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Preventive Intervention Effects on Developmental Progression in Drug Use: Structural Equation Modeling Analyses Using Longitudinal Data[1]

Lawrence M. Scheier,[2,3] Gilbert J. Botvin,[2] and Kenneth W. Griffin[2]

This study examined the plausibility of the gateway hypothesis to account for drug involvement in a sample of middle school students participating in a drug abuse, prevention trial. Analyses focused on a single prevention approach to exemplify intervention effects on drug progression. Improvements to social competence reduced multiple drug use at 1- and 2-year follow-ups. Specific program effects disrupted drug progression by decreasing alcohol and cigarette use over 1 year and reducing cigarette use over a 2-year period. Controlling for previous drug use, alcohol was integrally involved in the progression to multiple drug use. Subgroup analyses based on distinctions of pretest use/nonuse of alcohol and cigarettes provided partial support for the gateway hypothesis. However, evidence also supported alternate pathways including cigarette use as a starting point for later alcohol and multiple drug use. Findings underscore the utility of targeting more than one gateway substance to prevent escalation of drug involvement and reinforce the importance of social competence enhancement as an effective deterrent to early-stage drug use.

KEY WORDS: drug progression; intervention effects; longitudinal; adolescence.

INTRODUCTION

Kandel's seminal research on stage sequential models of drug use suggests that drug use begins with alcohol (including beer and wine), proceeds to cigarette use or hard liquor, followed by progression to marijuana and other illicit drugs including pills, heroin, cocaine, and psychotropic compound such as LSD (Kandel, 1975; Kandel *et al.*, 1976; Kandel & Faust, 1975; Single *et al.*, 1974). Coupled with more recent empirical findings (e.g., Andrews *et al.*, 1991; Kandel *et al.*, 1992), these and related studies also highlight that marijuana plays a crucial role serving as a linkage between licit (i.e., beer, wine, hard liquor, and cigarettes) and subsequent illicit drug use (i.e., LSD, pills, and heroin). Stage sequence models also suggest that drug use is cumulative. That is, students reporting use of illicit drugs such as marijuana or heroin also report use of lower-ranked drugs such as alcohol (Kandel, 1975; Single *et al.*, 1974). Importantly, use of a lower-ranked substance does not necessarily portend use of a higher-ranked substance. The pivotal role of alcohol (including beer, wine, and hard liquor) and tobacco as gateway substances coupled with the cumulative nature of early drug use help to shape the current prevention agenda (e.g., Botvin, 1995). Many, if not all, prevention programs focus on delaying initiation as well as reducing susceptibility to gateway drug use.

Despite the significance of early studies detailing stage sequential models, empirical findings do not unequivocally support the invariant nature of drug progression. Some studies indicate that cigarettes and not alcohol play a prominent role in beginning drug use (e.g., Fleming *et al.*, 1989; Kandel & Yamaguchi,

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[2] Department of Public Health, Institute for Prevention Research, Weill Medical College of Cornell University, New York, New York.

[3] Correspondence should be directed to Lawrence M. Scheier, Department of Public Health, Institute for Prevention Research, Weill Medical College of Cornell University, 411 East 69th Street, Kips Bay 201, New York, New York 10021; e-mail: lmscheie@med.cornell.edu

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1985). Other studies reinforce that cigarettes do not feature in the early stages of drug use and that alcohol use can proceed directly to marijuana use (e.g., Ellickson *et al.*, 1993b; Potvin & Lee, 1980; Welte & Barnes, 1985). For example, Ellickson *et al.* (1993b) reported that increased involvement with alcohol and cigarettes among middle school students increased the probability of using marijuana, cocaine, and other illicit substances over a 4-year period. However, analysis of more refined measures of weekly alcohol and cigarette use produced several alternative stage sequences. For instance, weekly alcohol use followed marijuana onset and weekly smoking came after initial pill use and prior to hard drug use. In a related vein, Donovan and Jessor (1983) reported that excessive and problematic drinking represents a clear stage between marijuana use and later illicit drug use.

Although some studies have relied on unidimensional scaling techniques to discern patterns of drug progression, additional studies have utilized covariance structure analysis to contrast stage sequential models. Huba *et al.*, for instance, examined simplex and common factor models of drug progression (Huba *et al.*, 1981; Huba & Bentler, 1983). A simplex model specifies an invariant drug progression from alcohol to cigarettes to marijuana, and as Huba *et al.* (1981) indicate, provides a quantitative analogue to a Guttman scaling approach. A common factor model, on the other hand, posits alternative and less restrictive (i.e., ordered) pathways from one drug type to another. Support for a common factor approach derives primarily from problem behavior theory (PBT; Jessor & Jessor, 1977), which suggests that a common psychosocial vulnerability presage early-stage drug use. Because a common psychosocial vulnerability underlies varied forms of drug use, a common factor model suggests that alcohol use can lead directly to marijuana use or precede involvement with all three of the gateway substances (i.e., multiple drug use).

Unfortunately, evidence for and against simplex and common factor models is far from conclusive. Huba and colleagues, for instance, reported that both a simplex and common factor model accounted adequately for drug progression in a sample of middle school students. Hays *et al.* (1987), on the other hand, reported that among middle school students a common factor model rather than a simplex model provided a superior fit to the data. Interestingly, Hays *et al.* suggest that the sequence of stages may not necessarily be invariant and that alcohol use can directly precede marijuana use. In a separate study, Hays *et al.* (1986) reported that a nonsimplex model fit better than a simplex model for early (corresponding to ages 13–14) and late adolescents (ages 17–18). However, simplex and nonsimplex models were both appropriate representations of the data for adolescents between 15 and 16 years of age.

Evidence of Drug Progression From Prevention Trials

Much of the current body of knowledge regarding stage sequences derives primarily from epidemiological and etiologic studies. However, analysis of prevention data also has contributed to our current knowledge of drug progression (e.g., Collins *et al.*, 1994, 1997; Graham *et al.*, 1991; Spoth *et al.*, 1999). Graham *et al.* (1991) examined 1-year prevention data and showed that students exposed to a normative education intervention were significantly less likely to transition from a lower-ranked class of drug (e.g., alcohol) to a higher-ranked class (e.g., alcohol and tobacco). Furthermore, latent transition analyses (LTA) showed that treated students were less likely to move between latent statuses designating nonuse of alcohol to a category representing alcohol use over a 1-year period. Treated youth who reported alcohol at pretest were more likely to remain in this latent status than control students who were more likely to report the combined use of alcohol and tobacco. Further etiologic analyses based on untreated control students indicated that cigarette use was a more potent predictor of advanced drug use (i.e., problem alcohol use mixed with marijuana use) than alcohol use. Furthermore, students whose drug use was limited to tobacco in the seventh grade were more likely to transition to a higher-ranked status (i.e., alcohol and tobacco) than students who reported only using alcohol. Separately, Collins *et al.* (1994) showed that drunkenness plays a crucial role in advancing drug use beyond alcohol to include tobacco and marijuana use.

In a recently published report, Spoth *et al.* (1999) indicated that a universal, family-focused intervention reduced significantly the likelihood of treated youth transitioning from a nonuse to use status as compared with untreated control youth. Overall, treated youth participating in a seven-session program designed to reduce family risk and enhance family protective processes or a five-session family competency-training program were more likely to remain nonusers as compared with control students.

These effects held up one and 2-years post-intervention. Further analysis of expected frequencies for each latent status (e.g., alcohol users only) indicated that control students were more likely to move to an advanced drug status group that involved marijuana use as compared with either of the intervention groups. Interestingly, those youth already reporting drug use at the 1-year follow-up period and receiving the five-session, family competency intervention were more likely to remain in their current use status than control youth who advanced in their reported drug use.

Importance of the Current Study

As this brief review shows, information on stage sequences obtained from prevention trials augments empirical findings from etiologic studies. Notwithstanding the importance of these studies, several gaps in the literature exist that need to be filled. First, it is important to extend our current knowledge regarding intervention effects on drug progression beyond immediate effects or those that persist over 1 or 2 years. Early program effects may dissipate or otherwise go undetected if studies are limited to short-term outcomes. Drug initiation and drug progression may take place over a longer time frame and require extended data collections to monitor these events. To address this point, this study examines drug progression in a cohort of middle school students participating in a school-based, drug abuse, prevention trial over a 4-year period. This period coincides with an important period of risk for initiation to alcohol, cigarettes, and marijuana use (e.g., Kandel & Logan, 1984; Newcomb & Bentler, 1986). Systematically examining drug progression over an extended time-period and concentrating on the role of the three most prevalent substances (alcohol, cigarettes, and marijuana) for this age group should benefit the design and implementation of school-based prevention efforts.

A second concern relates to the limited range of prevention modalities examined in previous studies of drug progression. Collins *et al.* (1994, 1997), for instance, relied on secondary analysis of prevention data that reflected largely a normative education intervention strategy. The full scope of the prevention trial from which they drew these data included resistance skills training and didactic strategies to impart information about the health and social consequences of drug use (see e.g., Hansen & Graham, 1991; Hansen *et al.*, 1988). However, a manipulation check showed that only the four-lesson normative education component effectively reduced rates of drug use. Furthermore, the experimental design used in the study by Spoth *et al.* (1999) relied on brief interventions, which may hinder obtaining long-term effects. Despite the importance of these relatively recent studies, it is essential that researchers examine a broader range and more extensive set of prevention modalities to insure replicable and durable findings.

The present study focused on one of several prevention approaches included in the Life Skills Training (LST) program. Evidence from several evaluations shows the LST intervention reduces successfully rates of gateway drug use over short (Botvin *et al.*, 1980; Botvin & Eng, 1982) and long-term (Botvin *et al.*, 1990, 1995a) follow-up periods. Additional findings attest to the program's ability to reduce illicit drugs (marijuana, inhalants, psychedelics, and narcotics: Botvin *et al.*, 2000). The present study focuses exclusively on determining the long-term effects of a social skills competence enhancement component of the LST program. Although the intervention includes a broad array of cognitive–behavioral strategies aimed toward reducing susceptibility to early-stage drug use, use of a single component emphasizing assertive skills and social competence is purely for illustrative purposes.

