

Effectiveness of Multidimensional Family Therapy With Higher Severity Substance-Abusing Adolescents: Report From Two Randomized Controlled Trials

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Objective: We used growth mixture modeling to examine heterogeneity in treatment response in a secondary analysis of 2 randomized controlled trials testing multidimensional family therapy (MDFT), an established evidence-based therapy for adolescent drug abuse and delinquency. **Method:** The first study compared 2 evidence-based adolescent substance abuse treatments: individually focused cognitive-behavioral therapy and MDFT in a sample of 224 urban, low-income, ethnic minority youths (average age = 15 years, 81% male, 72% African American). The second compared a cross-systems version of MDFT (MDFT—detention to community) with enhanced services as usual for 154 youths, also primarily urban and ethnic minority (average age = 15 years, 83% male, 61% African American, 22% Latino), who were incarcerated in detention facilities. **Results:** In both studies, the analyses supported the distinctiveness of 2 classes of substance use severity, characterized primarily by adolescents with higher and lower initial severity; the higher severity class also had greater psychiatric comorbidity. In each study, the 2 treatments showed similar effects in the classes with lower severity/frequency of substance use and fewer comorbid diagnoses. Further, in both studies, MDFT was more effective for the classes with greater overall substance use severity and frequency and more comorbid diagnoses. **Conclusions:** Results indicate that for youths with more severe drug use and greater psychiatric comorbidity, MDFT produced superior treatment outcomes.

Keywords: adolescent drug abuse, multidimensional family therapy, comorbidity, growth mixture modeling

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Significant strides have been made in the adolescent substance abuse treatment specialty, resulting in numerous promising and efficacious treatments (Waldron & Turner, 2008). However, the field

now faces many questions regarding whether treatments are generalizable across contexts, and which treatments are most effective in addressing diverse client characteristics. Although the question of whether treatment works has been answered with a resounding “yes,” we still know little about why treatments work and which treatments work best for different types of clients. For instance, previous research has suggested that adolescents with co-occurring substance abuse and other psychiatric disorders are more challenging to treat (Grella, Hser, Joshi, & Rounds-Bryant, 2001), and the literature is limited on which treatments work best with this population.

Heterogeneity in recovery patterns—the norm following substance abuse treatment (Chung, Martin, & Clark, 2008)—complicates these fundamental but complex questions. With respect to randomized controlled trials (RCTs), Godley, Dennis, Godley, and Funk (2004) examined posttreatment growth trajectories in a sample of 563 youths who met American Society of Addiction Medicine criteria for outpatient cannabis treatment. Youths were primarily male (82%) and Caucasian (63%) or African American (29%) in ethnicity, and the majority were involved in the juvenile justice system (62%). These researchers identified five posttreatment trajectories: low use with limited days in con-

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trolled environment, low use with many days in controlled environment, moderate decreasing use, increasing use, and consistently high use. Further, they found that adolescents in the moderate decreasing use class reported fewer depressive symptoms than other classes; however, this group also had a higher proportion of adolescents reporting conduct disorder symptoms.

Halliday-Boykins, Henggeler, Rowland, and DeLucia (2004) conducted a similar study in which 156 youths (65% male) presenting with psychiatric emergencies were randomized to receive multisystemic therapy or hospitalization. Youths averaged 12.9 years of age and were primarily of African American (65%) and Caucasian (33%) ethnicity. The study focused on psychiatric symptoms rather than substance use, and intake levels of substance use were therefore not assessed; however, psychiatric disorders were common (66% met criteria for disruptive behavior disorders, and 40% met criteria for mood disorders). These researchers identified five classes of trajectories: high improved, high unimproved, borderline improved, borderline unimproved, and subclinical. Groups of adolescents who showed improvement reported less hopelessness but higher suicidal ideation. With regard to family functioning, parents who reported greater empowerment were also more likely to have adolescents in the groups that showed improvement.

Although these studies have elucidated a variety of posttreatment symptom trajectories following substance abuse treatment, they do not get to the heart of the question we introduced previously: What treatments seem to be most effective with these different groups of adolescents? Regarding response to treatment, Godley et al. (2004) did not examine treatment effects in the identified subgroups. Halliday-Boykins et al. (2004) failed to find evidence to support the greater effectiveness of multisystemic therapy in the classes they identified. However, the question of whether treatment effectiveness varies for different groups of adolescents retains great heuristic and clinical value. Further, some methodological factors might explain why Halliday-Boykins et al. found no evidence of treatment effects. First, the modeling approach they applied constrains slope variances to zero over time, which essentially removes interindividual variability in change within class. Bauer and Curran (2003) have demonstrated that this approach has led to overextracting (identifying too many) latent classes. Overextracting classes inevitably leads to less power to detect treatment effects, given that there will be fewer individuals within each latent class. Second, Halliday-Boykins et al. did not test treatment effects within the groups of adolescents they identified but instead used a logistic regression procedure in which treatment condition predicted group membership. This modeling approach tests for treatment differences between classes but does not address differences in treatment effects within class (Muthén et al., 2002).

In the current study, we used growth mixture modeling (GMM) in two RCTs examining the effectiveness of multidimensional family therapy (MDFT). Following recommendations from leading methodologists and developers of GMM (Muthén, 2004), we allowed growth parameters to vary across individuals and tested treatment effects within each latent class. We also examined psychiatric comorbidity and family functioning as correlates of latent class membership.

The samples of the two studies we conducted are distinct from one another on at least two primary dimensions: (a) They came

from two geographic locations (Philadelphia, PA, vs. Miami/Tampa, FL), and (b) they were from different racial and cultural backgrounds (80% African American vs. mixed African American, Hispanic, and White non-Hispanic ethnicity).

The main outcome results in both studies were reported in Liddle, Dakof, Turner, Henderson, and Greenbaum (2008) and Liddle, Rowe, Dakof, and Henderson (2008), respectively. In both studies, MDFT was related to decreases in substance use (substance use problem severity, Liddle, Dakof, et al., 2008; frequency of substance use, Liddle, Rowe, et al., 2008) larger than those produced by comparison treatments (individual cognitive-behavioral therapy [CBT] in Liddle, Dakof, et al., 2008, and enhanced services as usual [ESAU] in Liddle, Rowe, et al., 2008).

Given the heterogeneity in individual change trajectories (described more fully in a following section), we first hypothesized that at least two classes of change trajectories characterized in part on baseline severity would be identified. We were uncertain about the relationship between the background covariates—psychiatric comorbidity and family functioning—and group membership, given the equivocal relationships observed in the Godley et al. (2004) and Halliday-Boykins et al. (2004) studies, but we nevertheless included these variables in the models because they were significantly associated with class membership in both studies. Finally, given the superiority of MDFT in addressing more intractable substance use problems (Liddle, Dakof, et al., 2008; Liddle, Rowe, Dakof, Henderson, & Greenbaum, 2009), its multiple-systems-focused treatment delivery (focusing on effecting change in parents, adolescents, and families' interactions with social systems), and its capacity to improve psychiatric symptomatology in samples with significant comorbidity as well as substance use (Liddle et al., 2009), we hypothesized that MDFT would be more effective than comparison treatments among the classes demonstrating greater baseline substance use and comorbidity.

