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Dynamic Associations between Maternal Depressive Symptoms and Adolescents' Depressive and Externalizing Symptoms

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Abstract

The current prospective study investigated transactional relations between maternal depressive symptoms and children's depressive and externalizing symptoms. Participants included 240 children (M age = 11.86 years, SD = 0.56; 53.9 % female) and their mothers who were part of a 6-year longitudinal study. Measures of maternal depression (Beck Depression Inventory), child depression (Children's Depression Inventory), and children's externalizing symptoms (Youth Self-Report Form) were assessed annually. Data analyses using dynamic latent difference score structural equation models indicated that the observed relations between mothers' and adolescents' symptoms were stable across the 6 years. Higher levels of maternal depressive symptoms predicted subsequent elevations in children's depressive symptoms and in their externalizing problems over time. Among mothers with high initial levels of depression, children's depressive symptoms predicted subsequent declines in mothers' depressive symptoms. Children's externalizing problems were not related to subsequent change in maternal symptoms.

Keywords

adolescents; depressive symptoms; externalizing behavior; latent difference score models; maternal depression

The association between maternal depression and children's emotional and behavioral problems is well-documented (Beardslee, Versage, & Gladstone, 1998; Goodman & Gotlib, 1999). Offspring of depressed mothers are at an increased risk of mood and anxiety disorders (e.g., Hammen, Burge, Burney, & Adrian, 1990; Trapolini, McMahon, & Ungerer, 2007), and externalizing behavior problems (Gross, Shaw, Moilanen, Dishion, & Wilson, 2008). Maternal depression is related to increased risk for psychopathology during adolescence and into adulthood (Bouma, Ormel, Verhulst, & Oldehinkel, 2008; Cortes, Flemming, Catalano, & Brown, 2006; Rohde, Lewinsohn, Klein, & Seeley, 2005). Weismann, Wickramaratne et al. (2006) reported that children with a depressed mother were three times more likely to develop major depression, anxiety disorders, and substance dependence in adulthood compared to offspring of nondepressed mothers.

Whereas maternal depression is associated with risk for emotional and behavioral problems among children, such child adjustment problems also have been implicated as predictors of maternal distress. Sameroff (1975) argued that examining only the influence of parents on children ignores the dynamic, transactional nature of family relationships; that is, children likely influence their environment (e.g., their parents) as much as the environment influences them. Reciprocal interaction patterns have been found between depressed

mothers and their children (Hammen, Burge, & Stansbury, 1990; Radke-Yarrow, Nottelmann, Belmont, & Welsh, 1993). In a community sample of parents and adolescents, Rueter and Conger (1998) showed that a reciprocal model best accounted for the relations between parenting and adolescent interpersonal responses over a two-year period of time.

Having a child with psychopathology may be a stressor that contributes to the onset or exacerbation of mothers' depressive symptoms (Hammen, Burge, & Adrian, 1991). Mothers of children with emotional or behavioral problems are two to three times more likely to be depressed as compared to mothers of well children (Civic & Holt, 2000). Elevated levels of depressive symptoms also have been found among mothers of children receiving treatment for psychiatric problems (Gerkensmeyer, Perkins, Scott, & Wu, 2008; Kahn, Wise, Finkelstein, Bernstein, Lowe, & Homer, 1999). Thus, mothers' and children's psychopathology likely mutually influence each other, such that maternal depressive symptoms predict changes in children's symptoms, and children's symptoms predict changes in maternal depression (e.g., Elgar, McGrath, Waschbusch, Stewart, & Curtis, 2004).

Evidence consistent with possible mutual influences between maternal and child symptoms also comes from studies in which remission of mothers' depression has been linked with improvements in children's functioning (Garber, Ciesla, McCauley, Diamond, & Schloedt, in press; Gunlicks & Weissman, 2008). In a study in which mothers received pharmacotherapy for depression, Weissman, Pilowsky et al. (2006) reported that among children whose mother's depression remitted during the first three months of treatment, children's internalizing and externalizing disorders decreased by 11 % during the same time period, whereas children whose mother's depression did not remit showed an increase in psychopathology. Similarly, Garber and colleagues (in press) reported that children whose parents' depression remitted showed sharper linear declines in their own symptoms compared to children of nonremitted depressed parents. Studies in which mothers received interpersonal psychotherapy for depression have shown improved social functioning and decreased depressive symptoms in their children (Swartz et al., 2008; Verdelli et al., 2004). Finally, Kennard and colleagues (2008) found in a sample of children receiving treatment for depression that mothers' symptoms decreased, even though mothers were not being treated directly.

Only a handful of studies, however, have explicitly tested possible mutual influences of mothers' and children's symptoms on each other (Elgar, Curtis, McGrath, Waschbusch, & Stewart, 2003; Elgar, Waschbusch, McGrath, Stewart, & Curtis, 2004; Ge, Conger, Lorenz, Shanahan, & Elder, 1995; Gross, Shaw, & Moilanen, 2008; Jaffee & Poulton, 2006). In a longitudinal study of mothers and their sons, Gross, Shaw, and Moilanen (2008) found reciprocal relations between maternal depressive symptoms and boy's aggressive and antisocial behavior between ages 5 and 6. Similarly, Jaffee and Poulton (2006) reported reciprocal relations between maternal depressive symptoms and children's internalizing symptoms at ages 5 to 7. In a daily diary study, Elgar, Waschbusch et al. (2004) showed that mothers' depression and anxiety on one day were related to children's inattentiveness, impulsiveness, and over-reactive behavior the following day, which in turn were related to mothers' fatigue the next day. Ge and colleagues (1995) reported mutual influences between fathers' and daughters' psychological distress (composite of hostility, anxiety, and depression) when girls were middle adolescents, and between mothers' and sons' psychological distress when boys were early adolescents.