Separating General From Specific Program Effects on Drug Progression

Consistent with the need to examine multiple influences on drug progression, latent variable structural equation modeling (SEM) provided a multivariate framework for testing the efficacy of the intervention to disrupt drug progression. Structural equation modeling makes it possible to test a wide range of hypothesized program effects and combine these with specific tests detailing drug progression. In particular, SEM provides a powerful means to separate general from specific (unique) program effects (Bentler, 1990a; Newcomb, 1992, 1994). To illustrate this point briefly, consider that LST targets improving student's general assertiveness and increasing their social competence. Socially competent youth are hypothesized to be more likely to refuse active offers to use drugs based on their ability to employ a wide range of assertiveness and domain-specific refusal skills (e.g., Botvin, 1983, 1995). At a general level, program effects involve enhanced social competence,

whereas specific or unique effects refer to program effects on individual skills (e.g., improvements to domain-specific refusal skills).

In the current study, students responded to a wide range of self-report questionnaire items tapping perceived confidence in using social skills, frequency of implementing assertiveness, and drug-specific refusal skills. Using confirmatory factor analysis (CFA) methods, the common variance among multiple indicators of these skills is posited to reflect a latent construct of *general assertiveness*, otherwise referred to as social competence. This conceptualization reflects most accurately the theoretical background of LST, which is based largely on self-efficacy and social learning theory (Bandura, 1977). To frame this conceptualization in analytic terms, tests of general program effects include specification of a path from a measure of program status (capturing the distinction between experimentally treated students and untreated controls) to a latent construct reflecting social competence. With the inclusion of statistical controls for early levels of competence, a positive regression weight corresponding to this indirect path indicates the program contributed beneficially to improved social competence.

In contrast to general program effects, specific (unique) program effects include improvements to individual skills not reflected by changes in perceived social competence (i.e., the portion of unique variance in skills enhancement not captured by the common factor variance). Using the conceptual framework outlined earlier, specific program effects include greater use of drug-specific refusal skills, frequent assertiveness, and greater perceived social confidence. In a latent variable model, specification of these effects includes paths from the program measure to the indicators assessing individual skills. Consideration of unique effects is important primarily because the latent construct of perceived social competence is not a pure (unidimensional) construct. Each indicator represents a different facet of social competence and it is the common factor variance obtained from the combined set of indicators that reflects social competence. After partialling for the common variance portion of the construct, the unique or nonfactor-determined variance reflects substantively important contributions associated with individual skills. Omission of these effects would imply that LST improves social competence without attending to important changes in individual skills. Conversely, specification of effects identified only from individual skills without consideration of the common factor variance would undermine the notion that repeated use and consolidation of skills over time enhances perceived social efficacy. Thus, omission of either unique or general program effects (i.e., common factor portion) can lead to model misspecification (see for example, Newcomb, 1994, for a more elaborate discussion of problems inherent with omission of specific effects).

The same analytic framework for testing general versus specific program effects extends to tests of drug progression. In the present study, discrete indicators of alcohol, cigarette, and marijuana use reflect a latent construct of multiple drug use. Involvement with multiple drugs during adolescence implies high-risk drug use because of its social, medical, and legal implications (e.g., Newcomb & Bentler, 1988). In addition to these concerns, involvement with multiple drugs at an early stage in adolescence portends greater involvement with a wider range of drugs at later stages (e.g., Kandel & Logan, 1984; Kandel & Yamaguchi, 1993; Newcomb & Bentler, 1986). One effective means of conceptualizing high-risk involvement with multiple drugs is to specify a latent factor of multiple drug use. The common factor portion of this construct reflects a student's reported use of all three of the gateway substances, leaving the unique portion of variance associated with each indicator to reflect specific drug use (i.e., alcohol only).

Using the same format for specifying general program effects, paths between early and later multiple drug use capture general drug progression (i.e., stability of involvement over time). Paths from the skills construct to multiple drug use reflect the degree to which the program disrupts high-risk, multiple drug use. Once this path is controlled statistically, paths from the skills construct to the individual drug types capture specific disruption in drug progression (i.e., lowering rates of alcohol only). To gain a more complete picture of the full array of program effects, a model should include construct level effects as well as unique or specific effects (e.g., specifying paths from indicators of assertiveness skills to individual drug types). Failure to identify the full complement of these effects might produce null findings and lead to an assertion of program failure when in fact the program lowered rates of specific drug use. The method for identifying specific program effects on individual drug types involves use of post hoc specification searches based on the multivariate Lagrangian Multiplier (LM) test (Chou & Bentler, 1990). The method for conducting these searches in the context of an overall model testing strategy is outlined in greater detail here.

METHOD

Participants

Two cohorts of middle school students participated in a randomized, prevention trial conducted in the Northeast portion of the United States between 1987 and 1991. In the first cohort (A) students in the treatment condition received a 15-session intervention in the fall of the 7th grade that focused on personal and social competence enhancement, social resistance training, and normative education. Treated students received an additional ten booster sessions in the 8th grade and five booster sessions in the 9th grade. In the 10th grade students participated in another follow-up data collection, although no booster sessions were implemented. A second cohort of students (Cohort B) received the same intervention conducted in the spring immediately following the fall cohort. Students from 45 of the original 56 schools participated in the second prevention trial and provided pretest and annual follow-up data from the 7th through 10th grades. The pretest sample for the combined cohorts contained 3,288 students and was 52% male. Subsequent follow-up samples included 2,724 students in the 8th grade (T3: 50.5% male), 2,468 students in the 9th grade (T4: 50% male), and 2,228 students in the 10th grade (T5: 49.4% male). The pretest sample was 91% White (and this did not change across the three follow-up data collections) and 75% of the students came from suburban areas, 21% from rural areas, and 4% from urban locales.

Trained research staff conducted each data collection during a single classroom session. Information inside the cover page on each survey stressed the confidential nature of the survey and students received oral instructions prior to the survey that emphasized the importance of being honest. Researchers used identification numbers lithocoded on each survey to link student information across time. Each student received a packet containing a survey and a #2 lead pencil. Research staff collected each survey individually at the end of the classroom session. No teachers or school personnel were present during the testing procedure.

After blocking on pretest levels of cigarette use, schools were assigned randomly to one of three conditions: two treatment conditions (E1: $N = 1{,}074$ and E2: $N = 1{,}028$), and a no-contact control condition ($N = 1{,}186$). In addition to the standard prevention curriculum, the E1 condition included a 1-day training workshop during which time program staff provided teachers with verbal feedback regarding implementation and reinforcement to enhance program fidelity. The main purpose of the training workshop was to familiarize teachers with the intervention program and its theoretical rationale. The workshop began with a brief overview of the problem of substance abuse and included discussion regarding the merits of previous prevention approaches. After the general introduction to the intervention strategy, the remainder of the workshop consisted of discussion, demonstration, and participation in selected intervention activities. The E2 condition consisted of the same prevention curriculum, however, research staff provided teachers with a 2-hr training videotape and there was no implementation feedback. Through material in the teacher's manual and the teacher training tape, teachers learned about the rationale behind the curriculum and why it is appropriate to use it at the seventh grade level. An important function of the training tape was to provide teachers with an understanding of the theoretical basis for the curriculum in order to minimize the likelihood that they will make well-intentioned changes, which may actually be detrimental to program effectiveness. In addition, the training video described how the program works; how it was to be used, address problems that have arisen in the past, and how they should deal with them. An advantage of the video material is that teachers are able to see the lessons being conducted by other teachers and have the opportunity to review the videotape material whenever they wish.

There were no reported statistically significant differences on any of the outcome measures for the E1 and E2 conditions (Botvin *et al.*, 1990); therefore analyses for this study combine the two intervention groups. The treatment-as-usual control group received no training or prevention curriculum. Teachers were given primary responsibility for implementing the prevention curriculum, thus taking advantage of their teaching experience and classroom management skills. Student peer leaders served an important informal function as positive role models for the skills and behaviors being taught in the intervention, particularly with respect to drug use behavior.

Intervention Components

The drug abuse prevention curriculum involved a broad-spectrum, cognitive–behavioral prevention strategy called Life Skills Training (LST). The main purpose of this approach is to facilitate the

development of drug abuse-specific skills and knowledge as well as contribute to the development of generic personal and social skills. The intervention essentially encompasses three prevention modalities including normative education (drug-specific cognitions), social skills training and social competence enhancement, and personal competence (i.e., self-management) skills. In the normative education component, students receive instruction regarding the short- and long-term consequences of substance use, knowledge about the actual levels of drug use among both adults and adolescents in order to correct normative expectations about drug use; information about smokers rights and the declining social acceptability of cigarette smoking; information and class exercises demonstrating the immediate physiological effects of cigarette smoking; material concerning media pressures to smoke, drink, or use drugs; and techniques used by cigarette and alcoholic beverage advertisers to promote the use of these substances; and techniques for resisting direct peer pressure to smoke, drink, or use drugs.

The personal skills component contains material concerning decision making designed to foster the development of critical thinking and responsible decision making; material designed to provide students with techniques for coping with anxiety (i.e., cognitive and behavioral self-control strategies); and material designed to provide students with the basic principles of personal behavior change, goal directedness, and self-improvement. The social skills component contains strategies designed to improve general interpersonal skills. Included is material concerning effective communications, general social skills (e.g., initiating social interactions, conversational skills, complimenting); skills related to boy/girl relationships; and both verbal and nonverbal assertive skills. All participating teachers in the prevention conditions were provided with a Teacher's Manual, which contained detailed lesson plans consisting of the appropriate content and activities for each intervention session. In addition, all participating students in the treatment groups were provided with a Student Guide. In addition to the material covered in each classroom session, students were given outside assignments to both prepare them for specific sessions and to reinforce material already covered. Furthermore, students applied goal-setting principles taught in the intervention along with basic principles of self-directed behavior change within the context of a semester long "self-improvement" project. More extensive descriptions of the prevention strategy and curriculum materials can be found in several previously published reports (Botvin *et al.*, 1990; Botvin & Dusenbury, 1987; Botvin & Tortu, 1988).