Study 1

This study is a secondary analysis of data collected in an RCT comparing MDFT and individually delivered CBT. The two treatments were (a) delivered by equally experienced therapists, (b) of equal length and intensity, and (c) delivered in the same format.

Method

Participants. To be eligible for this study, participants had to be between the ages of 12 and 17.5 years and could neither currently require inpatient detoxification nor be actively suicidal. Referrals to the study were made from the juvenile justice system (48%), state department of child welfare (36%), schools (11%), or other child-serving agencies (5%). Two hundred eighty-seven youths and families were referred to the study; 224 (78%) of the youths came for an intake interview and agreed to participate in the study. Reasons for nonparticipation included missing the intake appointment ($n = 43$), running away from home ($n = 6$), or being sent to residential treatment ($n = 14$) prior to the intake appointment. Study youths were primarily male and African American, and all were drug users, with 75% meeting criteria for cannabis dependence and 13% meeting criteria for cannabis abuse. Thirteen percent of youths met criteria for dependence on a drug other than cannabis, and 2% met criteria for "other" substance abuse (see

Table 1 and Liddle, Dakof, et al., 2008, for a more complete description of sample characteristics).

Procedures. The study was approved and monitored by the institutional review board of the university with which study investigators were affiliated. Trained research assistants contacted parents and youths to describe the study purpose and procedures, including randomization, and to obtain written informed consent prior to the first assessment session. The research assistants emphasized that participation was voluntary and that parents and youths had the right to discontinue participation at any time. Next, a research assessment was completed by staff who received approximately thirty hours of initial training and additional, ongoing supervision to standardize data collection procedures and to minimize circumstances that might threaten the validity of the data (e.g., client/family resistance, reading problems). After the baseline assessment, adolescents were randomly assigned either to CBT ($n = 112$) or to MDFT ($n = 112$). Follow-up assessments were conducted at termination of treatment and then at 6 and 12 months following treatment termination. See Figure 1 for a Consolidated Standards of Reporting Trials (CONSORT) flow diagram.

Treatment conditions. Both MDFT and CBT were office based and were administered once per week (60- to 90-min sessions). The treatment was provided free of charge, and transportation assistance was available to reduce logistical barriers to treatment. Youths were not allowed to participate in concurrent behavioral treatments but were allowed to receive medication management if necessary. The study was designed so that the only differences between the treatments were the treatment format and the theories of change and therapeutic techniques underlying them. Both treatments were designed to be 4–6 months in duration. Furthermore, the treatments experienced similar rates of enrollment (22 individuals refused treatment in each condition) and

retention (90 participants in each condition successfully completed therapy). The median number of sessions of therapy was eight for both treatment conditions (MDFT mean = 9.45, $SD = 9.32$; CBT mean = 8.03, $SD = 8.67$, $p = .205$).

Therapists who delivered the two treatments were nested within each treatment condition and had similar experience and educational backgrounds prior to working on this project. In addition, there were no therapist effects or differences between the two treatments on treatment dosage (operationalized as either the number of sessions participants received or the total amount of time they were in treatment). Moreover, a high degree of treatment fidelity was achieved in that each condition emphasized model-unique techniques and avoided interventions uniquely prescribed in the other condition (Hogue et al., 1998). Please see Liddle, Dakof, et al. (2008) for a more detailed description of the two interventions administered.

Measures. Demographic and background information was obtained in the intake interview. Specific variables gathered from this interview were youth age, gender, race/ethnicity (African American, Hispanic, White non-Hispanic), family structure (two parent, stepparent, single parent, other), mother's education, family income, age of first drug use, and juvenile justice involvement (defined by whether the youth was on probation or not when he or she was enrolled in the study).

Substance use problem severity was measured with the Personal Involvement With Chemicals (PIC) scale of the Personal Experience Inventory (PEI; Winters & Henley, 1989). The PEI is a multiscale self-report measure assessing substance use problem severity and psychosocial risk. The PIC is a 29-item scale focusing on the psychological and behavioral depth of substance use involvement and related consequences in the previous 30 days. Items address issues such as using substances to feel calm; using them during the whole day, weekends, or school; and canceling plans in order to get high. Widely used in applied research settings, the PEI has demonstrated excellent reliability (Cronbach's $\alpha s = .84-.97$) and validity (e.g., scales significantly related to diagnostic ratings) across samples of adolescents from multiple ethnic backgrounds (Winters, Latimer, Stinchfield, & Egan, 2004). Cronbach's alpha for the current study was .95.

The timeline follow-back method (TLFB; Sobell & Sobell, 1992) was administered as a measure of substance use frequency. The TLFB obtains retrospective reports of daily substance use by employing a calendar and other memory prompts to stimulate recall. Youths reported on specific substances used daily for the 30-day period prior to each assessment. We calculated a total drug use score corresponding to the number of days participants had used any drug in the previous 30 days.

Psychological symptoms were measured with the Diagnostic Interview Schedule for Children, Second Edition (DISC-2; Piacentini et al., 1993). The DISC is a semistructured interview used to identify the presence or absence of psychiatric disorders according to criteria of the *Diagnostic and Statistical Manual of Mental Disorders* (3d ed., rev.; American Psychiatric Association, 1987). In the current study, participants received a total score corresponding to the number of disorders (including substance use disorders) for which they reached diagnostic criteria.

Family functioning was measured with the Family Environment Scale (FES; Moos & Moos, 1984). Adolescent and parent reports on the family Conflict and Cohesion subscales were used in the

Table 1
Study 1 Sample Characteristics

Variable	Treatment condition		Overall
	MDFT	CBT	
	<i>M (SD)</i>		
Age, years	15.3 (1.25)	15.5 (1.21)	15.4 (1.23)
Total no. diagnoses	3.55 (2.31)	3.24 (1.89)	3.41 (2.14)
Family income (<i>Mdn</i>)	\$13,000	\$12,000	\$13,000
	<i>n (%)</i>		
Gender			
Male	92 (82)	90 (80)	182 (81)
Female	20 (18)	22 (20)	42 (19)
Ethnicity/race			
African American	80 (71)	81 (72)	161 (72)
White non-Hispanic	19 (21)	19 (17)	40 (18)
Hispanic	10 (11)	12 (11)	23 (10)
Family structure			
Single parent	67 (60)	62 (55)	129 (58)
Two parent	22 (20)	16 (14)	38 (17)
Blended	14 (13)	20 (18)	34 (15)
Other	9 (8)	14 (13)	23 (10)

Note. MDFT = multidimensional family therapy; CBT = cognitive-behavioral therapy; *SD* = standard deviation; *Mdn* = median; *n* = number of participants.

