Reduced Substance Use as a Secondary Benefit of an Indicated Cognitive–Behavioral Adolescent Depression Prevention Program

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Our first aim was to test whether a group cognitive–behavioral (CB) depression prevention program reduces substance use escalation over 2-year follow-up relative to two active comparison interventions and a brochure assessment control. Our second aim examined whether reductions in depressive symptoms mediate intervention effects, as posited by the affect-regulation model of substance use. In this indicated prevention trial, 341 high school adolescents at risk for depression because of the presence of elevated depressive symptoms were randomized to a Group CB intervention, group supportive-expressive group intervention, CB bibliotherapy, or educational brochure control condition. Participants in Group CB had significantly lower rates of substance use compared with brochure control participants at both 1- and 2-year follow-up and lower substance use at 2-year follow-up relative to bibliotherapy participants; no other condition differences were significant. Mediational analyses suggested that reductions in depressive symptoms from baseline to posttest accounted for changes in substance use over 2 years for participants in Group CB relative to brochure control participants but did not mediate effects relative to those receiving bibliotherapy. Results suggest that a secondary benefit of this CB group indicated depression prevention program is lower rates of long-term substance use. Findings supported the hypothesis that, relative to a nonactive comparison condition, reductions in depressive symptoms mediated the effects of Group CB prevention on substance use escalation.

Keywords: depression, prevention, adolescents, substance use, mediation, secondary benefits

Adolescence is the peak risk period for substance use initiation and escalation, with first use of alcohol, tobacco, and other drugs typically occurring during this period (Johnston, O'Malley, Bachman, & Schulenberg, 2008). Alcohol and other drug use negatively impacts physical development and family relationships and is associated with school failure, criminality, unwanted pregnancy, sexually transmitted infections, accidents, homicide, and suicide (Chassin, Pitts, & Prost, 2002; Chassin, Ritter, Trim, & King, 2003). Tobacco use is the leading preventable cause of death in the United States (U.S. Department of Health and Human Services, 2004).

Negative mood states have been theorized to increase the risk for substance use (Wills, Sandy, Shinar, & Yaeger, 1999), and clinicians have suggested that some depressed individuals "self-medicate," consuming psychoactive substances as a coping mechanism to reduce negative affect (e.g., Khantzian, 1985; Swendsen et al., 2000). Consistent with this affect-regulation model, depres-

sive symptoms and major depressive disorder (MDD) increase the risk for substance use onset in adolescents (e.g., Kuo, Gardner, Kendler, & Prescott, 2006; Measelle, Stice, & Hogansen, 2006; Sihvola et al., 2008), although this effect has not emerged in all studies (e.g., Degenhardt, Hall, & Lynskey, 2003; Hallfors, Waller, Bauer, Ford, & Halpern, 2006). Studies with null findings either focused on depression predicting initial use of a single substance (e.g., cannabis) or examined whether a brief measure of current depressive symptoms predicted substance use one year later, which suggests that the impact of depressed mood on future substance use applies to a broader range of substances or requires a comprehensive assessment of depression.

Also consistent with the affect-regulation model, cognitive–behavioral (CB) treatments for depression have been associated with reduced substance use for depressed adults in addiction treatment (Brown, Evans, Miller, Burgess, & Mueller, 1997; Patten et al.,1998), and antidepressant therapies tend to achieve significant, albeit modest, reductions in both depression and substance use for adults with comorbid depression and substance use disorders, especially for nicotine dependence and alcohol use disorders (Nunes & Levin, 2004; Torrens, Fonseca, Mateu, & Farre, 2005). Trials with adolescents, however, have found that neither psychosocial (Rohde, Clarke, Mace, Jorgensen, & Seeley, 2004) nor pharmacological (Cornelius et al., 2009; Riggs et al., 2007) treatments for depression significantly reduce substance use, suggesting that depression plays a more potent maintenance role for substance use during adulthood than adolescence.

Few randomized trials have tested whether reducing depression reduces risk for escalation in substance use, an objective for which adolescent depression prevention (as opposed to treatment) pro-

grams seem well suited. We first examined this question using an indicated CB depression prevention program with older adolescent (M age = 18.6 years) young women with elevated depressive symptoms (Burton, Stice, Bearman, & Rohde, 2007). Although the Group CB intervention significantly reduced depressive symptoms relative to assessment-only controls, there were no intervention effects on future substance use.

A second trial evaluated the CB depression prevention program in a younger sample (M age = 15.6 years) of both female and male adolescents (Stice, Rohde, Seeley, & Gau, 2008). This trial evaluated the efficacy of an indicated Group CB depression prevention program relative to both an educational brochure control condition and two active dismantling comparison conditions that provided the two components of the CB group: CB bibliotherapy and supportive-expressive group treatment. CB group participants showed significantly greater reductions in depressive symptoms compared with supportive-expressive, bibliotherapy, and brochure control participants at posttest (6 weeks after baseline), although only the difference relative to brochure controls remained significant at 6-month follow-up. Consistent with the affect-regulation model, CB participants showed significantly lower substance use at posttest than either brochure control or bibliotherapy participants, and lower substance use than participants in all three alternative conditions by 6-month follow-up. Supportive-expressive group participants also had lower substance use relative to brochure controls at 6-month follow-up but not at posttest; bibliotherapy participants did not differ from brochure controls on substance use at either assessment point. We recently completed the 2-year follow-up of this study and reported effects for depression outcomes in Stice, Rohde, Gau, and Wade (2010). Group CB participants showed greater reductions in depressive symptoms than bibliotherapy and brochure control participants at the 1-year follow-up and significantly or marginally greater reductions by 2-year follow-up.

