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An Adaptive Approach to Family Intervention: Linking Engagement in Family-Centered Intervention to Reductions in Adolescent Problem Behavior

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This study used Complier Average Causal Effect analysis (CACE; see G. Imbens & D. Rubin, 1997) to examine the impact of an adaptive approach to family intervention in the public schools on rates of substance use and antisocial behavior among students ages 11–17. Students were randomly assigned to a family-centered intervention ($N = 998$) in 6th grade and offered a multilevel intervention that included (a) a universal classroom-based intervention, (b) the Family Check-Up (selected; T. J. Dishion & K. Kavanagh, 2003), and (c) family management treatment (indicated). All services were voluntary, and approximately 25% of the families engaged in the selected and indicated levels. Participation in the Family Check-Up was predicted by 6th-grade teacher ratings of risk, youth reports of family conflict, and the absence of biological fathers from the youths' primary home. Relative to randomized matched controls, adolescents whose parents engaged in the Family Check-Up exhibited less growth in alcohol, tobacco, and marijuana use and problem behavior during ages 11 through 17, along with decreased risk for substance use diagnoses and police records of arrests by age 18.

Keywords: family intervention, compliance, substance use, conduct problems, early adolescence

A major tenet of prevention science is that a program that tightly links developmental and intervention research is likely to provide effective strategies for reducing child and adolescent maladjustment and preventing the occurrence of more serious forms of problem behavior, such as delinquency, antisocial behavior, substance use, and deviant peer association (Dishion & Patterson, 1999). Problem behavior in adolescence is particularly salient because of the possible social–emotional and cognitive harm to youths and potential life course implications and eventual costs to society (Biglan, Brennan, Foster, & Holder, 2004). Early-onset substance use is of particular concern because of the increased risk for the development of drug abuse and dependence and because of the disruptive effect on late adolescent and young adult transitions (e.g., Anthony & Petronis, 1995; Kandel, Davies, Karus, & Yamaguchi, 1986).

Although problem behavior is clearly multiply-determined, a large body of research has shown that processes within families are central to the etiology of problem behavior from early childhood through early adolescence (for review, see Dishion & Patterson, 2006). In particular, coercive social interaction dynamics in families appear to support the early development of overt forms of problem behavior in the family setting (Patterson, Reid & Dishion, 1992). Coercion involves inadvertent reinforcement of problem behavior through escape conditioning processes, as parents and youths reinforce escalations in aversive interchanges over time. Parental efforts to supervise and monitor child behavior are also central to the development of problem behavior in adolescence. Parental supervision tends to decrease for youths at highest risk—those most in need of parental support and monitoring—when the adolescents are about age 13–14 (Dishion, Nelson, & Bullock, 2004). This process, referred to as *premature autonomy*, is likely bidirectional, and as youths become more involved with peer cliques that participate in deviant activities, they naturally pull away from parental supervision, involvement, and monitoring (Dishion et al., 2004; Dishion, Poulin, & Medici Skaggs, 2000). Such results support the notion that the family is a crucial point for intervention/prevention to disrupt causal network leading to growth in problem behavior over adolescence (Dishion & Kavanagh, 2003; Dishion & Stormshak, 2006).

In line with this view, previous research has demonstrated that actively motivating parents to monitor and continue to manage substance-using adolescents results in improved parental supervision and decreased adolescent substance use (Dishion, Nelson, & Kavanagh, 2003). This finding is consistent with a large group of studies showing that parenting interventions that target these processes improve parenting skills, which in turn improves youths' mental health outcomes (e.g., Bullock & Forgatch, 2005; Spoth, Redmond, & Shin, 1998). Although parenting interventions have been shown to be effective in randomized clinical trials, one challenge is to determine efficient ways to engage large numbers of families in family-based prevention in order to maximize public

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health benefits. Because nearly all youths within the United States attend middle school, the public school environment is an important site for efforts to prevent adolescent substance use (e.g., Catalano et al., 2002). The prevention community is increasingly interested in designing strategies that link school interventions with those that target parenting practices, to increase the potential for a more significant public health impact (Spoth, Kavanagh, & Dishion, 2002).

In the face of limited resources, one strategy for systematically integrating parent-focused interventions into the school environment is to adaptively tailor school-based interventions so that those families most in need of parenting support are those who are engaged in family interventions (Dishion, Kavanagh, & Kiesner, 1999). In recent years the examination of "adaptive interventions" for the treatment of youth behavior problems has been increasingly emphasized (Collins, Murphy, & Bierman, 2004). Contrary to traditional research-based strategies, in which all youths ideally receive identical intervention during the course of a study, an adaptive intervention framework recognizes that individual adolescents or families may have very different intervention needs, with differing targets for potential intervention and differing intervention dosages likely in order to be maximally effective. The core feature of an adaptive intervention framework is that specific intervention targets and doses are determined individually based on decision-rules in order to adapt treatment to the needs of the families. Advantages include decreased likelihood of negative effects of intervention components that are not appropriate for a given individual, decreased waste of limited resources, potentially increased compliance with treatment, and increased intervention potency (Collins et al., 2004). Such advantages enable intervention researchers to address problems of public health significance within a cost-effective, sensitive intervention framework that more closely resembles real-world clinical practice.

The Adolescent Transitions Program (ATP) is an adaptive intervention for delivery in the public school environment (Dishion & Kavanagh, 2003). The model comprehensively links the universal, selected, and indicated family interventions in a way that titrates the intervention intensity to the needs and motivation of the family. The goals of the universal intervention are to support parents' supervision, involvement, and management of their children and to identify and motivate the parents of high-risk youths to engage in, and stay engaged in, this active family management process. The Family Check-Up (FCU; Dishion & Kavanagh, 2003) was designed as a selected intervention that motivates parents to improve parenting practices when needed. The FCU is a brief three-session intervention that involves an initial interview, a family assessment, and a feedback session that focuses on motivation for parenting. Following the FCU, a menu of family-centered interventions is offered that provide support for family management practices in adolescence (see Dishion & Kavanagh, 2003). The intervention is designed to link up intervention services within the school and community to promote the well-being and improved behavior of the child or adolescent. The intervention, described in more detail by Dishion and Stormshak (2006), actively promotes self-selection into the most appropriate intervention services based on systematic assessments, resources available, and the motivation and skills of the parents.

However, the results of adaptive interventions are complex to evaluate, because the perceived need for intervention may be confounded with willingness to engage in treatment. Several analytic approaches—including per-protocol analysis, which excludes nonparticipating families, and as-treated analysis, which groups individuals by the treatment actually received—are possible. However, these approaches break randomization, and their potential for bias is great (Little & Yau, 1998). A critical step in evaluating the impact of an adaptive, tailored intervention is to identify a subset of the randomized control group that resembles those who do actively engage in a voluntary intervention. This group of control families should provide the most accurate picture of how youths receiving the FCU would have developed without intervention.