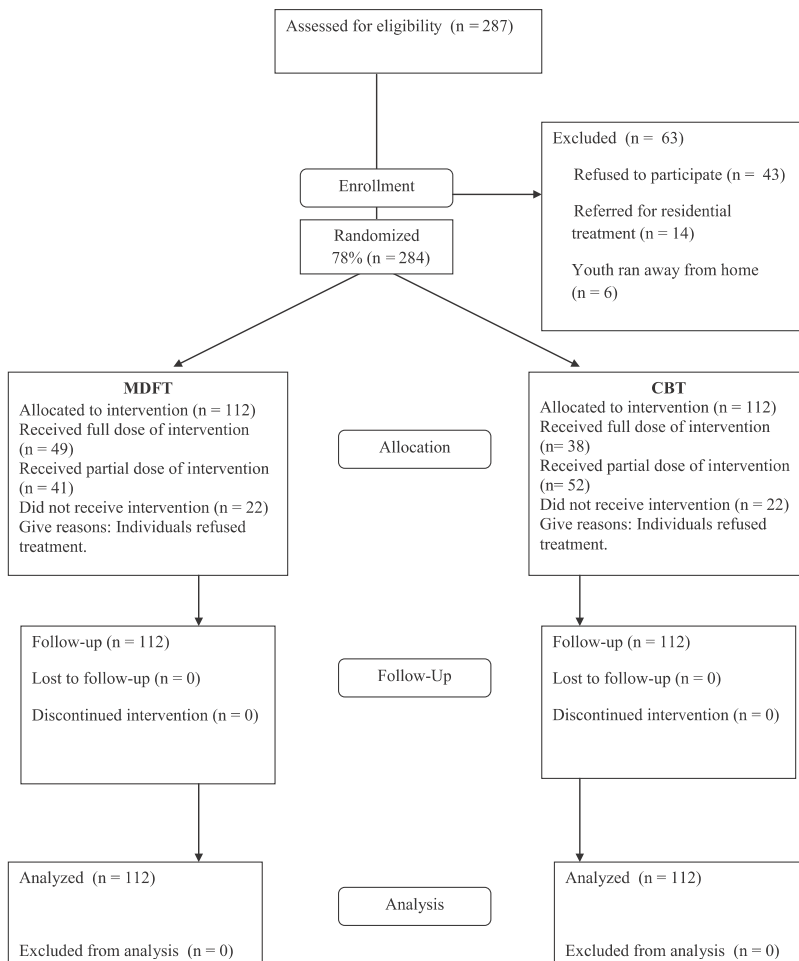


Figure 1. Study 1 CONSORT flow diagram. MDFT = multidimensional family therapy; CBT = cognitive-behavioral therapy.

analyses. These subscales are composed of nine true-false items each and have strong reliability. The internal consistency reliability for parent reports in this sample was .70 for cohesion and .66 for conflict (adolescent report: Cohesion = .70, Conflict = .69).

Analytic strategy. We used GMM (Muthén, 2004), as implemented in Mplus Version 5.1 (Muthén & Muthén, 2009), to identify unobserved groups of latent trajectory classes of substance use frequency and problem severity. We selected GGM because it is ideally suited toward modeling heterogeneity in complex multivariate, longitudinal distributions (Bauer & Curran, 2003), which are often encountered in adolescent substance abuse treatment research. Our analytic approach progressed through the following steps. First, we examined descriptive statistics to gauge the extent of the heterogeneity and nonnormality present in the data. We then examined a single-class unconditional (no covariate) latent growth curve model to determine the extent of the interindividual variability in change trajectories. Prior to progressing with multiple-class GMM models, we examined participant characteristics (i.e., severity of substance use and number of comorbid diagnoses) as moderators of treatment effects in a single class model to determine whether these moderators could adequately account for the

heterogeneity in the data. We created interaction terms by centering the predictors and multiplying them together and included both main effects and interactions in the moderator analyses. Finally, we progressed to GMM proper. After identifying the optimal number of latent classes (determined by statistical fit indices such as the Bayesian information criterion [BIC] and adjusted likelihood ratio tests; e.g., Lo-Mendell-Rubin likelihood ratio test [L-M-R LRT], bootstrap likelihood ratio test [BLRT]), we used multinomial logistic regression to examine associations between latent class membership and participant characteristics and then examined treatment effects within each latent class. To control for therapist nesting effects, we used the sandwich variance estimator (Diggle, Heagerty, Liang, & Zeger, 2002) available in Mplus in all analytic models. The sandwich estimator produces corrected standard errors in the presence of nonindependent data due to nesting, in this case, clients nested within therapists.

Results

Our primary aim in Study 1 was to examine whether the more comprehensive treatment (but not longer or more intense), MDFT,

was more effective than CBT with high-severity youths and whether both treatments were equally effective with less severe youths. A one-class unconditional LGC for substance use problem severity revealed that, overall, youths averaged 27.94 ($SE = 1.12$) on the PIC scale, which decreased an average of 4.19 points ($SE = 0.57$) per wave (assessment) over the 12-month follow-up. There was also significant individual variability at entry to the study (mean intercept variance = 114.93, $SE = 31.17$, $pseudo\ z = 3.68$, $p < .001$), but the interindividual variability in slope trajectories was not significant (mean slope variance = 9.51, $SE = 7.54$, $pseudo\ z = 1.26$, $p = .207$).

We then conducted moderator analyses to examine the extent to which initial substance abuse problem severity, number of comorbid diagnoses, and the interaction between these variables and treatment condition explained variability in substance use problem severity growth trajectories. Results of this analysis were not significant (treatment moderator coefficient for drug use problem severity = 0.12, $SE = 0.10$, $pseudo\ z = 1.27$, $p = .203$; treatment moderator coefficient for number of comorbid diagnoses = 0.44, $SE = 0.61$, $pseudo\ z = 0.72$, $p = .474$).

With respect to frequency of substance use, youths reported they had used drugs on approximately 11 days in the previous 30 ($M = 10.80$, $SE = 0.83$), and this use had decreased between waves by approximately 2 days of use ($M = -2.04$, $SE = 0.36$) per wave. Growth parameter variances were significant for both intercept (variance = 95.98, $SE = 31.74$, $pseudo\ z = 3.02$, $p = .002$) and slope (variance = 12.98, $SE = 4.43$, $pseudo\ z = 2.93$, $p = .003$). As with drug use problem severity, neither of the moderator effects (treatment by initial frequency of drug use and treatment by number of diagnoses) was significant.

Because these more traditional analyses could not adequately address our research questions, we proceeded with GMM and conducted these analyses in several steps. First, we needed to identify symptom severity trajectory classes. In this step, we examined two types of substance use outcomes, frequency of substance use and substance use problem severity. Next, we explored the presence of covariates other than treatment effects that might be associated with group membership to further characterize the latent classes; finally, within each latent class, we examined the primary hypotheses of treatment effects. These results are presented in order in the following sections.

Identification of latent classes. Results shown in the upper panel of Table 2 support the two-class model as the optimal solution for substance use problem severity. Relative to the one-class model, the two-class model showed better fit on the BIC and showed a statistically significant L-M-R LRT ($p = .011$) and BLRT ($p < .001$). When we compared the two- and three-class models, the evidence suggested that the two-class model fit substance use problem severity trajectories better than the three-class model. As compared to the two-class model, the three-class model had a larger BIC value, a lower entropy, and a nonsignificant L-M-R LRT ($p = .180$). Additionally, the BLRT did not converge. Most important, the three-class model produced nonadmissible values (i.e., negative residual variances) indicating model misspecification and convergence problems.

Likewise, for frequency of substance use, a better fit on the fit indices as well as a statistically significant L-M-R LRT ($p = .005$) was shown by the two-class model. We attempted to fit a three-class solution, but the model produced a nonpositive definite matrix (see Table 2). Therefore, we selected the two-class solution as the best fitting model for substance use frequency trajectories.