Mutual influences between maternal and child symptoms, however, have not been found consistently across age and gender (e.g., Jaffee & Poulton, 2006; Pilowsky et al., 2008). Jaffee and Poulton (2006) posited that the effect of maternal depression on children's

symptoms would be strongest during periods of transition (e.g., school changes, adolescence) because these are times when children are particularly reliant on maternal support. In contrast, Jaffee and Poulton posited that the effect of children's symptoms on mothers' depression would be strongest in early childhood, serving as a psychosocial stressor when mothers have had fewer episodes of depression and their symptoms may be less stable. Partially supporting these hypotheses, Jaffee and Poulton showed reciprocity in mothers' and children's symptoms for younger children (i.e., 5–7 years old) but not when they were early adolescents (i.e., 11–13 years old). Jaffee and Poulton further hypothesized that the link between mothers' and children's symptoms would decline across time, but they were not able to address this because they only had data up to age 15. Therefore, they recommended that "Studies that assess mothers' depression and children's problem behaviors throughout middle childhood and the entire period of adolescence are needed to test this hypothesis" (p. 124). One goal of the present study was to test the bidirectional relation between mothers' and children's symptoms across adolescence.

Another factor contributing to inconsistent results across studies examining the reciprocity hypothesis may be the data analytic methods used. Prior investigations of the mutual influences between mothers' and children's psychopathology primarily have used either latent growth curve modeling (LGCM) or auto-regressive cross-lag models (ARCL). LGCM models individual trajectories of change and estimates individual differences in participants' initial levels and rates of change (i.e., slopes) on a particular variable. When two growth curves are modeled (i.e., *parallel process* model) the slopes are calculated separately for mothers' and children's symptoms and then correlated. LGCM can answer questions regarding how mothers' and children's growth curves are correlated; however, the relation between mothers' and children's symptoms is not time dependent (Ferrer & McArdle, 2003). Therefore, LGCM does not account for the dynamic interplay between changes in mothers' and children's symptoms, or for example, how mothers' symptoms can predict subsequent change in children's symptoms. On the other hand, ARCL models can examine interrelations between static levels of variables across time. Although these models can answer questions regarding time-dependent relations, they do not account for growth in these variables or individual differences in growth trajectories (Ferrer & McArdle, 2003).

An alternative analytic approach used in the current study to test the longitudinal associations between mothers' and children's symptoms is dynamic bivariate latent difference score (LDS) modeling, which is based on principles of dynamical systems theory (also referred to as a *dual change score model*; Ferrer & McArdle, 2003; McArdle & Hamagami, 2001). LDS models incorporate features of both LGC and ARCL models in the same model. The essential difference between LDS analyses and these other data analytic methods is in the underlying model of change that is assumed (Ferrer & McArdle, 2003; Sbarra & Allen, 2009). Compared to other methods for examining change (e.g., LGC, ARCL), LDS analyses address specific questions about how two processes change together and how each variable simultaneously predicts subsequent change in the other variable over time, also referred to as *longitudinal coupling*, while also allowing for individual difference in change. Thus, LDS models presumably will more accurately capture theoretical notions of transactional relations between mothers' and children's psychopathology than has been done in the change models used in previous studies.

Therefore, the primary aim of the current study was to examine the dynamic, transactional relations (i.e., longitudinal coupling) between maternal depressive symptoms and adolescents' depressive and externalizing symptoms, using a dynamic factor modeling approach. We hypothesized that (a) high levels of maternal depressive symptoms would predict subsequent elevations in adolescents' depressive symptoms and externalizing problems, and (b) high levels of adolescents' depressive and externalizing symptoms would

predict subsequent elevations in maternal depressive symptoms. Additionally, we examined whether the transactional relations between mothers' and children's symptoms were constant or changed across the adolescent years, as suggested by Jaffee and Poulton (2006).

This study builds on previous research in several important ways. First, although theoretical perspectives highlight the importance of examining mutual influences between mothers' and children's symptoms, the few studies that have tested such relations have found discrepant results. The current study directly tested whether dynamic relations between mothers' and adolescents' symptoms are constant or varied across a 6-year period of adolescence (see Pettit & Arsiwalla, 2008). Second, the data analytic techniques used thus far may not have been appropriate for testing reciprocal relations. Therefore, based on these previous studies, it is not really possible to draw conclusions about whether and how mothers' and children's symptoms predict each others' symptom trajectories. Third, we used different informants about mothers' and children's symptoms, thereby eliminating method variance that may have contributed to the significant relations found in some prior studies (e.g., Jaffee & Poulton, 2006). Finally, dynamic associations between mothers' and children's symptoms were examined in offspring of depressed (high risk) and nondepressed (low risk) mothers. Use of such a sample of children who varied in risk, as compared to a normative community sample, would increase the variability on the measures of psychopathology in both mothers and children as well as increase the likelihood of observing change on these measures over time.

