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RISK, PROTECTION, AND VULNERABILITY TO ADOLESCENT DRUG USE: LATENT-VARIABLE MODELS OF THREE AGE GROUPS*

LAWRENCE M. SCHEIER†
University of California, Los Angeles

MICHAEL D. NEWCOMB
University of Southern California, Los Angeles

RODNEY SKAGER
University of California, Los Angeles

ABSTRACT

Much research has focused on the relationships between risk factors and adolescent drug use (DU). Less is known regarding the role of protective factors and how they may inoculate youth from initiating or escalating their DU. Using latent-variable modeling and a risk factor method, we examined the cross-sectional role of risk and protective factors in predicting teenage DU for three age groups, separately by gender. Data are from a biannual statewide survey of California students. A Vulnerability latent construct was reflected in three unit-weighted indexes: risk for initiation to DU, risk for problem DU, and protection from DU. A Polydrug Use construct was reflected in eight measures of alcohol and drug use. Structural equation models revealed that for all age/gender groups, Vulnerability was strongly related to Polydrug Use as well as having specific effects on the DU measures. Effects between Vulnerability and DU were more numerous for seventh and eleventh grade than ninth grade students. Ninth grade females had the fewest effects

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†Dr. Scheier is now at the Institute for Prevention Research, Department of Public Health, Cornell University Medical College, 411 East 69th Street, New York, NY 10021.

overall. Number of specific effects between protection and DU remained stable with increasing age. Results underscore two important foci for prevention: 1) the importance of considering age-related developmental phenomena in the overall context of DU prevention; and 2) that programs continue to emphasize risk reduction, while simultaneously developing and reinforcing protective agents.

A wide literature has been concerned with the correlates of drug use (DU) among youth. Many factors have been implicated in this research, although no single predictor can account for a substantially large proportion of variance in DU. As a result, prevention programs have relied on diverse theories to guide their attempts to mitigate adolescent DU. While research on correlates of DU has expanded our knowledge of the psychosocial, environmental, and sociological forces which may be potential intervention targets, evaluations of prevention programs have not been promising [1-3]. Moreover, both regional and national surveys of teenage DU indicate that recent declines in drug use are specific to some substances and subgroups, and in some cases are ever so slight [4-7].

The lack of a clear, consistent, and possibly unified approach toward understanding the etiology of teenage DU has stimulated the search for alternate theories and explanations. We briefly review one new approach, which utilizes a risk factor method to explain DU. We then integrate existing research on the role of protective factors in explaining DU, and present and test a more elaborate model, which examines the role of vulnerability (both risk and protection) on DU.

A RISK FACTOR APPROACH TOWARD UNDERSTANDING DU

One promising development toward elaborating the etiology of adolescent DU has been the multiple risk factor method [8]. This approach suggests that a unit-weighted index of risk factors will better predict DU than individual salient predictors. From this perspective, vulnerability increases with an increasing number of risk factors, such that individuals with greater vulnerability are more likely to engage in DU. In this regard, the precise nature of a risk factor diminishes in importance, whereas the sheer number of risk factors takes on added importance in determining vulnerability. This combined theoretical and methodological approach has been successful in explaining teenage DU both cross-sectionally [9-10] and prospectively [11-12]. More recently, Scheier and Newcomb have used two conceptually distinct unit-weighted risk indexes to predict prospectively onset to DU and more problematic DU [13-14].

THE ROLE OF PROTECTIVE INFLUENCES ON ADOLESCENT DU

The literature on protection, vulnerability, and adolescent DU is less clear and only recently developed. Few empirical studies of this type have been undertaken and these results are preliminary, rely on different methods, and do not necessarily share similar theoretical foundations [15-17]. From the few studies which have examined the role of protective factors in ameliorating both risk and DU, several important findings have emerged. For example, Brook, Nomura, and Cohen, found several protective factors that mitigated DU including, low conflict in school and a positive learning environment in which students and teachers were committed to learning [15]. In a separate study, Brook, Whiteman, Gordon, Nomura, and Brook found that peer risk influences to initiate alcohol use (i.e., peer drug use and peer deviance) was attenuated by the protective effects of personality (e.g., conventionality and achievement) and family factors (e.g., positive parent-child relationships and parental nonuse) [16]. These and other studies highlight the importance of protective factors as they both mitigate risk and attenuate DU [15-20].

Newcomb and Felix-Ortiz tested a combined risk and protective factor model of adolescent DU with prospective data [18]. They tested both moderating and direct effects of two unit-weighted indexes of risk and protection on adolescent and young adult DU. Results of this study indicate that both risk and protection and their interaction were highly associated with DU in adolescence and predicted changes in adult DU and drug problems. Importantly, Newcomb and Felix-Ortiz conceptualized protective factors consistent with prior notions of risk suggesting that, "protection may function in a manner similar to risk and should be operationalized as a multiple-factor index" [18, p. 281]. Moreover, one essential and important distinction they make regarding the role of protective factors is that their influences are not merely defined by the absence of risk, but, rather, by their ability to predict independent and unique pieces of variance in the criterion.

RELATIONSHIP OF VULNERABILITY TO DEVELOPMENT AND GENDER

The adolescent years represent both entry into and transition from middle to senior high school and are generally regarded as an important and often stressful development period [21]. These age periods present new developmental tasks consisting of cognitive, social, emotional, and physical growth [22-23] and are also a major time for initiation of DU behaviors [24-25]. Thus, it is important to learn more about how changes in normative psychosocial development coincide with changes in risk and vulnerability to DU. Along with their age-appropriate and culturally-anticipated developmental transition, it is also important to assess

whether these youth may encounter developmental changes which influence their vulnerability to DU [26]. In the present study, we examined the relationships between psychosocial risk and protective factors and DU in three age groups including seventh, ninth, and eleventh grade.

The trials and tribulations of adolescent growth also include experimenting with many new behaviors (i.e., dating, independence, employment). Some researchers have suggested that for many youth, experimental use of drugs use can be regarded as "normative" behavior consistent with adolescent development; however, little is known how processes of vulnerability influence these behaviors increasing or decreasing susceptibility for continued and problematic use [27-29].

For example, senior high students near graduation may face unique developmental tasks consistent with early trials at young adulthood. As they approach the end of compulsory education, they encounter new adult-like experiences including: career vocational and educational planning, long-term relationship commitments, greater exercise of formal reasoning, and possibly independence from home. Several researchers have shown with regard to DU behaviors these ages mark an important transition away from parental influences and a movement toward peer influences [30-32]. By examining data from distinct age-groups in adolescence we may capture important psychosocial influences (i.e., both risk and protective) operating during a possibly stressful developmental period from the beginning to the end of secondary school.

