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Bivariate latent change score analysis of peer relations from early childhood to adolescence: Leading or lagging indicators of psychopathology

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Bivariate Latent Change Score Analysis of Peer Relations from Early Childhood to Adolescence:
Leading or Lagging Indicators of Psychopathology

by

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Table of Contents

Figures

Tables

Acknowledgments

1. Abstract

Despite significant public health concerns, the association between problematic peer relations (e.g., bullying) and psychopathology remains unclear. Thus far research has suggested three possible models of this association: that peer relations lead, or are a risk factor for symptoms of psychopathology (interpersonal risk model); lag, or are a consequence of psychopathology (interpersonal scar model); or both lead and lag psychopathology (transactional model). We additionally propose and test the hypothesis that peer relations may be a leading or lagging indicator of psychopathology depending on the developmental period (developmental model). Measures of youth's peer relations (as reported by a parent and teacher on the MacArthur Health and Behavior Questionnaire (HBQ)) and clinical symptoms (as indicated by a clinician on a semi-structured clinical interview (PAPA/CAPA)) were assessed at up to 6 time points between the ages of 3 and 11. We used bivariate latent change score models to identify leading/lagging longitudinal relationships between different aspects of children's peer relations (peer victimization, peer-directed aggression, social withdrawal, and prosocial behavior) and dimensions of psychopathology (depression, anxiety, and externalizing symptoms). Results indicated that peer victimization was a significant leading indicator of depression from early childhood into early adolescence, and aggression of externalizing symptoms (specifically in late childhood/early adolescence). Findings emphasize bullying (both as a victim or perpetrator) as a substantial risk factor for depression and externalizing disorders, even beyond established risk factors such as adverse life events, socioeconomic status, and psychiatric family history.

2. Introduction

Bullying is an increasingly recognized childhood public health problem, with some evidence of increasing prevalence. A recent report from the Centers for Disease Control and Prevention estimates that 20% of high school students in the United States have been bullied, and a meta-analysis of 80 studies suggests that among adolescents, world-wide prevalence estimates of victimization (i.e. being bullied) is 36%, along with a prevalence of 34.5% for perpetration (i.e. bullying others) (Modecki, Minchin, Harbaugh, Guerra, & Runions, 2014). Bullying has been associated with a number of negative outcomes including higher risk for depression, anxiety, and externalizing disorders, as well as criminality and suicidality in adulthood (Klomek, Sourander, & Elonheimo, 2015; Takizawa, Maughan, & Arseneault, 2014). Beyond bullying, other aspects of peer relationships are associated with both harmful and protective influences on psychopathology, such as social withdrawal from peer interactions (Katz, Conway, Hammen, Brennan, & Najman, 2011; Schwartz, McFadyen-Ketchum, Dodge, Pettit, & Bates, 1999) or prosocial acts of sharing with or caring for peers (Slee, 1995). Despite significant public health concerns, the underlying association between poor peer relationships (including victimization, aggression, withdrawal, lack of prosociality) and mental health remains unknown. The goal of the current study was to investigate the longitudinal relationships between problematic peer relationships and mental health, thereby informing causal theories about the association between peer relationships and mental health.

2.1 Theoretical models of peer relations and psychopathology

There currently exist three primary models of causality relating peer relationships with mental health risk: interpersonal risk, interpersonal scar, and transactional models (see Rudolph, 2017 for a review).

Interpersonal risk model

The "interpersonal risk" model proposes that peer stressors/difficulties (e.g., victimization, rejection, poor friendship quality) promote risk for subsequent development of psychiatric symptoms (i.e. leading indicator). This model hypothesizes that, for example, greater peer victimization serves as an antecedent and predicts a later increase in depressive symptoms. This model has received the most research attention, with a number of studies suggesting that poor peer relations predict increased risk for subsequent psychopathology. For example, early and increasing peer victimization from 2nd to 5th grade predicted depressive symptoms at 5th grade (Rudolph, Troop-Gordon, Hessel, & Schmidt, 2011). Another study found that peer victimization among 3rd and 4th graders predicted depressive symptoms one year later, but depressive symptoms did not predict peer victimization a year later, with similar relationships found in older children (Kim, Leventhal, Koh, Hubbard, & Boyce, 2006; Prinstein & Aikins, 2004; Vernberg, 1990; Zwierzynska, Wolke, & Lereya, 2013).