Fortunately, there are recently developed statistical techniques for analyzing randomized intervention designs that are capable of systematically analyzing "compliance" as an index of engagement, referred to as Complier Average Causal Effect (CACE) analyses (Imbens & Rubin, 1997; Jo, 2002; Little & Yau, 1998). CACE analysis was developed based on the recognition that treatment noncompliance can be a major threat to randomized interventions, leading to biased estimates of intervention effects and limited power to detect significant effects when they do exist (Angrist, Imbens, & Rubin, 1996). There are several approaches to CACE analysis, and more recently, one approach that has been integrated into a general framework for analyzing person- and variable-centered approaches is referred to as mixture modeling, which involves the use of Mplus statistical software (B. Muthén, 2004; L. K. Muthén & Muthén, 1998–2007). Jo (2002) applied the mixture modeling framework to identify the optimal comparison group from the control condition for observed treatment-compliers in the intervention condition. Briefly, this application of mixture modeling permits the modeling of two aspects of intervention process—the prediction of intervention engagement and the examination of the differential outcomes.

In this report, we use CACE analysis to identify predictors of intervention engagement and to examine the effect of engagement with the selected and indicated levels of the ATP intervention on the development of problem behavior among students in Grades 6–12. In general, we predicted that families with young adolescents at highest risk would be most likely to engage in the intervention condition. Among those families that engaged, we predicted that receipt of the family intervention would predict less growth in problem behavior and substance use across adolescence. These analyses extend prior results for the ATP in the following important ways: (a) whereas prior results have employed intention to treat (ITT) analyses, the CACE approach used in this article permits more precise estimates of the effects of compliance with the selected and indicated levels of intervention on problem behavior development, (b) whereas prior ITT analyses (Connell, Dishion, & Deater-Deckard, 2006) focused on a broad substance use composite, the current analyses focus more specifically on separate substance use types and also include antisocial behavior, and (c) the current analyses include a longer time span and additional assessment data (diagnostic and arrest outcomes) that were not previously available.

Method

Participants

Participants included 998 adolescents and their families, recruited in sixth grade from three middle schools within an ethni-

cally diverse metropolitan community in the Northwest region of the United States. Parents of all sixth grade students in two cohorts were approached for participation, and 90% consented to participate (see Figure 1). The sample included 526 male (52.7%) and 472 female (47.3%) participants. By youth self-report, there were 423 Caucasians (42.3%), 291 African Americans (29.1%), 68 Latinos (6.8%), 52 Asian American families (5.2%), and 164 (16.4%) youths of other ethnicities (including biracial). Biological fathers were present in 585 families (58.6%). Youths were randomly assigned at the individual level to either control (498 youths) or intervention (500 youths) classrooms in the spring of sixth grade. Public schools agreed to randomization of students to a family resource center (FRC) because it reduced the need for services at the schoolwide level. Approximately 80% of youths were retained across the longitudinal span of the current study (Wave 2, $n = 857$; Wave 3, $n = 829$; Wave 4, $n = 820$; Wave 6, $n = 794$).

Intervention Protocol

The FCU is part of the multilevel ATP intervention program (see Dishion & Kavanagh, 2003; Dishion, Kavanagh, et al., 2003). The first level of the program, a universal intervention, established an FRC in each of the three participating public middle schools. The parent-centered services of the FRC were available for the entire intervention group. These included brief consultations with parents, telephone consultations, feedback to parents on their students' behavior at school, and access to videotapes and books. In addition, the FRC parent consultant conducted six in-class lessons referred to as the SHAPe Curriculum for students. The intervention was modeled after the Life Skills Training program described by Botvin, Baker, Dusenbury, Tortu, and Botvin (1990) but reduced in scope (6 in SHAPe vs. 16 in Life Skills Training). The focus of the six sessions was the following: (a) School Success, (b) Health Decisions, (c) Building Positive Peer Groups, (d) The Cycle of

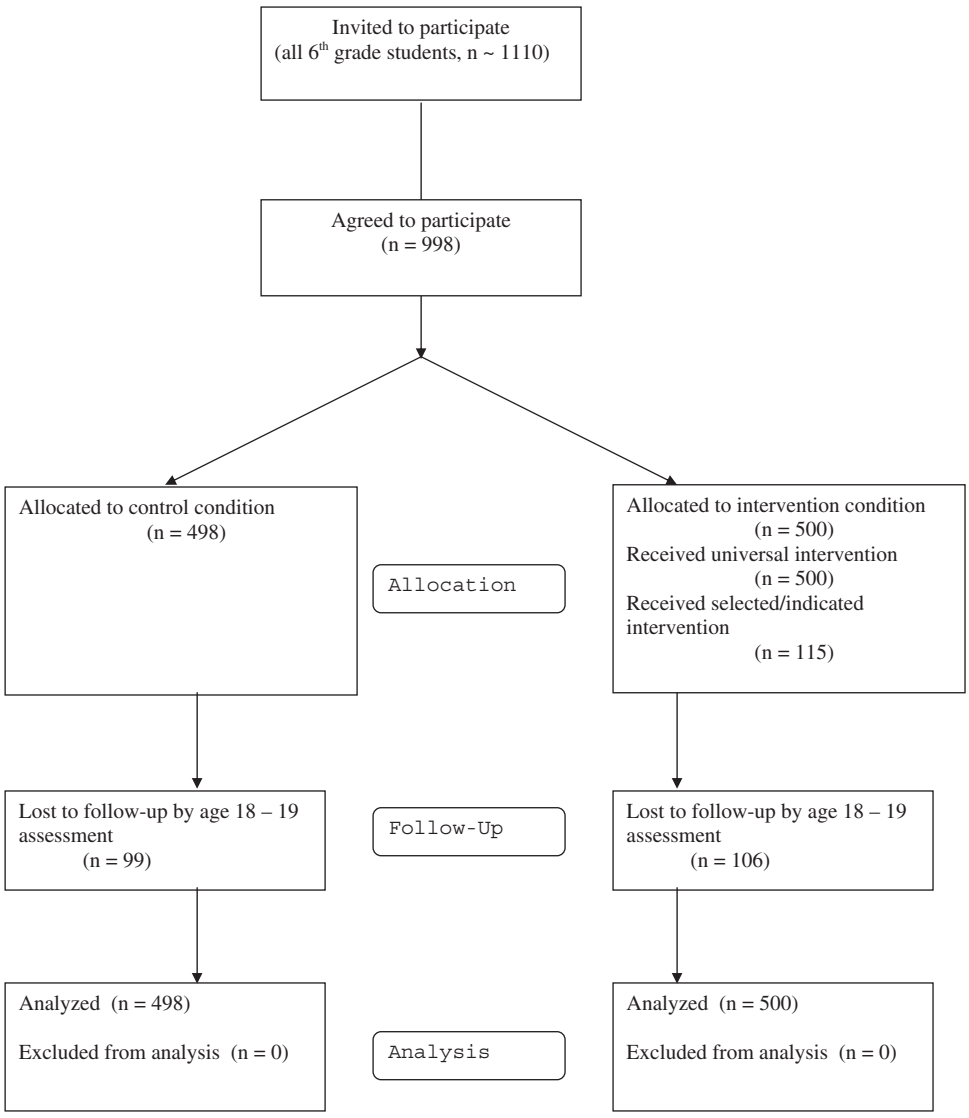

Figure 1. Flow of participants through the study.