Method

Participants

Participants were 240 mothers and children who were part of a longitudinal study of children at risk for psychopathology. Children (54 % female) were first assessed in sixth grade ($M_{age} = 11.86$ years, $SD = 0.56$) and then annually through grade 12. The mean age of mothers at the first assessment was 38.01 years ($SD = 4.85$). The child sample was 81.5 % Caucasian, 14.8 % African American, and the remaining 3.7 % were Hispanic, Native American, or reported "Other." Families were predominantly working class (e.g., nurse's aide, salesclerk) to middle class (e.g., store manager, teacher) with a mean socioeconomic status (Hollingshead, 1975) of 41.67 ($SD = 13.29$).

Procedure

Parents of fifth grade children from metropolitan public schools were invited to participate in a study about parents and children. A brief health history questionnaire comprised of 24 medical conditions (e.g., diabetes, heart disease, depression) and 34 medications (e.g., fluoxetine, amitriptyline) and a letter describing the project were sent to over 3,500 families. Of the 1,495 interested mothers, the 587 who had endorsed either a history of depression, use of antidepressants, or no history of psychopathology were interviewed further by telephone. Of these 587 screened, 349 mothers reported either a history of depression or no history of psychiatric problems. The remaining 238 families were excluded because the mothers did not indicate sufficient symptoms to meet criteria for a depressive disorder (38 %), had other psychiatric disorders that did not also include a depressive disorder (19 %), were no longer interested (21 %), they or the target child had a serious medical condition (14 %), the target child was in the wrong grade (6 %), or the family had moved out of the area (2 %). The Structured Clinical Interview for *Diagnostic and Statistical Manual of Mental Disorders* diagnoses (Spitzer, Williams, Gibbon, & First, 1990) was then conducted in person with the 349 mothers who had a history of some depression or had had no psychiatric problems. Inter-rater reliability was calculated on a random subset of 25 % of these interviews. There was 94 % agreement ($kappa = .88$) for diagnoses of depressive disorders.

The final sample of 240 families consisted of 185 mothers who had a history of a mood disorder (high-risk group) and 55 mothers who were lifetime free of psychopathology (low-risk group). There was 19 % attrition from the Time 1 to the Time 7 assessment. The analytic approach used in the current study accounted for missing data, such that all available data were used and participants with incomplete data were included in analyses.

Children were first assessed in sixth grade (Time 1) and then yearly through 12th grade (Times 2 through 7). Research assistants, unaware of the mother's psychiatric history, interviewed and administered a battery of questionnaires separately to the mother and adolescent. The study procedures met the approval of the institutional review board for the protection of human subjects. Mothers provided informed consent, and children completed an assent form. Only those measures relevant to the current study are described below.

Measures

Maternal Depressive Symptoms were assessed annually with the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erlbaugh, 1961), which measures affective, cognitive, behavioral, and somatic symptoms. For each of the 21 items, mothers chose one of four statements that best described how they had been feeling during the past two weeks. Items were scored 0–3 and were summed to create a total score (range 0 to 63). The BDI has good validity in both psychiatric (Beck et al., 1961) and community samples (Bumberry, Oliver, & McClure, 1978). Coefficient alphas in this sample ranged from .89 to .92 across all assessments.

Children's Depressive Symptoms were assessed annually with the Children's Depression Inventory (CDI; Kovacs, 1981), which is a 27-item self-report measure of cognitive, affective, and behavioral symptoms of depression. Children chose one of three sentences that best described them during the past two weeks. Items were scored 0 to 2 and were summed to create a total score (range 0 to 54). The CDI has good internal consistency, test-retest reliability, and convergent validity with other self-report measures (Sitarenios & Kovacs, 1999). In the current sample, coefficient alphas ranged from .80 to .90.

Child Externalizing Symptoms were assessed with the Child Behavior Checklist-Youth Self Report (CBCL-YSR; Achenbach, 1991). Children indicated how true a statement was about them using a 3-point scale (0 = *not true*, 1 = *somewhat or sometimes true*, 2 = *very true or often true*). The Externalizing subscale includes symptoms of aggression and delinquency; higher scores reflect higher levels of externalizing problems. Coefficient alphas in this sample ranged from .86 to .89.

Results

Descriptive Statistics

Q-Q plots of the study variables indicated that maternal and child depressive symptoms and child externalizing problems were positively skewed; therefore, a square root transformation was applied to all variables (Tabachnick & Fidell, 2001). Q-Q plots of the transformed variables were analyzed to check that this transformation was successful. Means and standard deviations of the original variables and intercorrelations among the transformed variables are presented in Table 1. Maternal depressive symptoms were significantly correlated with child externalizing problems in grades 6, 8, 9, 10, and 12, and significantly correlated with children's depressive symptoms at every time point except grade 11 (Time 6). There was a negative correlation between sex and children's externalizing problems in grade 6, such that boys had higher levels of externalizing symptoms ($r = -.25, p < .05$). All analyses controlled for child sex and risk (i.e., mothers' depression history).

Data Analyses

The longitudinal, dynamic relations between maternal depressive symptoms and adolescents' depressive and externalizing symptoms were examined by fitting dynamic, bivariate latent difference score (LDS) structural equation models (McArdle & Hamagami, 2001, see also Hawley, Ringo Ho, Zuroff, & Blatt, 2006; Sbarra & Allen, 2009). Based on classical change score models, LDS analyses begin by partitioning observed scores into true scores (i.e., latent scores) and error variances. The latent scores at each time point are then used to predict the latent score at the next time point, and the disturbance terms represent the difference scores (i.e., latent difference scores, or latent change).