Similar models have been tested for other types of problematic peer behaviors such as social withdrawal and aggression. A longitudinal study showed that social impairment at age 15 mediated the relationship between early social withdrawal behavior at age 5 and depression at age 20 (Katz et al., 2011). Bullies were at an increased risk for later aggression, and those that were both bullies and victims were at an increased risk for aggression and externalizing symptoms 1 year later (Kim et al., 2006). Despite these and other positive findings, some investigations have failed to find that negative peer relations predicted later psychopathology (e.g., Heilbron & Prinstein, 2010; Khatri, Kupersmidt, & Patterson, 2000; Lansford et al., 2007; Prinstein, Borelli, Cheah, Simon, & Aikins, 2005). Therefore, there is a need for further study of

this model in longitudinal samples.

Interpersonal scar model

The "interpersonal scar" model proposes the opposite direction of causality: that psychopathology impairs social relationships (i.e. lagging indicator). This model predicts that, for example, greater depressive symptoms would precede and predict a later increase in peer victimization. This model has received less attention, though there is some evidence in support of this direction of causality. For example, in 5–6-year-old children, teacher-reported broad behavior problems (e.g., withdrawal, depressed/anxious, aggression) predicted peer nominated victimization 3 years later (Schwartz et al., 1999). Similar findings have been shown in slightly older children: children's depression symptoms in 3rd grade predicted their perceived peer acceptance in 6th grade (Rudolph, Ladd, & Dinella, 2007), and high depression symptoms among 10-year-old children predicted increased peer victimization one year later, even mediating a reduction in peer acceptance the following year (Kochel, Ladd, & Rudolph, 2012). As with the interpersonal risk model there is need for further study, and need for comparison between the models.

Transactional model

Finally, the third model attempts to integrate the interpersonal risk and scar models, suggesting a "transactional" model, whereby psychopathology and poor peer relations affect one another interactively over development, resulting in, for example, stable or worsening trajectories of peer victimization and depressive symptoms that dynamically influence each other. While past research provides evidence for both the interpersonal risk and scar models,

3

fewer have directly assessed the validity of a transactional model. One exception found that peer victimization predicted increased likelihood of being categorized as depressed or anxious (according to a clinical cutoff) 6 months later, but also found that those that were depressed or anxious were more likely to be victimized 6 months later (Fekkes et al., 2006).

Overall, despite a growing number of studies on the relationships between peer relations and mental health, no previous study has directly compared these three theoretical models simultaneously, and it therefore remains unclear which model best accounts for these associations. These mixed findings in the field are illustrated by two separate meta-analysis, one for depression and anxiety disorders and one for externalizing disorders (e.g., behavior disorders), that each found evidence for both peer victimization predicting later psychopathology as well as psychopathology predicting later peer victimization (Reijntjes et al., 2011; Reijntjes, Kamphuis, Prinzie, & Telch, 2010). Comparing the relative fit of these three theoretical models to longitudinal data presents an important means of determining the applicability of each model.

2.2 Variation in the link between peer relations and mental health over development

Different developmental models may be more appropriate for specific periods of development. For instance, adolescence is a period marked by a shift in social behaviors towards peer acceptance and integration (Nelson, Jarcho, & Guyer, 2016), a consequence of pubertal maturation. In fact, peer victimization peaks in adolescence (Nansel et al., 2001; Nylund, Bellmore, Nishina, & Graham, 2007), while the prevalence of major depression, social anxiety, and conduct-related issues are also steeply increasing (Beesdo, Knappe, & Pine, 2009; Cohen et al., 1993; Costello, Copeland, & Angold, 2011; Kessler et al., 2005; Merikangas et al., 2010),