The primary aim of this report is to examine the degree to which lower substance use for Group CB participants relative to the three other intervention conditions detected at 6-month follow-up persists through 2-year follow-up. Our second aim is to test whether reductions in depressive symptoms mediate the effects of CB group depression prevention on any long-term effects on substance use detected in Aim 1, using latent growth curve models in which growth in the mediator and outcome are modeled (MacKinnon, 2008). This long-term meditational model (Stice, Marti, Rohde, & Shaw, 2011) posited that change in depressive symptoms would fully or partially mediate the effects of Group CB relative to comparison conditions on escalation in future substance use. Using a randomized, controlled trial to test whether interventions that reduce depression also reduce the risk for substance use escalation provides an evaluation of the affect-regulation hypothesis that complements the conclusions that can be drawn from prospective risk factor studies (Hinshaw, 2002).

Method

Participants

Participants were 341 high school students (56% female) who ranged in age from 14 to 19 years (M = 15.6; SD = 1.2) at baseline. The sample was composed of 2% Asians, 9% African

Americans, 46% Caucasians, 33% Hispanics, and 10% who specified "other" or mixed heritage, which was somewhat more ethnically diverse than the greater Austin area (7% African American, 18% Hispanic, 65% Caucasian). Educational attainment of parents was 26% high school graduate or less; 17% some college; 35% college graduate; 18% graduate degree, which was somewhat higher than the adult population from which we sampled (34% high school graduate or less; 25% some college; 26% college graduate; 15% graduate degree).

Procedures

Participants were recruited using mass mailings, leaflets, and posters that invited students experiencing sadness to participate in a trial of interventions designed to improve current and future mood. Interested students were given a depression screener (the Center for Epidemiologic Studies-Depression scale [CES-D]; Radloff, 1977) and a consent form by mail, which described the study conditions, randomization, and assessment procedures. Parents provided written consent and adolescents provided written assent. Adolescents who returned a signed consent form and scored 20 or above on the CES-D were invited to complete a baseline assessment. We selected this cutoff because an epidemiologic study (Roberts, Lewinsohn, & Seeley, 1991) found that 31% of community-dwelling adolescents scored above 20 on the CES-D, and this cutoff maximized sensitivity for detecting youth at risk for major depression. Students who met diagnostic criteria for current major depression were excluded and given treatment referrals.

Participants were recruited at six schools between 2004 and 2007 and were randomly assigned by the project coordinator using computer-generated random numbers to one of four conditions: (a) CB group (n = 89), (b) supportive-expressive group (n = 88), (c) CB bibliotherapy (n = 80), or (d) an educational brochure control condition (n = 84).

CB and supportive-expressive group interventions consisted of six weekly 1-hr sessions. Groups were facilitated by a clinical psychology graduate student and cofacilitated by an undergraduate psychology student. If a participant missed a session, a brief (10- to 15-min) meeting was conducted with the youth to review missed material when possible. Detailed manuals for both group interventions contained a theoretical rationale for the program, general facilitator guidelines, material needed for each session, and outlines for all sessions (session topics, points to cover in each section, anticipated time requirements for each section, home practice assignments for the CB condition). The first author rated session recordings for adherence and competence using scales adapted from prior trials (Rohde et al., 2004). Two sessions from the first group for each facilitator and one from each subsequent group were randomly selected for ratings (27% total). Adherence was measured using session-specific checklists for the concepts, skills, and exercises detailed in the scripts. Each item was rated for full, partial, or minimal presentation. General facilitator competence was rated using eighteen 3-point items that assessed the various indicators of a competent therapist (e.g., leader fosters supportive group process, allocates time fairly across group members). Regarding treatment fidelity, 96% of the CB components and 100% of the supportive-expressive components were rated as full adherence. Regarding leader competence, 94% of the items in the CB sessions were rated at good competence (5% at partial, 1%

at poor) and 94% of the items in the supportive-expressive sessions were rated at good competence (6% at partial, 0% at poor).

Participants completed a survey and diagnostic interview at baseline, posttest, 6-month, 1-year, and 2-year follow-ups. They received $20 for completing each assessment. Assessors, who were blinded to condition, had at least a bachelor's degree in psychology and received 40 hours of training in the use of the semistructured interviews. Assessors were required to show a minimum kappa agreement of .80 for diagnosis with expert raters before starting data collection and to maintain this throughout the study (assessed in a randomly selected 10% of taped interviews). Assessments and groups were conducted at the high schools after classes. The University of Texas at Austin research ethics board approved this study. Previous reports of this trial (Stice et al., 2008; 2010) provide additional study details.

Group CB Depression Prevention Intervention

Our brief CB program drew upon the Clarke et al. (1995) program, general CB concepts for the prevention and treatment of depression, and our experience with the design of eating disorder prevention programs. Sessions focused on building group rapport, increasing pleasant activities, learning and practicing cognitive restructuring techniques, and the development of response plans for future life stressors. In-session exercises require youth to apply the skills taught in the intervention. We used homework to reinforce the skills taught in the sessions and help participants learn how to apply the skills to their daily life. We also used motivational enhancement exercises to maximize willingness to use the new skills, behavioral techniques to reinforce use of the new skills, and group activities to foster feelings of social support and group cohesion.