With respect to substance use problem severity, the two classes were distinguished by differences in initial severity (Class 1 mean intercept = 19.82; Class 2 mean intercept = 39.13) as well as degree of decreased severity over time (Class 1 mean slope = -4.47 ; Class 2 mean slope = -3.71). An LRT that compared models with the intercepts (and slopes) constrained to equality and then freely estimated showed that the two classes differed both in initial status, $\Delta\chi^2(1) = 38.34$, $p < .001$, and change over time, $\Delta\chi^2(1) = 8.75$, $p < .001$. The first class (58% of the population) was characterized by lower initial severity and more symptom improvement over time, and we named it the lower severity (LS) class. The second class comprised 42% of the population. Youths in this class showed higher initial severity of substance use problems, and we named it the higher severity (HS) class. Although the reduction in substance use problems was greater for LS participants, slope estimate = -4.47 , $SE = 1.01$, $pseudo\ z = -4.42$, $p < .001$, 95% CI [-6.49 , -2.45], $d = 2.84$, the average decrease for the HS adolescents also was statistically significant, slope esti-

Table 2
Fit Indices, Entropy Values, and Likelihood Ratio Tests for One- to Three-Class Solutions for Study 1 Substance Use Problem Severity and Frequency of Substance Use

Model	Loglikelihood	df	BIC	Entropy	L-M-R LRT	BLRT
Substance use problem severity						
One class	-2,380.010	6	4,792.437	N/A	N/A	N/A
Two class	-2,341.847	10	4,737.721	.560	.011	<.001
Three class	-2,311.182	14	4,740.286	.485	.180	Did not converge
Frequency of substance use						
One class	-2,295.962	9	4,640.628	N/A	N/A	N/A
Two class	-2,256.986	12	4,578.912	.892	.024	<.001
Three class	-2,253.047	15	4,587.269	.505	Did not converge	Did not converge

Note. df = degrees of freedom; BIC = Bayesian information criterion; L-M-R LRT = Lo-Mendell-Rubin likelihood ratio test; BLRT = bootstrap likelihood ratio test; N/A = not applicable.

mate = -3.71 , $SE = 1.52$, $pseudo\ z = -2.44$, $p = .015$, 95% CI [$-6.75, -0.67$], $d = 1.03$ (see Figure 2).¹

Like the substance use problem severity classes, the two substance use frequency classes showed a similar pattern of significant intercepts and declining slopes, with one class characterized by higher initial severity (HS mean intercept = 27.75; LS mean intercept = 8.42). The baseline severity of the two classes was statistically different, as were the average slopes (intercepts, $\Delta\chi^2(1) = 94.93$, $p < .001$); slopes, $\Delta\chi^2(1) = 16.85$, $p < .001$). However, the class reporting more frequent substance use at baseline also showed a greater decrease over time (HS mean slope = -2.84 ; LS mean slope = -1.79).

Latent class covariates. To further describe the latent classes, we used multinomial logistic regression analyses to explore pre-treatment characteristics that were associated with latent class membership for severity of substance use problems. The covariates examined included (a) gender, (b) race/ethnicity, (c) age, (d) juvenile justice involvement, (e) total number of psychiatric diagnoses, and (f) youth- and parent-reported family cohesion and conflict. The logistic regressions were first conducted for each individual covariate. Subsequently, to avoid complications due to variance shared by associations among the covariates themselves, we included covariates from the univariate analyses that met at least a marginal level of significance ($p < .10$).

Univariate regression models indicated that among the covariates, total number of psychiatric disorders and adolescent-rated family cohesion were significantly associated with, and parent-rated family conflict was marginally associated with, substance use. There were no significant covariate effects associated with substance use frequency. Results indicated that HS participants ($M = 3.15$) reported having more diagnoses than did LS participants: Class 1 mean = 2.69, coefficient = 1.10, $SE = 0.38$, $pseudo\ z = 2.91$, $p = .004$, 95% CI [$-1.86, -0.34$], odds ratio = 0.33. Further, parents of HS youths ($M = 3.58$) reported more family conflict than did parents of LS youths: LSD mean = 4.26, coef-

ficient = -0.25 , $SE = 0.11$, $pseudo\ z = -2.32$, $p = .020$, 95% CI [$0.03, 0.47$], odds ratio = 1.28.²

Treatment effects. We next examined treatment effects by adding treatment condition as a within-class covariate to investigate treatment effects within each latent class for each outcome. Treatment condition was entered as a between-subjects covariate (0 = MDFT, 1 = CBT) on which the growth parameters of each latent class were regressed. The significant covariates from the previous analysis (i.e., number of diagnoses and family conflict) were also included for substance use problem severity. For the LS class of substance use problem severity, results indicated that the two treatments showed similar effects (treatment coefficient for slope = 0.43, $SE = 1.17$, $pseudo\ z = 0.37$, $p = .712$, $d = 0.12$). For the HS class, there were significant differences in treatment effects indicating that MDFT participants decreased their substance use problem severity more than CBT participants did (holding constant the effects of total number of diagnoses and family conflict), treatment coefficient for slope = 5.63, $SE = 1.95$, $pseudo\ z = 2.89$, $p = .004$, 95% CI [$1.73, 9.52$], $d = 1.58$ (see Figure 3). For substance use frequency, there were no significant differences in treatment effects in either class: HS, treatment coefficient for slope = 0.32, $SE = 0.35$, $pseudo\ z = 0.91$, $p = .907$; LS, treatment coefficient for slope = -0.07 , $SE = 0.54$, $pseudo\ z = -0.13$, $p = .916$.

Study 2

This study is a secondary analysis of data collected in an RCT comparing an innovative two-stage, cross-systems (juvenile justice—substance abuse treatment) intervention for detained, substance-abusing adolescents. MDFT was developed to work in two phases—in detention and postrelease—with detained, drug-involved juvenile offenders. The core treatment was also adapted to integrate interventions for HIV/sexually transmitted disease prevention. The comparison treatment was the usual services that youths received when in detention and then when referred for substance abuse treatment services. The study team enhanced the usual services by assisting community substance abuse treatment agencies with engaging treatment-referred youths (e.g., providing initial training on treatment engagement to clinical staff and transportation assistance to support youths attending their treatment sessions).

Method

Participants. Participants were enrolled in two juvenile detention facilities in Florida (Miami-Dade and Pinellas Counties). Eligibility criteria were that youths must (a) be between the ages of 13 and 17, (b) endorse substance abuse problems, and (c) have at least one parent figure able to participate in the intervention and research assessment. Potential participants were excluded if they had mental retardation or pervasive developmental disorders, psychotic features, or current suicidality. Of the 170 youths who met study eligibility criteria, 154 agreed to participate (85 in Miami-

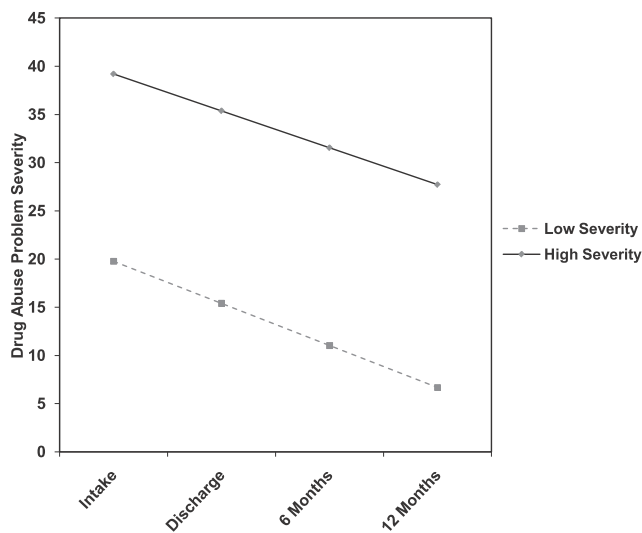


Figure 2. Study 1 model-estimated substance use problem severity mean trajectories for lower severity and higher severity classes.