Before testing associations between maternal depressive symptoms and children's depressive or externalizing symptoms, we first tested four different univariate LDS models, as outlined by McArdle and Hamagami (2001; see also Hawley et al., 2006). Tests of univariate models are equivalent to first testing unconditional growth models in a latent growth curve modeling framework. These univariate models included a (1) no change model, in which scores did not change over time, (2) a proportional change model, in which change over time was predicted by one's previous score, (3) a constant change model, in which latent growth parameters were used to represent change, including an intercept and linear slope, and (4) a dual change model, in which latent change was predicted by both a proportional coefficient (e.g., one's previous score) and a constant, linear slope (e.g., systematic, linear changes over time, after accounting for proportional change). We tested two types of dual change models: (a) a model in which the proportional coefficient was time-invariant and (b) a model that allowed for time-variant proportional coefficients, such that the direction and magnitude with which one's previous score predicted subsequent change could vary across time.

Next, we examined two bivariate LDS models to test the dynamic association between (1) mothers' and children's depressive symptoms, and (2) mothers' depressive symptoms and children's externalizing problems. In a dynamic bivariate LDS model, latent change in children's symptoms (depressive or externalizing) can be predicted from: (1) a constant slope (i.e., linear change that occurs as a function of time); (2) their level of symptoms at the previous time point (i.e., proportional coefficient); and (3) some proportion of their mothers' depressive symptoms at the previous time point (i.e., longitudinal coupling). At the same time, latent change in maternal depressive symptoms can be predicted from: (1) a constant slope, (2) their level of symptoms at the previous time point (i.e., proportional coefficient); and (3) some proportion of their child's symptoms at the previous time point (i.e., longitudinal coupling). Depending on the results of the univariate LDS models, it may not be necessary to include the constant slope and/or proportional coefficients in the model. Thus, LDS models conceptualize change as systematic growth over time that may be accelerated or slowed down depending on one's previous state (i.e., their previous level of symptoms), and/or the previous state of another variable.

An example that includes all possible parameters, with time-varying proportional coefficients, is depicted in Figure 1. The parameters γ_{MC} and γ_{CM} represent longitudinal coupling and are the parameters of interest in the current study. If only one γ parameter is significant, this would represent unidirectional longitudinal coupling. For example, if only γ_{MC} is significant, this would indicate that maternal depressive symptoms predict subsequent change in children's depressive symptoms (or externalizing problems) over time. On the other hand, if only γ_{CM} is significant, this would indicate that children's depressive symptoms (or externalizing problems) predict subsequent change in maternal depressive symptoms over time. If both γ parameters are significant, this would suggest bidirectional longitudinal coupling, whereas if neither γ parameter is significant, this would indicate that

support for dynamic, transactional relations between maternal and children's symptoms was not found.

In summary, analyses proceeded in two steps. First, univariate LDS models were fit to examine change in each variable of interest (i.e., mothers' depressive symptoms, children's depressive symptoms, and children's externalizing problems). Second, the main analyses consisted of fitting bivariate LDS models to examine dynamic, longitudinal coupling between (1) maternal depression and children's depressive symptoms and (2) maternal depression and children's externalizing problems.

Models were fit using AMOS 16.0 (Arbuckle, 2007) statistical software with full-information maximum likelihood estimation to handle missing data. The fit of a particular model was evaluated using several fit indices, including the relative χ^2 index (χ^2/df), where scores below 2 suggest a good fit between the model and sample data (Bollen, 1989), the comparative fit index (CFI; Bentler, 1990), in which scores above .95 indicate good model fit, and the root mean square error of approximation (RMSEA; Browne & Cudeck, 1993) in which values less than .05 suggest good model fit. Recent studies from other fields provide evidence that the sample size and occasions of measurement in the present study were sufficient for examining dynamic associations (e.g., Ferrer & McArdle, 2004; Hawley et al., 2006).

Preliminary Analyses: Univariate Latent Difference Score Models

Results from the univariate LDS models are presented in Table 2. The best fitting model representing change in maternal depressive symptoms (BDI) was a constant change model. Both dual change models did not significantly fit the data better compared to the constant change model (time-invariant model: $\Delta\chi^2(1) = 0.12$; time-variant model: $\Delta\chi^2(6) = 10.92$); therefore, the constant change model was the most parsimonious and provided a good fit to the sample data. The dual change model with a time-variant proportional coefficient provided the best fit to the adolescents' data for both depressive symptoms and externalizing problems. Therefore, a constant change model was used to represent mothers' depressive symptoms (i.e., $\beta_{M1} - \beta_{M7}$ in Figure 1 were not estimated), and a dual-change model with time-varying proportional coefficients (as presented in Figure 1) was used to model children's depressive symptoms and externalizing problems in the bivariate latent difference score models that follow.

