American Journal of Community Psychology 1999;27:599–641. [PubMed: 10676542]
15. Johnson AL, Morrow CE, Accornero VH, Xue L, Anthony JC, et al. Maternal cocaine use: estimated effects on mother-child play interactions in the preschool period. Journal of Developmental and Behavioral Pediatrics 2002;23:191–202. [PubMed: 12177564]

16. Kellam SG, Anthony JC. Targeting early antecedents to prevent tobacco smoking: findings from an epidemiologically based randomized field trial. American Journal of Public Health 1998;88:1490–1495. [PubMed: 9772850]

17. Kellam SG, Werthamer-Larsson L, Brown CH, Mayer LS, et al. American Journal of Community Psychology 1991;19:563–584. [PubMed: 1755436]

18. Kellam SG, Hunter RC. Prevention begins in first grade. Principal 1990;70:17–19.

19. Kennedy CM, Lipsitt LP. Risk-taking in preschool children. Journal of Pediatrics and Nursing 1998;13:77–84.

20. Kennedy CM, Rodríguez DA. Risk taking in young Hispanic children. Journal of Pediatric Health Care 1999;13:126–135. [PubMed: 10531905]

21. Le Bon O, Basiaux P, Streel E, Tecco J, Hanak C, Hansenne M, Ansseau M, Pelc I, Verbanck P, Dupont S. Personality profile and drug of choice; a multivariate analysis using Cloninger's TCI on heroin addicts, alcoholics, and a random population group. Drug and Alcohol Dependence 2004;73:175–182. [PubMed: 14725957]

22. Lynskey MT, Health AC, Bucholz KK, Slutske WS, Madden PA, Nelson EC, et al. Escalation of drug use in early-onset cannabis users vs. co-twin control. Journal of the American Medical Association 2003;289:427–433. [PubMed: 12533121]

23. Morojele NK, Brook JS. Adolescent precursors of intensity of marijuana and other illicit drug use among adult initiators. Journal of Genetic Psychology 2001;162:430–450. [PubMed: 11831352]

24. Office of Applied Studies, United States. Results from the 2003 National Survey on Drug Use and Health: National Findings (DHHS Publication No. SMA 04-3964, NSDUH Series H-25). Rockville, MD: Substance Abuse and Mental Health Services Administration; 2004.

25. Paulhus DL. Two-component models of socially desirable responding. Journal of Personality and Social Psychology 1984;46:598–609.

26. Stata Corporation. College Station, TX: Stata Statistical Software: Release 8.2 Stata Corporation; 2004.

27. Storr CL, Reboussin BA, Anthony JC. Early childhood misbehavior and the estimated risk of becoming tobacco-dependent. American Journal of Epidemiology 2004a;160:126–130. [PubMed: 15234933]

28. Storr CL, Zhou H, Liang KY, Anthony JC. Empirically derived latent classes of tobacco dependence syndromes observed in recent-onset tobacco smokers: epidemiological evidence from a national probability sample survey. Nicotine and Tobacco Research 2004b;6:533–545. [PubMed: 15203787]

29. Wagner FA, Velasco-Mondragon HE, Herrera-Vazquez M, Borges G, Lezcano-Ponce E. Early alcohol or tobacco onset and transition to other drug use among students in the State of Morelos, Mexico. Drug and Alcohol Dependence 2005;77:93–96. [PubMed: 15607846]

30. Wells VE, Halperin W, Thun M. The estimated predictive value of screening for illicit drugs in the workplace. American Journal of Public Health 1988;78:817–819. [PubMed: 3381957]

31. Wilcox HC, Anthony JC. The development of suicide ideation and attempts: an epidemiologic study of first graders followed into young adulthood. Drug and Alcohol Dependence 2004;76S:S53–S67. [PubMed: 15555817]