IMPORTANCE OF THE CURRENT STUDY

Notwithstanding the importance of these earlier risk and protective factor trials, several important questions remain unresolved. First, Brook and her colleagues mainly explored the role of protective factors in offsetting risk for alcohol initiation, so relatively little is known about relationships between risk and protective factors and other drugs (e.g., marijuana, cocaine, hard drugs), many of which are experimented with during the adolescent years. In the current study we expand upon the five DU measures we used in previous research (i.e., alcohol, cigarettes, marijuana, cocaine, and hard drugs), including measures of being high at school, freebase, cocaine, and multiple drug use (i.e., beer with cannabis). Thus we are able to provide a more detailed examination of the role of risk in promoting a larger set of DU behaviors, while similarly examining the role of protective factors in diminishing these same DU behaviors. Second, Newcomb and Felix-Ortiz greatly expanding upon current notions of vulnerability, however, they included only one index of risk, whereas previously we have demonstrated empirically the need for distinguishing risk for initiation from risk for a more problematic DU. Thus in the current study, all three indexes are examined simultaneously for their influences (both shared and unique) on DU behaviors. In addition, the sample size we use is considerably larger than those used in prior

research and provides the opportunity to examine developmental phenomenon specific to the adolescent years and separately by gender. With respect to gender differences in DU, most studies reveal that teenage males report higher prevalences of drug use than teenage females [4]. Multiple substance use patterns appear to be more equivocal between the sexes [33], however, clear differences in single substance use patterns have emerged in most studies [29, 34-36]. Based on these findings of gender differences and the likelihood that the psychoemotional maturation processes may differ for adolescent boys and girls, analyses by sex are appropriate in research on risk and protective factors [37].

Finally, several benefits are gained from using a risk factor method when compared to standard regression techniques [15]. For example, risk factor methods: a) include a wider array of predictions than models with uniquely identified predictors; b) avoid sample-determined optimal regression weights associated with unique predictors; c) regard predictors as equipotential for each individual; and d) utilize additive indexes, which capture interactions among predictors and enhance determination of heightened vulnerability without excluding important predictors.

METHODS

Sample

The California student substance use survey is administered biannually to seventh, ninth, and eleventh grade students in public schools under the sponsorship of the Office of the Attorney General. In the 1989/90 survey, eighty-seven public secondary schools (44 senior high and 43 intermediate schools) were selected according to a stratified, random sampling plan based on geographical, ethnic, socioeconomic, and school enrollment representation. Within each participating school, 15 percent of the students were randomly selected from the seventh, ninth, and eleventh grades and administered the survey. More extensive information on school selection and survey administration is presented elsewhere [6].

A total of 6,282 students responded to the anonymous questionnaire containing self-report items on DU, reasons to use and avoid DU, perceived parental attitudes toward DU, perceived friend's DU, experiences and behaviors related to DU (e.g., availability, purchasing), learned effects from school prevention efforts on DU, and sources of DU knowledge (e.g., parents, peers, media, siblings, school). For the most part, the seventh grade survey was a subset of the identical ninth and eleventh grade surveys. Items added to the ninth and eleventh grade surveys assessed deviance, grades, parent education, reasons why students take drugs, and perceived adult DU. A breakdown of the sample by ethnicity, grade, gender, and various background characteristics is shown in Table 1.

Table 1. Sample Description and Background Characteristics by Grade and Gender

	7th Grade		9th Grade		11th Grade	
	Female (N = 871)	Male (N = 916)	Female (N = 1108)	Male (N = 1083)	Female (N = 1166)	Male (N = 1281)
Ethnicity (%)[a]						
Asian	8.0	9.5	14.5	14.2	14.5	15.3
American Indian	4.5	3.7	3.7	3.6	3.1	2.6
Black	9.6	8.7	4.9	4.5	7.4	6.8
Hispanic	26.3	27.5	30.3	33.4	25.4	23.2
White	38.6	36.6	36.4	34.2	41.3	44.7
Other	13.0	14.0	10.2	10.1	8.3	7.4
Age (%)						
11	2.2	1.6				
12	72.1	61.7				
13	23.4	32.8				
14	2.3	3.9	64.5	65.0	1.1	0.7
15			29.5	30.0	1.8	1.3
16			5.9	5.0	59.8	63.2
17					31.9	30.0
18					5.4	4.8
Living situation[b]						
Both parents			67.8	67.5	61.7	63.7
One parent			27.7	27.4	29.6	28.8
Relative			2.4	2.4	5.1	3.6
Foster home			0.5	0.7	0.6	0.5
Other			1.5	1.9	3.0	3.4
Grade point average						
A			16.2	15.1	9.8	9.1
B			46.1	44.2	48.6	47.8
C			28.2	32.0	35.3	34.1
D			6.5	4.7	4.8	7.3
F			3.0	4.0	1.5	1.8
ADU measures[c]						
Alcohol use	45.7	54.0	64.6	60.6	76.3	75.8
Cigarette use	13.9	18.4	23.2	23.1	26.9	25.4
Cannabis use	5.2	8.5	20.2	18.2	30.8	29.8
Cocaine use	1.0	2.6	5.0	5.3	8.7	9.0
Hard drug use	15.2	18.2	18.6	18.9	24.5	24.5
Polydrug use	8.3	11.7	21.5	19.8	30.3	28.9
Freebase use	1.6	2.5	4.2	5.1	8.7	7.2
High at school	2.9	4.8	14.4	12.7	24.1	25.2

[a]Distributions for ethnicity were representative of statewide enrollment (cf. California State Department of Education, The California Basic Educational Data System (CBEDS), Racial or ethnic distribution of staff and students in California public schools, 1988-89).
[b]Some items present in 9th and 11th grade version only.
[c]Percentages indicate proportion of students reporting ever used.

Drug Use Scales

Eight DU scales were used. Five measures were selected from an ongoing longitudinal investigation of adolescent and adult DU [38]. These included alcohol (average of beer, wine, and liquor), cigarettes, cannabis (average of marijuana and hashish), cocaine, and a composite of hard drugs (i.e., amphetamines, psychedelics, barbiturates, sedatives, tranquilizers, inhalants, PCP, heroin, and other narcotics). Response formats for these items ranged from "never" (1) to "more than once a day" (7) and assessed frequency of use over the past six months (except for cigarettes which was on a 7-point anchored scale from "never" to "more than a pack a day"). Three other items included: Frequency of multiple drug use (e.g., beer with cannabis); freebase cocaine (i.e., crack, rock, or gravel) both rated from "never" (1) to "more than ten times" (5); and being high at school, rated from "never" (1) to "more than six times" (4). These items were also included as DU measures.

All eight DU scales were used for each group to reflect a latent construct of Polydrug Use. Several researchers have provided empirical support for the use of a latent construct of Polydrug Use to capture the general tendency to use multiple drugs [31, 38, 39]. By using a latent factor of Polydrug use we are able to capture the common variation among several substances, reflective of situations, for example, when youth smoke cigarettes or marijuana and drink alcohol in combination. In addition, we also tested effects of specific vulnerability to drug effects for the eight measures of DU not captured by the construct of Polydrug Use. These nonstandard or unique effects, capture specific residual covariation (as regression paths) between the risk and protection indexes and the eight separate measures of drug use [38, 40, 41].

Theoretical and Empirical Basis of Assigning Risk and Protective Factors to Their Respective Indexes

We used a combined theoretical and empirical basis for assigning risk factors to their respective indexes. Previously, we reported a method based on theory and existing research for assigning risk factors to two conceptually distinct risk indexes [13-14, 42]. This earlier research presented a conceptual framework from which to assign risk factors. However, we expanded our theoretical arguments to cover more risk and protective factors available in the current data. This greater integration of theory into the assignment process supports wider generalizability and validation.