Longitudinal Coupling between Mothers' and Adolescents' Depressive Symptoms

The bivariate LDS model examining the dynamic relation between change in mothers' and children's depressive symptoms provided a good fit to the sample data, $\chi^2(121) = 159.25$, $p < .01$, $\chi^2/df = 1.32$, CFI = .97, RMSEA = .04 (90 % CI = .02–.05). Parameter estimates from this model are presented in the left side of Table 3. As predicted, maternal depressive symptoms were significantly associated with subsequent change in children's depressive symptoms over time, $\gamma_{MC} = .07$, $p < .05$. Considering all parameter estimates (i.e., slope, proportional, and coupling coefficients), children whose mothers had higher levels of depression showed less decline in their depressive symptoms over time (Grade 6 to 8, and Grade 10 to 11), as well as greater elevations in their depressive symptoms (Grade 8 to 10, and Grade 11 to 12) as compared to children whose mothers had lower levels of depressive symptoms (see Figure 2, Panel A).

Children's depressive symptoms also predicted subsequent change in mothers' depressive symptoms. Lower levels of children's symptoms significantly predicted subsequent increases in mothers' symptoms over time, $\gamma_{CM} = -.19$, $p < .05$, whereas higher adolescent depressive symptoms was related to a minimal decrease in subsequent maternal depression

(2.56 points on the BDI over a 6-year period; see Figure 2, Panel B). That is, among mothers with high levels of depressive symptoms at the first evaluation, maternal symptoms increased at a faster rate when their children had lower levels of depressive symptoms. This was not evident, however, for mothers who had low levels of depressive symptoms at study onset.

To examine whether the transactional relation between mothers' and children's depressive symptoms differed across time, we compared the bivariate LDS model to one in which the coupling parameters were permitted to vary across time. Allowing γ_{MC} [$\Delta\chi^2(5) = 4.36$], or γ_{CM} [$\Delta\chi^2(5) = 7.85$], to vary over time did not provide a significantly better fit to the data.

Longitudinal Coupling between Maternal Depressive Symptoms and Adolescents' Externalizing Problems

The bivariate LDS model examining the dynamic relation between change in mothers' depressive symptoms and adolescents' externalizing problems provided a good fit to the data, $\chi^2(121) = 189.32$, $p < .001$, $\chi^2/df = 1.57$, CFI = .95, RMSEA = .05 (90 % CI = .04–.06). Parameter estimates from this model are presented in the right two columns of Table 3. Controlling for child sex and risk, we found unidirectional longitudinal coupling between maternal depression and change in children's externalizing problems over time, $\gamma_{MC} = .60$, $p < .05$. Additionally, children's previous level of externalizing problems predicted subsequent declines in their symptoms (grades 6, 8, 11, and 12). Thus, children whose mothers had higher levels of depressive symptoms showed significantly greater elevations in externalizing symptoms over time. Allowing γ_{MC} , [$\Delta\chi^2(5) = 6.25$], or γ_{CM} , [$\Delta\chi^2(5) = 8.43$], to vary across time did not provide a significantly better fit to the sample data, suggesting that the transactional relation between maternal depressive symptoms and children's externalizing problems did not change.

Discussion

The current study examined relations between maternal depressive symptoms and adolescents' depressive symptoms and externalizing problems using a dynamic factor modeling approach. Although mutual influences between parent and child psychopathology have been posited (e.g. Elgar, McGrath et al., 2004; Gunlicks & Weissman, 2008), only a few empirical studies have directly tested these reciprocal relations. The current study found positive coupling between mothers' and children's depressive symptoms, such that maternal symptoms predicted fewer declines in or subsequent elevations in adolescents' symptoms over time.

Although some prior studies have found a significant relation between improvements in children's and mothers' depressive symptoms in a clinical sample (e.g., Kennard et al., 2008), other studies have not found significant relations (e.g., Pilowsky et al., 2008), or have found associations only in young children or in boys (Ge et al., 1995; Jaffee & Poulton, 2006). Whereas these previous studies examined interrelations among static levels of mothers' and children's symptoms, the present study used a data analytic method that allowed us to examine how mothers' and adolescents' symptoms simultaneously predicted each others' *change trajectories* over time. Given the paucity of studies that have examined the dynamic and reciprocal relations of *changes* in children's and mothers' depressive symptoms, further investigation of such transactional relations needs to be conducted over a wider age range, particularly across the important transitional period from pre to post adolescence.

The present study also found unidirectional longitudinal coupling between maternal depressive symptoms and children's externalizing problems. Higher levels of maternal

depression symptoms predicted subsequent elevations in children's externalizing symptoms. Children's levels of externalizing symptoms, however, were not related to subsequent change in maternal depressive symptoms. Although previous studies have found that children's externalizing problems predicted mothers' depressive symptoms, these studies primarily relied on mothers' reports of their own and their children's symptoms (e.g., Cortes et al., 2006; Gross Shaw, & Moilanen, 2008; Jaffee & Poulton, 2006), were conducted with boys only, or were found only in young children (e.g., Gross, Shaw, & Moilanen, 2008). In contrast, the present study used different reporters of mothers' depressive symptoms and children's externalizing problems, thereby avoiding potential mono-method bias, and used a sample of youth at varied risk for psychopathology based on maternal history of depression. Moreover, the data analytic technique used provided a more stringent and robust test of dynamic transactional relations.