Group Supportive-Expressive Intervention

The goals of this condition were to establish and maintain rapport, provide support, and help participants identify and express feelings; this group did not cover any specific skills from the CB conditions. Sessions provided a forum to discuss feelings in a safe environment based on the rationale, which was presented to group members, that sharing feelings with another person reduces stress and improves our mood, listening to others helps us realize we are not alone, and it's more helpful to listen than tell others what to do. Participants were encouraged to discuss changes in their experiences, as well as any emerging problems or worries. No direct advice was given. Participants and facilitators actively supported and responded to each another.

Bibliotherapy Intervention

Participants in the bibliotherapy condition were given copies of *Feeling Good* (Burns, 1980), which provides relevant and practical CB techniques for preventing and reducing negative moods. Participants were told, "This book has been shown to be helpful to some individuals who are feeling sad or depressed. This copy is yours to keep, so feel free to write or highlight in it as you read. We encourage you to use this as a self-help resource."

Educational Brochure Control Condition

At baseline, participants were given an NIMH brochure that describes major depression and recommends treatment for de-

pressed youth ("Let's Talk About Depression" NIH Pub. 01–4162), as well as information about local treatment options. They completed the same assessments as those in the other conditions, which allowed us to monitor depression and suicidal ideation, and to contact parents and provide treatment referrals as necessary.

Measures

Substance use. Substance use was measured with 10 items from Stice and Barrera (1995). Adolescents reported the frequency and quantity of intake of beer/wine/wine coolers and hard liquor, frequency and quantity of cigarettes (number of smoking days, number of cigarettes per smoking day), and frequency of marijuana, stimulants, downers, inhalants, and hallucinogen use during the past month. Frequency items used 7-point response scales (0 = *never*; 1 = *a few times*; 2 = *less than monthly*; 3 = *1–3 times a month*; 4 = *1–2 times a week* ; 5 = *3–4 times a week*; 6 = *5–7 times a week*). Based on the polysubstance use reported in our sample and consistent with other studies that have predicted overall substance use composite scores (e.g., Chassin, Curran, Hussong, & Colder, 1996; Coley, Votruba-Drzal, & Schindler, 2008; Hussong & Chassin, 1997; Wills, Vaccaro, & McNamara, 1994), items were averaged to form an overall substance use measure, which was then normalized with a square-root transformation. This scale has shown internal consistency (α = .87), 1-year test–retest reliability (r = .50), and predictive validity for changes in parenting (Stice & Barrera, 1995). In the current study the scale showed adequate internal consistency (α = .79) and good 6-week test–retest reliability for brochure controls (r = .71).

Depressive symptoms. Sixteen items assessing *DSM–IV* major depression symptoms were adapted from the Schedule for Affective Disorders and Schizophrenia for School-Age Children (K-SADS; Kaufman, Birmaher, Brent, Rao, & Ryan, 1996), a semistructured diagnostic interview. Participants reported the peak severity of each symptom over the past month using an expanded response format (response options: 1 = *not at all* to 4 = *severe symptoms* [ratings of 3 and 4 reflecting diagnostic levels]). Severity ratings for each symptom were averaged to form a continuous depressive symptom composite. The depressive symptom severity score has shown 1-week test–retest reliability (r = .93), interrater agreement (r = .85), internal consistency (α = .75), predictive validity (Nolen-Hoeksema, Stice, Wade, & Bohon, 2007), and sensitivity to detecting intervention effects (Stice et al., 2008).

Data Analysis

Preliminary analyses examined the comparability of participants across conditions. Next, linear mixed effects models (Fitzmaurice, Laird, & Ware, 2004; Hedeker & Gibbons, 2006) with random intercepts and slopes, an unstructured covariance structure, individual time scores measured in months from baseline assessment, and baseline depression scores as a covariate tested whether there were differential changes between the prevention intervention conditions in substance use from baseline to 1- and 2-year follow-up assessments. These models use all available data, thereby accommodating participants with incomplete data. Models with a quadratic term were considered, but based on the Akaike information criteria (AIC) and Bayesian information criteria (BIC) fit statistics,

the linear only model (AIC = 1480, BIC = 1495) showed superior fit to the linear and quadratic model (AIC = 1515, BIC = 1542). Because mixed effects models do not provide standardized regression coefficients, partial correlation coefficients, computed on the basis of t values and degrees of freedom (Rosenthal & Rubin, 2003) were computed for effect sizes. Partial correlation coefficients were converted to a d-statistic using the formula provided by Rosenthal (1991).