Overall, we classified and assigned risk and protective factors using four major theoretical systems including: environmental [43], problem [44], developmental progression [45] and interactional [46]. We also included more recent empirical findings with a greater emphasis on social influence and differential association [47-49], peer cluster [50-52], and self-derogation theories [19, 53-56]. While each of these respective theories has increased considerably our current knowledge

We also separated risk and protective factors for the older (9th and 11th grade) students according to how well they measured social-control or conformity to conventional behavior. Hirschi used four elements; attachment, commitment, involvement, and belief to characterize the strength of adolescent's bond to society [65]. Failure to bond leads to an overriding sense of self-rejection, disenfranchisement and alienation from normative institutions [54-56]. In many cases, traditional peer groups are replaced with deviant associations which promote and are more tolerant of delinquency and DU [66]. The literature is clear on linkages between deviance (reflecting lack of conformity) as a strong risk factor for problem DU, thus we assigned a multi-item deviance scale to RFPROB [44, 48, 66-67].

Much attention is placed on the role of disrupted home situations and lack of family cohesion in promoting DU [68-71]. Loss of family functioning through separation, divorce, or loss can induce some youth to turn to DU as a potential coping mechanism to relieve affective distress and turmoil. Because attempts to use drugs as a palliative coping mechanism (i.e., reducing negative affect) may be part of (negative) instrumental learning and can promote exacerbated DU, we assigned a single item that assessed the current living situation of these youth to RFPROB. Parent drug-related attitudes and DU are related to adolescents initiating DU and we assigned a multi-item scale assessing exposure to adult DU to RFINIT [15, 16, 45, 72].

Seventh Grade Analyses

In addition to those risk factors already mentioned, the seventh grade survey also contained items assessing perceived parents' attitudes toward DU, sources of knowledge regarding DU, exposure to prevention education, several items assessing what students learned from school classes about the consequences of DU, and several items assessing behaviors related to DU (e.g., "have you ever been in a car with friends who were drinking while driving?").

A number of questions (e.g., reasons to avoid alcohol and drugs, what you have learned from school prevention activities?) were dichotomous items. We examined correlations between each of these items separately and the eight DU measures. Where four or more correlations between a potential risk or protective factor and any of the eight DU measures were significant, the factor was retained for further analyses. Additionally, composite scales were formed for several variables. Both principal components and common factor analysis, the latter using maximum likelihood extraction and promax rotation, were used to determine scale composition. Several categorical items (e.g., "where did the money for buying drugs come from?", and "where were you the first time you tried a drug other than alcohol?") were rescaled to "0" for no-risk (corresponding to never bought and never used) and "1" for risk (e.g., using money from any source to buy drugs and using drugs in any situation) on an a priori basis. From the original forty potential

risk and protective factors included in the survey, seventeen were retained as risk and protective factors for subsequent analyses.

We conducted multiple regression analyses separately for the eight DU measures as outcomes and the seventeen risk and protective factors as predictors. Using block entry, risk and protective factors which contributed unique and significant variances to *any* of the eight criterion were retained. Multiple *R*'s for the eight DU measures ranged from .07 for frequency of cocaine use to .39 for frequency of alcohol use. The resultant sixteen significant risk and protective factors were then dichotomized using an extreme 20th percentile solution [10, 12-13]. Thus, for risk factors, the upper 20 percent of a distribution received a "1" for being "at-risk," while the remaining portion of the distribution received a "0." Conversely, for protective factors, the lower 20 percent of a distribution on a risk factor received a "1" designating protection while the remaining portion of the distribution received a "0." Certain factors were positively scaled toward protection (e.g., reasons to avoid using drugs) and for these factors the upper 20 percent received a "1."

Prior to the separation of risk factors into the initiation and problem risk indexes we computed average absolute correlations (AC) between the risk and protective factors and the eight measures of DU. To avoid potential multicollinearity between the indexes where a single item or composite scale produced both a risk factor and protective factor, the factor with the highest AC with the DU outcomes was retained. Table 2 contains the final set of risk and protective factors (for all age groups) and indicates percentages considered "at-risk" or "protected" for each factor.

Ninth and Eleventh Grade Analyses

There was considerable overlap between the seventh grade and high school (9th and 11th grade) surveys. Where items were identical we formed composites for ninth and eleventh grades the same as the seventh grade. A few composite indexes for the older students were created due to the similarity and high intercorrelations among several sets of items. Four items assessed adult use of alcohol, marijuana, pills, and hard drugs and were summed into composite scales. Six items assessed deviance (cutting class, being expelled, arrested, put on probation, getting into trouble with the police or excessive absenteeism from school) and were formed into a unit-weighted deviance scale.

Eleven items tapped how learning about alcohol and drugs affected students' decisions regarding alcohol and drug use. One item ("what I have learned has not affected me") overlaps with one of the school prevention items ("I have learned nothing about alcohol and drugs from school") and was deleted. From the remaining ten dichotomous items, we formed a unit-weighted index assessing positive learning influence from school alcohol and drug education (factor analysis empirically supported this unidimensionality).

Again we conducted regression analyses for both ninth and eleventh grade using block entry with twenty-seven risk and protective factors as the independent predictors and the eight DU measures as dependent measures. Proportions of variance accounted ranged from 17 percent for crack (freebase) to 51 percent for alcohol for the ninth grade and 17 percent for freebase to 51 percent for being high at school for the eleventh grade. The same assignment scheme from the seventh grade was used for ninth and eleventh grades, with the addition of the new scales contained in the high school survey.

Analysis Procedure

Both confirmatory factor analysis (CFA) and latent-variable structural equation models (SEMs) were used implemented with the EQS statistical program [73]. Path SEMs were tested even though the data were cross-sectional. The directional paths in these analyses test hypothesized direct effects from the latent construct of Vulnerability to Polydrug Use. While a more conservative approach would simply study correlations and avoids causal inferences, such an approach does not partition the shared variances among the indicators of Vulnerability (RFINIT, RFPROB, PROTECT) and Polydrug Use. SEM path regressions more directly address the research questions, since the regression paths indicate unique variances associated with the effects of Vulnerability on Polydrug Use, as well as the effects of risk (both RFINIT and RFPROB) and PROTECT on increased or decreased Polydrug Use, when controlling for the general effect of Vulnerability [41].

RESULTS

Mean Differences on Risk and Protective Indexes

As expected, the distributions for the risk and protective indexes were positively skewed with fewer students having greater numbers of risk or protective factors. This characteristic was observed for all age and gender groups. Two-way analysis of variance (ANOVA) was used to test for gender and grade main effects and the gender x grade interaction on the three indexes. Significant interactions were found for RFINIT, $F(2,6419) = 6.17$, $p < .05$, and PROTECT, $F(2,6419) = 5.33$, $p < .01$ (all indexes were standardized to a mean of 0 and standard deviation of 1 to account for differences in number of items). Significant main effects were also observed based on gender for RFINIT, $F(1,6419) = 4.35$, $p < .05$; and PROTECT, $F(1,6419) = 5.32$, $p < .05$. Female seventh graders had the highest means overall for all three indexes, while male eleventh graders had the lowest means overall for all three indexes.