One interesting although surprising finding was that levels of adolescents' depressive symptoms were negatively linked with subsequent change in mothers' symptoms. This association was found for mothers who had high levels of depressive symptoms (1 *SD* above the mean) at the beginning of the study, whereas symptom trajectories among mothers with low initial levels of depressive symptoms were essentially unrelated to their children's symptoms. For mothers with high depression levels at the first evaluation, lower levels of adolescents' depressive symptoms predicted subsequent elevations in their mothers' depressive symptoms over time, whereas high levels of adolescents' symptoms predicted a minimal decrease in mothers' symptoms (see Figure 2B). Individuals with high initial levels of depression might be expected to show an increasing trajectory of their depressive symptoms over time. In the context of their child's dysphoria, however, these mothers may set aside their own distress in an effort to care for their children (although see Gerkenmeyer et al., 2008). It also is possible that attending to their children's symptoms might serve as a distraction from their own, or that addressing the sources of their child's problems may have a side benefit of slowing the trajectory of their own distress. Given the unexpected nature of this finding, these results and our interpretation should be taken with caution; replication clearly is needed.

The current study also examined whether the relation between mothers' and adolescents' symptoms varied across time. Jaffee and Poulton (2006) posited that the effect of mothers' depressive symptoms on children's trajectories of problem behaviors would differ with age, and might be stronger during periods of transitions (e.g., entering school, moving into adolescence) because of the increased need for social support at these times. In the present study, however, models in which the presence and strength of this association remained constant across time provided a significantly better fit to the data than models in which these relations were allowed to vary, indicating the stability of these relations across adolescence. Although interpreting null findings (i.e., the absence of change in this relation) must be done with caution, we speculate that these predominantly high-risk youth might have learned not to turn to their depressed mothers for support during times of increased stress (e.g., social, psychological, and biological transitions occurring during adolescence) (Elgar, McGrath, et al. 2004).

Additionally, although in the current study the association between mothers' and adolescents' symptoms was basically constant from grade 6 to 12, the possibility remains that the strength of this relation may differ in early childhood or during other transitional periods. That is, the magnitude of the relation between mothers' and children's symptoms may change as a function of the child's developmental period (Pettit & Arsiwalla, 2008). Overall, however, when accounting for all change parameters (i.e., the effect of mother's symptoms as well as children's previous symptoms), youths' depressive and externalizing

symptoms followed a nonlinear trajectory, highlighting the complex changes in children's symptoms over time.

A strength of the current study was the use of dynamic factor modeling to examine transactional relations between mothers' and children's symptoms in contrast to autoregressive cross-lag models or parallel growth models used in other studies. Dynamic LDS models incorporate features of both latent growth curve and cross-lag models, thereby more accurately modeling the transactional relation between maternal and child symptoms. Moreover, these models also consider how mothers' and children's symptoms simultaneously predict subsequent change in each others' symptoms over time.

Limitations of the current study provide directions for future research. First, although a strength of this study was that information about mothers' and children's symptoms was provided by different sources, only self-report questionnaires were used. Given the data analytic approach applied in this study, dimensional measures rather than categorical diagnoses made sense. Nevertheless, questions regarding the dynamic relation between diagnoses of depression in mothers and children also should be examined using alternative techniques appropriate for such categorical data. Second, the depression inventories (BDI, CDI) asked participants about their symptoms regarding only a two week period, although the same two-week period was used for both mothers and children. The fact that significant associations were found for this brief "snap shot" of time suggests the potential robustness of these relations. Third, as with any longitudinal study, the timing and length of the assessment intervals may impact the observed associations. More micro models of the transactional relations between mothers' and children's symptoms based on more frequent evaluations that capture fluctuations in symptoms will complement work that has primarily assessed symptoms annually (Pettit & Arsiwalla, 2008). Last, the current study examined dynamic relations between levels (i.e., severity) of mothers' and children's symptoms. Other characteristics of mothers' and children's psychopathology, such as duration and timing, also should be explored (e.g., Hammen & Brennan, 2003).

Evidence was found for transactional relations between mothers' and adolescents' symptoms, but the mechanisms underlying these relations still need to be identified. For example, maternal depressive symptoms may interfere with children's ability to develop adaptive regulatory strategies for dealing with stress (e.g., Feng, Shaw, Kovacs, Lane, O'Rourke et al., 2008; Silk, Shaw, Skuban, Oland, & Kovacs, 2006), which then may contribute to the development of children's emotional and behavioral problems. Moreover, mothers and children with higher levels of symptoms may engage in dysfunctional interaction patterns and higher levels of conflict (e.g., Jacob & Johnson, 1997) or have poorer relationship quality (e.g., Fanti, Henrich, Brookmeyer, & Kuperminc, 2008), which may mediate relations between mothers' and children's symptoms. Finally, possible third variables (e.g., genes, family functioning, stress) also might contribute to changes in both mothers' and children's symptoms. Understanding the pathways through which maternal and child symptoms are related over time, as well as the individual and environmental characteristics that strengthen or weaken the dynamic relations between their symptoms, remains an important direction for future research.

A clinical implication of the current findings is that family members' psychopathology may contribute to the maintenance and course of each other's symptoms over time. Therefore, a comprehensive assessment of other family members' functioning may be important for clinicians working with either depressed adults or children with emotional or behavioral problems. For example, the effectiveness of treatment with depressed or externalizing children may be improved by assessing and treating mothers' depressive symptoms. Similarly, treatment of depressed mothers also might include assessment and intervention

with their children. Finally, although this study examined dynamic relations between mothers' and children's symptoms, future research should consider associations among other family members' mental health, particularly fathers and siblings, as well as the relations among other family dyads and triads.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Dynamic bivariate latent difference score (LDS) model of mothers' and children's depressive symptoms. Note: CDI = Child Depression Inventory, BDI = Mothers' Beck Depression Inventory. Unlabeled one-arrow paths were set equal to 1. Error variances of observed variables were set equal across time for maternal and child depressive symptoms, respectively, and the error variances of mother and child depressive symptoms within each time point were correlated (not shown in model).