Behavioral and Psychosocial Measures

Multiple Drug Use

Tests of drug progression involved three explicit models that relied on testing different combinations of predictors in the 7th grade and different outcomes in the 9th and 10th grades. In Model 1, three drug frequency measures reflected a latent construct of pretest multiple drug use, which was repeated in the 9th and 10th grades. A single item assessed current alcohol use (i.e., "how often [if ever] do you drink alcoholic beverages?"). Responses ranged on a 9-point anchored scale from 1 (*never tried them*) to 9 (*more than once a day*). A single item assessed frequency of cigarette use (e.g., "how much do you generally smoke now?"). Responses ranged on a 7-point anchored scale from 1 (*never*) to 7 (*more than a pack a day*). A single item assessed frequency of marijuana use (e.g., "how often [if ever] do you usually smoke marijuana?"). Responses ranged on a 9-point anchored scale from 1 (*never tried it*) to 9 (*more than once a day*).

A second model focused on the etiologic role of alcohol use in promoting later multiple drug involvement. For this model, three single-item indicators reflected a latent construct of alcohol involvement specified in the seventh grade. In addition to the frequency of alcohol use item, a second item assessed intensity (e.g., "how much [if at all] do you usually drink each time you drink?"). Responses ranged on a 6-point scale from 1 (*I don't drink*) to 6 (*more than 6 drinks*). A third item assessed drunkenness (e.g., "how often [if ever] do you get drunk?"). Responses ranging on a 9-point anchored scale from 1 (*I don't drink*) to 9 (*more than once a day*). Coefficient alpha for the three alcohol items by the adjusted Werts *et al.* (1974) method[4] was .81. Previous tests of stage sequences show that cigarettes also represent an initial starting point for

[4]Cronbach's alpha provides a lower bound estimate for determining scale homogeneity but does not adjust for measurement error at the item level. Werts *et al.* (1974) provide an alternative and more efficient method to compute internal consistency estimates based on structural composites that correct for measurement error. For multi-item composite scales used as structural indicators this procedure replaces the Cronbach (1951) method for computing internal consistency estimates.

early-stage drug use. Accordingly, a third model included a single manifest indicator capturing frequency of cigarette use in the 7th grade, a latent construct of alcohol involvement in the 9th grade and a latent construct of multiple drug use in the 10th grade.

Assertiveness Skills

Three multi-item indicators reflected a latent construct of assertiveness skills (i.e., social competence). Eight items from the 40-item Gambrill and Richey (1975) Assertion Inventory assessed frequency of implementing defense of rights assertiveness skills. Exploratory factor analyses using both principal axis and common factoring methods provided empirical support for a single reliable scale that taps defense of rights (e.g., Henderson & Furnham, 1983). Wills *et al.* (1989) working with middle school students obtained a similar factor solution and reported moderate associations between assertive behavior and drug use. A common stem ("how often you do the following") preceded each item. Sample items include "request that someone return borrowed things" and "take something back to the store if it doesn't work right." Response categories ranged from 1 (*Never*) to 5 (*Almost always*). Based on the combined pretest sample, internal consistency for this scale was .74.

A second indicator included seven items to tap social and interpersonal self-efficacy. A common stem, "how confident you are that you could do well in the following situations," preceded each question. Sample items for social efficacy included "ending a conversation with friends without offending them," "making requests or asking favors," and "saying no to an unfair request." A 5-point response format ranged from 1 (*Not at all confident*) to 5 (*Very confident*). Internal consistency for these seven items was .69.

Refusal skill efficacy was based on three items that reflect drug-specific resistance self-efficacy ("how confident you are that you could, . . . refuse a cigarette offered by a friend") and frequency of drug-specific refusal skill (i.e., "how often do you . . . say no when someone tries to get you to smoke" and "say no when someone tries to get you to drink"). Response categories for the frequency items were identical to the defense of rights items and the refusal efficacy item included a response format identical to the social confidence items. Internal consistency for the three items was .73.

Data Management and Model Testing Procedures

Covariance structure analysis is regarded as a complete-data method (there can be no missing values) and use of alternative ad hoc procedures such as listwise deletion has been shown to bias parameter estimation. Therefore, data imputation proceeded using the EMCOV utility (Graham *et al.*, 1996), which relies on the EM (expectation maximization) algorithm (Dempster *et al.*, 1977; Rubin, 1987). Missing data imputation included maximum likelihood estimates based on experimental condition, gender, alcohol use (low vs. high), risk-taking (a 5-item measure of impulsiveness taken from Eysenck and Eysenck, 1975), and self-reported grades (ranging from 1: *Mostly A's* to 7: *D's or lower*).[5]

Certain core assessment features remained constant across all three models of drug progression. All three models included pretest measures of program status (i.e., a single manifest indicator coding experimental condition as 1: *treated* and 0: *control*) and a latent construct of assertiveness skills, the latter of which controlled for developmental stability. An immediate 1-year, posttest assessment in the eighth grade included a latent construct of assertiveness skills. Factor coefficients for the repeated measure indicators of assertiveness skills were constrained to equivalence from the seventh to eighth grade. These cross-time constraints test for measurement invariance and provide a means to examine developmental constancy in the construct over time (Pentz & Chou, 1994).

The main hypothesized program effect in each model included a path from the program measure to 8th grade assertiveness skills (controlling for pretest assertiveness). This indirect path assesses whether the

[5]Level of missing data varied between assessments and were as follows: Time 1 (7th grade) 62% had complete data, an additional 25% had at most two missing values, and the remainder had three or more missing. The variable with the most missing at Time 1 was assertiveness frequency (27%) and average level of missing data for the drug behavior measures was 1.50%. At Time 3 (8th grade), 83% had complete data, 13% had at most two missing. Average level of missing for the behavioral measures was 1.1% (and was less than 1% for most of the alcohol measures). The variable with the most cases missing was refusal skill efficacy (8.7%). At Time 4 (9th grade), 89.5% had complete data; 8% had at most two missing values. Average level of missing for the behavioral measures was 1.2%. The variable with the most cases missing was assertive frequency (4.3%). At Time 5 (10th grade), 89.0% had complete data; 8.4% had at most two missing values. Average level of missing for the behavioral measures was 1.1%. The variable with the most cases missing was refusal skill efficacy (3.5%).

intervention enhances social skills over a 1-year period. Additional model specification included paths from 8th grade assertiveness to the drug outcome constructs in the 9th and 10th grades. These nonmediated construct-to-construct paths assess whether activation of the target skills disrupts drug progression (at a general level). Following inclusion of all main hypothesized effects, the LM test provided guidance on the inclusion of nonstandard effects. The LM test provides a multivariate framework for adding paths or residual covariances (freeing previously constrained parameters) based on the overall contribution of the parameter toward reducing the model likelihood chi-square test statistic. A nested chi-square difference test provides a means to evaluate statistically the improvement in fit between a restricted model with constrained parameters and a model that relaxes (frees) specific constraints. If an investigator constrains a specific (nonstandard) effect, this essentially means the effect corresponding to this path is posited as zero. Freely estimating a previously constrained path creates a model that is nested within the restricted model with a degree of freedom difference of 1. Three considerations provide a framework from which to gauge the inclusion of parameters: substantive contribution of the parameter according to theory, the magnitude of expected parameter change, and consistency between the estimated parameter change and the overall zero-order covariance pattern (i.e., ruling out possible suppressor effects).

The framework for adding parameters relies on specification searches available in the EQS statistical program (Bentler, 1995). Detection of unique (nonstandard) effects systematically considered: (1) program effects on individual assertiveness skills (i.e., manifest indicators); (2) effects of individual assertiveness skills on individual drug types and latent drug outcomes; and (3) direct evidence of drug progression examining 1-, 2-, and 3-year lags.

RESULTS

Bivariate correlations and summary descriptive statistics for the complete set of measures used in the modeling are contained in Table 1 (the upper matrix contains data for the treatment condition and the lower matrix for the untreated control condition). Numbers corresponding to each named variable refers to the assessment point (e.g., ALCUSE1 is alcohol use at T1 in the seventh grade). There was little evidence of any substantial departures from normality and most of the distributional characteristics for the individual items and scales were within acceptable limits. Any departures from normality were not sufficiently large enough to strain the robustness of the ML estimation procedure used in the SEM (Huba & Harlow, 1987). A careful inspection of the bivariate relations indicated a small lack of pretest equivalence. Mean comparisons showed that control students reported more frequent and more intense drinking and more drunkenness than treated youth. Control youth reported more assertiveness confidence and more frequent assertive behavior, although the control students reported less confidence in their assertive skills at the 1-year follow-up. Cross-sectional associations among the individual drug types were moderate to large indicating a propensity for multiple (and concurrent) drug use among some youth. The moderate-sized associations among the drug use measures across time indicated that once initiated to drug use, youth were likely to remain users 2 and 3 years later (of the same and different substances). Associations between the drug use and assertiveness skill measures all were significant and in the expected direction both within and across time.

Attrition Analyses

Despite aggressive tracking efforts, there was a loss of 17.5% of the students between baseline and the first follow-up (for both cohorts combined). A little less than 10% of the students were unavailable at the 9th grade posttest and an additional 9.7% of the students were unavailable by the 10th grade. In school-based studies a great deal of subject loss is attributed to family relocations, absenteeism, transfers out of the school districts, and a small (<1%) percent of refusals through negative consent. Analyses to determine if any systematic bias contributed to subject loss from the pretest to each follow-up assessment indicated that there was a greater loss of students who reported using alcohol, cigarettes, and marijuana (all ps $< .001$ for proportional analyses). Females were significantly more likely to remain in the panel sample, $\chi^2(1) = 25.7$, $p < .001$ (57.4% vs. 48.3%, for male vs. female dropouts, respectively).