Table 2. Percentage at Risk (or Protected) for Risk and Protective Factors: By Grade and Gender

	7th Grade		9th Grade		11th Grade	
	Female (871)	Male (916)	Female (1108)	Male (1083)	Female (1166)	Male (1281)
Protective Index						
Not learning about ADU from one's own or friend's use	69.7	70.9	44.6	41.6	37.2	34.3
Exposure to school-based prevention education	92.7[a]	86.8	11.8	11.5	10.1	9.8
Reason to avoid ADU—lose close friend	45.7	33.0	—[b]	—	—	—
Parent's attitude toward alcohol use	73.6	71.1	—	—	—	—
Parent's attitude toward marijuana use	93.0	90.9	—	—	—	—
Reasons why kids use alcohol and drugs	—[b]	—	24.4	24.5	25.1	26.6
Involvement in prevention activities	—	—	21.6	23.0	19.8	20.8
Parent educational level	—	—	25.9	23.3	28.7	30.4
Already decided not to drink alcohol or use drugs	—	—	30.3	31.9	24.3	26.0
Initiation Risk Index						
Where you tried a drug for the first time	15.4	17.1	25.8	24.6	41.4	42.2
Difficulty of getting marijuana or drugs	25.7	23.8	33.6	34.5	50.5	50.6
Frequency of best friend's alcohol use	33.8	35.5	—	—	—	—
Frequency of best friend's marijuana use	11.5	14.2	—	—	—	—
Consequences of frequent use of alcohol	21.8	24.9	—	—	—	—
Consequences of frequent use of marijuana	18.1	25.7	—	—	—	—
Obtain knowledge of ADU from parents, school, and media	12.4	21.6	—	—	—	—
Notice other students coming to school high	—	—	18.1	18.4	29.2	29.8
How many adults you know involved in ADU	—	—	34.3	36.0	47.2	45.3
Most kids use alcohol or other drugs to have fun	—	—	44.6	42.5	61.3	60.7
Most kids use drugs at school/ with friends outside school or parties	—	—	13.7	15.5	19.6	21.1

Table 2. (Cont'd.)

	7th Grade		9th Grade		11th Grade	
	Female (871)	Male (916)	Female (1108)	Male (1083)	Female (1166)	Male (1281)
	Problem Risk Index					
Where do you get the money to buy alcohol and drugs?	6.2	8.6	12.3	10.7	23.5	23.2
Been in car with friends who are drinking and driving	20.7	23.8	21.8	23.1	37.7	36.8
Reasons to avoid using alcohol and other drugs	9.0	14.4	8.1	7.2	6.5	7.6
Most kids get drugs at school (e.g., friends)	25.3	19.9	—	—	—	—
Best friends in trouble at school or drop out of school	—	—	18.7	22.2	26.8	26.9
How best friends would act toward a friend loaded on alcohol/drugs	—	—	19.6	20.3	30.1	32.2
Deviance scale	—	—	24.4	24.1	35.7	34.5
Interested in school	—	—	20.4	20.0	17.9	20.3
Grade point average	—	—	9.5	8.7	6.3	9.1
Not learned anything from school prevention programs	—	—	11.0	9.7	8.7	8.6
Think about quitting school for job/family responsibilities	—	—	27.7	28.1	35.8	34.2
Family living situation	—	—	32.2	32.5	38.3	36.3

[a]This item negatively worded (not exposed to education) for 7th grades.
[b]Some factors present in 7th grade version only, while others present in 9th and 11th grade version only.

Confirmatory Factor Analyses (CFA)

Figure 1 presents the generic model for our CFA analyses. Standardized factor loadings and correlations among the risk and protective indexes and Polydrug Use for all grades by gender are contained in Table 3. Across all three age groups, factor loadings for cannabis, cocaine, hard drugs, freebase, and being high at school are substantially higher for ninth and eleventh grades than seventh graders. This pattern is consistent for both males and females.

There are some minor differences in factor loadings between males and females. Given the size of the respective samples, however, these differences appear to be slight and may not be practically significant. Overall, seventh grade DU is best characterized by alcohol, cigarettes, and cannabis use. Polydrug use in grade seven principally reflected use of these three substances in combination.

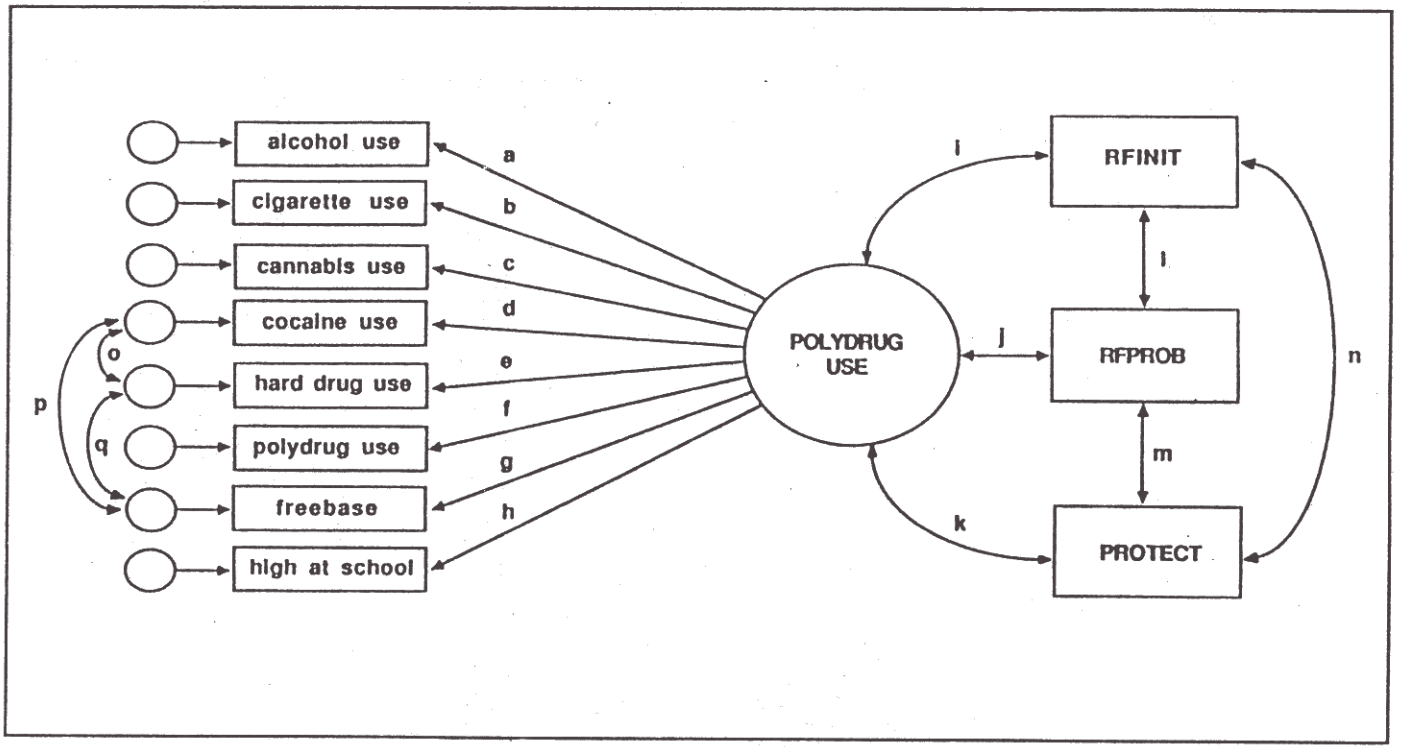

Figure 1. Confirmatory measurement model depicting associations among three indexes and latent construct of Polydrug Use. Large circle is latent factor; rectangles are measured variables. Double-headed arrows are covariances; small circles with unidirectional arrows are residual variances. Letters designate standardized parameter estimates corresponding to Table 3.