Respect, (e) Coping With Stress and Anger, and (f) Solving Problems Peacefully. Included in this intervention were brief parent–student activities designed to motivate family management. The universal intervention was designed to support positive parenting practices and to engage parents of high-risk youths for the selected intervention.

The selected intervention was the FCU, a brief, three-session intervention based on motivational interviewing and modeled after the Drinker's Check-Up (Miller & Rollnick, 2002). Although all families could receive the FCU, families of high-risk youths, determined by teacher ratings, were specifically offered the FCU in seventh and eighth grades. The three sessions consisted of an initial interview, an assessment session, and a feedback session. During the initial interview, a therapist explored parent concerns and stage of change and encouraged the parents to have a family assessment. During the assessment session, the family was videotaped in the home while engaging in a variety of tasks that would help evaluate parent–child interactions. In the feedback session, the therapist systematically summarized the results of the assessment using motivational interviewing strategies. An essential objective of the feedback session was to explore potential intervention services that support family management practices.

One outcome of the FCU was a collaborative decision between the parent and parent consultant on the indicated services most appropriate for their family. Services included empirically validated interventions, including a behaviorally oriented parent group intervention (Dishion & Andrews, 1995; Forgatch & DeGarmo, 1999), individually based behavior family therapy (Patterson, 1975; Patterson, Reid, Jones, & Conger, 1975), and multisystemic family therapy (Henggeler, Schoenwald, Borduin, Rowland, & Cunningham, 1998). When the students moved on to high school, FRC services were discontinued. Students who left the targeted schools were offered services if they remained in the county.

Services were delivered by Parent Consultants, a firm that provided two master's-level therapists and one with a bachelor of science. Parent consultant ethnicity closely matched that of the participating families. Parent consultants were trained with a combination of strategies (provided primarily by author Kathryn Kavanagh)—including didactic instruction, role-playing, and videotaped supervision—throughout the 2 years of intervention activity. The strategies came from a written manual that was a prepublication version of Dishion and Kavanagh (2003), which provides further ATP intervention details.

In the intervention condition, 115 families (23%) elected to receive the FCU, and 88 of these received further intervention services after the FCU. For Cohort 1, 46% of FCUs were completed following the seventh grade family assessment, 53% were completed following the eighth grade family assessment, and 1% were completed following the ninth grade family assessment. For Cohort 2, 93% of FCUs were completed following the seventh grade family assessment, and 7% were completed following the eighth grade family assessment. These families had an average of 8.9 hr of direct contact with the intervention staff during the course of the study ($SD = 9.42$). Contrary to expectations, most families elected to receive brief consultations and periodic FCU meetings rather than more intensive forms of treatment.

Assessment Procedures

In the spring semester, from the sixth through ninth grades, and again in the eleventh grade, student were surveyed with an instrument developed and reported on by colleagues at the Oregon Research Institute (Metzler, Biglan, Rusby, & Sprague, 2001). Assessments were conducted primarily in the schools. If students moved out of their original schools, we followed them up at their new location. Youths were paid $20 for completing each assessment.

Measures

Adolescent substance use and problem behavior. Youths completed a self-report survey about their drug use and antisocial behavior at ages 11, 12, 13, 14, and 16–17. Each year, they were asked to report the frequency with which they had used alcohol, tobacco, and marijuana in the previous month. Youth reports of engagement in problem behavior were measured averaging across six items. Items assessed the number of times in the past month that teens reported having engaged in the following behaviors: (a) lying to parents, (b) skipping school, (c) staying out all night without permission, (d) stealing, (e) panhandling, and (f) carrying a weapon. Responses were given on a 6-point scale, ranging from 1 (*never*) to 6 (*more than 20 times*). Good internal reliability was found for this scale across assessments (alpha reliability ranged from .63 to .74 across years).

Child gender. Child gender was coded as 0 = "male," and 1 = "female."

Child ethnicity. Youth-reported ethnicity was coded as 0 = "Caucasian," and 1 = "ethnic minority."

Father presence. Youth reports of biological father presence in their primary residence in sixth grade were coded as 0 = "biological father not present," and 1 = "biological father present."

Teacher report of sixth grade risk behavior. This measure was revised from an earlier version of a measure developed by Soberman (1994). Teachers were asked to use a 16-item questionnaire to rate their full roster of sixth grade students on a variety of risk behaviors associated with problem behavior in adolescence. The frequency with which youths engaged in these problem behaviors was reported on a 5-point scale ranging from 1 (*never/almost never*) to 5 (*always/almost always*). Items included aggression, oppositionality, peer relationship problems, disliking school, and moodiness. The mean for this sample was 1.85 ($SD = 0.85$). High internal consistency reliability was found for this scale (alpha reliability = .95). This variable was mean-centered for use in analyses.

Deviant peer involvement in sixth grade. Youth reports of deviant peer involvement in sixth grade were measured averaging across four items. Items assessed youths' reports of the number of times in the past week they had spent time with peers who (a) get into trouble, (b) fight a lot, (c) take things that don't belong to them, and (d) smoke cigarettes or chew tobacco. Responses ranged from 0 (*never*) to 7 (*more than seven times*). The mean for this sample was 0.76 ($SD = 1.11$). Good internal reliability was found for this scale (alpha reliability = .79). Deviant peer involvement was centered about its mean for use in all analyses.

Family conflict in sixth grade. Youth reports of family conflict in sixth grade were measured averaging across 5 items. Items

reflected the frequency with which family members engaged in a variety of conflict behaviors (e.g., "got angry with each other," "argued at the dinner table"). Responses ranged from 0 (*never*) to 7 (*more than seven times*). The mean for this sample was 0.91 ($SD = 1.03$). Good internal reliability was found for this scale (alpha reliability = .81). This variable was mean-centered for use in analyses.

Intervention status. Random assignment was coded as 0 = "control," and 1 = "intervention."

Engagement status. Engagement status was coded to reflect family participation in the FCU (and further intervention services as warranted). Families in the intervention condition who elected to receive the FCU were coded 1 ($n = 115$), and families in the intervention condition who did not receive the FCU were coded 0 ($n = 385$). In the control condition, engagement status was coded as missing data.