Regression analyses using a dichotomous retention measure (dropouts = 0, panel = 1) indicated that dropouts reported drinking greater quantities of alcohol ($\beta = -.12$, $p < .05$), lower grades ($\beta = .12$, $p < .001$), and perceived more peer ($\beta = -.15$,

Table 1. Summary Descriptive Statistics and Correlations by Treatment Condition and Assessment

M, *SD*, and variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
M	—	—	1.80	1.07	1.06	1.32	1.26	3.06	1.40	1.46	2.58	2.23	3.54	1.58	1.75	13.12	25.62	29.09	12.27	27.28	29.40
SD	—	—	1.14	0.40	0.43	0.72	0.59	1.82	1.15	1.25	1.65	1.52	1.94	1.42	1.63	2.35	4.61	4.45	2.84	5.18	5.36
ALCUSE1	1.94**	1.24	—	0.28	0.32	0.65	0.69	0.34	0.19	0.12	0.30	0.30	0.28	0.16	0.20	−0.38	−0.06	−0.10	−0.25	−0.12	−0.09
CIGUSE1	1.08	0.45	0.24	—	0.47	0.29	0.35	0.19	0.33	0.24	0.19	0.23	0.15	0.28	0.18	−0.29	−0.07	−0.04	−0.17	−0.05	−0.03
POTUSE1	1.09	0.58	0.26	0.49	—	0.40	0.31	0.12	0.18	0.20	0.12	0.13	0.10	0.14	0.11	−0.22	−0.08	−0.03	−0.08	−0.08	−0.08
ALCINT1	1.42**	0.83	0.63	0.35	0.34	—	0.77	0.30	0.19	0.24	0.34	0.31	0.21	0.16	0.17	−0.36	−0.11	−0.10	−0.26	−0.13	−0.11
ALCDRK1	1.33*	0.68	0.68	0.46	0.51	0.78	—	0.30	0.16	0.19	0.33	0.30	0.24	0.18	0.16	−0.37	−0.11	−0.07	−0.23	−0.12	−0.11
ALCUSE4	3.05	1.85	0.38	0.20	0.19	0.38	0.38	—	0.40	0.48	0.78	0.81	0.61	0.34	0.43	−0.22	−0.10	−0.05	−0.40	−0.06	−0.09
CIGUSE4	1.48	1.21	0.20	0.32	0.22	0.24	0.22	0.51	—	0.59	0.37	0.44	0.29	0.65	0.41	−0.23	−0.08	−0.05	−0.38	−0.09	−0.10
POTUSE4	1.56	1.45	0.25	0.21	0.23	0.34	0.30	0.58	0.56	—	0.45	0.54	0.35	0.40	0.55	−0.22	−0.11	−0.04	−0.32	−0.08	−0.07
ALCINT4	2.55	1.69	0.35	0.21	0.16	0.38	0.37	0.77	0.49	0.54	—	0.82	0.57	0.38	0.45	−0.26	−0.09	−0.09	−0.41	−0.05	−0.11
ALCDRK4	2.23	1.55	0.34	0.23	0.20	0.34	0.33	0.82	0.59	0.66	0.82	—	0.56	0.39	0.47	−0.24	−0.10	−0.05	−0.41	−0.07	−0.11
ALCUSE5	3.59	1.96	0.35	0.18	0.12	0.30	0.32	0.58	0.32	0.36	0.55	0.52	—	0.41	0.52	−0.24	−0.02	−0.05	−0.31	−0.03	−0.05
CIGUSE5	1.68	1.49	0.18	0.29	0.16	0.22	0.19	0.36	0.65	0.39	0.42	0.41	0.44	—	0.54	−0.21	−0.08	−0.08	−0.32	−0.09	−0.10
POTUSE5	1.83	1.69	0.27	0.17	0.20	0.32	0.30	0.45	0.40	0.60	0.51	0.50	0.55	0.57	—	−0.18	−0.04	−0.04	−0.28	−0.04	−0.05
REF1	13.24	2.25	−0.41	−0.35	−0.23	−0.45	−0.44	−0.29	−0.23	−0.25	−0.28	−0.27	−0.23	−0.24	−0.21	—	0.25	0.31	0.32	0.20	0.20
ASSCNF1	26.18**	4.59	−0.04	−0.04	−0.04	−0.05	−0.05	−0.04	−0.03	−0.06	−0.01	−0.02	0.01	−0.03	−0.02	0.28	—	0.30	0.17	0.27	0.28
ASSBEH1	29.73**	4.31	−0.11	−0.13	−0.12	−0.14	−0.15	−0.14	−0.10	−0.11	−0.07	−0.11	−0.00	−0.09	−0.05	0.34	0.32	—	0.19	0.22	0.38
REF3	12.25	2.91	−0.33	−0.20	−0.20	−0.30	−0.30	−0.47	−0.41	−0.40	−0.48	−0.45	−0.36	−0.40	−0.41	0.35	0.10	0.17	—	0.28	0.34
ASSCNF3	26.73**	4.71	−0.12	−0.01	−0.05	−0.11	−0.10	−0.11	−0.04	−0.08	−0.11	−0.09	−0.08	−0.12	−0.14	0.21	0.38	0.30	0.37	—	0.42
ASSBEH3	29.65	5.26	−0.07	−0.07	−0.03	−0.08	−0.04	−0.16	−0.09	−0.13	−0.14	−0.12	−0.09	−0.16	−0.13	0.19	0.25	0.38	0.36	0.48	—

Note. Treatment group ($N = 1299$) is contained in the upper triangle; Control group ($N = 731$) is contained in the lower triangle. rs $< -.05$ or $> .05$ are significant for both groups. *M* = mean, *SD* = standard deviation, ALCUSE = alcohol frequency; CIGUSE = cigarette frequency; POTUSE = marijuana frequency; ALCINT = drinking intensity; ALCDRK = drunkenness; REF = refusal skill efficacy; ASSCNF = assertive confidence; ASSBEH = assertive behavior. Variable numbers designate assessment (1 = 7th, 3 = 8th, 4 = 9th, 5 = 10th grade).

*$p \leq .05$. **$p \leq .01$ for mean comparisons.

$p < .001$) and adult ($\beta = -.07$, $p < .05$) cigarette use. The equation accounted for 14.5% of the variance in retention status, $F(20, 941) = 8.0$, $p < .001$. Despite a disproportionate loss of males and high-end drug users, there was no evidence of differential attrition by experimental condition.

Drug Prevalence and Longitudinal Patterns of Use

At baseline, 21% of the sample reported use of alcohol, 9.1% reported use of cigarettes, and 3.4% reported use of marijuana. One year later, these numbers increased to 40, 16, and 8% for alcohol, cigarettes, and marijuana, respectively. In the 9th grade, 53% of the sample reported use of alcohol, 19% reported use of cigarettes, and 12.6% reported use of marijuana. By the 10th grade 63.8% of the panel sample reported use of alcohol, 20% reported use of cigarettes, and 16% reported use of marijuana.

Analysis of marginal frequencies indicated that the sequential nature of drug use largely conformed to the stages reported in the literature. Using marijuana as the highest-ranked drug and creating dichotomous use/nonuse indicators for each drug class, 59.6% of those students reporting marijuana use in the 7th grade also reported some alcohol and cigarette use. Slightly less than one quarter of the students reporting marijuana and alcohol use had not tried cigarettes, 9.2% had not tried alcohol but had tried cigarettes, and 6.4% had tried marijuana but not alcohol or cigarettes. Although the longitudinal analyses did not include measures of 8th grade drug use, examination of the marginal frequencies confirmed that use of lower-ranked substances preceded use of higher-ranked substances during this interim period. Among students reporting marijuana use in the 8th grade, 67% used alcohol and cigarettes in the 7th grade, 27% tried alcohol but had not used cigarettes, 4.2% tried cigarettes but not alcohol, and 1.4% reporting using marijuana but not alcohol or cigarettes. In the subsequent year, 40.3% of 9th grade students reporting marijuana use also reported using alcohol and cigarettes in the preceding year. Thirty-nine percent of marijuana users used alcohol but not cigarettes, 5.8% used cigarettes and not alcohol, and 15% reported abstaining from alcohol and cigarettes but reported using marijuana. By the 10th grade, 46% of the marijuana users reported having used alcohol in the previous year, 42% used alcohol but not cigarettes, 2% used cigarettes but not alcohol, and 10.4% of the sample did not use alcohol or cigarettes.

Results of Longitudinal Structural Equation Models (SEMs)

Figure 1 contains the results of a model testing developmental progression involving general drug use (i.e., multiple drug use). For ease of presentation, Fig. 1 combines findings from the CFA and structural portion of the model. When tested independently, the measurement portion of the model (and with each successive model) indicated the latent constructs were statistically reliable and psychometrically sound, $\chi^2(81, N = 2{,}030) = 847.05$, $p < .001$ (for the model specifying latent constructs of multiple drug use: individual test results for all subsequent CFA models are available from the first author). Any fine-turning and additional model specification to improve the fit indices was applied in the structural portion of the modeling (i.e., residual covariances that captured longitudinal relations). Tests for measurement invariance for the repeated measure indicators of skills and drug outcomes indicated satisfactory equivalence for the assertiveness skills measures and nonequivalence for the three drug frequency measures. A multiple group model examined if experimental condition was responsible for the partial invariance for the drug use indicators. The hypothesized factor structure fit the data equally well for both the intervention and control students and relaxing the imposed constraints across conditions would not significantly improve the fit of the model. Although there were some slight discrepancies between the experimental conditions (marijuana factor loading for Time 1 treatment: $\lambda = .640$, $SE = .014$ and control $\lambda = .586$, $SE = .025$; and alcohol loading for Time 4 treatment: $\lambda = .618$, $SE = .047$ and control $\lambda = .734$, $SE = .060$), none were substantively large and the factor pattern for the drug use indicators was highly similar. Also not depicted for purposes of clarity in Fig. 1 are correlated residual error terms for repeated measures (e.g., covariances between seventh and eighth grade skill measures) and disturbances for the endogenous measures (reflecting variances net after prediction).