suggesting that these elevations in risk may be related to one another. That is, during adolescence youth become more sensitive to poor peer relations as victimization and rejection are becoming more common, making this a potentially salient risk factor for the onset of psychopathology at this stage of development. Therefore, in early adolescence the interpersonal risk model may best characterize the association between peer relations and psychopathology. This idea is consistent with studies showing that peer victimization predicts increased symptoms of (social) anxiety and depression to a greater extent than symptoms predict peer victimization in adolescents (Bond, Carlin, Thomas, Rubin, & Patton, 2001; Storch, Masia-Warner, Crisp, & Klein, 2005). This hypothesis is also supported by a study that found that early pubertal maturation strengthened the relationship between peer victimization and depression (Nadeem & Graham, 2005), suggesting an influence of puberty, a common-marker for the onset of adolescence, on reactions to peer victimization.

On the other hand, because peer relationships are less central emotionally and psychologically in the life of younger children (3-5 years-old), it may be less likely that problematic peer relations at those ages confer risk for psychopathology. At the same time, research demonstrating the presence of clinically significant depression in preschool-aged children (Luby, 2010) would reasonably suggest that early-onset depressive symptoms could impair interpersonal functioning, and thereby later peer relations, as predicted by the interpersonal scar model.

There is limited research into whether the association between peer relations and psychopathology changes across development, and the studies that have examined changes in this association as a function of developmental stage have focused on adolescence. For example,

5

a recent study of peer victimization in twins suggests exposure to peer victimization in pre-adolescence (11-years-old) confers greater risk for psychopathology than exposure later in adolescence (16-years-old) (Singham et al., 2017). Moreover, another study of MZ twins (between the ages of 8- and 17-years-old and discordant for victimization) confirmed that peer victimization is an environmental risk factor for social anxiety and suicidality in young adulthood (Silberg et al., 2016). Finally, from 5 to 11 years old, combinations of aggressive behavior and peer rejection or social withdrawal and peer rejection predicted externalizing and anxiety symptoms, respectively (Ladd, 2006). When added to social withdrawal behavior, peer rejection predicted anxiety symptoms more strongly in *late* than early childhood (Ladd, 2006). These studies support the concept of adolescence as a sensitive period for peer relations—that is, a developmental period (e.g., early adolescence) during which children are especially sensitive to specific external stimuli, in this case peer relationships, which in turn could contribute to the increase in psychopathology from childhood to adolescence.

2.3 Current study

The current study aims to fill a gap in the literature by identifying whether peer relations (or specific aspects of peer relations) represent leading or lagging indicators of psychopathology across varying developmental period. We tested this by comparing interpersonal risk, interpersonal scar, and transactional models of the association between been peer relations and psychopathology using a longitudinal sample of 3- to 14-year-old children with up to 6 waves of assessments. We hypothesized that early childhood psychopathology, specifically depression and externalizing symptoms, will precede and predict later disruptions in peer relations (in line with the *interpersonal scar* model). However, we predicted that later childhood and pre-adolescent

problematic peer relations will more strongly predict later increases in symptoms of general

psychopathology, including depressive, anxiety, and externalizing disorders (in line with the

interpersonal risk model). This could suggest that the transactional model will best fit the data.

However, when the temporal association between peer relations and psychopathology is allowed

to differ across development, we hypothesize that the developmental model will best fit the data,

with psychopathology predicting change in peer relationships in pre-adolescence, but peer

relationships predicting increases in psychopathology in adolescence. We tested these models

using bivariate latent change score analysis (e.g., Ferrer et al., 2007; Ferrer & McArdle, 2010;

McArdle & Grimm, 2010; Usami, Hayes, & McArdle, 2015, 2016). Additionally, while it is

likely that both psychopathology and peer relations will show relationships with other factors

such as gender, socioeconomic status, adverse childhood events, race, intelligence quotient, or

family history of psychopathology, we predict that the hypothesized models of the links between

peer relationships and psychopathology will hold even when accounting for these variables.