Arrest records. With parental permission, court records were searched for every county where youths reported having resided from age 11 to 16–17. Arrest records included a range of potential offenses, including status violations, misdemeanors, and felony offenses. *Arrest* was defined as a police contact for problem behavior regardless of adjudication. Within any given year, relatively few youths in the study were arrested, and arrest records were not available for 217 youths (21.7%). Over the course of the study, however, 31.3% of youths were arrested one or more times (range = 1–38 arrests). For this study, we focused on the total number of arrests, due to the ease with which this variable could be incorporated into the main CACE analysis for antisocial behavior, in light of the relatively small number of youths arrested in any single year.

Lifetime substance abuse diagnoses. The Composite International Diagnostic Interview (World Health Organization, 1997) was administered to youths when they were approximately age 19. Trained research staff who were blind to family intervention status administered the Composite International Diagnostic Interview, which yields lifetime diagnoses according to the definitions and criteria of the International Classification of Diseases and Related Health Problems (World Health Organization, 1992) and the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994). Current analyses focused on the following diagnoses: alcohol abuse or dependence, nicotine dependence or withdrawal, and cannabis abuse or dependence. Due to study attrition, interviews were not available for 206 youths (20.6%). Among the remaining youths, 193 (24.3%) were positive for lifetime diagnoses of alcohol abuse or dependence, 76 (9.6%) for nicotine dependence or withdrawal, and 181 (22.8%) for cannabis abuse or dependence.

Analytic strategy. Using Mplus 4.1 (L. K. Muthén & Muthén, 1998–2007), we conducted CACE analyses as mixture models and used full information maximum likelihood estimation to account for missing data so that the *N* for all CACE models was 998. As described in detail by Jo (2002), CACE analysis is predicated on several assumptions that are necessary for CACE to provide an unbiased estimate of the intervention effect for compliers. These assumptions are (a) assignment to treatment is random; (b) potential outcomes for each participant are independent of the outcomes for other participants; (c) for noncompliers in either the intervention or control condition (i.e., never-takers or always-takers), the distribution of potential outcomes is independent of the treatment assignment; (d) there are no "defiers," or individuals who will always do the opposite of instructions regardless of the instruction; and (e) the average causal effect of assignment to treatment on the actual receipt of treatment is not zero. Assumption c, known as the "exclusion restriction," is typically the most questionable (Jo, 2002), and we were confident of meeting the other four conditions. Violations of this assumption may lead to biased CACE estimates of intervention effects, particularly in the face of low compliance rates (Jo, 2002). However, the potential effects of bias due to violations of the exclusion restriction can be ameliorated by the use of covariates to yield more precise estimates of compliance status. In the presence of significant predictors of compliance with treatment, CACE results provide accurate estimates of the true CACE effect (for details, see Jo, 2002).

To examine the effect of adding covariates on the CACE estimate of the intervention effect, we conducted a series of analyses for each of the four youth outcomes. First, a CACE model that included only treatment assignment as a predictor was examined. Treatment assignment was allowed to predict only the slope of problem behavior in the engagers class, but it was not allowed to predict the slope in the nonengagers class, the intercept in any class, or class membership. Second, this model was extended to include covariates, which were allowed to predict intercept and slope in both classes, along with class membership. Third, the model was extended to include diagnostic or arrest outcomes, with outcomes regressed on covariates, and treatment was allowed to predict outcomes only in the engagers class. Because there were no substantial differences in the magnitude of the CACE estimates of intervention effects across the above-described models for any of the four outcome variables, we present here only the finding from the third models. Details of the full series of models are available upon request. In all models, engagement status was used as a training variable for class membership determination, which was known in the intervention group but was missing in the control group. An example of the final model, with substance use as the outcome, is shown in Figure 2.

Results

Descriptive Analyses

Descriptive statistics and correlations between variables are presented in Table 1. Although little difference in the mean level of antisocial behavior was seen over time, data shown in Table 1 reveal substantial increase in substance use (tobacco, alcohol, and marijuana) over time, especially from Waves 4 to 6, reflecting the 1st to the 3rd year in high school. The correlations reveal that, in general, random assignment to the intervention condition was not significantly correlated with problem behaviors over time.

Preliminary analyses focused on discriminating the families within the intervention group who engaged in the FCU from those who did not (engagers vs. nonengagers). As shown in Table 2, observed engagement with treatment in the intervention condition was significantly related to the likelihood of biological fathers being absent from the home, youth reports of elevated family conflict and deviant peer affiliation, and teacher reports of elevated risk behaviors at school. These findings suggest that families most

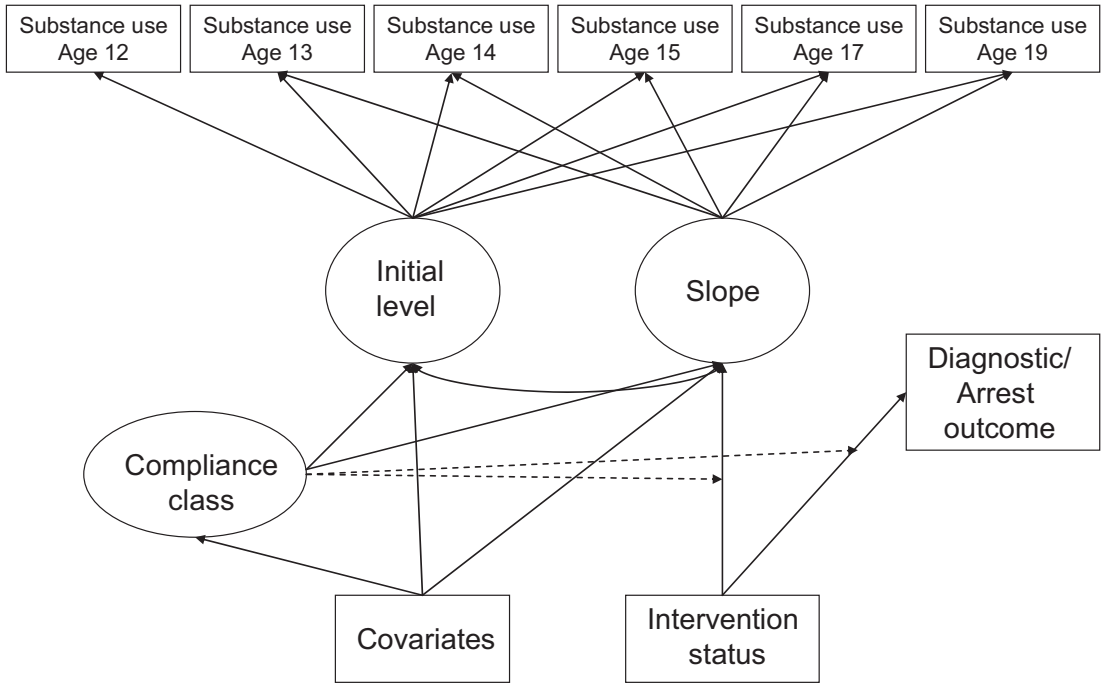

Figure 2. Complier Average Causal Effect model with covariates and categorical outcomes for substance use.

vulnerable and experiencing the most difficulty were those most likely to agree to an FCU. Preliminary analyses also examined differences in the likelihood of substance use disorder diagnoses or arrest across treatment and control groups. No significant differences were found for either alcohol abuse/dependence, $\chi^2(1, N = 998) = 0.98$, *ns*; nicotine abuse/dependence, $\chi^2(1, N = 998) = 3.09$, *ns*; marijuana abuse/dependence, $\chi^2(1, N = 998) = 0.74$, *ns*; or number of arrests, $F(1, 781) = 0.69$, *ns*.