Inspection of the correlation matrix corresponding to Fig. 1 indicated that assertive skills was significantly and negatively related to early multiple drug use ($r = -.56$, $p < .001$). The slight lack of pretest equivalence noted in Table 1 is also evident in the significant association between the program measure and assertive skills ($r = -.06$, $p < .01$), with a slightly elevated level of reported assertiveness among the untreated control students. There was moderate stability in multiple drug use from the 7th to 9th grades

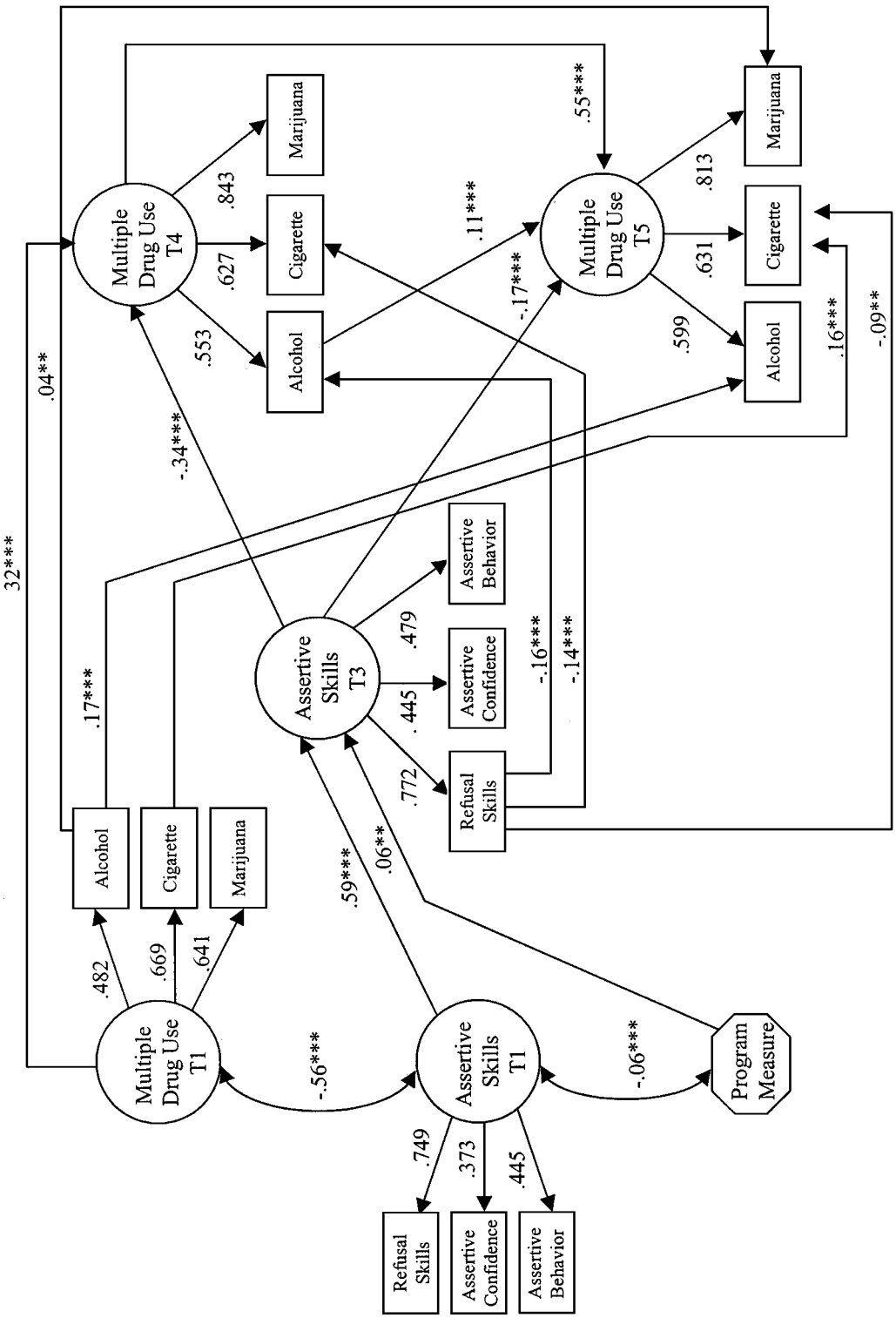

Fig. 1. Test of stage sequential model and prevention effects on general drug use. Model is trimmed with respect to nonsignificant paths. T1 = 7th grade, T3 = 8th grade, T4 = 9th grade, and T5 = 10th grade. ($^{*}p \leq .05$. $^{**}p \leq .01$. $^{***}p \leq .001$.)

($\beta = .32$, $p < .001$), and a relatively greater degree of stability between the 9th and 10th grades ($\beta = .55$, $p < .001$). Psychosocial functioning also was moderately stable from the 7th to 8th grade ($\beta = .59$, $p < .001$).

With respect to developmental progression, several interesting findings are worth noting. Controlling for early multiple drug use, early alcohol use predicted 10th grade marijuana use ($\beta = .04$, $p < .01$). Cigarette use in the 7th grade predicted 10th grade cigarette use ($\beta = .16$, $p < .001$) and 7th grade alcohol predicted 10th grade alcohol use ($\beta = .17$, $p < .001$). Interestingly, 9th grade alcohol use predicted 10th grade multiple drug use ($\beta = .11$, $p < .001$). Figure 1 also shows that the intervention disrupted developmental progression. For instance, the program significantly improved the assertive skills ($\beta = .06$, $p < .05$) and the improvement in skills translated to lowered rates of multiple drug use in the 9th ($\beta = -.34$, $p < .001$) and 10th grades ($\beta = -.17$, $p < .001$). The total absolute effect (also called the effect coefficient; Alwin & Hauser, 1975) exclusive of nonstandard paths on 9th grade multiple drug use was .02 ($p < .05$)[6] and likewise on 10th grade multiple drug use was .02 ($p < .05$). This latter effect includes the overall indirect effect of the program on multiple drug use in the 9th grade (T4) combined with indirect program effects on 10th grade (T5) multiple drug use. In addition to an overall effect on assertive skills there also were several unique effects of specific skills on later drug use. Refusal skill efficacy reduced 9th grade alcohol ($\beta = -.16$, $p < .001$) and cigarette use ($\beta = -.14$, $p < .001$) and reduced 10th grade cigarette use ($\beta = -.09$, $p < .01$). Not depicted for purposes of clarity but included in the model are correlated residuals from the 7th to 9th grade for repeated measures of alcohol frequency ($r = .24$) and cigarette frequency ($r = .23$). Similar across-time correlated residuals are included from the 9th to 10th grade for repeated measures of alcohol frequency ($r = .42$), cigarette frequency ($r = .54$), and marijuana frequency ($r = .30$). Overall, the full set of baseline measures and the mediator accounted for 28% of the variance in 9th grade (T4) multiple drug use and 51% of the variance in multiple drug use in 10th grade (T5).

The hypothesized model provided an adequate fit to the sample data, $\chi^2(84, N = 2{,}030) = 716.91$, $p < .001$, but had a significant test statistic and a $\chi^2 : df$ ratio exceeding 5.0. As a guide to model fit in covariance structure analysis, smaller ratios of the likelihood chi-square to degree of freedom ($\chi^2 : df$) indicate a better model fit ($\chi^2 : df$ under 5.0 indicate a good fit; Bentler, 1995). It is important to note, however, that with large samples trivial deviations from the implied covariance matrix will prevent obtaining a nonsignificant p-value and a ratio within acceptable limits. The absolute, (Normed Fit Index, NFI: Bentler & Bonett, 1980 = .925; Non Normed Fit Index, NNFI: Bentler, 1995 = .904), and incremental fit indices (Comparative Fit Index, CFI: Bentler, 1990b = .933) all were reasonably high and exceeded the benchmark value of .90. In addition, the discrepancy between the sample covariance matrix and implied model structure was quite small (Standardized Root Mean Square Residual, RMSR = .06, and Root Mean Square Error of Approximation, RMSEA: Steiger & Lind, 1980 = .06 with 95% Confidence Intervals, CI = .057–.065).

Examining the Role of Alcohol in the Etiology of Drug Use

Model 2 focused exclusively on the etiological role of alcohol in promoting later multiple drug use. A sample restriction included eliminating all students reporting pretest cigarette use (87 students were eliminated because of this sample restriction). This sample restriction provides a framework for detecting the etiological role of alcohol in promoting later cigarette use and tests specifically whether cigarette use intervenes between early alcohol and later multiple drug use. Proportional tests indicated that among cigarette abstaining youth, early alcohol use was associated with later cigarette use, $\chi^2(1) = 24.50$, $p < .001$ (16.9% vs. 7.8%, users of alcohol vs. nonusers of alcohol who became cigarette users, respectively).

[6]Computation of total parameter effects includes the sum of the indirect effects and the direct effect. In other words, the total effect on 9th grade multiple drug use is the product of the indirect effect corresponding to the path from the program to assertiveness multiplied by the effect corresponding to the path from assertiveness skills to 9th grade multiple drug use, which is then added to the direct effect of the program on 9th grade multiple drug use. In this model, the direct effect from the program to 9th grade multiple drug use was nonsignificant and constrained at zero (i.e., the program effect is mediated entirely by assertive skills). Additional components that should be factored into computation of the total effect include nonstandard effects (i.e., from the program to an indicator of assertiveness skills) that also mediate program influences on later drug use. In this respect, inclusion of the path from the program to refusal skill efficacy ($\beta = .05$, $p < .05$), from the program to assertive confidence ($\beta = .03$, $p < .05$), and from the program to assertiveness skills ($\beta = .03$, $p < .05$) provides a more complete picture of the magnitude of the effect coefficient.

Nonuse of either alcohol or tobacco was protective (92.2% nonusers of both substances remained nonusers of cigarettes in the eighth grade). Figure 2 shows the results of the final SEM depicting the etiological role of alcohol (again the CFA and path findings are combined). Because sample restrictions in Model 2 excluded pretest cigarette users, subsequent drug use would attribute primarily to the effects of early alcohol use.[7] Quite possibly, some new cigarette users could be introduced to the sample in the period between the eighth and ninth grades. There were 160 new cigarette smokers between the eighth and ninth grades and 178 new cigarette smokers between the seventh and eighth grades representing 9% of the total available sample at each respective time point.