¹ Cohen's d effect sizes were calculated by dividing the slope estimate by its baseline standard deviation (Feingold, 2009).

² Adolescent conflict is reverse scored such that lower scores reflect more conflict.

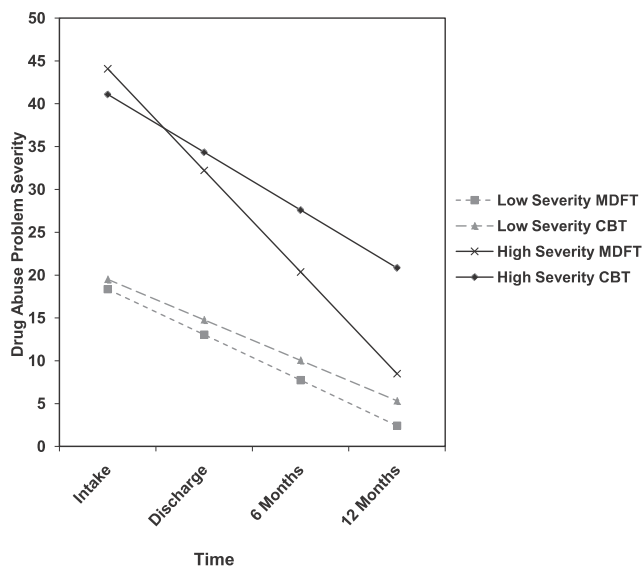


Figure 3. Study 1 treatment effect differences for model-estimated substance use problem severity mean trajectories for lower severity and higher severity classes. MDFT = multidimensional family therapy; CBT = cognitive-behavioral therapy.

Dade County, 69 in Pinellas County), yielding a 91% response rate.

Participants were predominantly males (82%), with an average age of 15.4 years ($SD = 1.1$). Youths were ethnically diverse: 60% African American, 22% Hispanic, 17% White non-Hispanic, and 1% other ethnic background. Sixty-one percent of the participants had a cannabis use disorder, 20% had an alcohol use disorder, and 10% had another substance use disorder. Many youths met criteria for a comorbid psychiatric disorder (43% for conduct disorder, 20% for attention-deficit/hyperactivity disorder, and 9% for a depressive disorder). Participants had an average of 3.9 lifetime arrests ($SD = 3.3$; see Table 3).

Procedures. Procedures for Study 2 were highly similar to those implemented in Study 1. The study was approved and monitored by the university's institutional review board, and adolescents provided their written informed assent (and parents their written permission for their adolescents to participate) before the baseline assessment. Trained research assistants obtained informed consent from youths and their parents and conducted the initial research assessment, after which the participants were randomly assigned to MDFT—Detention to Community (MDFT-DTC; $n = 76$) or ESAU ($n = 78$). Follow-up assessments were conducted at 3, 6, and 9 months following baseline. See Figure 4 for a CONSORT flow diagram.

Treatment conditions. In this study, MDFT was delivered in detention in the first phase and in participants' homes after release from detention; ESAU was office based and used group-based treatment delivery. The treatment was provided free of charge, and transportation assistance was provided to youths receiving ESAU. Please see the Internet-based version of this manuscript for supplementary material describing the ESAU intervention in more detail. Both treatments were designed to be 4–6 months in duration. As in Study 1, youths were allowed to receive medication

management but not to participate in concurrent behavioral treatments. Consistent with study hypotheses, MDFT-DTC participants were more likely to be retained in treatment (87%, $n = 66$) than ESAU participants (23%, $n = 18$), $\chi^2(1, N = 154) = 63.13, p < .001$. However, youths in both treatments received approximately their target treatment dosage per month (6 hr of MDFT-DTC and 4 hr of ESAU), and both treatments were delivered with adequate fidelity. MDFT fidelity ratings were judged to be comparable to those produced in Study 1 using equivalence testing procedures (Liddle et al., 2009). Please see Liddle, Dakof, Henderson, and Rowe (in press) for a more detailed description of the two interventions.

Measures. The measures used in Study 2 were similar to those used in Study 1 on which we reported previously. We collected the same demographic and background information (with the exception of juvenile justice involvement, because all participants were juvenile justice involved as an inclusion criterion for study participation); assessed participants' substance use with the PEI and TLFB (however, substance use was assessed for the previous 90 days in Study 2 as opposed to 30 days in Study 1); and assessed family functioning with the Cohesion and Conflict subscales of the FES. We also assessed participants' total number of psychiatric diagnoses. However, whereas in Study 1 diagnoses were obtained from the DISC-2, in Study 2 they were obtained from the DISC Predictive Scales (Lucas et al., 2001). The DISC Predictive Scales identify the presence or absence of 13 psychiatric disorders according to criteria of the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994). As compared to the full Diagnostic Interview Schedule for Children, the measure has demonstrated excellent sensitivity and specificity for psychiatric disorders (sensitivity = .86, specificity = .98; Lucas et al., 2001). Internal consistency reliabilities for the PEI, FES Cohesion, and FES Conflict for this sample were .93,

Table 3
Study 2 Sample Characteristics

Variable	Treatment condition		
	MDFT-DTC	ESAU	Overall
	<i>M (SD)</i>		
Age	15.4 (1.19)	15.4 (1.06)	15.4 (1.12)
Total no. diagnoses	2.47 (2.55)	3.15 (2.76)	2.82 (2.67)
Family income (<i>Mdn</i>)	\$25,000	\$19,600	\$13,000
	<i>n (%)</i>		
Gender			
Male	63 (83)	65 (83)	128 (83)
Female	13 (17)	23 (17)	26 (17)
Ethnicity/race			
African American	40 (53)	54 (69)	94 (61)
White, non-Hispanic	12 (16)	14 (17)	26 (17)
Hispanic	22 (29)	12 (14)	34 (22)
Family structure			
Single parent	50 (66)	50 (64)	100 (65)
Two parent	14 (18)	9 (12)	23 (15)
Blended	4 (5)	6 (8)	10 (6)
Other	8 (11)	13 (16)	21 (14)

Note. MDFT-DTC = multidimensional family therapy—detention to community; ESAU = enhanced services as usual; *SD* = standard deviation; *Mdn* = median; *n* = number of participants.