3. Methods

Participants were from the Preschool Depression Study (PDS), a prospective longitudinal investigation of young children and their families conducted at Washington University (Luby, Si, Belden, Tandon, & Spitznagel, 2009). The current study reports on 306 children from the PDS who completed 3-6 behavioral assessments out of a possible 6 assessments across a 7-year period. Parental written consent and child assent were obtained before participation and the Washington University School of Medicine Institutional Review Board approved all procedures. Details of recruitment have been previously reported (Luby, Gaffrey, Tillman, April, & Belden, 2014; Luby, Si, et al., 2009). To briefly summarize, 3- to 6-year olds were recruited from primary care practices and preschools/daycares throughout the St. Louis metropolitan region using a validated screening checklist (Preschool Feelings Checklist [PFC] (Luby, Heffelfinger, Koenig-McNaught, Brown, & Spitznagel, 2004)) to oversample preschoolers with symptoms of depression and healthy controls. See Table 1 for demographic descriptive statistics at each time point.

| | Age/Covariate | | | N | | | | |
Wave	N	Mean	SD	Male	Female	White	African-American	Other
1	302	4.45	0.80	157	145	164	98	40
2	277	5.48	0.80	141	136	154	89	34
3	262	6.47	0.80	134	128	144	88	30
4	233	9.04	0.82	121	112	134	71	28
5	262	10.17	0.90	141	121	143	84	35
6	236	11.17	0.88	122	114	126	79	31
Income-to-needs	280	2.06	1.18					
Adverse life events	304	2.77	1.91					
IQ	222	104.47	14.86					
		Absent (N)	Present (N)					
First degree relative with a mood disorder		121	182					

Table 1. Descriptive statistics for the age and sex of participants, and covariate measures

3.1 Materials and Measures

Peer Relations scales

One parent and one teacher of each participant completed the MacArthur Health and Behavior Questionnaire HBQ (Armstrong et al., 2003) at each available behavioral assessment. Parents and teachers completed the child version (1.0) of the HBQ when children were 8 years old or younger, and the teen version (2.1) of the HBQ when children were 9 years old or older. Only items that were the same or highly similar across the two versions were used. Psychometric studies support using multiple informants to capture unique perspectives and thus distinct and meaningful information (Luby, Si, Belden, Tandon, & Spitznagel, 2009), and use of multiple informants among previous studies of peer relations is common and notably advantageous over a

single informant (e.g., De Los Reyes & Prinstein, 2004). We used the 'Peer Relations' subscale to measure *peer victimization*. We used items from the 'Overt Hostility' and 'Relational Aggression' subscales as a measure of peer-directed *aggression*. We used items from the 'Asocial with Peers' and 'Social Inhibition' subscales as a measure of *social withdrawal*. We used items from the 'Prosocial Behavior' subscale as a measure of peer-directed *prosocial behavior*. See supplemental materials for additional details on subscale construction, item content, and internal consistency (alphas: 0.80-0.94).

Psychopathology scales

Symptoms of psychopathology were assessed at each wave using the Preschool Age Psychiatric Assessment (PAPA) when children were 7 years old or younger (Egger et al., 2006; Egger, H. L., Ascher, & Angold, 2003), and the Child and Adolescent Psychiatric Assessment (CAPA) when children were 8 years old or older (Angold et al., 1995; Angold & Costello, 2000). The PAPA and CAPA consist of a series of developmentally appropriate questions covering the DSM-IV criteria for disorders of childhood, with parental reports used exclusively before age 9. All diagnostic interviews were audiotaped and reviewed for reliability using established methods previously reported (Luby, Belden, Pautsch, Si, & Spitznagel, 2009). The depression severity score was created by calculating the percentage of items from the MDD module endorsed by the caregiver and/or child about the child during each assessment (range 0-100; range 0-72 in the current sample). Inter-rater reliability was high for a diagnosis of depression ($\kappa = 1.0$; ICC = 0.98). The anxiety and externalizing symptom severity was created by calculating the core anxiety symptoms or core externalizing symptoms as endorsed by either the caregiver or the youth for each assessment wave (range 0-13 and 0-34, respectively, in the current sample).