Turning first to evidence of drug progression, 7th grade alcohol involvement predicted 9th grade multiple drug use ($\beta = .16$, $p < .001$) and multiple drug use remained moderately stable between the 9th and 10th grades ($\beta = .57$, $p < .001$). Frequency of 7th grade alcohol use predicted 9th ($\beta = .25$, $p < .001$) and 10th grade alcohol use ($\beta = .23$, $p < .001$). Alcohol intensity (number of drinks per occasion) predicted alcohol frequency in the 9th grade ($\beta = .23$, $p < .001$) and likewise predicted alcohol frequency in the 10th grade ($\beta = .13$, $p < .001$).

Interestingly, alcohol intensity predicted 9th grade marijuana use ($\beta = .05$, $p < .001$) and alcohol frequency predicted 10th grade marijuana use ($\beta = .05$, $p < .01$). Drunkenness in the 7th grade predicted alcohol frequency both in the 9th ($\beta = .31$, $p < .001$) and 10th grades ($\beta = .24$, $p < .001$). Correlated errors between repeated measures (these covariances are not depicted in the figure for purposes of clarity) in the period between 7th and 9th grade included alcohol frequency ($r = .24$) and cigarette frequency ($r = .23$). From the 9th to 10th grade these associations included alcohol frequency ($r = .42$), cigarette frequency ($r = .54$), and marijuana frequency ($r = .30$: ps $< .001$). There were no significant paths from early alcohol involvement to later specific cigarette use.

The prevention effects observed in the previous model persisted even with the exclusion of pretest cigarette users. The program increased social competence ($\beta = .06$, $p < .001$) and this translated into decreased 9th ($\beta = -.48$, $p < .001$) and 10th grade multiple drug use ($\beta = -.11$, $p < .001$). In addition to improved social competence, assertive behavior was associated with decreased cigarette use in the 10th grade ($\beta = -.04$, $p < .01$). The absolute effect coefficient for 9th grade multiple drug use was .03 ($p < .05$) and the effect coefficient for 10th grade multiple drug use was .02 ($p < .05$). Overall proportion of variance accounted for in 9th grade (T4) multiple drug use by baseline predictors and the 8th grade mediators was 18.6%. The same set of predictors and mediators as well as 9th grade drug outcomes accounted for 48% of the variation in 10th grade (T5) multiple drug use. A final model containing both hypothesized and nonstandard effects provided an adequate fit to the data, $\chi^2(83) = 598.54$, $p < .001$, NFI = .944, NNFI = .929, CFI = .951, RMSR = .05, and RMSEA = .06. Consistent with the previous model, residual covariances were included between 9th and 10th grade alcohol frequency ($r = .29$), cigarette frequency ($r = .55$), and marijuana frequency ($r = .35$: ps $< .001$).

Examining the Role of Cigarette Use in the Etiology of Drug Use

A final model examined the etiological role of early cigarette use in promoting later alcohol and multiple drug use. In contrast to the previous model that excluded cigarette users and that focused on alcohol initiation, this model hypothesized a formative role for early cigarette use in promoting later alcohol and multiple drug use. To effectively test this model, the sample was restricted to students reporting no alcohol use at pretest (sample loss due to this restriction

[7] At the suggestion of one of the reviewers, in a separate analysis we also excluded students reporting any marijuana use at pretest (baseline). This sample delimitation helps to insure that all potential confounds are eliminated from the alcohol etiology model and that any form of pretest smoking behavior is not a contributing factor to later onset of multiple drug use. Only 13 students overall reported any marijuana use at pretest resulting in a sample of $N = 1{,}930$ students for the alcohol etiology analysis. There were some slight differences in the findings from the model using all $N = 1{,}943$ students and the modified sample excluding marijuana users, $\chi^2(81) = 531.45$, $p < .001$, NFI = .948, CFI = .956, SRMR = .05, RMSEA = .05 (CI = .049–.058). The corresponding effect coefficient for the model eliminating marijuana users was $-.02$ ($p < .05$) for the path from the program measure to 9th grade multiple drug use and $-.03$ ($p < .05$) from the program measure to 10th grade multiple drug use. Other noted differences included a significant path from 8th grade refusal skill efficacy to 9th grade alcohol frequency ($\beta = -.15$, $p < .05$) and a path from 8th grade refusal skill efficacy to 9th grade cigarette frequency ($\beta = -.15$, $p < .05$). One other path between 9th grade alcohol frequency and 10th grade multiple drug use, which was significant in the original model, was no longer significant with the additional sample delimitation. Importantly, the magnitude of the remaining effects from the model eliminating only cigarette users did not attenuate with the exclusion of reported pretest marijuana users.

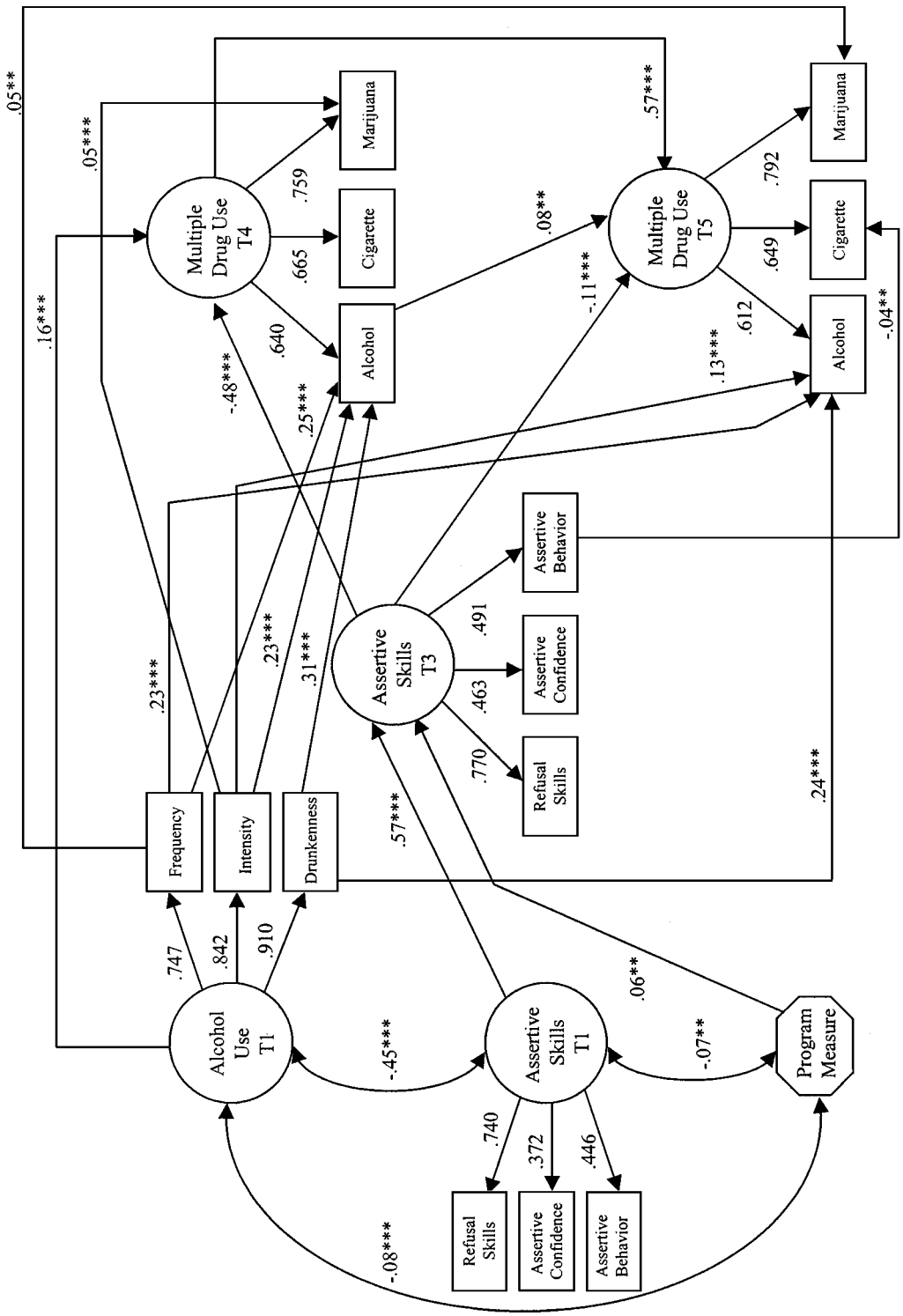

Fig. 2. Developmental model indicating etiologic role of early alcohol use: Sample reporting no pretest cigarette use.

represented 16.6%).[8] Among alcohol abstaining youth who reported having tried cigarettes, cigarette users were more likely to become alcohol users over time, $\chi^2(1) = 21.50$, $p < .001$ (62.5% vs. 28.7%, users and nonusers of cigarettes, respectively). Abstaining from alcohol use was protective, but somewhat less than abstaining from cigarette use (71.32% remained alcohol nonusers who were cigarette nonusers at pretest).

Figure 3 contains the results of a model testing the etiological role of early cigarette use. Among the general hypothesized effects, cigarette use predicted 9th grade alcohol use (reflected by frequency, intensity, and drunkenness; $\beta = .15$, $p < .001$) and had a small but significant effect on 10th grade multiple drug use ($\beta = .08$, $p < .01$). Alcohol use in the 9th grade predicted later multiple drug use ($\beta = .55$, $p < .001$). Among the drug-specific (unique) effects, early cigarette use predicted 10th grade cigarette use ($\beta = .15$, $p < .001$) and 9th grade alcohol use ($\beta = .15$, $p < .001$). Ninth grade alcohol frequency predicted 10th grade alcohol frequency ($\beta = .32$, $p < .001$) and 9th grade alcohol intensity predicted 10th grade alcohol frequency ($\beta = .10$, $p < .001$).