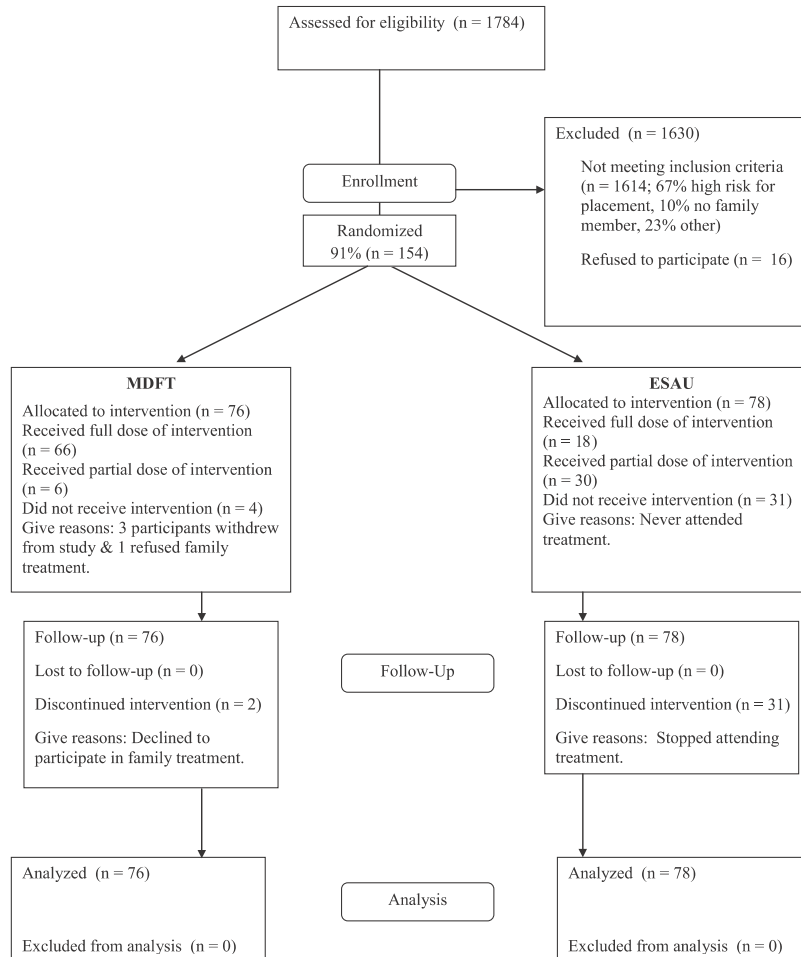


Figure 4. Study 3 CONSORT flow diagram. MDFT = multidimensional family therapy; ESAU = extended services as usual.

.79 (adolescent report) and .75 (parent report), and .67 (adolescent report) and .82 (parent report), respectively.

Analytic strategy. The analytic strategy for Study 2 was identical to that for Study 1. However, we used a natural log transformation to improve the normality of the TLFB distribution. Although robust maximum likelihood estimation is available in Mplus for data that are substantially skewed and kurtotic, we took a conservative approach by both transforming the data and using MLR estimation.

Results

Our objective in Study 2 was to replicate and extend the findings of Study 1 in a sample of adolescents recruited in a juvenile detention center. The two samples were geographically and demographically distinct. To conserve space, we include the preliminary and moderator analyses as conducted in Study 1 as supplementary material and proceed directly with the GMM analyses. As in Study 1, the moderator results were not significant, and the analyses could not account for the heterogeneity in the individual growth trajectories.

Identification of latent classes. The LRT for nested models revealed that both for substance use frequency and for problem

severity, an unconditional one-class model including intercept, slope, and quadratic growth parameters produced superior fit to a model including only intercept and slope. Therefore, subsequent growth mixture models that included multiple latent classes were based upon intercept, slope, and quadratic growth parameters.

Model fit statistics for the two-class model for drug use problem severity showed better fit on the BIC than did the one-class model (see Table 4) and showed a statistically significant L-M-R LRT ($p < .001$) and BLRT ($p < .001$). Although the three-class model produced a lower BIC than did the two-class model, along with higher entropy and significant L-M-R LRT, the third class contained only 10 participants and had growth parameters that varied only slightly from the second class. Further, Muthén (2003) has emphasized that substantive considerations should be considered as strongly as statistical ones when determining the optimal number of classes. Therefore, we selected the two-class model as optimal, as doing so keeps results consistent with Study 1. Likewise, we selected the two-class model as the optimal model for frequency of substance use to maintain consistent results with previous models, given the similar pattern of estimates evidenced with this outcome.

Table 4

Fit Indices, Entropy Values, and Likelihood Ratio Tests for One- to Three-Class Solutions for Study 2 Substance Use Problem Severity and Frequency of Substance Use

Model	Loglikelihood	df	BIC	Entropy	L-M-R LRT	BLRT
Substance use problem severity						
One class	-1,981.703	10	3,998.406	N/A	N/A	N/A
Two class	-1,908.341	12	3,877.048	.773	<.001	<.001
Three class ^a	-1,866.583	20	3,833.904	.807	.033	<.001
Frequency of substance use						
One class	-1,075.254	10	2,200.877	N/A	N/A	N/A
Two class	-1,053.487	14	2,177.491	.870	.003	<.001
Three class	-1,029.786	18	2,150.237	.904	.004	Did not converge

Note. df = degrees of freedom; BIC = Bayesian information criterion; L-M-R LRT = Lo-Mendell-Rubin likelihood ratio test; BLRT = bootstrap likelihood ratio test; N/A = not applicable.

^a Extracted third class too small ($n < 10$).

Latent class covariates. We used the same variables and procedures as in Study 1 for examining correlates of latent class membership. When covariates were added to the unconditional two-class model, total number of diagnoses, adolescent-reported family cohesion and conflict, and parent-reported family cohesion and conflict were all significant in univariate models. However, when entered together in a multivariate model, the only significant correlate was total number of diagnoses, estimate = -0.34 , $SE = 0.10$, $pseudo\ z = -3.31$, $p = .001$, 95% CI $[-0.54, -0.14]$, odds ratio = 0.71, with Class 1 reporting more diagnoses ($M = 4.21$) than Class 2 ($M = 1.79$).

The substance use problem severity classes were distinguished by baseline severity (Class 1 mean intercept = 43.75; Class 2 mean intercept = 63.99). The classes showed statistically significant decreases in problem severity that were similar to one another in magnitude: Class 1 mean slope = -10.02 , $SE = 1.60$, $pseudo\ z = -6.25$, $p < .001$, 95% CI $[-13.22, -6.82]$, $d = 2.51$; Class 2 mean slope = -10.09 , $SE = 3.22$, $pseudo\ z = -3.13$, $p = .002$, 95% CI $[-16.53, -3.65]$, $d = 2.52$. Both classes also showed statistically significant rebounds in problem severity between 6- and 9-month follow-up waves: Class 1: estimate = 2.81, $SE = 0.51$, $pseudo\ z = 5.54$, $p < .001$, 95% CI $[1.79, 3.83]$, $d = 0.70$; Class 2: estimate = 3.44, $SE = 1.19$, $pseudo\ z = 2.90$, $p = .004$, 95% CI $[1.06, 5.82]$, $d = 0.86$.