Table 3. Confirmatory Factor Analyses Results by Grade and Sex: Polydrug Use Factor Loadings and Correlations among Risk and Protective Indexes and Polydrug Use

	7th Grade		9th Grade		11th Grade	
	Male	Female	Male	Female	Male	Female
Polydrug Use Factor Loadings[a]						
Alcohol (a)[b]	.750	.768	.742	.734	.668	.668
Cigarettes (b)	.590	.642	.651	.708	.650	.589
Cannabis (c)	.614	.641	.819	.827	.836	.833
Cocaine (d)	.330	.293	.529	.485	.530	.542
Hard drugs (e)	.484	.395	.674	.608	.636	.610
Polydrug (f)	.711	.647	.767	.797	.822	.828
Freebase (g)	.365	.300	.526	.428	.441	.472
Being high at School (h)	.604	.565	.742	.784	.774	.783
Correlations among Indexes and Polydrug Use						
Poly, RFINIT (i)	.69	.67	.55	.62	.59	.62
Poly, RFPROB (j)	.63	.58	.69	.71	.68	.71
Poly, PROTECT (k)	−.38	−.40	−.15	−.24	−.26	−.23
RFINIT, RFPROB (l)	.58	.49	.47	.54	.54	.53
RFPROB, PROTECT (m)	−.20	−.26	−.18	−.26	−.27	−.29
RFINIT, PROTECT (n)	−.49	−.47	−.09	−.12	−.15	−.14
Correlations among Residual Drug Use Variances						
Cocaine, hard drugs (o)	.46	.26	.29	.46	.30	.39
Cocaine, freebase (p)	.22	.59	.33	.46	.32	.34
Hard drugs, freebase (q)	.26	.19	.25	.50	.32	.33

[a]Parameter estimates are standardized, signifcance level determined by z-critical ratio. All parameter estimates significant at $p < .001$.
[b]Letters in parentheses correspond to Figure 1.

Qualitatively, the factor loadings for ninth and eleventh graders across males and females were extremely comparable and no real observable patterns to characterize or distinguish their DU emerged.

Developmental Differences in Polydrug Use

Several specific comparisons across age groups and within substance categories (i.e., 7th grade alcohol use vs. 9th and 11th grade alcohol use) are worth noting. With the exception of alcohol, and grouping ninth and eleventh graders together, all the factor loadings steadily increased in magnitude with age. For the older students the increasing magnitude of the factor loadings for cannabis, cocaine,

hard drugs, multiple drug use, and being high at school probably reflects greater diversification with DU and thus greater inclination to use a wider array of substances as part of their Polydrug Use.

Average absolute differences (AAD) between factor loadings were essentially equivalent for gender comparisons (male versus female) within grade (average differences among all grades was .04), however, these differences increased for gender-specific comparisons across grade. For example, the AAD for seventh grade males compared to ninth grade males was .13, while the same comparison for females was .15. The same pattern was observed between seventh and eleventh grade males (AAD = .13) and females (AAD = .17). From ninth to eleventh grade the AAD was identically .04 for males and females. Overall, these differences underscore that some growth and differentiation occurs between seventh and ninth grades with respect to types of DU and the characterization of Polydrug Use, although these behaviors were quite similar (and thus possibly stable) between ninth and eleventh grade and there were few differences emerging between males and females.

Associations Between Risk and Protection and Polydrug Use

The lower portion of Table 3 contains the intercorrelations among risk and protective indexes and Polydrug Use. Across all grades Polydrug Use was strongly and positively correlated with both risk indexes and more moderately and negatively with the protection index. The strongest association between PROTECT and Polydrug Use was for seventh grade females, while the weakest association was for ninth grade males. Risk for initiation was more strongly associated with PROTECT than RFPROB for seventh graders (for both males and females). This pattern reverses for ninth and eleventh grade students for whom PROTECT and RFPROB are more strongly associated than are PROTECT and RFINIT (for both males and females). Overall, the associations among indexes and between indexes and Polydrug Use serve as a validity check reinforcing our conceptualization of risk and protection.

Also depicted in Table 3 are several a priori correlations between residual variables. These residual covariances capture specific associations not entirely reflected in the latent construct of Polydrug Use and likely represent a proclivity to experience similar pharmacological effects from different substances (i.e., cocaine and crack [14, 74]).

CFA and SEM fit indexes are contained in Table 4. None of the CFA models achieved nonsignificance ($p > .05$), indicating that further modifications (i.e., fine tuning) may be considered. However, by several other model fit criteria these models are adequate [75-76]. The significant versus nonsignificant model fit criteria may not be appropriate for these analyses. That is, large samples and increased power make it extremely difficult to fit the real sample data to the hypothetical model [77-78]. We decided to conduct any further modifications and

Table 4. Results of Initial and Final Confirmatory Measurement and Structural Path Models: By Sex and Grade

	N	χ^2	*df*	CFI[a]
Confirmatory Factor Model (3 Indexes)				
7th grade females	871	267.22	38	.923[b]
7th grade males	916	352.86	38	.906
9th grade females	1108	286.69	38	.957
9th grade males	1083	272.18	38	.953
11th grade females	1166	240.36	38	.964
11th grade males	1281	294.07	38	.958
Confirmatory Factor Model (Vulnerability)				
7th grade females	871	290.46	40	.915
7th grade males	916	393.10	40	.895
9th grade females	1108	304.91	40	.955
9th grade males	1083	277.91	40	.952
11th grade females	1166	264.67	40	.960
11th grade males	1281	305.00	40	.956
Structural Path Model (Vulnerability)				
7th grade females	871	92.98	26	.977
7th grade males	916	144.30	23	.964
9th grade females	1108	139.31	33	.982
9th grade males	1083	127.65	30	.980
11th grade females	1166	89.15	26	.989
11th grade males	1281	71.48	24	.992

[a]Comparative Fit Index (CFI), a sample size adjusted analogue to the Normed Fit Index which indicates the amount of variation and covariation accounted for by the hypothetical model in the sample data.
[b]All models significant at $p < .001$.

model fine-tuning as part of the SEMs, which more appropriately addresses the research hypotheses.