Consistent with findings from the two previous models, the intervention improved social competence ($\beta = .08$, $p < .001$). This indirect effect translated into less alcohol use in the 9th grade ($\beta = -.28$, $p < .001$) and less multiple drug use in the 10th grade ($\beta = -.07$, $p < .05$). In addition to general program effects, 8th grade refusal skills decreased 10th grade cigarette use ($\beta = -.12$, $p < .001$). The absolute effect coefficient for 9th grade alcohol use was .02 ($p < .01$) and for the 10th grade multiple drug use was .02 ($p < .05$). The total proportion of variance accounted for in 9th grade (T4) alcohol use was 11% and for 10th grade (T5) multiple drug use was 35%. Fit indices showed this model to be an adequate fit to the data, $\chi^2(67, N = 1693) = 551.19$, $p < .001$, NFI = .934, NNFI = .920, CFI = .941, RMSR = .07, and RMSEA = .07. Finally, we examined a model that fixed to zero the path from 7th grade cigarette use to 10th grade multiple drug use. With this additional constraint, the model posits essentially that alcohol mediates entirely the relation between early cigarette and later multiple drug use. The decrement in fit between the two models was significant, $\Delta\chi^2(1) = 9.50$, $p < .05$, indicating that the path from early cigarette use to later multiple drug use was essential to fit the hypothesized model to the sample data. An additional test constrained the path from early cigarette use to 9th grade alcohol use and the decrement in fit between models also was significant, $\Delta\chi^2(1) = 35.15$, $p < .001$. In effect, among youth abstaining from pretest alcohol use but having reported use of cigarettes, alcohol use represents an essential and intermediate step between early cigarette use and later multiple drug use.

[8]The inclusion of marijuana users at pretest in the cigarette etiology model also potentially confounds findings associated with program effects. Thus, in a separate set of analyses we excluded marijuana users at Time 1 (7th grade) and examined differences between this model and the cigarette etiology model that included reported marijuana users. Overall, there were 28 reported marijuana users in this select sample (excluding alcohol users $N = 1,665$). The sample exclusion did not alter appreciably the findings. In fact, there was only one additional significant path evident in the model excluding reported marijuana users and that included an effect of 9th grade drunkenness on 10th grade alcohol frequency of use ($\beta = .29$, $p < .001$). Otherwise, the absolute effect sizes were comparable between models (.02 in both models) and the fit indices did not vary.

DISCUSSION

Results of the current study provide partial support for a stage sequential model of early-stage drug use involving the three most prevalent substances used in adolescence. With the passage of time from the 7th to 10th grades, an increasing number of youth reported having tried alcohol, cigarettes, and marijuana. Proportional analyses reinforced the cumulative nature of drug use and showed that students reporting marijuana use were likely to have used alcohol and cigarettes previously. All three substances were integrally involved as major determinants of multiple drug use, although early involvement with alcohol and cigarettes is pivotal in the progression to marijuana and multiple drug use. To a large degree these findings comport with previous reports of a stage sequential nature of drug use. However, there were some modest deviations from the reported invariant developmental progression of early-stage drug use. In particular, alcohol was noted to play an important etiologic role in determining later drug involvement and stimulated directly later marijuana use. Most of the youth reporting 10th grade marijuana use (16% of the panel sample reported having tried marijuana) had used alcohol and cigarettes during the intervening time following the pretest assessment. Only a very small fraction of these youth abstained from alcohol and cigarette use in the intervening time between their reported use of alcohol (7th grade) and subsequent marijuana use. For some youth then, not having cigarettes as part of

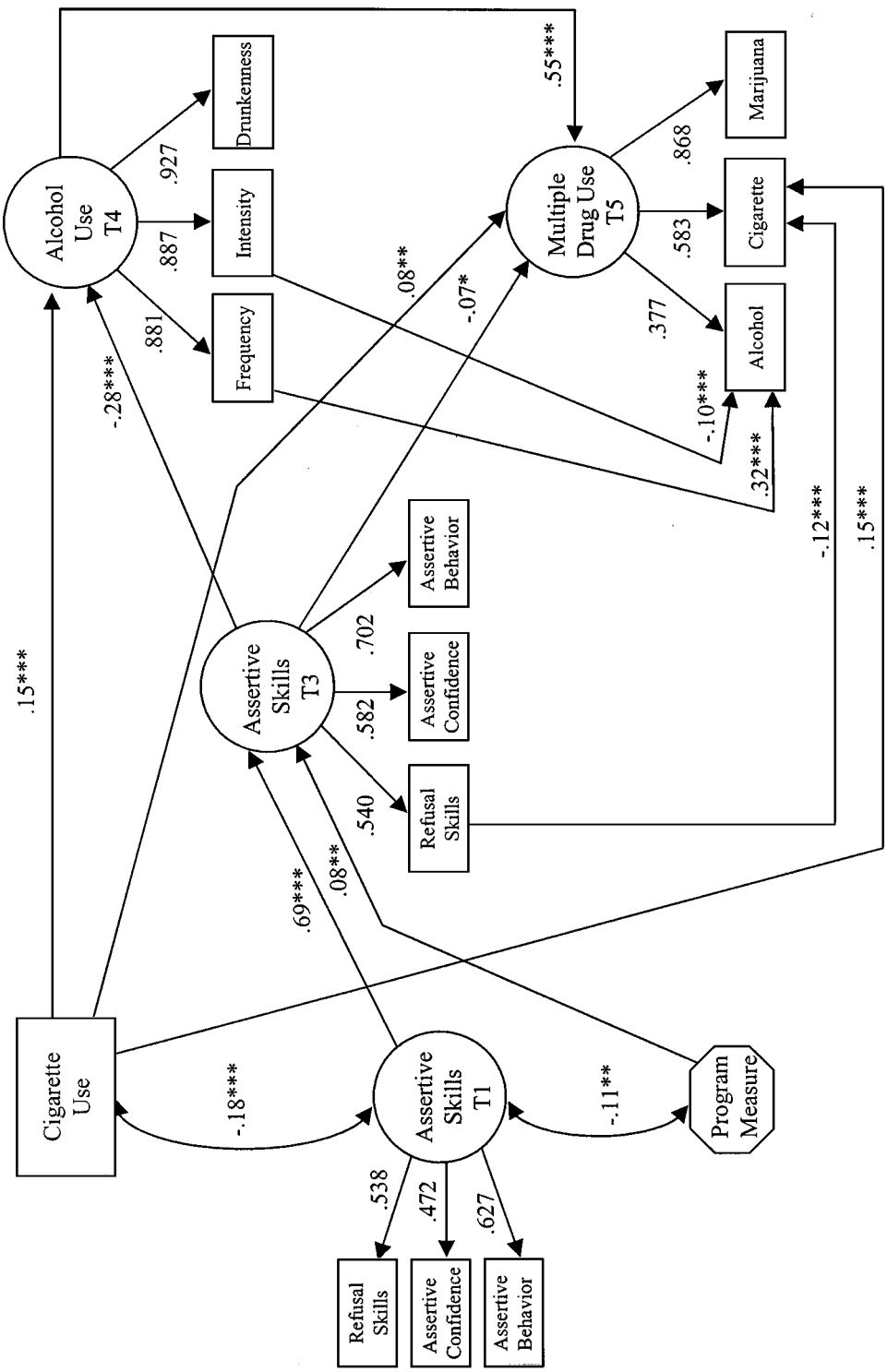

Fig. 3. Developmental model indicating etiologic role of cigarettes: Sample reporting no pretest alcohol use.

their behavioral repertoire in the 7th grade did not dampen movement into multiple drug use in the 9th or 10th grades.

In addition to a direct movement from alcohol to later marijuana use, the analyses that excluded pretest alcohol users facilitated showing direct linkages between early cigarette and later alcohol and multiple drug use. Overall, these effects were relatively small, but point toward the need to consider the important determining role of cigarettes. Clearly, prevention programs that aim to interrupt drug sequences by reducing psychosocial vulnerability can maximize their effects by attending to the etiologic role of all three drug types at this early stage.

Added to the explicit tests of drug progression, the current study examined program effects associated with a multimodal, cognitive–behavioral intervention program. Three important findings emerged from this portion of the analyses. First, the use of latent variable technology permitted inclusion of multiple indicators of assertiveness skills to reflect a hypothetical dimension of social competence. Social competence is multifaceted and comprises many interrelated skills that reflect interpersonal mastery and social confidence (e.g., Waters & Sroufe, 1983). In this regard, the intervention includes a wide range of cognitive–behavioral strategies intended to improve assertiveness, teach drug-specific refusal skills, and help youth to acquire greater interpersonal confidence. The increase in perceived social mastery and interpersonal confidence, in turn, reduces vulnerability to negative peer and social influences. Buffeted by their social confidence, experimentally treated youth are less likely to accept active offers to drink, smoke cigarettes, and use marijuana and are more likely to make healthy decisions. In addition to ascertaining its pivotal role in reducing drug use, findings from this study reinforce the conceptualization of social competence as a latent psychological mechanism. In all three models, social competence was psychometrically sound and developmentally stable.

Another important feature of the current study is the inclusion of statistical controls for maturational influence and developmental consistency in the hypothesized intervening mechanisms (Pentz & Chou, 1994). This is particularly noteworthy with an experimental design where an investigator wants to ensure that activation of targeted skills provides a valid index from which to gauge *real* program effects. It is reasonable to expect that most youth will acquire a basic level of social competence as they navigate the early years of adolescence. It also is reasonable to expect that during the formative years, skills will accrue and benefit from repeated use and become an indelible part of the adolescent experience. In effect, youth in both experimental groups are likely to report natural maturation of skills and gain social competence as part of normative development. All other factors considered, and net of maturational influences, any remaining variability in the targeted skills attributes to the intervention.

Tests for factorial invariance across time reinforced that despite maturational effects and growth over time, social competence remained developmentally intact. Thus, effects attributed to the program are not spurious or confounded by maturation or historical influences. There was limited evidence of measurement invariance for the drug use measures. One reason for the lack of developmental stability in drug behaviors may attribute to the influx of new drug users between pretest and follow-up and the infusion of new patterns of drug use (e.g., alcohol without cigarettes or vice versa). Epidemiological evidence shows the middle school period as one of heightened risk for onset to drug use (Johnston *et al.*, 1999). Efforts to curb or forestall the onset of drug use should maximize their effect during the earliest time prior to consolidation of these behaviors and their incorporation into everyday functioning.