For contrasts where the impact of CB group prevention on reducing substance use persisted through 2-year follow-up, we tested whether depressive symptoms mediated substance use outcomes for CB group relative to the alternative condition. Mediation was examined using latent growth curve (LGC) models in a structural equation modeling framework (SEM) in which parallel growth in the mediator and the outcome variables was modeled (MacKinnon, 2008). Mediation models were constructed with the Mplus software (Muthén & Muthén, 1998–2010) using direct maximum likelihood estimation, which makes use of all available data. We tested whether (a) the initial variable (i.e., Group CB condition relative to the control condition) predicts the outcome (i.e., substance use; path c), (b) the initial variable predicts change in the mediator (depressive symptoms; path a), (c) change in the mediator predicts change in the outcome (path b), and (d) the relations between the initial variable and the outcome is reduced to zero if the mediator is included in the model (path c'), which demonstrates full mediation or evidence of a significant reduction, which would suggest partial mediation. Paths a, b, and c' are estimated in a model in which we tested the indirect effect from condition variable to the substance use variable through depressive symptoms with bias corrected bootstrap estimates that test the null hypothesis that the relation between condition and substance use does not depend on the mediator (i.e., the product of the a and b paths is 0). In the event that models did not show acceptable model fit, we identified theoretically viable changes to the models based on the modification indices.

Prior to the constructing parallel growth models, we tested for multivariate normality, an assumption of SEM. Change in the growth patterns were examined for both the mediator and outcome variables to assess the best model of longitudinal change. We visually examined growth plots of change in the depressive symptoms and substance use, and examined models of static, linear, and quadratic change. In the event of nonlinear change, we evaluated transformations, which linearize nonlinear relations, and piecewise models, which account for distinctly different periods of change (Bollen & Curran, 2006). The LGC models were comprised of factors that represent initial status and growth rate. We assessed the fit of various models of change across time by comparing AIC values of models, using the criteria that decreases of greater than 2 in AIC indicate improved model fit (Burnham & Anderson, 2002). Mediation in the growth models was assessed following the parallel growth model suggested by MacKinnon (2008). Change in the mediator was regressed on the initial status of the mediator and the intervention condition. Change in the outcome was regressed on the initial status of the outcome, change in the mediator, and intervention condition. Tucker-Lewis Index (TLI) > .90, Confirmatory Fit Index (CFI) > .90, and Root Mean Square Error of Approximation (RMSEA) < .08) were used to assess model fit.

Results

Sample Description

Participants assigned to the four conditions did not differ on demographic factors, treatment services received for emotional/behavior problems during the past year, or substance use, although as previously reported (Stice et al., 2008), intervention condition was associated with differences in baseline depressive symptoms, $F(3, 334) = 4.80$; $p = .003$; $\eta^2 = .04$; bibliotherapy participants had significantly lower baseline depressive symptoms than Group CB and supportive-expressive participants, but not brochure controls. Thus, all analyses controlled for baseline depressive symptoms. Participants assigned to the various conditions did not show significant differences in treatment expectancy, group attendance, treatment fidelity and competence, or attrition (Stice et al., 2008). The percentage of participants who did not provide data was 3% at posttest, 9% at 6-month follow-up, 15% at 1-year follow-up, and 22% at 2-year follow-up.

Attendance was similar across groups; 52% of CB participants attended all 6 sessions compared with 47% of supportive-expressive participants; 89% of CB participants and 85% of supportive-expressive participants attended at least 3 of the 6 sessions. Among bibliotherapy participants, 41% indicated they read at least half the book, 37% read less than a quarter, and 22% did not read any of the book.

At baseline, 50% of participants reported having used alcohol at least once, 26% reported some cigarette use, 28% reported some marijuana use, and 8% reported some use of other drugs. These rates are similar to national norms for this age group (e.g., 2010 annual prevalence rates of 10th graders for alcohol, marijuana, and other illicit drugs = 52%, 28%, and 12%, respectively; lifetime prevalence of smoking = 33%; Johnston, O'Malley, Bachman, & Schulenberg, 2011). Baseline substance use did not significantly differ ($p > .05$) by intervention condition for any of these substances. Participants who completed all five assessment waves ($n = 230$) were compared with those who did not ($n = 109$) on baseline substance use; attrition use was not significantly related to either baseline substance use ($\beta = -0.12$, $SE = 0.17$, $p = .479$) or the interaction of condition by baseline substance use ($\beta = -0.07$, $SE = 0.35$, $p = .676$).

Substance use during the follow-up consisted almost exclusively of polysubstance use or alcohol use only: of the 148 participants who reported any substance use at the last assessment, 59% reported use of more than one drug category; of the remaining participants, 33% reported alcohol use only, 5% reported cigarette use only, and 3% reported marijuana use only; none reported use of only other drugs; of the participants who reported any substance, 90% used alcohol. The pattern of substance consumption corroborated our use of a single composite measure of substance use. Substance use scores by condition at the five assessment points are shown in Table 1.

Substance Use Outcomes in the 1- and 2-Year Follow-Up Periods

Results from the linear mixed effects models testing for differential changes in substance use across intervention condition from baseline to 1- and 2-year are shown in Table 2. Group CB partic-

Table 1
Observed Substance Use Descriptive Statistics by Intervention Condition at the Various Assessment Points

Substance use	CB (n = 89)				Supportive (n = 88)				Bibliotherapy (n = 80)				Control (n = 84)			
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max
Baseline	0.48	0.53	0.00	2.00	0.60	0.75	0.00	3.30	0.58	0.68	0.00	2.80	0.39	0.60	0.00	2.80
Posttest	0.40	0.58	0.00	2.70	0.65	0.88	0.00	3.30	0.64	0.77	0.00	3.00	0.38	0.52	0.00	2.00
6-month follow-up	0.39	0.65	0.00	3.30	0.62	0.86	0.00	3.70	0.73	1.01	0.0	5.40	0.61	0.84	0.00	3.10
1-year follow-up	0.47	0.64	0.00	3.10	0.74	0.85	0.0	3.50	0.77	0.93	0.00	3.60	0.62	0.76	0.00	2.90
2-year follow-up	0.58	0.77	0.00	3.10	0.84	0.95	0.0	4.30	0.93	0.93	0.00	3.30	0.66	0.87	0.00	3.50