* indicates the latent variable score; Δ indicates the latent difference score (i.e., latent change), β_C and β_M represent time-varying proportional coefficients for children and mothers, respectively; γ_{MC} represents unidirectional longitudinal coupling from mothers to children, such that mothers' depressive symptoms predict subsequent change in children's symptoms over time; γ_{CM} represents unidirectional longitudinal coupling from children to mothers, such that children's depressive symptoms predict subsequent change in mothers' symptoms over time.

Figure 2.

Panel A Expected change in children's depressive symptoms over time. Note: Scores transformed back to original scale. Mean Time 1 child depressive symptoms scores used. BDI = Mothers' Beck Depression Inventory. Low BDI = Time 1 BDI score was less than 1 *SD* below mean. High BDI = Time 1 BDI score more than 1 *SD* above mean.

Panel B. Expected change in mothers' depressive symptoms over time. Note: Scores were transformed back to original scale. BDI = Mothers' Beck Depression Inventory; CDI = Child Depression Inventory. Low CDI and Low BDI = Time 1 score was less than 1 *SD* below mean. High CDI and High BDI = Time 1 score was 1 *SD* above mean. Average BDI trajectory is plotted based on mean Time 1 BDI and CDI scores.

Table 1

Means, Standard Deviations, and Inter-Correlations among Study Variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
1. Risk Status	--																						
2. Child Sex	.06	--																					
3. Grade 6 M-BDI	.39**	-.04	--																				
4. Grade 6 CDI	.19**	-.07	.23**	--																			
5. Grade 6 YSR-EXT	.13*	-.24**	.24**	.54**	--																		
6. Grade 7 M-BDI	.35**	-.12†	.67**	.24**	.20**	--																	
7. Grade 7 CDI	.21**	-.03	.17*	.50**	.51**	.26**	--																
8. Grade 7 YSR-EXT	.11†	-.12†	.06	.40**	.61**	.13†	.53**	--															
9. Grade 8 M-BDI	.32**	-.01	.62**	.12	.11	.52**	.27**	.08	--														
10. Grade 8 CDI	.20**	-.05	.18*	.41**	.34**	.26**	.60**	.41**	.21**	--													
11. Grade 8 YSR-EXT	.23**	-.07	.14†	.33**	.57**	.17*	.49**	.64**	.17*	.48**	--												
12. Grade 9 M-BDI	.39**	-.04	.53**	.18*	.08	.58**	.25**	.15*	.54**	.28**	.22**	--											
13. Grade 9 CDI	.14*	.06	.06	.29**	.17**	.09	.44**	.29**	.06	.48**	.41**	.28**	--										
14. Grade 9 YSR-EXT	.20**	-.05	-.01	.26**	.38**	.10	.33**	.51**	.00	.35**	.61**	.28**	.44**	--									
15. Grade 10 M-BDI	.31**	-.12	.55**	.18*	.07	.49**	.18*	.01	.61**	.17†	.21*	.52**	.04	.0.	--								
16. Grade 10 CDI	.19*	.05	.11	.29**	.22**	.18*	.33**	.14	.11	.36**	.28**	.27**	.50**	.20**	.23**	--							
17. Grade 10 YSR-EXT	.24**	-.05	.14†	.34**	.47**	.16†	.24**	.38**	.14	.25**	.50**	.27**	.25**	.60**	.20*	.49**	--						
18. Grade 11 M-BDI	.34**	-.13†	.48**	.11	.08	.44**	.23**	.14†	.57**	.20**	.17*	.58**	.14†	.07	.63**	.10	.22**	--					
19. Grade 11 CDI	.23**	.08	.13†	.28**	.10	.24**	.42**	.23**	.14†	.46**	.25**	.31**	.57**	.32**	-.05	.52**	.38**	.08	--				
20. Grade 11 YSR-EXT	.22**	-.02	.03	.25**	.37**	.12	.30**	.39**	.08	.19*	.51**	.21**	.31**	.58**	-.03	.29**	.69**	.09	.47**	--			
21. Grade 12 M-BDI	.35**	-.08	.51**	.25**	.15*	.56**	.23**	.20*	.54**	.17*	.15†	.66**	.15†	.20*	.55*	.12	.20*	.66**	.14†	.12	--		
22. Grade 12 CDI	.15*	.12	.13†	.26**	.19*	.18*	.49**	.27**	.22**	.49**	.42**	.38**	.54**	.24**	.22**	.50**	.34**	.18*	.56**	.38**	.14†	--	
23. Grade 12 YSR-EXT	.22**	-.03	.06	.29**	.38**	.24**	.39**	.40**	.13†	.32**	.51**	.29**	.30**	.50**	.04	.36**	.63**	.10	.46**	.70**	.20**	.58**	--
Mean	--	--	6.94	6.11	9.40	7.20	4.76	9.14	5.85	4.68	9.14	6.41	4.88	9.04	7.12	5.74	10.41	7.19	5.17	9.45	7.05	5.72	9.12
SD	--	--	7.79	4.99	6.85	8.04	4.45	6.68	6.57	5.06	6.68	7.09	5.22	6.50	8.57	5.50	6.93	7.92	5.40	7.17	8.15	6.39	6.56

* $p < .05$,
** $p < .01$;

Note: N = 240 at Grade 6. *M* and *SD* of original variables and correlations among transformed variables presented. M-BDI = Mothers' Beck Depression Inventory, CDI = Child Depression Inventory, YSR-EXT = Youth Self-Report Externalizing Subscale.