Despite not remaining developmentally consistent over time, drug use was moderately stable from the 9th to 10th grade. Thus, any disruption to early 9th grade drug use would effectively deter continued drug use. The carryover of program effects from an earlier point in time is likely to forestall entry to more problematic drug use and portend an enormous public health benefit. In addition, program effects were ubiquitous regardless of the point of entry to initial drug use, reinforcing the importance of early interventions that broadly consider gateway substance use.

A second finding worth highlighting regards the magnitude of program effects for the three models. The program activated the targeted skills in the manner hypothesized and changes in assertive skills led to reductions in both general and specific types of drug use. The magnitude of the total program effect on drug use was appreciably small but nevertheless led to modest reductions in levels of drug use. In other words, for a small change in assertiveness and social competence, there are corresponding large reductions in drug use (on a scale of 5 : 1 in Model 1) gained from exposure to the intervention. At a more refined level, the magnitude of the effect coefficient (total program effect) was largest with students who reported

abstaining from cigarette use at pretest (Model 2). One essential issue that may facilitate program effects with regard to alcohol etiology is the relatively higher prevalence of alcohol use compared with other gateway substances in this sample specifically, and in the larger population of students in this age cohort more generally (e.g., Johnston *et al.*, 1999). Even the marginal cell frequencies indicated the strong role of alcohol in the early stages of drug use and more often than not alcohol was a factor in higher-order drug use (i.e., a majority of marijuana users also reported alcohol use).

Along these same lines, all of the longitudinal analyses highlighted the pivotal role of alcohol as a gateway entry-level substance and as an intervening step facilitating progression toward multiple drug use. Given the salient role of alcohol for these youth, it is understandable then that programs implementing social skills training to improve assertiveness and reduce alcohol use may have their greatest impact on alcohol. It also is worth noting that the intervention is multimodal and despite this study's exclusive focus on social skills, other program components attended to normative education and competence enhancement. In effect, despite the analytic focus on one prevention approach, these students may have responded to changes in the normative environment coupled with their increased social competence and the two (or even three) strategies combined worked effectively. What this study highlights is that the intervention works most effectively for the drug that is most prevalent and that plays a generative role in determining later high-risk drug use. Notwithstanding, the effect coefficients were not markedly different across all three models, which argues for a continued emphasis on reducing gateway substance use in general and perhaps a renewed emphasis on reducing alcohol use in particular.

A different issue regards the proportion of variation accounted for by each specific model. The largest overall proportion of variance accounted for by the full set of pretest measures and intervening mediators was in the model containing no sample delimitations and specifying multiple drug use at all three assessment points. These two issues identify two different features of the intervention. One is its relative strength in reducing drug use, which was greatest among youth with reported alcohol but no pretest cigarette use. Prevalence data for this period indicate the rapid emergence of recent onset alcohol users (alcohol prevalence is double in the 8th compared with 7th grades). The complicit nature of alcohol use in all three models (i.e., more paths involved alcohol use than the other two drugs combined) and the sizable effect of assertive skills on later drug use in the model targeting alcohol etiology highlights the importance of staging interventions to the period of maximal exposure to the conditions of risk that induce early experimentation with alcohol use.

A second issue concerns how well the specified model accounts for variation in the behavioral outcomes. It is worth noting that the model with the least amount of sample variation accounted for by the specified relations involved cigarette etiology (with alcohol as an intermediate endpoint). Clearly, in this case a larger set of predictors and perhaps more detailed developmental relations are required to fully understand the early stages of drug use. Identifying cigarette use as a basement substance does not adequately explain the progression from one drug to another and additional drug-specific mechanisms are required. This is exemplified more clearly by the larger proportion of variance accounted for in the model specifying long-term linkages between multiple drug use. Regardless of which point of entry to drug use, findings from all three models suggest that prevention efforts are well intended if they focus on all three gateway substances and direct a substantial portion of their influences toward enhancing social competence and specifically drug-refusal skill efficacy.

Additional specific features of the models are worth noting. In particular, regression coefficients linking assertive skills with later reported drug use were noticeably larger in magnitude over a 1-year period than a 2-year period. In fact, the disparity in size between the path coefficients corresponding to the direct effect of assertiveness skills to later drug use (both 9th and 10th grade) was on the magnitude of three to one. In terms of relative size, the largest effect of assertiveness skills on subsequent drug use was obtained in the model excluding cigarette users at pretest (and therefore restricting the sample to those youth reporting experimentation with alcohol). This point harkens back to the earlier point regarding the central role of alcohol in drug initiation and the relatively larger magnitude of program effect size in a model specifying alcohol etiology. With regard to the diminution of program effect over time, an interesting point worth noting is that the intervention included booster sessions in the 8th and 9th grades. Additional evaluations of the intervention using different analytic techniques have shown that intervention effects persist 6.5 years after implementation (Botvin *et al.*, 1995a). In effect,

the observed reductions in effect size highlight a need to model the intervening mechanisms beyond the initial period of exposure in the period between 7th and 8th grades.

A third point worth noting is that in addition to providing evidence of program effects on social competence, intervention students also benefited from their exposure to treatment with respect to individual skills. In the model with no sample restrictions (all types of initial drug use considered simultaneously), improved assertiveness skills led to higher levels of reported refusal skill efficacy. In turn, refusal skills decreased alcohol and cigarette use over a 1-year period and cigarette use over a 2-year period. Findings from the model testing alcohol as the entry point to later drug use revealed that the intervention activated multiple components of assertiveness skills. In fact, exposure to the program enhanced social competence, which in turn led to increased levels of assertive behavior (frequency of defense of rights). These individual skills then reduced levels of cigarette use over a 2-year period. A third model examining the etiologic role of cigarette use showed that improvements to assertive skills led to increases in refusal efficacy, which in turn reduced cigarette use over a 2-year period. Overall, all three models show that skill enhancement both at a general and individual level lead to reductions in reported levels of drug use.

LIMITATIONS OF THE STUDY

Several limitations of the current study are worth noting. Despite the use of multiple indicators to reflect latent constructs, the primary method of data collection relied on self-report, which can introduce a certain level of bias from method variance into the model. Notwithstanding, evidence is accumulating that self-reports of drug use with adolescent samples provide reliable and valid estimates of use (Barnea *et al.*, 1987; Gfroerer, 1985; O'Malley *et al.*, 1984; Stacy *et al.*, 1985). In addition to the limitations associated with self-report data, with few exceptions the drug items exclusively assessed frequency of use. The one exception was alcohol use, which included items to tap intensity (i.e., quantity) and drunkenness. Findings did show that frequent and intense alcohol use (including drunkenness) are integrally involved in predicting continued alcohol use and predicting onset to multiple drug use. Unfortunately, indicators of intensity were not available for marijuana and cigarette use, which precluded examining the role of consumption intensity for those substances in predicting future drug use. One explanation for the role of alcohol intensity suggests that intermediate steps exist between frequent use and later more exacerbated use. Furthermore, additional factors that heighten sensitivity to the pharmacological properties of a drug and that are associated with chronic and intense use can facilitate movement from a lower-ranked to a higher-ranked drug (i.e., alcohol to marijuana).

Second, the analyses of prevention effects included only one of several prevention modalities (i.e., social competence) in an effort to elucidate intervention effects. The intervention is a multi-modal, competence-enhancement prevention program and contains a broad spectrum of cognitive–behavioral intervention strategies. Core strategies focus on enhancing personal competence (e.g., self-management skills), normative education (e.g., correcting misperceptions regarding the social acceptability of drug use), and social resistance skills training. The sampling of assertiveness skills to reflect social competence represent only a few of the potential assessments from a larger domain of items and more extensive analyses are required to elucidate the full range of program effects possible.

Two additional factors can potentially influence results in randomized prevention trials. First, the unit of observation for the SEM analyses was the individual; however, the unit of assignment for the prevention trial was the school. Clustering effects within schools due to intact social groups can contribute to the outcome variance. Failure to control for clustering effects biases estimation of program effects (Murray, 1998). Controlling for the magnitude of the intraclass correlation coefficient (ICC), a quantitative estimate of the magnitude of clustering, provides a partial remedy to this problem. A careful examination of ICCs for the skill measures indicates that they are quite small (.02–.05). Clustering may represent a more relevant consideration when applied to normative beliefs, which reflect a prevailing social consensus (i.e., a climate regarding the social acceptability of drug use). Moreover, the hypothesized causal agents of change in the intervention and in the current analyses portend enhancing individual-level skills and clustering may exert relatively little influence. In this regard, the longitudinal SEM analyses represent a useful approach to detect program-related change despite randomization at the level of larger aggregates (i.e., school). Notwithstanding, future studies may want to consider using multilevel and random coefficient

approaches to continue addressing important concerns regarding drug progression in the context of data obtained from school-based prevention trials (e.g., Krull & MacKinnon, 1999).

Additional methodological considerations include systematic bias in the sample resulting from a selective loss of high-end alcohol and drug users, which can potentially influence the study findings. Males reported higher levels of alcohol use and were less likely to be part of the panel sample. Despite some selective loss, the imputation methods considered factors that may influence retention and included controls for mechanisms that may contribute to missing data (i.e., grades, risk-taking, and gender).

Overall, these analyses represent a first pass at understanding prevention effects on developmental progression. Naturally, cross-validation and replication of these findings is an essential next step. This is especially noteworthy in light of the homogeneous racial and demographic composition of the current sample and that other researchers have reported racial variations in developmental progression (Welte & Barnes, 1985). Additional tests of the intervention with inner-city, ethnic minority youth have provided empirical validation of program efficacy (Botvin *et al.*, 1992, 1995c). However, more extensive tests of mediation and assessing effects on developmental progression are required to validate externally the benefits of the intervention with ethnic minority youth.

Finally, one important feature of the current analyses was the reliance on post hoc specification searches to fit models with nonstandard paths that capture program- and drug-specific effects. Despite the exploratory nature of this analytic approach, these analyses relied on a concerted and systematic strategy to identify program effects and drug-specific relations. Evidence is accruing, however, that specification searches with moderately small samples (<2,000) can be specious and capitalize on chance (MacCallum *et al.*, 1992). The current sample size marginally exceeded this threshold, however; future prevention trials should strive to replicate with sufficiently large enough samples to insure robust findings

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