10

3.2 Statistical Analyses

From the preschool period (mean age = 4.45 years, range = 3.01–6.00) to late

childhood/early adolescence (mean age = 11.17 years, range = 9.31–13.5), parent and teacher

report of the child's peer relations was collected over 6 waves (see STable 1 for descriptive

statistics). First, simple bivariate growth models were used to determine the presence of

longitudinal relationships between peer relations scales and psychopathology scales. Models that

indicated significant correlated change (i.e. correlated slopes) were further investigated using

bivariate latent change score models to assess leading and lagging relationships between peer

relations and psychopathology.

Bivariate latent change score models

Bivariate latent change score models produce coupling coefficients (γ), which represent

the force from one variable (e.g., peer victimization) at time t that lead to changes in another

variable (e.g., depression symptoms) at the next time point $t + 1$ (e.g., Ferrer et al., 2007).

Bivariate latent change score analysis also models the change in scores (e.g., ΔMDD) as a

function of the slope (s) and intercept (i), as well as the covariance between s and i, in addition to

the influence of the variable (at time t) on the change between the two time points (e.g., ΔMDD),

referred to as the self-feedback parameter (β) (Ferrer et al., 2007). The relative advantages of

bivariate latent change score analyses over other longitudinal models has been described in depth

(Ferrer & McArdle, 2010; Usami et al., 2015, 2016). Briefly, bivariate latent change score

models take into account growth, absent in cross-lagged models, and assess the coupling

between specific time points over-and-above changes due to growth in individual trajectories,

absent in growth models. Maximum likelihood estimates with robust (Huber-White) standard

errors were obtained from the Lavaan package, version 0.5-23.1097 in R (Rosseel, 2012).

Model specification

We fit three models in line with the three theoretical models—interpersonal risk, interpersonal scar, and transactional models—in addition to a baseline model and a developmental model. The *baseline model* assumed no influence of peer relationships on psychopathology, or vice versa, beyond concurrent correlations between intercepts and slopes. In this model, the coupling coefficients were constrained to 0. Because the *interpersonal risk model* predicts that poor peer relationships represent a risk factor for psychopathology, coupling coefficients representing the effect of peer relations on psychopathology severity were allowed to freely vary, while coupling coefficients representing the effect of psychopathology severity on peer relations were constrained to 0. Similarly, to examine the fit of the *interpersonal scar model*, the coupling coefficients for psychopathology severity to peer relations are allowed to vary, while the reverse path was constrained to 0. To assess the fit of the *transactional model*, coupling coefficients modeling the effect of both paths were allowed to vary. Across all of these models, coupling coefficients were fixed to be equivalent across time points. Similar procedures have been conducted to test time-dependent associations between reading and antisocial behaviors (McArdle & Grimm, 2010).

To assess the fit of a *developmental model* where psychopathology severity could more greatly influence peer relations in early childhood (3-8 years-old), but peer relations more greatly influence psychopathology symptoms in late childhood/early adolescence (9-11 years-old), we used a bivariate latent change score model where the coupling coefficients were allowed to take

different values across assessment waves. Support for our hypothesis would be found if coupling coefficients show only a significant influence of psychopathology on change in peer relations at early time points (1–3), but show only a significant influence of peer relations on change in psychopathology at the later time points (5–7). Similar procedures have been conducted to test developmental change in time-dependent associations between reading and cognition (Ferrer et al., 2007).