For substance use frequency, the only significant correlate was total number of diagnoses, coefficient = -0.14 , $SE = 0.07$, $pseudo\ z = -2.03$, $p = .043$, 95% CI $[-0.28, -0.01]$, odds ratio = 0.87, with Class 1 ($M = 3.32$) reporting more diagnoses than Class 2 ($M = 2.39$). Average substance use frequency class trajectories for the two substance use frequency latent classes, adjusted for total number of diagnoses, are shown in Figure 5. Consistent with Study 1, the two substance use frequency classes were distinguished by baseline frequency (Class 1 mean intercept = 36.60; Class 2 mean intercept = 22.65) as well as change in frequency over time (Class 1 mean slope = 1.05; Class 2 mean slope = -14.44). However, unlike Study 1, the classes also showed quite distinct curvilinear change (Class 1 mean quadratic slope = 1.03; Class 2 mean quadratic slope = 2.08; see Figure 5). An LRT showed that the two classes differed in initial status, $\Delta\chi^2(1) = 8.38$, $p < .01$, but not in linear change over time, $\Delta\chi^2(1) = 2.51$, $p > .05$. However, the two models differed in their

curvilinear change, $\Delta\chi^2(1) = 6.91$, $p < .01$. Based on their model-estimated trajectories (see Figure 5), we termed Class 1 higher frequency, stable (HFS) and Class 2 lower frequency, rebounding (LFR).

The HFS class comprised 46% and the LFR class comprised 54% of the population. The LFR class significantly decreased its overall substance use over time but also showed increasing substance use between 6 and 9 month follow-up waves: linear slope: estimate = -2.67 , $SE = 0.18$, $pseudo\ z = -14.79$, $p < .001$, 95% CI $[-3.03, -2.31]$, $d = 3.21$; quadratic slope: estimate = 0.73, $SE = 0.06$, $pseudo\ z = 11.73$, $p < .001$, 95% CI $[0.61, 0.85]$, $d = 0.88$. The HFS class remained stable over time, showing nonsignificant linear (estimate = 0.05, $SE = 0.24$, $pseudo\ z = 0.22$, $p = .829$) and quadratic change (estimate = -0.03 , $SE = 0.09$, $pseudo\ z = -0.33$, $p = .744$).

Treatment effects. Again, we included significant covariates from the preceding analyses along with treatment condition. In this analysis, we adjusted for the number of comorbid diagnoses as a

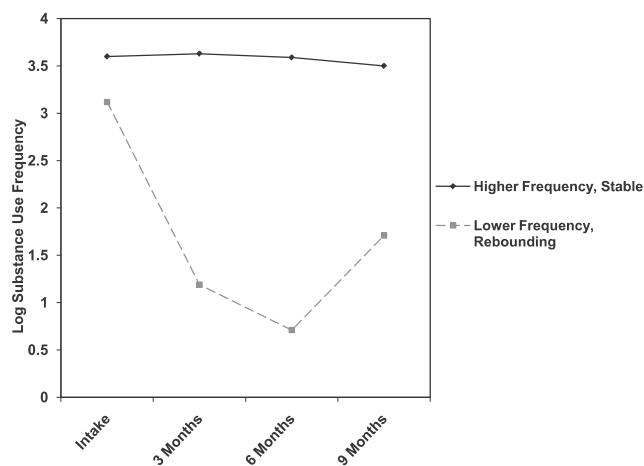


Figure 5. Study 2 model-estimated natural log-transformed substance use frequency mean trajectories for higher frequency, stable, and lower frequency, rebounding classes.

within-class covariate.³ For substance use problem severity, there were no significant differences in treatment effects for either class (LFR: treatment coefficient for slope = -1.97 , $SE = 3.06$, $pseudo\ z = -0.65$, $p = .519$; HSS: treatment coefficient for slope = 7.56 , $SE = 6.49$, $pseudo\ z = 1.17$, $p = .244$). For frequency of substance use, consistent with the pattern of results found for substance use severity in Study 1, MDFT and ESAU participants showed similar decreases in substance use frequency in the LFR class (treatment coefficient for slope = -0.01 , $SE = 0.63$, $pseudo\ z = -0.02$, $p = .947$). In the HFS class, however, MDFT participants decreased their substance use frequency more than ESAU participants did: treatment coefficient for slope = 0.53 , $SE = 0.17$, $pseudo\ z = 3.03$, $p = .002$, 95% CI [0.18, 0.88], $d = 0.64$ (see Figure 6). The quadratic effects did not significantly differ across the treatments for either latent class.

Clinical Significance

We examined the clinical significance of our findings using the reliable change index (RCI), developed by Jacobson & Truax (1991), calculated separately by study. We calculated the RCI for the substance use dimension on which we found treatment differences in each study, substance use problem severity in Study 1 and frequency of substance use in Study 2. The RCI is an index that shows the proportion of individuals who move from a dysfunctional status to one consistent with a normative sample as the result of treatment. Because the two latent classes identified in each study were distinguished in part by initial severity, we also calculated and report results separately for each class, based on participants' most likely class membership. For Study 1, we calculated the RCI based on results from the PEI normative sample in Study 1; for Study 2, because normative data for the TLFB did not exist, we used the recommendation of Jacobson and Truax of calculating the RCI based on a two standard deviation change. For Study 1,

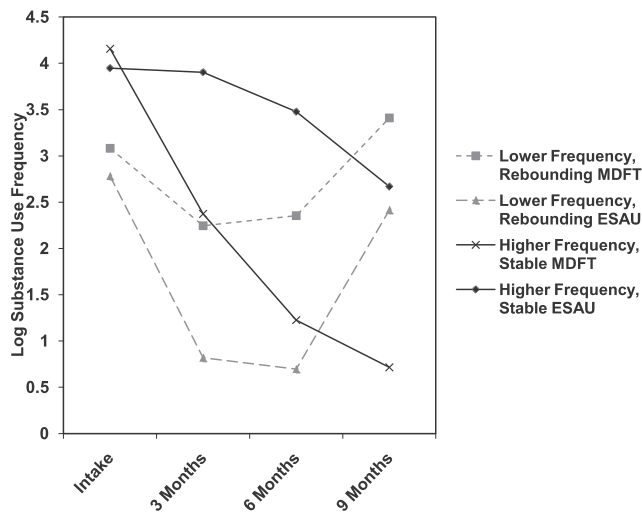


Figure 6. Study 2 treatment effect differences, adjusted for number of comorbid diagnoses as within-class covariate, for model-estimated, natural log-transformed substance use frequency mean trajectories for lower frequency, rebounding, and higher frequency, stable classes. MDFT = multidimensional family therapy; ESAU = extended services as usual.

71% of the more severe class (76% MDFT, 65% CBT) and 73% of the less severe class (71% MDFT, 75% CBT) showed clinically significant improvement. For Study 2, 24% of the more severe class (30% MDFT, 18% ESAU) and 35% of the less severe class (34% MDFT, 35% ESAU) showed clinically significant improvement. In both studies, there were no treatment differences in the proportion of youths who showed clinically significant improvement.

Discussion

In two studies, as hypothesized, MDFT was more effective than the comparison treatments (individual CBT in Study 1 and ESAU in Study 2) in decreasing substance use (problem severity in Study 1 and frequency in Study 2) among a class of youths demonstrating greater baseline substance use and psychiatric comorbidity. However, there were no significant treatment differences in decreases in substance use for the class reporting lower levels of baseline substance use and less psychiatric comorbidity. Among the more severe class, the results from the two studies differed in the dimension of substance use on which MDFT was more effective: In Study 1 it was drug use problem severity, and in Study 2 it was frequency of substance use. We can speculate on the reasons for these between-study differences. Perhaps due to a shorter window in Study 1 (30 vs. 90 days), the TLFB estimates showed a more restricted range (and therefore less heterogeneity for the GMM analyses) than did Study 2. Regarding substance use problem severity, perhaps the shorter follow-up period in Study 2 (only 5 months as compared to 12 months in Study 1) did not allow sufficient time for the drug dependence symptoms tapped by the PEI to sufficiently decrease. This is plausible not only on the results obtained in Study 2 but also in another RCT (Liddle et al., 2001) in which the change pattern fits that obtained in Study 2.