Table 2

Results from Univariate Latent Difference Score Models

Parameters	No Change			Proportional Change ^a			Constant Change			Dual Change ^a			Dual Change ^b		
	BDI	CDI	EXT	BDI	CDI	EXT	BDI	CDI	EXT	BDI	CDI	EXT	BDI	CDI	EXT
Linear Slope															
Mean	(--)	(--)	(--)	(--)	(--)	(--)	.04	-.09*	.71	.14	.27	.67	.14	.17	.19
Variance	(--)	(--)	(--)	(--)	(--)	(--)	.01	.02**	.82	.02	.04*	1.38*	.02	.03 [†]	1.12*
Proportional Coefficient(s)															
β_1	(--)	(--)	(--)	.01	.00	.01*	(--)	(--)	(--)	-.05	-.18*	-.16 [†]	-.04	-.21*	-.15 [†]
β_2	(--)	(--)	(--)	.01	.00	.01*	(--)	(--)	(--)	-.05	-.18*	-.16 [†]	-.13	-.14	-.07
β_3	(--)	(--)	(--)	.01	.00	.01*	(--)	(--)	(--)	-.05	-.18*	-.16 [†]	.002	-.11	-.14
β_4	(--)	(--)	(--)	.01	.00	.01*	(--)	(--)	(--)	-.05	-.18*	-.16 [†]	-.01	-.06	.07
β_5	(--)	(--)	(--)	.01	.00	.01*	(--)	(--)	(--)	-.05	-.18*	-.16 [†]	-.06	-.16 [†]	-.18*
β_6	(--)	(--)	(--)	.01	.00	.01*	(--)	(--)	(--)	-.05	-.18*	-.16 [†]	-.07	-.11	-.18*
Fit Indices															
χ^2	64.52	133.61	153.19	63.23	133.60	149.52	41.34	72.35	81.11	41.22	69.71	77.70	30.42	42.13	56.03
df	45	45	45	44	44	44	40	40	40	39	39	39	34	34	34
χ^2/df	1.43	2.97	3.40	1.44	3.04	3.40	1.03	1.81	2.03	1.06	1.79	1.99	.90	1.24	1.65
CFI	.97	.82	.83	.97	.82	.84	1.00	.93	.94	1.00	.94	.94	1.00	.98	.97
RMSEA	.04	.09	.10	.04	.09	.10	.01	.06	.07	.02	.06	.06	.00	.03	.05
AIC	82.52	151.61	171.19	83.23	153.06	169.52	69.34	100.35	109.11	71.22	99.71	107.70	70.42	82.13	96.03

[†] $p < .10$,* $p < .05$,** $p < .01$;

Note: Best fitting model for each variable indicated in bold. Unstandardized parameter estimates reported. Variables were square root transformed. (--) indicates that the parameter was not estimated.

^a model constrained $\beta_1 - \beta_7$ to be equal across time;^b model allowed $\beta_1 - \beta_7$ to vary across time.

BDI = Mothers' Beck Depression Inventory, CDI = Child Depression Inventory, EXT = Youth Self-Report- Externalizing Subscale. Analyses controlled for children's sex and risk.

Table 3

Results from Bivariate LDS Models of Maternal Depressive Symptoms and Adolescents' Depressive Symptoms and Externalizing Problems

Parameter Estimates	Maternal Depression ↔ Adolescent Depressive Symptoms		Maternal Depression ↔ Adolescent Externalizing Problems	
	BDI	CDI	BDI	YSR-EXT
Linear Slope				
Mean	.49 (.22) [*]	.25 (.19)	.02(.09)	-.07 (.68)
Variance	.03 (.02) [†]	.04 (.02) [*]	.01 (.004) [*]	1.62 (.57) ^{**}
Proportional Coefficient				
β ₁	(-)	-.27 (.08) ^{**}	(-)	-.19 (.17) ^{**}
β ₂	(-)	-.21 (.09) [*]	(-)	-.11 (.08)
β ₃	(-)	-.18 (.10) [†]	(-)	-.19 (.08) [*]
β ₄	(-)	-.12 (.10)	(-)	.03 (.09)
β ₅	(-)	-.22 (.09) [*]	(-)	-.22(.07) ^{**}
β ₆	(-)	-.17 (.09) [†]	(-)	-.22 (.07) ^{**}
Coupling Parameters				
γ _{MC}		.07 (.03) [*]		.60 (.22) ^{**}
γ _{CM}	-.19 (.10) [*]		.00 (.01)	

Unstandardized parameter estimates reported. Variables were square root transformed. (-) indicates that the parameter was not estimated. BDI = Mothers' Beck Depression Inventory, CDI = Child Depression Inventory, YSR-EXT = Youth Self-Report-Externalizing Subscale. Analyses controlled for children's sex and risk.

[†] $p < .10$,

^{*} $p < .05$,

^{**} $p < .01$