Table 1
Descriptive Statistics and Correlations

Variable	*M*	*SD*	Treatment assignment	Child gender	Ethnicity	Family conflict	Deviant peers	Teacher risk	Biological father presence
Antisocial									
Wave 1	1.35	0.56	.03	−.12*	.18*	.41*	.57*	.35*	−.07*
Wave 2	1.35	0.55	.02	−.06	.13*	.29*	.36*	.17*	−.03
Wave 3	1.30	0.43	−.01	−.08*	.06	.20*	.27*	.24*	−.10*
Wave 4	1.33	0.45	−.02	.03	.07	.15*	.17*	.15*	−.06
Wave 6	1.35	0.44	−.01	−.07*	−.07	.14*	.13*	.07*	−.02
Tobacco									
Wave 1	0.50	2.20	.04	.03	.09*	.20*	.32*	.13*	−.01
Wave 2	0.70	2.59	.04	.03	.04	.12*	.20*	.12*	−.01
Wave 3	0.60	2.44	.00	.07	−.01	.13*	.17*	.14*	−.09*
Wave 4	1.13	3.75	.00	.06	−.08*	.04	.13*	.15*	−.16*
Wave 6	2.26	5.41	.04	.06	−.09*	.08*	.16*	.12*	−.06
Alcohol									
Wave 1	0.55	1.76	.03	−.03	.10*	.28*	.30*	.16*	.01
Wave 2	0.61	1.69	.09*	−.01	.02	.12*	.14*	.10*	.02
Wave 3	0.65	1.82	−.02	.01	−.05	.11*	.15*	.10*	−.02
Wave 4	0.69	1.99	−.02	.05	−.10*	.04	.06	.07*	−.09*
Wave 6	1.10	2.32	.04	−.03	−.20*	.02	.03	−.01	.10
Marijuana									
Wave 1	0.22	1.23	.03	−.02	.08*	.17*	.26*	.16*	−.06
Wave 2	0.34	1.50	.10*	.03	.11*	.07*	.18*	.13*	−.03
Wave 3	0.46	1.77	.01	−.01	.04	.10*	.16*	.18*	−.06
Wave 4	0.69	2.30	−.03	.06	.01	.04	.12*	.14*	−.10*
Wave 6	1.34	3.31	.00	−.04	−.07*	.06	.09*	.04	−.03

* $p < .05$.

Table 2
Comparison of Engager and Nonengager Families, for Families Randomly Assigned to Treatment Condition

Variable	Nonengagers (n = 385)		Engagers (n = 115)		Omnibus test
	%	*M (SD)*	%	*M (SD)*	
Female gender	44.9		51.3		$\chi^2(1, N = 998) = 1.44$, *ns*
Ethnic minority status	55.6		62.6		$\chi^2(1, N = 998) = 1.78$, *ns*
Biological father present	60.0		40.0		$\chi^2(1, N = 998) = 14.72$, $p < .05$
Sixth grade family conflict		0.84 (0.94)		1.25 (1.28)	$F(1, 488) = 13.81$, $p < .05$
Sixth grade deviant peers		0.66 (1.05)		1.01 (1.26)	$F(1, 489) = 9.05$, $p < .05$
Sixth grade teacher report of risk		1.79 (0.85)		2.13 (0.91)	$F(1, 498) = 14.17$, $p < .05$

Note. Only participants randomly assigned to the intervention are included in these analyses, because engagement status is not observable in the control condition.

CACE Model Results

Because CACE analysis is a mixture model, typical estimates of model fit, such as the chi-square test, are not available. One index of the quality of classification of the trajectory groups within the model is represented by entropy, which is a summary measure of the probability of membership in the most-likely class for each individual (i.e., in the engager or nonengager class). There are no specific guidelines for interpreting entropy, but possible values range from 0 to 1.0, and values closer to 1.0 represent better classification (L. K. Muthén & Muthén, 1998–2007). In the current analyses, entropy for all analyses was good (alcohol use entropy = .87; tobacco use entropy = .96; marijuana use entropy = .94; antisocial behavior = .90), indicating that the CACE mixture models yielded relatively good discrimination for determining membership in the engager versus nonengager class. Results for the alcohol use, tobacco use, marijuana use, and antisocial behavior models are shown in Tables 3, 4, 5, and 6, respectively.

Predictors of engagement. For all four models, results for predictors of engagement followed a logistic regression framework, examining the extent to which variables discriminate membership in the engager versus nonengager classes. Across all four models, for youths in the sixth grade engagement was predicted by greater likelihood of biological father absence from the home, elevated family conflict, and elevated teacher reports of risk. For the tobacco and marijuana use models, engagement was also predicted by female gender, and in the tobacco use model only, engagement was also predicted by greater deviant peer affiliation.

Predictors of within-class variation. Of particular importance, random assignment to treatment was significantly related to the slope parameter in the engagers class for all four models. Results of intervention effects for engagers for alcohol, tobacco, and marijuana use and antisocial behavior development are presented in Figure 3. As shown, within the engagers class, family participation in the FCU inhibited growth in substance use from ages 12 to 17 years.

Additional predictors of variation in substance use trajectories were also examined across models. Of note, ethnicity effects were seen in all models, with generally less growth shown in ethnic minority youths than in Caucasian youths in alcohol, tobacco, and marijuana use across adolescence. Peer deviance also emerged as a consistent predictor of substance use across models, predicting more

Table 3
CACE Model Results Predicting Class Membership and Within-Class Variation in Growth Trajectory for Alcohol Use