For these models, the parent and teacher reports on the HBQ were equally weighted observed variables comprising a single latent variable for each peer relations scale at each time point; latent variables for each of the symptoms dimensions were used. Each latent repeated-measure was regressed onto 5 time-invariant covariates: participants' initial income-to-needs at time point 1, sex, race, initial adverse life events at time point 1, immediate familial history of an affective disorder, and intelligence quotient. In the simple bivariate growth models, significant correlations between the intercepts or slopes of the two constructs would demonstrate the presence of a cross sectional or longitudinal relationship, respectively. Results from bivariate latent change scores are described if there was an improvement in model fit over the baseline model for all fit indices and the coupling coefficients were significant (e.g., Table 4 and Table 5). Best fitting models were selected based on likelihood-ratio tests (LRT), and relative RMSEA, SRMR, CFI, AIC, and BIC. Lower RMSEA, SRMR, AIC, and BIC values and higher CFI values indicate better model fit.

4. Results

Descriptive statistics for age and gender at each wave and covariates are shown in Table 1. Table 2 presents results from the simple bivariate growth models assessing the presence of a

longitudinal relationship (i.e. correlated slopes) between each peer relations scale and

psychopathology scale. Table 3 presents results from the bivariate latent change score models for

each theoretical model relating peer relations to psychopathology severity.

Correlations	Depression	Anxiety	Externalizing
Peer victimization			
pe0p1	-0.041	-0.066	-0.138
pe1p0	-0.066	0.019	0.355*
pe0p0	0.655*	0.387*	0.472*
pe1p1	0.841*	0.612*	0.341
Aggression			
ag0p1	-0.023	-0.113	-0.239
ag1p0	-0.493*	-0.243	-0.434*
ag0p0	0.496*	0.289*	0.599*
ag1p1	0.468*	0.304	0.570*
Social Withdrawal			
sw0p1	-0.188	-0.103	0.083
sw1p0	-0.171	-0.059	0.217*
sw0p0	0.474*	0.309*	0.127
sw1p1	0.575*	0.296*	-0.016
Prosocial			
pro0p1	0.113	0.062	0.265*
pro1p0	0.342*	0.271*	0.214
pro0p0	-0.468*	-0.347*	-0.484*
pro1p1	-0.509*	-0.256	-0.500*

Table 2. Growth curve intercept and slope correlations of peer relations and psychopathology scales.[1]

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[1] pe–peer victimization scale, ag–aggression scale, sw–social withdrawal scale, pro–prosocial scale, p–psychopathology scale; 0 indicates intercept, 1 indicates slope, * $p < .05$

Model	Depression			Anxiety			Externalizing		
	$\Delta\chi^2$ to Baseline	Df	p value	$\Delta\chi^2$ to Baseline	Df	p value	$\Delta\chi^2$ to Baseline	Df	p value
Peer victimization									
Interpersonal Scar	0.04	1	0.84	0.52	1	0.47	–	–	–
Interpersonal Risk	52.79	1	<0.01	0.50	1	0.48	–	–	–
Transactional	17.31	2	<0.01	2.11	2	0.35	–	–	–
Developmental	25.75	18	0.11	19.86	18	0.34	–	–	–
Aggression									
Interpersonal Scar	0	1	0.95	–	–	–	0.26	1	0.61
Interpersonal Risk	0.46	1	0.5	–	–	–	1.95	1	0.16
Transactional	0.62	2	0.73	–	–	–	4.04	2	0.13
Developmental	dnc	dnc	dnc	–	–	–	37.87	18	<0.01
Social withdrawal									
Interpersonal Scar	1.24	1	0.27	0	1	0.97	–	–	–
Interpersonal Risk	0.21	1	0.65	5.47	1	0.02	–	–	–
Transactional	0.68	2	0.71	4.09	2	0.13	–	–	–
Developmental	dnc	dnc	dnc	16.46	18	0.56	–	–	–
Prosocial									
Interpersonal Scar	2.35	1	0.13	–	–	–	7.60	1	0.01
Interpersonal Risk	1.01	1	0.31	–	–	–	0.00	1	0.99
Transactional	1.57	2	0.46	–	–	–	4.89	2	0.09
Developmental	dnc	dnc	dnc	–	–	–	28.81	18	0.05

Table 3. Chi-square test of theoretical models compared to baseline models.[2]

4.1 Peer victimization

Initial bivariate growth models indicated the presence of a longitudinal relationship with depression and anxiety symptoms (but not with externalizing symptoms), whereby both greater depression and anxiety were associated with greater peer victimization (see Table 2). Therefore these associations were further examined using bivariate latent change score models (Table 3).