Note. CB = cognitive–behavioral group; min = minimum; max = maximum.

ipants showed significantly smaller increases in substance use compared with brochure controls from baseline through both 1- and 2-year follow-ups ($d = .45$ [$p = .004$] and .32 [$p = 033$], respectively). They also showed significantly smaller increases in substance use relative to bibliotherapy participants from baseline through 2-year follow-up ($d = .43$ [$p = .006$]), a difference that reached the level of a trend at 1-year follow-up ($d = .28$ [$p = .067$]). None of the remaining contrasts were statistically significant at either longer-term follow-up point. A visual depiction of the changes in substance use by condition, derived from estimated marginal means, is shown in Figure 1.

Impact of Treatment Compliance

We also examined whether treatment compliance impacted the pattern of findings. These analyses were restricted to the participants who attended all six CB sessions ($n = 46$; 52% of CB participants), all 6 supportive-expressive sessions ($n = 41$; 47% of supportive-expressive participants) or read at least 50% of the bibliotherapy book ($n = 31$; 41% of bibliotherapy participants), comparing them to the 84 brochure control participants. Rerunning the linear mixed effects models testing for differential changes in substance use across conditions from baseline to 1- and 2-year indicated the same pattern of results, with one exception: whereas

the intent-to-treat results found a significant condition by time interaction in substance use for the Group CB versus bibliotherapy participants at 2-year follow-up, this difference fell to the level of the trend when analyses were restricted to compliers (Estimate = .008; $SE = .005$; t value = 1.84; $p = .067$; $d = .43$). Group CB participants continued to show significantly smaller increases in substance use compared with brochure controls from baseline through both 1- and 2-year follow-ups ($d = .49$ and .41, respectively), and none of the remaining contrasts were statistically significant at either longer-term follow-up point.

Test of Whether Depressive Symptoms Mediate Substance Use Outcomes

Variables included in the model failed to demonstrate multivariate normality, Doornik-Hansen test $\chi^2(20) = 200.58$, $p < .001$, and therefore we used bias corrected bootstrapping to assess statistical significance. Visual examination of depressive symptoms and substance use suggested a piecewise model for depression, which decreased sharply between baseline and posttest for participants in Group CB, then exhibited a slow decline from posttest to the 2-year follow-up (e.g., mean depressive symptoms for CB group participants at baseline, posttest, and 2-year follow-up = 1.88, 1.52, and 1.48, respectively; comparable scores for brochure

Table 2
Time × Condition Interactions Assessing Change in the Substance Use by Both Longer-Term Follow-Up Assessments

	Estimate	SE	t	p	D
Baseline to 1-year follow-up					
CB vs. Supportive-expressive	.006	.005	1.18	.237	.18
CB vs. Bibliotherapy	.010	.006	1.84	.067	.28
CB vs. Control	.016	.005	2.94	.004	.45
Bibliotherapy vs. Supportive-expressive	−.004	.006	−0.72	.471	.12
Bibliotherapy vs. Control	.005	.006	0.95	.345	.14
Supportive-expressive vs. Control	.009	.005	1.76	.078	.26
Baseline to 2-year follow-up					
CB vs. Supportive-expressive	.005	.003	1.56	.118	.24
CB vs. Bibliotherapy	.010	.004	2.79	.006	.43
CB vs. Control	.007	.003	2.15	.033	.32
Bibliotherapy vs. Supportive-expressive	−.005	.004	−1.31	.191	.20
Bibliotherapy vs. Control	−.003	.004	−0.74	.460	.12
Supportive-expressive vs. Control	.002	.003	0.59	.533	.10