With respect to youths with less severe substance use problems and comorbid psychiatric symptoms, perhaps the qualities of good therapy (e.g., effectively targeting known determinants of the disorder, being of sufficient length and intensity, having well-executed engagement interventions; Drug Strategies, 2003) regardless of its theoretical orientation are sufficient to produce desirable decreases in substance use. In this respect, the current study findings are consistent with those from a large-scale, well-controlled field trial that demonstrated a variety of high-quality, systematic adolescent substance abuse treatments were equally effective in reducing symptoms (over a 12-month period; Dennis et al., 2004). However, the results indicate that treatment modality, in this case MDFT, might be related to better treatment outcomes for youths reporting more drug use and experiencing more comorbid symptoms.

Results from the current study also suggest that youths with more severe and entrenched symptoms might benefit more from a family-based treatment such as MDFT, which takes a more comprehensive focus and targets a larger number of empirically supported risk factors (i.e., attempting to change the parents, the youths, and their interactions in relation to the family and relative

³ We entered number of comorbid diagnoses as a within-class covariate because it more clearly depicts treatment differences. The change trajectories depicted in Figures 5 and 6 are not directly comparable.

to the extrafamilial) than does a treatment focused primarily on the individual adolescent. A second reason that MDFT may have fared as it did is the explicit focus on changing family dynamics. Developmental psychopathology research has consistently identified family relationship factors as a prominent risk factor in the initiation and maintenance of substance use. Therefore, it stands to reason that a treatment designed to enhance family functioning may fare better than treatments that do not have such a focus. This reasoning underlies the theoretical bases of family-based treatments and has been supported by research (Henderson, Rowe, Dakof, Hawes, & Liddle, 2009; Huey, Henggeler, Brondino, & Pickrel, 2000). Results from the current study suggest that it may pertain more to youths with more severe substance use and comorbid psychiatric problems.

The study's findings must be considered in light of several limitations. First, the studies were conducted with rather homogeneous populations: mostly male, low-income, urban adolescents. Thus it is impossible to know if the results would generalize to other populations. Second, the measures we selected for the studies are limited in certain respects; primarily, the substance use variable relies on self-report. Although studies show that self-report is generally valid and has good agreement with collateral and biological reports (Del Boca & Noll, 2000), the study conclusions would be stronger if replicated with outcome data from multiple sources. Moreover, the reliability for parent-reported family conflict was fairly low, and we might have obtained different results if this scale were more reliable. Further, the two studies were conducted at different times, and they used different diagnostic interviews (in Study 1, the DISC; in Study 2, the DISC-2). Therefore, we are unsure if the relationships between class membership and psychiatric comorbidity would be the same had the studies used the same interview. Third, the studies did not incorporate a no-treatment control group. This has been the standard in the addictions field for several years, primarily for ethical reasons (i.e., withholding treatment from youths who very likely will develop more severe problems over time; Del Boca & Darkes, 2007). However, without a no-treatment control group, we must confine our interpretations to the relative effectiveness of the treatments tested against one another in the current study and cannot make statements regarding the treatments' effectiveness in an absolute sense. Fourth, although we found that MDFT and the comparison treatments statistically differed in decreases in substance use in a group of youths reporting more severe substance use and psychiatric comorbidity, the proportion of youths showing clinically significant decreases in substance use did not differ by treatment condition. Although these results may reflect the low power of the statistical approach (chi-square analyses conducted within latent class), they also suggest further room for MDFT treatment development to achieve stronger impact with regard to moving substance abusing youths "within the range of the functional population" (Jacobson & Truax, 1991).

A final limitation concerns the statistical validity of GMM itself. One issue is that because it analyzes trajectories, it confounds baseline severity (which is measured prior to randomization) with treatment response (which occurs after randomization). This fact underscores the importance of the unconfounded treatment effects analysis, in which randomization occurs before treatment is introduced. In both studies, primary outcome analyses indicated that MDFT outperformed the comparison treatments on the outcomes

we examined here, somewhat ameliorating the concern that the results are due to confounding pre- and posttreatment data. A second concern introduced by Bauer and Curran (2003) has to do with how the latent classes are interpreted. Because Bauer and Curran demonstrated that nonnormal data from a single class can produce results indicating that the data are produced by a mixture distribution, they caution against interpreting latent classes as real population subgroups. Two issues mitigate against concerns about the validity of the GMM-derived latent classes in the current studies. First, in Study 1 and Study 2 we used auxiliary information in the form of covariates to help clarify the model results and check the consistency of the results against substantive theories (Muthén, 2003). Second, Bauer and Curran emphasized that deciding whether latent classes should be interpreted as population subgroups requires a series of research studies "testing the validity of the assumption of population heterogeneity" (p. 359). The fact that we were able to replicate and extend results in two studies strengthens confidence in the results.

Clinical Implications

Despite these limitations, the results have promising clinical implications. Most prominent is the possibility that treatment outcome might be improved if youths were assessed for severity of drug use and comorbidity at intake and then matched to a particular treatment, with more severe problems being referred to family-based treatments, such as MDFT. Although these findings are tentative, substance abuse system planners and agency directors might consider incorporating them and a related body of findings in their efforts to enhance treatment outcomes by ensuring that higher severity adolescents receive treatments that address not only the youths but also their parents and family interaction patterns. Although the current results suggest that MDFT and comparison treatments performed equivalently for youths reporting less baseline substance use and comorbidity, this finding must be considered in light of the robust effects that MDFT has evidenced over comparison treatments for younger youths who have less entrenched substance use habits (Liddle et al., 2009). In fact, a prominent feature of MDFT research is its impact with a wide variety of clinical issues, including severity of symptoms, which have been achieved in multiple contexts (e.g., detention; Liddle, 2010).

Although the findings from the current study suggest a general pattern of treatment leading to decreased substance use, they were manifested with different measures of substance use. Therefore, replication with other MDFT RCTs is necessary. Further, other family-based treatments are in a position to conduct similar analyses, and it would be informative to see if similar results are obtained. This kind of research is needed with other efficacious family-based treatments (e.g., Henggeler, Schoenwald, Borduin, Rowland, & Cunningham, 1998) or CBT treatments that integrate a family-based conceptual and intervention focus (e.g., Latimer, Winters, D'Zurilla, & Nichols, 2003; Waldron, Slesnick, Brody, Turner, & Peterson, 2001).

The results also suggest that positive outcomes are achievable even among youths with severe substance use problems. Increasing the level of care from outpatient to intensive outpatient or residential treatment is typically seen as the treatment of choice for youths with severe problems or those who have failed at outpatient

treatment. In some cases (still to be defined empirically), this may be the best option. However, the findings from this study offer optimism about treating youths with severe problems in a traditional outpatient setting.

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