For depression symptoms, as shown in Table 4 (see STables 1 and 2 for means), the interpersonal risk and transactional models improved upon the baseline model for all fit indices.

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[2] dnc: Indicates that the model did not converge. – Indicates relationships not examined with bivariate latent change score models. Best fitting models with significant coupling are highlighted.

Compared to each other, the interpersonal risk model had a smaller BIC, while the transactional model had a smaller AIC and greater CFI. Coupling coefficients showed a significant influence of greater peer victimization predicting an increase in depression severity in both models (Table 4, Figure 1), along with a non-significant influence of depression on peer victimization in the transactional model. Because the models fit similarly well and the transactional model only indicated the presence of a significant influence of peer victimization on depression, but not of depression on peer victimization, the interpersonal risk model was chosen given its relative simplicity. While the intercepts remained correlated, the slopes were not, suggesting that the coupling is accounting for correlated longitudinal change between peer victimization and depression. This suggests that peer victimization represents a leading indicator of depression.

For anxiety symptoms, none of the models fit better than the baseline model, suggesting no leading or lagging relationship between peer victimization and anxiety severity.

Figure 1. Bivariate latent change score interpersonal risk model of peer victimization and depression.[3]

4.2 Aggression

Initial bivariate growth models indicated the presence of a longitudinal relationship with depression and externalizing symptoms (but not with anxiety symptoms), whereby both greater depression and externalizing were associated with greater aggression (see Table 2). Therefore these associations were further examined using bivariate latent change score models (Table 3).

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[3] Parent: Parent-report on peer victimization scale from HBQ, Teacher: Teacher-report on peer victimization scale from HBQ, MDD Prop: Proportion of MDD symptoms on PAPA/CAPA. β: self-feedback parameter, γ: coupling coefficient. Covariates were regressed onto the peer victimization and depression latent variables at each time point (e.g., Peer T1, Peer T2, MDD T1, MDD T2, …) and included income to needs, sex, race, intelligence quotient, adverse life events, and family diagnosis of an affective disorder.

For depression symptoms, none of the models fit better than the baseline model, suggesting no leading or lagging relationship between aggression and depression severity.