Note. CB = cognitive–behavioral group; d = effect size statistic d. Baseline to 1-year follow-up slope estimates are: CB −.001, supportive-expressive .005, bibliotherapy .011, and control .015; Baseline to 2-year follow-up slope estimates are: CB .001, supportive-expressive .006, bibliotherapy .011, and control .008.
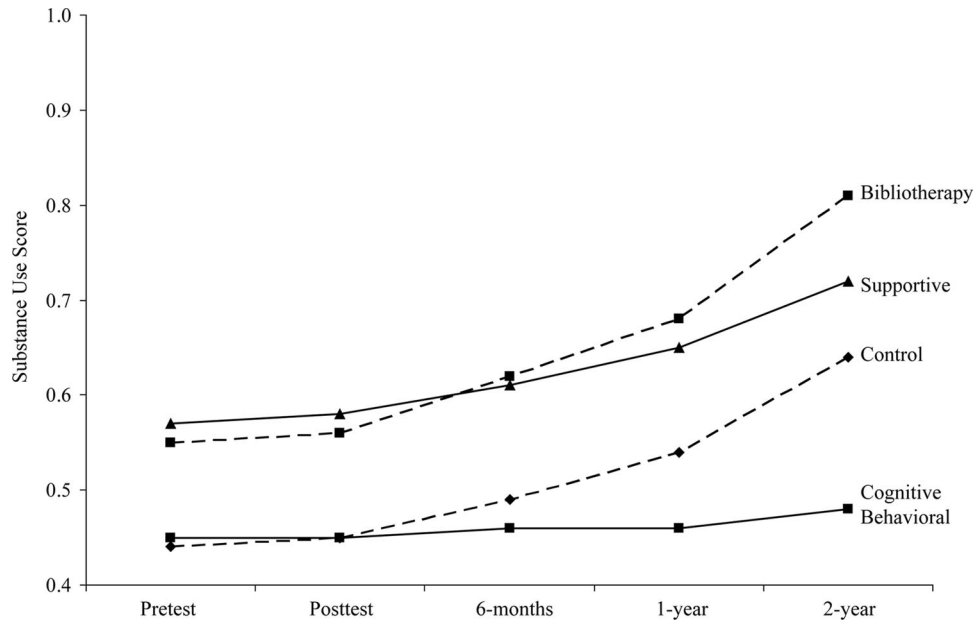
Figure 1. Model implied substance use trajectories by intervention condition. Model based on all observed substance use score from baseline through the 2-year follow-up. Effect size estimates for mean differences at baseline are: Cognitive–Behavioral vs. Control (*d* = .04), Cognitive–behavioral vs. Supportive (*d* = .23), Cognitive–Behavioral vs. Bibliotherapy (*d* = .19), Control vs. Supportive (*d* = .26), Control vs. Bibliotherapy (*d* = .22), and Supportive vs. Bibliotherapy (*d* = .04).

control participants = 1.81, 1.69, and 1.55; Stice et al., 2010). The change in AIC between a linear model and a piecewise model that modeled change for two distinct time segments (baseline to posttest vs. posttest to the 2-year follow-up) was 58.3, which indicated a superior fit for the piecewise model of depression change. We also examined transformations of month from baseline, as depressive symptoms appeared to decrease following posttest, but level off after 6 months. A log transformation of months improved the model fit: AIC decreased by 7.4. We also considered a piecewise model of substance use but AIC increased, suggesting that the piecewise model did not improve fit relative to the linear model. The AIC for the linear model of substance use change was equivalent to the log transformed months models and we therefore selected the log-transformed model to keep it on the same scale as depressive symptoms.

We first tested the mediation model for the Group CB condition versus brochure control. This model (Figure 2) demonstrated acceptable fit (TLI = .966; CFI = .973; RMSEA = .049).[1] Prevention condition significantly predicted the baseline to posttest change in depressive symptoms growth factor (−0.35, 95% confidence interval [CI] = −0.60, −0.20, β = −.62) but not posttest to 24-month change (0.03, 95% CI = −0.01, 0.08, β = .22), indicating that condition predicted immediate change in the mediator. Baseline to posttest change in depressive symptoms growth factor significantly predicted the substance use growth factor (0.25, 95% CI = 0.03, 1.99, β = .51), indicating that change in the mediator predicted change in the outcome. The direct effect of prevention condition significantly predicted the substance use growth factor (−0.07, 95% CI = −0.12, −0.03, β = −.25), but after controlling for change in depressive symptoms from baseline

to posttest, the direct path from condition to the substance use growth factor became nonsignificant (0.01, 95% CI = −0.10, 0.59, β = .05). The indirect path from intervention condition to the baseline to posttest change in depressive symptoms to growth in substance use was significant (−0.09, 95% CI = −0.85, −0.01, β = −.32). In summary, the results supported a model in which change in depressive symptoms fully mediated the impact of CB group versus brochure control in reducing future substance use.

We next tested the mediation model for CB group condition versus bibliotherapy. This model (also Figure 2) demonstrated acceptable fit (TLI = .962; CFI = .954; RMSEA = .060).[2] Prevention condition significantly predicted baseline to posttest change in the depressive symptoms growth factor (−0.55, 95% CI = −1.19, −0.28, β = −1.13). However, the second criterion of mediation (i.e., that change in the mediator predict change in the outcome) was not supported: baseline to posttest change in depressive symptoms growth factor did not significantly predict the substance use growth factor (0.02, 95% CI = −0.17, 0.86, β = .06). Controlling for change in depressive symptoms, the direct path from prevention condition to the substance use growth factor was nonsignificant (0.06, 95% CI = −0.16, 0.16, β = −.27), whereas the direct effect of condition on the substance use growth factor had been significant (−0.06, 95% CI = −0.12, −0.03, β =

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[1] Baseline and posttest residuals were allowed to covary based on the modification indices.