Intervention status, variable, and parameter	Class membership	Within-class variation					
		Nonengager class			Engager class		
	Engager vs. nonengager logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Alcohol abuse/ dependence logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Alcohol abuse/ dependence logit *(SE)*
Intervention status	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	−.43 (.17)*	−2.07 (.53)*
Variable							
Gender	−0.36 (0.21)	0.08 (0.08)	−0.007 (0.03)	−0.46 (0.23)*	0.09 (0.36)	0.01 (0.16)	−0.32 (0.47)
Ethnicity	0.27 (0.20)	0.11 (0.07)	−0.15 (0.03)*	−0.20 (0.23)	0.22 (0.39)	−0.42 (0.17)*	−0.91 (0.47)*
Biological father present (sixth grade)	0.40 (0.20)*	0.14 (0.09)	−0.08 (0.03)*	−0.36 (0.16)	0.11 (0.44)	−0.08 (0.17)	−0.13 (0.29)
Family conflict (sixth grade)	−0.31 (0.09)*	0.19 (0.07)*	−0.05 (0.02)*	−0.02 (0.15)	0.22 (0.19)	−0.08 (0.06)	0.36 (0.49)
Deviant peers (sixth grade)	−0.08 (0.09)	0.23 (0.07)*	−0.04 (0.02)*	0.05 (0.13)	0.38 (0.18)*	−0.06 (0.06)	−0.36 (0.26)
Teacher report of risk (sixth grade)	−0.34 (0.12)*	0.11 (0.07)	−0.001 (0.02)	−0.22 (0.16)	0.19 (0.21)	−0.11 (0.08)	−0.08 (0.19)
Parameter							
Intercept/threshold[a]	1.36 (0.22)*	0.24 (0.09)*	0.24 (0.09)*	0.90 (0.25)*	0.53 (0.49)	0.85 (0.26)*	−1.86 (0.72)*
Residual variance		0.15 (0.20)	0.00 (0.00)		2.67 (0.96)*	0.39 (0.14)*	

Note. CACE = Complier Average Causal Effect. Est. = estimate.
[a] Threshold is presented for categorical variables, including class membership and diagnostic status, for which parameter residual variance is not applicable.
* $p < .05$.

Table 4
CACE Model Results Predicting Class Membership and Within-Class Variation in Growth Trajectory for Tobacco Use

	Class membership	Within-class variation					
		Nonengager class			Engager class		
Intervention status, variable, and parameter	Engager vs. nonengager logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Nicotine dependence/ withdrawal logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Nicotine dependence/ withdrawal logit *(SE)*
Intervention status	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	−2.25 (0.53)*	−1.21 (0.51)*
Variable							
Gender	−0.56 (0.21)*	0.06 (0.10)	0.10 (0.05)*	0.40 (0.35)	0.66 (0.48)	0.09 (0.31)	0.43 (0.48)
Ethnicity	0.28 (0.20)	0.18 (0.10)	−0.16 (0.05)*	−0.38 (0.34)	0.60 (0.46)	−0.94 (0.28)*	−1.06 (0.55)
Biological father present (sixth grade)	0.68 (0.19)*	−0.07 (0.12)	−0.09 (0.06)	0.11 (0.36)	1.14 (0.56)*	−0.72 (0.32)	−0.01 (0.49)
Family conflict (sixth grade)	−0.22 (0.10)*	0.09 (0.09)	−0.04 (0.05)	0.11 (0.20)	−0.07 (0.24)	−0.04 (0.15)	−0.34 (0.25)
Deviant peers (sixth grade)	−0.22 (0.09)*	0.33 (0.11)*	−0.04 (0.05)	0.14 (0.20)	0.79 (0.25)*	−0.23 (0.15)	0.25 (0.18)
Teacher report of risk (sixth grade)	−0.41 (0.12)*	−0.01 (0.07)	0.06 (0.04)	−0.49 (0.31)	0.51 (0.33)	−0.07 (0.19)	−0.05 (0.26)
Parameter							
Intercept/threshold[a]	1.49 (0.23)*	0.20 (0.11)	0.25 (0.07)*	2.83 (0.45)*	−0.37 (0.54)	3.22 (0.54)*	0.05 (0.54)
Residual variance		0.00 (0.00)	0.20 (0.11)*		7.17 (2.14)*	2.32 (0.60)*	

Note. CACE = Complier Average Causal Effect. Est. = estimate.
[a] Threshold is presented for categorical variables, including class membership and diagnostic status, for which parameter residual variance is not applicable.
* $p < .05$.

frequent use of tobacco and marijuana at age 12 for both engagers and nonengagers, and more frequent age 12 alcohol use among nonengagers only. For alcohol use only, the presence of biological fathers predicted less growth in alcohol use among nonengagers. For tobacco use only, teacher perceptions of risk predicted more frequent tobacco use in sixth grade among treatment engagers.

Clinically significant outcomes. Intervention status was significantly related to all diagnostic outcomes and to the number of arrests experienced from grades six to eleven. Additional effects are also important to highlight. First, most of the predictable variability in outcomes was found for the engager youths. Among nonengagers, teacher-reported risk predicted a greater number of arrests. Among engagers, alcohol and marijuana use diagnoses were more common in Caucasian than in ethnic minority youths, cannabis abuse/dependence was more common in boys than in girls, and the number of arrests was positively related to deviant peer involvement but negatively related to family conflict.

Discussion

Previous studies of the randomized ATP model revealed that the intervention was associated with reductions in youth reports of

Table 5
CACE Model Results Predicting Class Membership and Within-Class Variation in Growth Trajectory for Marijuana Use

	Class membership	Within-class variation					
		Nonengager class			Engager class		
Intervention status, variable, and parameter	Engager vs. nonengager logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Alcohol abuse/ dependence logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Alcohol abuse/ dependence logit *(SE)*
Intervention status	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	−1.22 (0.28)*	−1.83 (0.52)*
Variable							
Gender	−0.48 (0.22)*	0.07 (0.06)	−0.03 (0.03)	−0.44 (0.22)	0.03 (0.35)	0.27 (0.18)	−1.18 (0.48)*
Ethnicity	0.14 (0.20)	0.15 (0.05)*	−0.07 (0.03)*	−0.50 (0.22)	−0.02 (0.35)	−0.21 (0.21)	−0.89 (0.44)*
Biological father present (sixth grade)	0.58 (0.19)*	0.02 (0.06)	−0.05 (0.03)	−0.16 (0.22)	−0.25 (0.37)	−0.02 (0.20)	−0.78 (0.49)
Family conflict (sixth grade)	−0.21 (0.09)*	0.03 (0.04)	−0.03 (0.02)	0.01 (0.12)	0.04 (0.17)	−0.02 (0.08)	0.04 (0.29)
Deviant peers (sixth grade)	−0.08 (0.08)	0.17 (0.07)*	−0.01 (0.02)	0.01 (0.12)	0.53 (0.20)*	−0.06 (0.10)	0.22 (0.27)
Teacher report of risk (sixth grade)	−0.43 (0.12)*	0.10 (0.06)	0.02 (0.03)	0.11 (0.15)	0.17 (0.22)	−0.08 (0.11)	−0.22 (0.25)
Parameter							
Intercept/threshold[a]	1.54 (0.24)*	0.02 (0.05)	0.20 (0.03)*	0.83 (0.24)*	0.53 (0.32)	1.37 (0.32)*	−2.23 (0.75)*
Residual variance		0.27 (0.18)	0.00 (0.00)		3.26 (1.26)*	0.88 (0.31)*	

Note. CACE = Complier Average Causal Effect. Est. = estimate.
[a] Threshold is presented for categorical variables, including class membership and diagnostic status, for which parameter residual variance is not applicable.
* $p < .05$.