Structural Equation Models

Next we conducted a series of SEMs separately for each grade and gender. Figure 2 presents the generic model for these SEM analyses and depicts latent constructs of both Polydrug Use (as in Figure 1) and Vulnerability (reflected in the

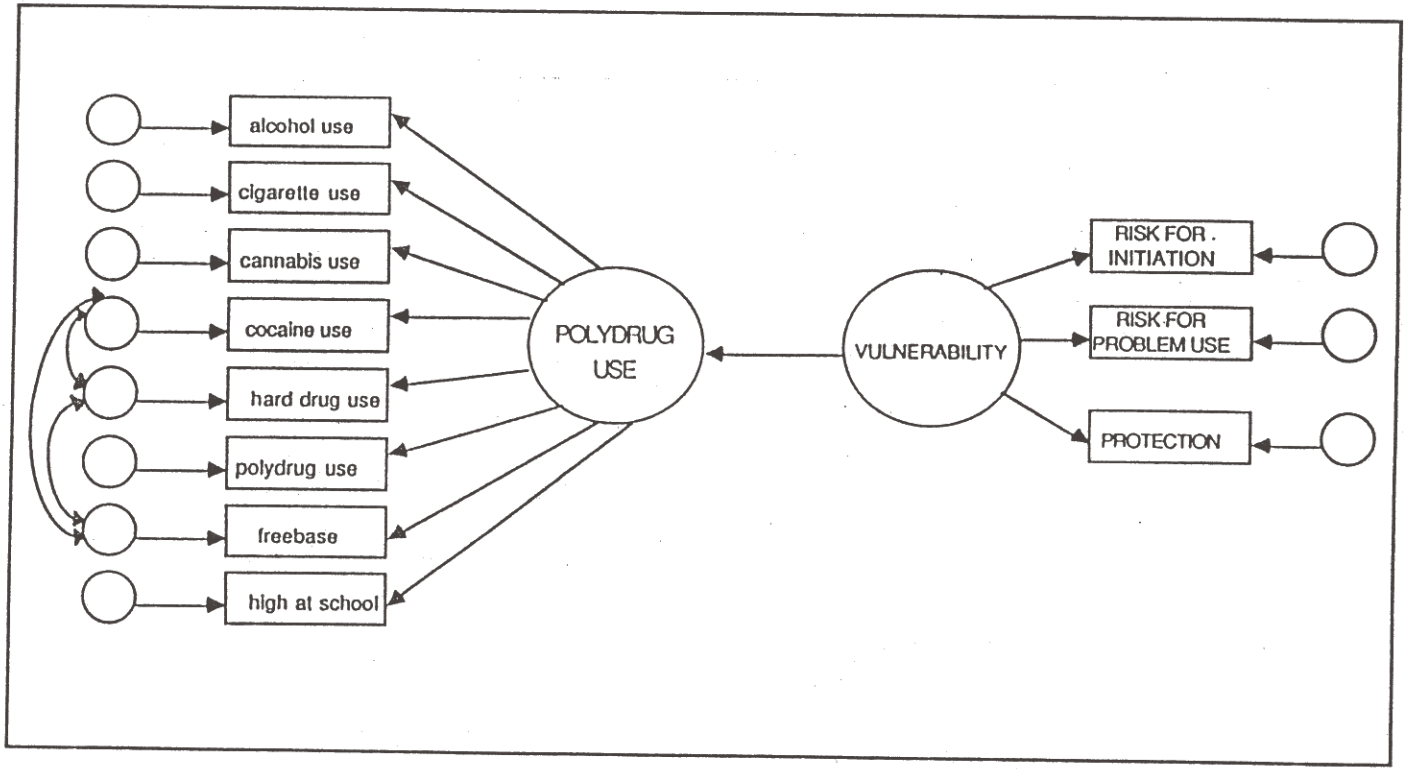

Figure 2. Structural model depicting regression paths from Vulnerability latent construct to Polydrug Use. Single-headed unidirectional arrows represent causal paths. Regression coefficients for hypothesized and nonstandard effects are contained in Table 5.

Eleventh Grade

The number of effects for eleventh graders (both males and females) was similar to the seventh graders. Vulnerability increased alcohol, cigarettes, cannabis, and multiple drug use for females, and increased alcohol, cigarettes, cocaine, multiple drug use, freebase use, and being high at school for males. The protection index decreased alcohol use and being high at school for females, and decreased alcohol and Polydrug Use for males. Risk for initiation increased alcohol and freebase use, being high at school, and Polydrug Use for females, and increased alcohol and cannabis use, being high at school, and Polydrug Use for males. Risk for problem use increased cocaine and freebase use, increased being high at school, and Polydrug Use for females, and increased cigarettes, cannabis, cocaine, and hard drug use for males.

Comparisons Across Age Groups

Specific (unique) effects between PROTECT and the DU measures remained fairly stable in number across the age groups. Interestingly, the size of the regression coefficients associated with the paths from PROTECT to DU never exceeded .10, and in comparison to RFINIT and RFPROB, were much smaller in magnitude for all grades. By far the largest effect size both within and across grades was from RFINIT to being high at school for seventh grade females (beta = .63) and males (beta = .84). The greatest number of effects from all three indexes across all grades were for alcohol (14), being high at school (12), and cigarette use (11), followed by multiple drug use and Polydrug Use. For the most part, and except for being high at school for seventh graders, the larger effects across grades included paths from Vulnerability to alcohol, cigarette, and multiple drug use, and RFPROB to Polydrug Use (or multiple drug use).

DISCUSSION

An important component to developing successful, rational, and heuristic DU prevention programs includes obtaining greater clarity on the nature and course of adolescent DU [80]. This would be facilitated by learning more about those risk factors which exert their influences early in the developmental course of DU and targeting programs toward reducing this risk [81]. Additionally, as we learn more about invulnerability to DU, programs can be targeted toward reinforcing and expanding the influences of protective agents, which mitigate both risk and drug use.

This study provides new information on the role of risk and protective influences on teenage DU. Whereas previous tests of a risk factor methodology have mainly focused on the influences of risk in promoting DU, this study has expanded this conceptual approach in several ways. First, since more than one etiological pathway exists for DU behaviors we have continued to separate etiological risk factors for initiation from those which predict more problematic

Table 5. Nonstandard Paths from Final Risk and Vulnerability Structural Model: Results by Sex and Grade

Risk Predictor		Drug Outcome		Standardized Parameter Estimate[a]
Observed Measure	Latent Construct	Observed Measure	Latent Construct	
Seventh Grade Females				
	Vulnerability		Polydrug Use	.47***[b]
	Vulnerability	Alcohol use		.33***
Protect index		Alcohol use		−.05*
	Vulnerability	Cigarette use		.20***
Initiation risk		Cigarette use		.15**
Initiation risk		Cannabis use		.22**
Initiation risk		Cocaine use		.34**
	Vulnerability	Hard drug use		.10*
	Vulnerability	Polydrug use		.18***
Problem risk		Polydrug use		.09**
Initiation risk		Freebase		.28**
Initiation risk		High at school		.63**
Problem risk		High at school		.07*
Problem risk			Polydrug Use	.31***
Protect index			Polydrug Use	−.10**
Seventh Grade Males				
	Vulnerability		Polydrug Use	.52***
	Vulnerability	Alcohol use		.26***
	Vulnerability	Cigarette use		.26***
Problem risk		Cigarette use		.14***
Protect index		Cigarette use		−.09**
Initiation risk		Cannabis use		.11**
Initiation risk		Hard drug use		.09**
Protect index		Hard drug use		−.04*
	Vulnerability	Polydrug use		.20***
Initiation risk		Polydrug use		.23***
Problem risk		Polydrug use		.12***
	Vulnerability	Freebase		.11**
Initiation risk		Freebase		.28***
Problem risk		Freebase		.13***
Initiation risk		High at school		.84***
Problem risk		High at school		.22***
Protect index		High at school		−.09**
Problem risk			Polydrug Use	.23***
Ninth Grade Females				
	Vulnerability		Polydrug Use	.68***
	Vulnerability	Alcohol use		.31***
Initiation risk		Alcohol use		.12***
protect index		Alcohol use		−.07***
	Vulnerability	Cigarette use		.29***
Protect index		Cocaine use		−.05*
Protect index		Polydrug use		−.05*
Initiation risk			Polydrug Use	.25***

Table 5. (Cont'd.)