32. Zuckerman M, Neeb M. Sensation seeking and psychopathology. Psychiatry Research 1979;1:255–264. [PubMed: 298353]

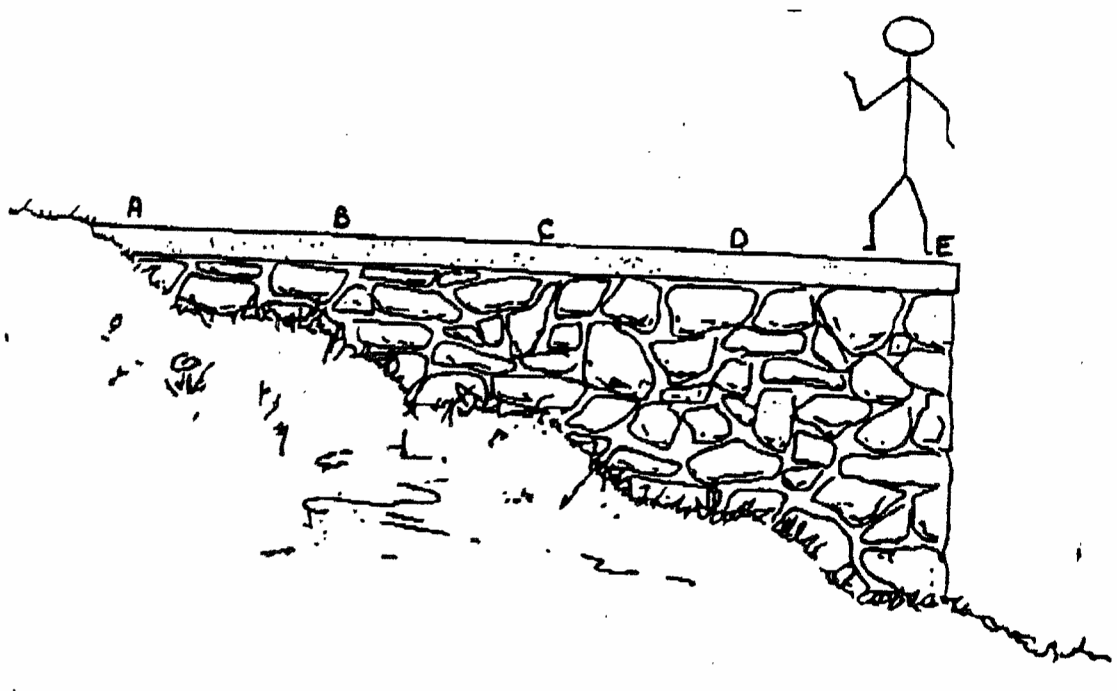

Figure 1.

Cartoon-based drawing presented to children from an urban school system, Mid-Atlantic region, United States: 1985–2002*

STANDARDIZED INTERVIEW SCRIPT READ VERBATIM BY INTERVIEWERS.

This is a cartoon drawing of a person walking along the top of a wall.

The places to jump down are marked A, B, C, D, and E.

You can see that the wall is very short at the place marked "A, where the grass grows right up to the edge of the wall.

And the wall is at least as tall as the person at the place marked "E' where the grass on the ground is quite a way down.

Now let's say this is a picture of you walking along the top of the wall.

The places where you can jump down are marked A, B, C, D, and E. Where along the top of the wall would you jump down?

(PROBE: Which letter marks the spot where you would jump down?)

Table 1

Characteristics of the baseline and follow-up samples among youth from an urban school system, Mid-Atlantic region, United States: 1985–2002[a]

	Baseline sample (first grade)		Young adulthood sample	
	No.	%	No.	%
Total	2,311		1,692	
Sex				
Female	1,160	50.2	902	53.3
Male	1,151	49.8	790	46.7
Disadvantaged minority group membership				
Minority (mainly African-American)	1,550	67.1	1,218	72.0
Nonminority (Caucasian, non-Hispanic)	761	32.9	474	28.0
Receipt of subsidized lunch in first grade[b]				
No	1,093	47.4	761	45.1
Yes (free or reduced-cost lunch)	1,212	52.6	927	54.9
First-grade cohort (year of entry to primary school)				
1 (1985)	1,196	51.8	856	50.6
2 (1986)	1,115	48.2	836	49.4
Childhood misbehavior rating[c]				
Lowest tertile	712	30.8	504	29.8
Middle tertile	688	29.8	514	30.4
Highest tertile	655	28.3	489	28.9
Missing data	256	11.1	185	10.9
Standardized Risk Taking Scale Values[d]				
Lowest tertile	547	23.7	443	26.2
Middle tertile	551	23.8	439	25.9
Highest tertile	565	24.5	445	26.3
Missing data	648	28.0	365	21.6

[a] Young adulthood data were obtained for 1,692 of the 2,311 participants originally recruited in 1985–1986 at the time of entry into first grade. Follow up was during 2000–2002 when the participants were ages 20–24.