Table 6
CACE Model Results Predicting Class Membership and Within-Class Variation in Growth Trajectory for Antisocial Behavior

Intervention status, variable, and parameter	Class membership	Within-class variation					
		Nonengager class			Engager class		
	Engager vs. nonengager logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Alcohol abuse/ dependence logit *(SE)*	Intercept est. *(SE)*	Slope est. *(SE)*	Alcohol abuse/ dependence logit *(SE)*
Intervention status	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	Fixed at 0	−.08 (.02)*	−4.51 (1.38)*
Variable							
Gender	−0.13 (0.19)	−0.06 (0.03)*	−0.01 (0.01)	−0.25 (0.20)	0.06 (0.08)	0.002 (0.03)	−0.23 (1.17)
Ethnicity	0.01 (0.20)	0.10 (0.02)*	−0.03 (0.01)*	0.33 (0.20)	−0.002 (0.08)	−0.04 (0.03)	1.42 (1.25)
Biological father present (sixth grade)	0.67 (0.19)*	−0.01 (0.03)	−0.01 (0.01)	−0.35 (0.27)	−0.02 (0.08)	0.03 (0.02)	0.63 (1.27)
Family conflict (sixth grade)	−0.36 (0.09)*	0.08 (0.02)*	−0.01 (0.005)*	−0.02 (0.27)	0.03 (0.04)	−0.01 (0.01)	−1.40 (0.51)*
Deviant peers (sixth grade)	−0.16 (0.09)	0.16 (0.03)*	−0.03 (0.007)*	−0.04 (0.12)	0.23 (0.04)*	−0.05 (0.01)*	1.52 (0.71)*
Teacher report of risk (sixth grade)	−0.34 (0.12)*	0.05 (0.02)*	−0.02 (0.01)*	1.01 (0.25)*	0.14 (0.05)*	−0.02 (0.02)	1.09 (0.72)
Parameter							
Intercept	1.17 (0.21)*	1.29 (0.03)*	0.02 (0.01)	1.15 (0.33)*	1.40 (0.08)*	0.08 (0.03)*	5.15 (1.64)*
Residual variance		0.05 (0.01)*	0.002 (0.001)	6.17 (1.78)*	0.08 (0.03)*	0.008 (0.003)*	45.67 (10.17)*

Note. CACE = Complier Average Causal Effect. Est. = estimate.
* $p < .05$.

substance use from ages 11 through 13, during the middle school years (Connell et al., 2006; Dishion, Kavanagh, Schneiger, Nelson, & Kaufman, 2002). In addition, changes in substance use were associated with improvements in direct observations of parent monitoring practices among high-risk youths (Dishion, Nelson, & Kavanagh, 2003). This study extends these analyses to look at the effects of the program through adolescence and to study the process of treatment engagement and the impact of engagement on the reduction of adolescent problem behavior.

Results reveal that elevated family conflict, absence of biological fathers from the home, and teacher reports of problem behavior in sixth grade consistently predicted engagement with the FCU across all models. Female gender also predicted engagement in the tobacco and marijuana use models, and peer deviance was related to engagement in the tobacco use model. Overall, these variables suggest that the universal level of the intervention is at least partially meeting the goal of identifying youths at risk and their families and attracting them into the selected level of the intervention. The finding for teacher risk is not surprising, because parent consultants who conducted the intervention were trained to actively solicit participation among the students at highest risk as identified by teachers (Dishion & Kavanagh, 2003). In addition, their perceptions of risk show teachers to be valuable potential gatekeepers in school-based interventions. Teachers are in a critical position to communicate their views to parents or other school personnel, which in turn may motivate parents to seek intervention. It is important to note, however, that teacher reports of risk are significantly correlated with ethnic minority status, such that teachers described ethnic minority youths as having engaged in more frequent problem behaviors in school than had Caucasian youths (Yasui, Dishion, & Kavanagh, 2007). These results suggest that future efforts to (a) work with teachers to accurately identify in-school risk behaviors and (b) alert them to the potential for racially biased reports of behaviors may be important additions to school-based intervention efforts.

Father absence, family conflict, and deviant peer involvement are factors that seem to underlie caregivers' willingness to engage in the FCU intervention, once offered. Family conflict may be a particularly potent predictor, because such conflict is likely to be aversive to both parents and youths, and families marked by such conflict may be more likely to recognize that these youths are at a high risk for developing problem behavior. The absence of biological fathers from the home may be a complex risk variable in that it is often associated with other family dynamics and processes that prompt caregivers to engage in family services. First, it may reflect a history of broader family conflict, which is itself a risk factor for the development of problem behaviors. In such instances, identification of risk status by means of the universal intervention may resonate with the parents' perceptions or experiences. Second, biological father absence may be associated with increased socioeconomic pressures on single mothers. In the face of limited access to other intervention resources, a school-based, free intervention service may be particularly attractive to such families. Presently, we do not know which set of circumstances most likely accounts for families' engagement in the FCU and linked intervention services. Finally, the finding that female gender emerged as a significant predictor of engagement for only two outcomes—tobacco and marijuana use—underscores the probabilistic nature of the process of identifying engagers in the control condition, because the predictors of engagement are not entirely consistent across outcomes. When smoking behaviors are considered, girls in the control group appeared more closely comparable than boys to the observed engagers in the treatment group. It is possible that smoking behaviors are more alarming to parents of girls than boys, such that gender emerges as a more salient predictor of engagement for these outcomes only, despite not being observed for other outcomes.

Most striking are the long-term effects of the intervention. Only 25% of the intervention group engaged in the FCU and linked behavioral interventions, so the CACE modeling approach to the analysis of an intervention trial was particularly appropriate. Using this approach, we found that engagement with a family-centered intervention reduced the risk for problem behaviors from early to late adolescence, including antisocial behavior and tobacco, alco-