Risk Predictor		Drug Outcome		Standardized Parameter Estimate[a]
Observed Measure	Latent Construct	Observed Measure	Latent Construct	
		Ninth Grade Males		
	Vulnerability		Polydrug Use	.64***
	Vulnerability	Alcohol use		.52***
Protect index		Alcohol use		−.06***
	Vulnerability	Cigarette use		.24**
Problem risk		Cigarette use		.08**
Initiation risk		Cannabis use		.12***
	Vulnerability	Polydrug use		.28***
Protect index		Polydrug use		−.07**
Initiation risk		High at school		.10**
Problem risk		High at school		.10**
Problem risk			Polydrug Use	.24***
		Eleventh Grade Females		
	Vulnerability		Polydrug Use	.56***
	Vulnerability	Alcohol use		.38***
Initiation risk		Alcohol use		.09**
Protect index		Alcohol use		−.04*
	Vulnerability	Cigarette use		.21***
	Vulnerability	Cannabis use		.08*
Problem risk		Cocaine use		.12**
	Vulnerability	Polydrug use		.18***
Initiation risk		Freebase		.06*
Problem risk		Freebase		.17***
Initiation risk		High at school		.19***
Problem risk		High at school		.33***
Protect index		High at school		−.10***
Initiation risk			Polydrug Use	.26***
Problem risk			Polydrug Use	.24**
		Eleventh Grade Males		
	Vulnerability		Polydrug Use	.52***
	Vulnerability	Alcohol use		.35***
Initiation risk		Alcohol use		.13**
Protect index		Alcohol use		−.06**
	Vulnerability	Cigarette use		.22***
Problem risk		Cigarette use		.08*
Initiation risk		Cannabis use		.06*
Problem risk		Cannabis use		.39*
	Vulnerability	Cocaine use		.05*
Problem risk		Cocaine use		.13*
Problem risk		Hard drug use		.23*
	Vulnerability	Polydrug use		.20**
	Vulnerability	Freebase		.13**
	Vulnerability	High at school		.30***
Initiation risk		High at school		.07**
Initiation risk			Polydrug Use	.24***
Protect index			Polydrug Use	−.09***

[a]Significances are determined by z-critical ratio on unstandardized regression coefficients.

[b]This effect was hypothesized a priori for all six models.

*$p < .05$

**$p < .01$

***$p < .001$

DU [13, 14, 82, 83]. Second, we have added a protective index containing several measures which have been linked both conceptually and empirically as factors which diminish or mitigate DU during the teenage years. Furthermore, we have expanded the number of risk and protective factors thus potentially capturing more of the etiological forces which serve to influence DU behaviors.

In addition to these developments, we have also used a larger sample size consisting of three different age groups; each age representing important developmental transitions. Bailey and Hubbard reported that the psychosocial influences underlying vulnerability changed with increasing age, although the ages examined in their study only partially overlap with the present study [26]. Moreover, they caution against viewing adolescence as a single age group with respect to vulnerability (their findings were specific to marijuana use). Our findings confirm that relationships between vulnerability and DU change with age, a finding which has important ramifications for the design and implementation of prevention programs [81, 82, 84].

Estimates of DU

Prevalences of DU for the three age groups were quite similar to results from recent national surveys and with similar age groups [5, 85]. Prevalences of DU increased with age and alcohol was the most prevalent drug used across all age/gender groups. After alcohol, prevalence patterns differed by grade and gender, however, cannabis, cigarettes, or multiple drug use (the latter most likely reflecting alcohol used in combination with cigarettes or cannabis) were the most frequently reported drugs used.

The few differences between factor loadings for Polydrug Use between males and females within age level supports recent trend data which shows the gender gap in DU closing [86]. However, the same effect was not obtained when we compared across age groups within gender. Drug use for seventh grade males and females was most unlike the DU of their older same-sexed peers (especially the 7th to 11th grade comparison). These differences were larger for females than they were for males across grades and were largest for the seventh to eleventh grade comparison. The increasing magnitude in factor loadings across grade underscored the older students' (both 9th and 11th grade) propensity toward using cannabis, hard drugs, cocaine, and more frequently reporting being high at school. One caution worth noting is that the use of hard drugs for the seventh grade was fairly infrequent and care must be taken when interpreting these findings.

Associations Among the Three Indexes and Polydrug Use

Previously, Scheier and Newcomb demonstrated different associations among risk influences (i.e., initiation versus more problem DU) and actual DU [13, 14]. In the current study, both risk indexes were strongly associated with Polydrug Use and of relatively equal magnitude. Nonetheless, the association between the two

risk indexes was not perfect and substantial variation was left unique to each. The latter finding leads us to believe that we have correctly conceptualized the separate risk pathways to different types of DU and that beyond their shared variance each index (including protection) contributes distinctively in predicting Polydrug Use.

We examined the relative contribution each risk and the protective index made toward predicting Polydrug Use and the individual DU behaviors when controlling for general DU. We expected RFPROB to be more strongly associated with Polydrug Use, while RFINIT would be less strongly associated in this relationship and more strongly associated with the individual gateway substances (e.g., alcohol or cigarettes). This expectation was upheld in several instances including: seventh grade females and males, ninth grade males, and eleventh grade females. Contrary to our expectation, however, ninth grade females, and both eleventh grade males and females also had a significant path from RFINIT to Polydrug Use. No such path existed from RFPROB to Polydrug Use for these groups with the exception of eleventh grade females.

It is worth noting that Polydrug Use was mainly reflected in alcohol, cigarette, and cannabis use, while with few exceptions the specific effects of RFPROB were greater in number and stronger in magnitude on the "hard" drug types (i.e., cocaine, freebase, and polydrug use) than RFINIT. Equally important, regression effects were largest for RFPROB predicting being high at school, the latter considered problem behavior.

With respect to the associations among the three indexes, one other important age-related comparison is worth noting: RFINIT and PROTECT were more strongly associated for seventh graders than for ninth or eleventh graders. The stronger association for seventh graders between protection and risk for initiation highlights the need to target prevention interventions at this youthful age when these behaviors (including attitudes and perceptions) are still developmentally and functionally linked. In addition, the results reinforce the notion of evolving vulnerabilities [26]. Quite possibly, early risk influences may transition into more problem behaviors not limited to DU, as evidenced by the moderate associations between RFINIT and RFPROB for all age and gender groups. Left unabated the problem behaviors may become part of the behavioral repertoire of these youth and may be resistant to prevention-oriented change [44]. If we can interpret these associations across age groups as an indication of developmental functions, albeit that they are restricted to the descriptive level of age differences and not age changes, then protective influences appear to have their greatest period of activity for the seventh graders and more limited, although present, influences for ninth and eleventh graders.