[2] The residual variance for the baseline to posttest change in depressive symptoms was negative in the original model and was thus constrained to zero to avoid nonpositive definite matrices.
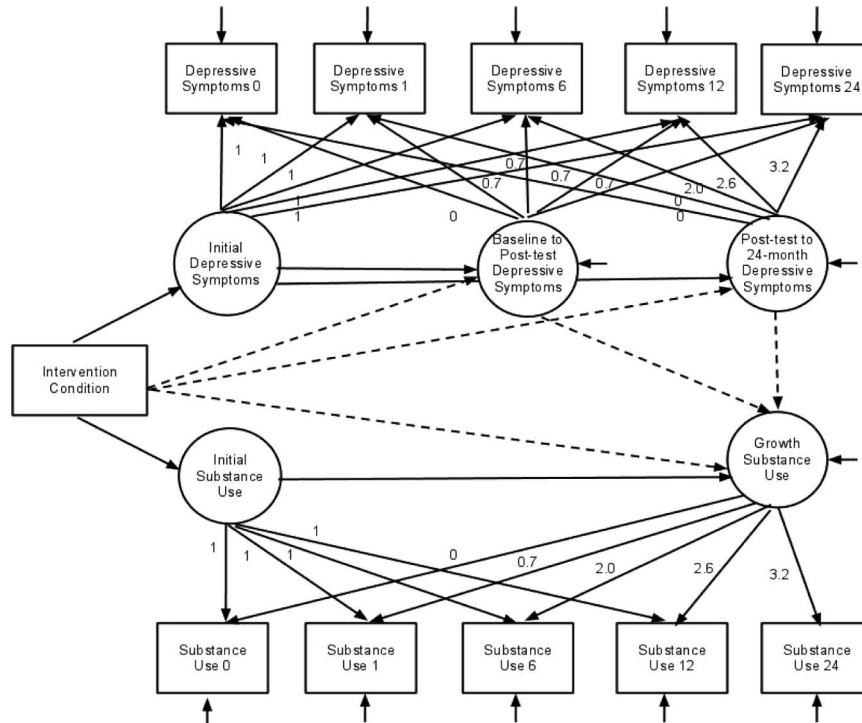
Figure 2. Parallel growth model of depressive symptoms and substance use. Dashed lined indicate mediation paths.

−.35) in a model that did not include the mediator as a predictor of substance use slope. Finally, the indirect path from intervention condition to the baseline to posttest change in depressive symptoms to growth in substance use was nonsignificant (−0.01, 95% CI = −0.30, 0.10, β = −.13). In summary, three of the five criteria for the mediation of CB group versus bibliotherapy by change in depressive symptoms were satisfied in the models.

Discussion

The present study extends the intriguing short-term findings from our previous report (Stice et al., 2008) regarding the apparent secondary benefit of an indicated CB group depression prevention in reducing the normative escalation of substance use over time in adolescents who have subclinical depressive symptoms. The impact of three active depression prevention interventions on future substance use suggested a complex and, we believe, potentially important set of findings that warranted targeted follow-up examination and the evaluation of a key mediational model, namely the affect-regulation hypothesis. Participants in the CB prevention group showed significantly lower rates of substance use relative to brochure controls at both 1- and 2-year follow-up assessments. In addition, Group CB participants showed significantly lower increases in substance use relative to adolescents in a bibliotherapy condition at 2-year follow-up, an effect that was at the level of a trend one year postintervention. Differences between CB group participants and supportive-expressive group participants in substance use escalation at both long-term assessment points were nonsignificant; the possible implications of this nonsignificant

finding are discussed below. The significant effects for substance use were in the moderate range (*d* = .32 to .45; *M d* = .40), representing meaningful intervention benefits that were detectable up to 2 years postintervention. Cuijpers (2002) noted that although well-designed prevention programs directly targeting substance use have reduced substance use during the intervention phase, effects have tended to not persist (e.g., mean overall effect size at 1-year follow-up was *d* = .10). The durability of substance use effects in the present study is noteworthy given that the CB group intervention consisted of six weekly 1-hr group sessions aimed at reducing depression. The present findings are consistent with a meta-analytic study of school-based substance use prevention programs (Gottfredson & Wilson, 2003), which found that effective school-based substance use prevention programs need not be lengthy.

The second aim of this study was to test the hypothesis that reductions in depression mediated the effects of the CB depression prevention program on substance use, relative to bibliotherapy and brochure control participants. Results provided full support for the affect-regulation model when participants in Group CB were compared with brochure controls but not to those receiving bibliotherapy. In the mediation model comparing Group CB to brochure control, CB group participation predicted greater reductions in substance use at 2-year follow-up and significant reductions in depressive symptoms by posttest (although not 2-year follow-up). In addition, overall change in baseline to posttest change in depressive symptoms predicted long-term change in substance use. Controlling for change in depressive symptoms reduced the impact

of the Group CB condition to nonsignificance and the indirect path from intervention condition to change in depressive symptoms to growth in substance use was significant, indicating support for full mediation.

In the mediation model comparing the Group CB and bibliotherapy conditions, only some of the criteria for mediation were supported. CB group participation predicted greater reductions in substance use at 2-year follow-up and significant reductions in depressive symptoms by posttest (but not 2-year follow-up) relative to bibliotherapy participation. In addition, controlling for change in depressive symptoms reduced the impact of Group CB, relative to bibliotherapy, on substance use to nonsignificance. However, baseline to posttest change in depressive symptoms failed to predict long-term change in substance use and the indirect path from intervention condition to depressive change to growth in substance use was not significant. The pattern of mediational findings comparing Group CB to bibliotherapy suggest that aspects of the Group CB intervention other than reductions in depressive levels account for its apparent effect on substance use escalation.