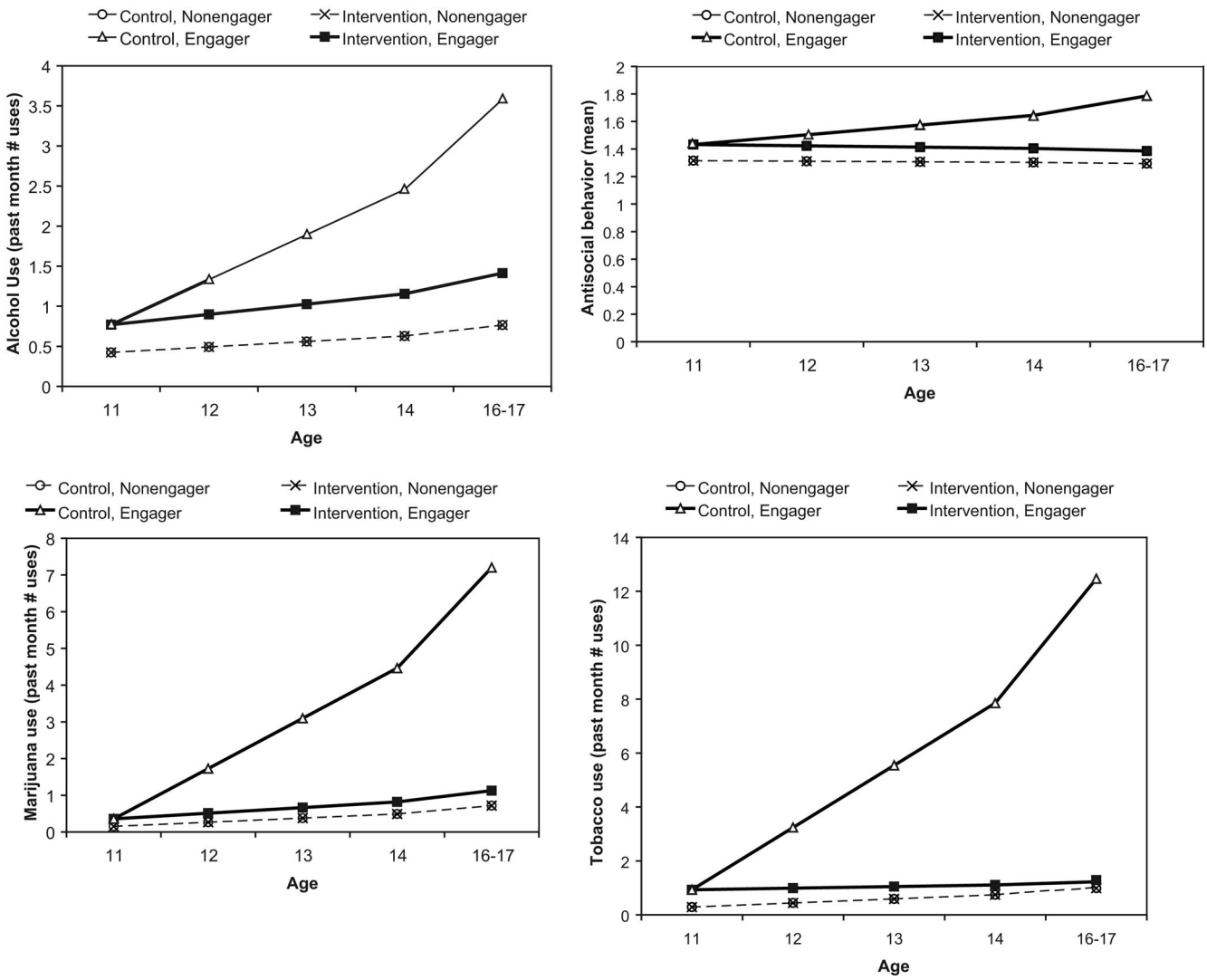

Figure 3. Complier Average Causal Effect results of intervention effect on the development of alcohol, tobacco, and marijuana use and antisocial behavior. The "Control, Nonengager" class and the "Intervention, Nonengager" class are perfectly overlapping, a central feature of this approach to modeling intervention effects.

hol, and marijuana use. All these problem behaviors were considerably reduced in adolescents up to age 17 in families that engaged in the FCU and that represented the group at highest risk. Also of note, the intervention led to significant reductions in the rate of arrest across adolescence, as well as in the likelihood of being diagnosed with an alcohol, tobacco, or marijuana use disorder by late adolescence. These important long-term outcomes bolster our confidence in the validity and practical implications of the CACE estimates of intervention effectiveness.

These CACE results are more specific than prior ITT analyses of the ATP intervention and support the view that family intervention is the active intervention component producing the long-term preventive effect. It is also worth noting that the magnitude of the intervention effect appeared stable across the three models tested, supporting the notion that whereas the addition of covariates to the model may have improved the estimation of membership in the engagement class and of the intervention effect, the CACE estimate of the intervention effect was a relatively robust one that changed little in the presence of these predictors.

Limitations

Several potential limitations are important to acknowledge. First, the sole reliance on youth reports of behavior problems and substance use is not optimal, and we would prefer to have multirater reports of these important outcomes. Unfortunately, alternative reports were not collected for the entire sample at each year. Support for the validity of these self-reports is provided by the inclusion of the juvenile arrest record data and the diagnostic interview data. Thus, although we would prefer to work with multirater constructs, we are confident in the validity of the current findings.

Second, some inference is required in the CACE framework to derive the engagement status for the control condition, and CACE results are susceptible to bias in the face of violations of the exclusion restriction assumption (Jo, 2002). However, identifying several key predictors of engagement lends confidence to the results, as do the relatively small differences between the CACE models with no covariates versus the CACE models with significant predictors of engagement. The minimal differences suggest that this study generally meets the assumptions underlying CACE analysis and provides unbiased estimates of intervention effects for engagers.

Additionally, research is needed into the specific mechanisms through which intervention is related to improvements in youth behavior over time. For example, in our earlier analyses of 4-year outcomes to the ATP intervention, we found that reductions in risk for substance use were mediated by increases in observed parental monitoring practices (Dishion, Kavanagh, et al., 2003). However, these analyses were conducted on a subset of the current sample, including only the participants at high risk in the first cohort. We have reassessed all families of youths at ages 16–17 by means of videotaped observations and are currently in the process of coding these tapes for the analysis of mediation. Because our intervention focuses on parent management practices, we expect that improvements in parenting practices will mediate improvements in adolescent problem behavior.

Implications for Prevention Research

These data suggest that effective parenting interventions delivered within a school context depend heavily on three basic factors:

1. proactive and timely engagement of parents when youths show signs of risk, and prior to "giving up" on influencing their adolescents. We suspect that the middle school years are optimal, but high school services may also be appropriate for many youths at moderate risk;

2. a school-based infrastructure that systematically and proactively identifies student behaviors that are indicative of school failure and escalating patterns of risk. We used teacher ratings as a convenient and inexpensive strategy in this study. However, it would be preferable to embed the family intervention within a schoolwide behavior management system, such as positive behavior support (Crone & Horner, 2003). A system such as this would carefully define student behavior outcomes that could be regularly assessed over time. In this way, parents would become accustomed to receiving systematic feedback as well as remedial services within the school context in response to emerging patterns of problem behavior that are harbingers of maladaptation; and

3. sensitive, well-trained parent consultants who are able to navigate the natural resistance that arises when youths and their families are faced with outside professionals consulting on parenting and family dynamics. The FCU appears to be an especially powerful engagement tool for family-centered interventions in this context. However, further work is needed to more effectively convince a larger percentage of families at moderate risk to take advantage of the FCU.

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