Comparison of Effects for Three Indexes and Vulnerability

Not only did the magnitudes of the associations between risk, protection, and DU change with increasing age, but also the sheer number of effects between the

three indexes and DU measures changed between grade levels. Number of effects was lowest for ninth compared to seventh and eleventh grade and greatest (in number) for eleventh grade except for RFINIT which had one more effect for males and females alike for seventh grade. Likewise, number of effects between Vulnerability and DU were fewest for the ninth graders, and greater (quantity) for the seventh and eleventh graders. Numbers of effects are in some regard a proxy for numbers of opportunities in which these youth potentially experience a functional linkage between DU and risk (or protective) influences [13]. Based on these findings, there appear to be shifting forces which modulate vulnerability concomitant with developmental changes.

Various life events may account for these differences. First and foremost, youth in the ninth grade experience increased pressures associated with a general need to achieve academic success and the demands of schoolwork increase with the transition from junior high school to high school. These transitions may in turn influence risk taking (i.e., increasing behaviors linked to DU) and reduce protective influences (i.e., increased stress and demand for academic performance may lead to increased coping responses).

Turning to the possibility of prevention effects, many programs are implemented in the younger age ranges (i.e., elementary through 7th grade) although the effects of these may not fully actualize until the ninth grade or later. This point has been argued by some researchers who claim that one or two-year follow-ups of prevention interventions are mistakenly interpreting absence of clear and unequivocal effects for "no" effects. For example, in one prevention study few effects were noted, however these program evaluations were conducted shortly after the program implementation sequence [87, 88]. Many of these youth may not have encountered opportunities to use the social and cognitive skills that form the basis of these prevention efforts and could potentially mitigate their DU. We speculate that for ninth graders overall, DU becomes less prevalent for these youth who are faced with increasing demands for academic excellence and pressures to succeed in school (including extracurricular activity such as athletic competition, music performance, or performance clubs). For the eleventh graders, the noted upswing in the number of effects both types of risk and DU may parallel increasing demands for personal growth (e.g., adult responsibilities) for which DU represents one palliative emotional coping mechanism [89, 90].

Patterns of drug-specific effects across age groups revealed that alcohol had the most effects followed by being high at school, cigarette and Polydrug Use. This is in concert with the relative magnitudes of the factor loadings which underscored that for all grade levels multiple drug use reflected mostly alcohol, cigarettes, and cannabis in combination. Thus the focus of prevention should continue to emphasize limited initiation to DU via gateway drugs which appear too be highly accessible and used by these youth [91].

Importantly, a distinction should be made between statistical significance and practical considerations based on these results. That is, the generally large sample

sizes across all grades and specifically the larger sample size for the ninth and eleventh grades increased the power of these analyses making it easier to detect significant effects. Alternatively, the larger number of significant paths in the eleventh grade analyses may also result from the increasingly complex social-psychological milieu these youth experience as part of daily living. A practical consideration for interventionists suggests that with increasing age there are more abundant (number of effects) opportunities to engage in riskier or more problematic behaviors (e.g., DU or being high at school). Likewise, as these youth transition from early adolescence into later adolescence they may also have greater opportunity to utilize and be affected by the influences of protective factors.

Strengthening Protective Influences through School-Based Prevention

These results also emphasize the need to enhance further already existing protective influences as they inoculate against the effects of risk (both for initiation and exacerbation of DU) and as they independently mitigate drug use. Across age and gender groups there were numerous protection effects, although comparatively, these effects were smaller in magnitude (but not in sheer number) than the effects for RFINIT and RFPROB. Flay and likewise Chassin, Presson, and Sherman have suggested that many social-psychologically based drug education programs are aimed at weakening the linkages between attitudes and behaviors; especially those attitudes which are reinforced through direct DU experience [92, 93]. In addition to these constructive efforts, this research underscores two critical aspects regarding the interplay of risk, protection, and vulnerability: 1) the need to reinforce the presence and influences of protective factors; those which directly reduce DU; and 2) the importance of strengthening existing bonds between protective factors and those experiences (prior to onset) which lead to DU; all of which would likely mitigate attempts to initiate DU [20].

For example, prevention programs might strengthen the health education component of their curriculum [94]. This would underscore the importance for youth of physical and health-related reasons why not to use drugs. Two aspects of the results of this research support this approach: for the seventh graders, the protective index consisted of two items directly related to positive learning environments including: (less) opportunities to learn from self or friend's DU and exposure to school-based prevention programs. Likewise, the protective index for the ninth and eleventh graders consisted of three separate factors underscoring the role of positive learning situations decreasing DU including: exposure to school-based prevention programs, (less) opportunity to learn from one's own or friend's use, and a composite factor consisting of coursework in health, participation in DU prevention activities (e.g., clubs, sobriety support groups), and attendance at DU prevention events. In effect, each of these protective factors contributed

uniquely to less DU. Together, their additive influences diminished the effects of risk and reduced DU. Like Brook and her colleagues who reported that school influence (i.e., prevention activities and achievement motivation) offset the influences of risk factors and mitigated DU [15, 16], we also found that protection plays an independent role as part of an overall construct of Vulnerability in diminishing DU. Taken together, these findings reinforce the importance of school cohesion (a primary site for engaging prevention activities), and suggest that stimulating academic interest and in general exposure to a broad-band of effective prevention activities will most likely increase the potentiality of protective factors as they offset risk and ameliorate DU.

Limitations of Current Findings and Implications for Future Research

Several limitations of these findings should be emphasized. First, further refinement of the selection methods used to distinguish risk factors into conceptually separate risk indexes may enhance prediction and ultimately shed greater light on the role of risk and protective influences and DU. We encourage other researchers to test a risk and protective factor method and include related etiological theories which may have escaped our knowledge.

Second, we were unable to distinguish among the protective factors between those which might exert their influences on acquisition of DU behaviors and those which are more specific to problem DU. Perhaps greater refinement of and discrimination among protective factors might lead to greater understanding of how these factors separately affect acquisition and exacerbation of DU.

Third, while the respective indexes are themselves continuous measures, we have not examined possible moderating or mediating influences among the indexes and between the indexes and DU [17]. Intrinsic to the risk factors method we utilized is the assumption that the effects of risk (or protection) are additive and equipotential. Quite possibly they may be better conceptualized as moderating (i.e., buffering) or mediating (i.e., interacting). Such potential effects have not been tested in these analyses, since our principle aim was to elucidate the direct effects in this model and clarify these relationships across three age groups. However, future analyses should build upon these and related findings thereby increasing our knowledge regarding relationships between Vulnerability and DU.

Furthermore, many of these youth may have already initiated DU and for these analyses we were unable to distinguish the relative role of risk and protective influences in predicting maintenance and cessation of DU as well as reciprocal influences (i.e., DU may influence risk or protection). Finally, and tied to this latter point, these data are cross-sectional which preempts making any real "causal" statements regarding the effects of Vulnerability on DU or vice versa. Panel data are required to disentangle these influences and empirically address these important relationships. However, this does not diminish the importance of

addressing and reinforcing various protective factors as they may influence risk, DU, and related health-compromising behaviors during critical developmental periods.

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Direct reprint requests to:

Lawrence M. Scheier, Ph.D.
College of Arts and Sciences
Temple University
Weiss Hall
Philadelphia, PA 19122