[b] Data on the subsidized-lunch status of six children were missing at baseline.

[c] Childhood misbehavior was rated in the fall of first grade according to the Teacher Observation of Classroom Adaptation-Revised (Werthamer-Larson et al. 1991). Ratings of misbehavior were missing because students transferred to other schools or due to circumstances in which the teacher could not complete the ratings.

[d] Standardized risk taking scale data were missing because participants failed to answer this question in ALL five assessments (e.g., because students transferred to other school system.

Table 2

Estimates of unadjusted relative risk for becoming an illegal drug user or legal drug user by young adulthood among youths from an urban public school system, Mid-Atlantic region, United States: 1985–2002[a]

	Cocaine (n = 102 users)			Cannabis (n = 1,102 users)			Tobacco (n = 1,049 users)			Alcohol (n = 1,617 users)		
Covariate	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**	**RR**	**95% CI**	**p-value**
Sex												
Female	1.0			1.0			1.0			1.0		
Male	1.8	1.2, 2.7	0.006	2.8	2.3, 3.5	<0.001	2.0	1.7, 2.5	<0.001	1.0	0.6, 1.6	0.99
Disadvantaged Minority												
Minority	1.0			1.0			1.0			1.0		
Nonminority	18.1	10.4, 31.7	<0.001	1.3	1.1, 1.7	0.014	2.3	1.8, 2.9	<0.001	2.1	1.1, 3.9	0.02
Subsidized/free lunch in 1st grade												
No	1.0			1.0			1.0			1.0		
Yes	0.3	0.2, 0.4	<0.001	0.9	0.7, 1.1	0.161	0.7	0.6, 0.9	0.002	0.6	0.4, 0.9	0.04
First-grade cohort												
1985	1.0			1.0			1.0			1.0		
1986	1.1	0.7, 1.6	0.76	1.0	0.8, 1.2	0.879	1.0	0.8, 1.2	0.84	1.5	0.9, 2.4	0.11
Childhood misbehavior rating[b]	1.3	1.1, 1.6	0.012	1.6	1.4, 1.8	<0.001	1.3	1.1, 1.4	<0.001	1.1	0.9, 1.4	0.41

[a] Data were obtained from 1,692 participants; see footnote in Table 1. These estimates of relative risk are from the generalized linear model (logit link) with a generalized estimating equations approach to address interdependencies of the four binary responses (cumulative occurrence of drug-taking by young adulthood).

[b] Childhood misbehavior was rated in the fall of first grade according to the Teacher Observation of Classroom Adaptation-Revised (Werthamer-Larson, et al. 1991). Ratings of misbehavior were missing because students transferred to other schools or due to circumstances in which the teacher could not complete the ratings. Relative risk estimates are for every increase of one standard deviation above the mean of the standardized scale.

Table 3

Unadjusted and adjusted estimated[a] predictive association linking an early risk-taking trait with later drug use: Estimates for the relative risk estimates of youth risk taking and the risk[b] of becoming an illegal drug user and/or legal drug user by young adulthood among youths from an urban public school system, Mid-Atlantic region, United States: 1985–2002[c]

Model[d]	Cocaine			Cannabis			Tobacco			Alcohol		
	RR	95% CI	p-value	RR	95% CI	p-value	RR	95% CI	p-value	RR	95% CI	p-value
Unadjusted	2.4	1.7, 3.4	< 0.001	1.9	1.6, 2.2	< 0.001	1.5	1.3, 1.7	< 0.001	1.4	1.0, 2.0	0.07
Adjusted[a]	1.9	1.3, 2.7	< 0.001	1.5	1.3, 1.8	< 0.001	1.2	0.9, 1.4	0.09	1.2	0.8, 1.9	0.36

[a] Estimates are adjusted for sex, race, disadvantaged minority status, socioeconomic status, age, and teachers' ratings of childhood misbehavior.

[b] These relative risk estimates convey the magnitude of increased risk of drug use onset in association with each is for every increase of one standard deviation increase in the childhood risk-taking scale score value above the mean of the standardized risk taking scale.

[c] Data were obtained from 1,692. See footnote in Table 1.

[d] These multivariate model estimates of relative risk are from the generalized linear model (logit link) with a generalized estimating equations approach to address interdependencies of the four binary responses (cumulative occurrence of drug-taking by young adulthood).