While present results provided support for the mediational thesis, it should be noted that the affect-regulation model conceptually implies that depressed individuals misuse substances to cope with current negative mood states rather than influencing their future substance use. In the present study, we found the reductions in depression occurring during a 6-week CB group intervention did not result in simultaneous reductions in substance use but rather predicted reduced substance use out to two years after the intervention. Our growth curve analyses revealed a clear nonlinear pattern in that depressive symptoms in the CB group condition substantially decreased during the intervention period and then leveled off, in contrast to the pattern of change in substance use, which exhibited a fairly constant rate of increase over follow-up. Although there was little evidence that change in depressive symptoms occurred at the same time as change in substance use, results did provide crucial evidence that change in a mediator should temporally precede change in the outcome (Stice, Presnell, Gau, & Shaw, 2007).

An alternative explanation for the effect of CB group on substance use is its group modality. Although Group CB was more effective than both bibliotherapy and brochure control conditions, it was not more effective than the other group intervention condition: supportive-expressive group. Further, although supportive-expressive group did not result in significantly lower rates of long-term substance use compared with brochure controls, we previously reported (Stice et al., 2008) that it reduced substance use relative to brochure controls at the 6-month follow-up ($p = .035$; $d = .21$) and there was a trend-level effect in the present study at 1-year follow-up ($p = .078$; $d = .28$). Given the weaker but near-significant effects on substance use for expressive-supportive group versus brochure controls, a provisional hypothesis is that group interventions with marginally depressed adolescents are preventive of future substance use experimentation and escalation. Whereas cognitive restructuring, which was present in both CB conditions but particularly strong in CB bibliotherapy, may be a key mechanism for long-term depression prevention (Stice et al., 2010), nonspecific therapeutic factors common to both group interventions aimed at preventing depression (e.g., normalization of depression, provision of hope and therapist support,

modeling and reinforcement of positive coping, interactions with a prosocial peer group) may have the secondary benefit of reducing future substance use.

Although the present findings appear to be long-lasting and clinically meaningful, we are not implying that CB group depression prevention interventions will reduce the rate at which substance use develops in *all* adolescents; adolescents in the present study were selected on the basis of elevated depression symptomatology. Whereas depressive symptoms and disorder are known to increase risk for substance use disorders (e.g., Armstrong & Costello, 2002; Swendsen et al., 2010), they are not the most robust or consistent risk factors. Other, more potent risk factors for adolescent substance use and abuse include externalizing disorders, previous substance use, parent–child conflict and associated family factors, drug-using peers, and a family history of substance use disorder (e.g., Armstrong & Costello, 2002; Brook, Brook, Zhang, & Cohen, 2009; Swendsen et al., 2010). A simulation study using data from the National Comorbidity Survey-Replication suggested that preventing depression or anxiety disorders would not be a particularly cost-effective method of preventing substance use disorders because a large number of internalizing disorders would need to be prevented to reduce the number of subsequent substance use disorders (Glantz et al., 2008). Rather than a primary goal of intervention, Glantz and colleagues suggested that any reductions in future substance use or abuse be conceptualized as important secondary benefits of preventing internalizing disorders. Our assumption is that subthreshold depression represents one risk factor for future substance use that applies to a subset of the adolescent population who will develop substance abuse problems.

Several limitations of this study should be noted. First, substance use was assessed with a brief survey that primarily focused on use in the previous 30 days, and no data were obtained regarding lifetime substance use or the symptoms of substance abuse or dependence. On a related note, we examined an overall substance use composite rather than using separate scales to measure use of alcohol and the various illicit drugs. This was done because the majority of participants who reported any substance use used multiple substances. However, alcohol use was almost synonymous with substance use in the sample (90% of participants who reported any substance use at the last follow-up assessment reported alcohol use, with or without other drugs) and the pattern of findings may be applicable primarily to alcohol use. Future research evaluating the secondary benefits of depression prevention interventions should assess substance use outcomes in much greater detail, including diagnostic interview and, if possible, examine associations with specific psychoactive substance use categories. Second, we examined only one potential mediator, based on the affect-regulation model, and additional mediators should be examined, if this secondary benefit finding is replicated. Third, the attrition rate by 2-year follow-up may have impacted findings, although attrition was not associated with intervention condition or initial levels of substance use.

Evaluating the etiology of any problem behavior is challenging and randomized prevention trials provide a unique opportunity to evaluate whether changes in a putative risk factor translates into change in future pathology (Hinshaw, 2002). Cross-sectional and naturalistic longitudinal designs are unable to rule out the possibility that emerging associations are attributable to unknown third variables. By randomizing participants in this study to the Group

CB prevention intervention or the alternative control conditions, we reduced the likelihood that the effects for substance use prevention are because of unmeasured third variables. Clinically, the present trial suggests that a fairly brief indicated CB group intervention aimed at reducing and preventing depression in adolescents at elevated risk for depression has the added benefit of delaying or preventing the onset and escalation of substance use in a subset of adolescents who are at elevated risk for substance use disorders. The apparent dual effects of Group CB for depression and substance use are encouraging because prevention programs that produce effects for more than one psychiatric problem have greater public health utility and cost effectiveness than those that produce effects for only one condition. Given the high prevalence of substance use and abuse in adolescents in conjunction with evidence that adolescent substance abuse is not easily preventable (e.g., Tobler et al., 2000; White & Pitts, 1998), that less than 25% of youth with substance use disorders receive treatment (Newman et al., 1996), and that substance abuse treatment often fails to result in lasting remission (Brown, D'Amico, McCarthy, & Tapert, 2001), a better understanding of various methods that may reduce substance use and abuse for at-risk adolescents is valuable.

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