For externalizing symptoms, as shown in Table 5 (see STables 1 and 2 for means), the interpersonal risk and developmental models improved upon the baseline model for all fit indices (except for BIC). Compared to each other, the interpersonal risk model had a smaller BIC, while the developmental model had a smaller RMSEA, SRMR, AIC and greater CFI. Therefore, the developmental model was chosen as the best fitting model. Coupling coefficients showed a significant influence of greater aggression at time point 4 predicting an increase in externalizing severity from time point 4 to time point 5 ($\gamma = 15.502$, $p = .027$; see Table 5, Figure 2). Neither the intercepts nor slopes remained correlated, suggesting that the coupling is accounting for correlated cross-sectional and longitudinal change between aggression and externalizing. This suggests that aggression represents a leading indicator of externalizing severity, specifically in late childhood/early adolescence.
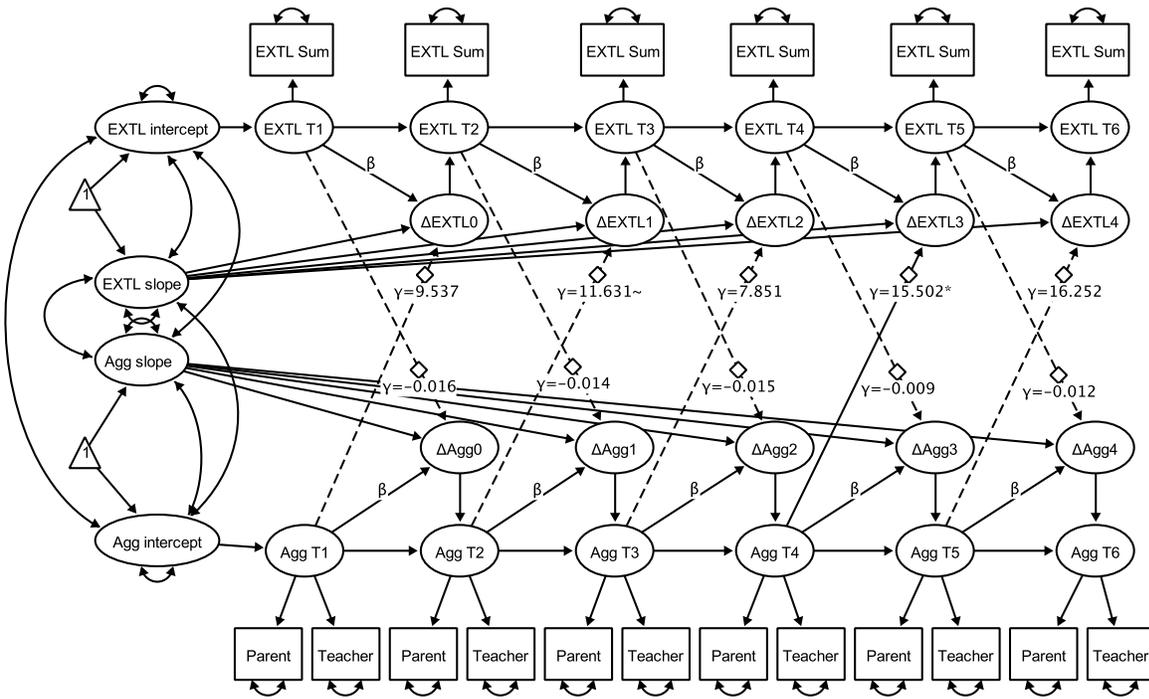
Figure 2. Bivariate latent change score developmental model of aggression and externalizing symptoms.[4]

4.3 Social withdrawal

Initial bivariate growth models indicated the presence of a longitudinal relationship with depression and anxiety symptoms (but not with externalizing symptoms), whereby both greater depression and anxiety were associated with greater social withdrawal (see Table 2). Therefore

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[4] Parent: Parent-report on aggression scale from HBQ, Teacher: Teacher-report on aggression scale from HBQ, EXTL: Sum of externalizing symptoms on PAPA/CAPA. β: self-feedback parameter, γ: coupling coefficient. For the coupling coefficients, dashed lines indicate non-significant coupling coefficients, while solid lines indicate significant coupling coefficients. Covariates were regressed onto the aggression and externalizing latent variables at each time point (e.g., Agg T1, Agg T2, EXTL T1, EXTL T2, …) and included income to needs, sex, race, intelligence quotient, adverse life events, and family diagnosis of an affective disorder.

these associations were further examined using bivariate latent change score models (Table 3).

For depression symptoms, none of the models fit better than the baseline model, suggesting no leading or lagging relationship between social withdrawal and depression severity.

For anxiety symptoms, the interpersonal risk model improved upon the baseline model for all fit indices (except BIC); however, coupling coefficients showed no significant influences of social withdrawal on anxiety severity. This suggests that, although longitudinally related, social withdrawal does not represent a significant leading or lagging indicator of anxiety severity.

4.4 Prosocial

Initial bivariate growth models indicated the presence of a longitudinal relationship with depression and externalizing symptoms (but not with anxiety symptoms), whereby both greater depression and externalizing were associated with less prosocial behavior (see Table 2). Therefore these associations were further examined using bivariate latent change score models (Table 3).

For depression symptoms, none of the models fit better than the baseline model, suggesting no leading or lagging relationship between prosocial behavior and depression severity.

For externalizing symptoms, while the interpersonal scar model improved upon the baseline model according to the LRT test ($\Delta\chi 2$), CFI, and AIC, it did not have a smaller RMSEA, SRMR, and BIC. The developmental model improved upon the baseline model according to the LRT test ($\Delta\chi 2$), CFI, SRMR and AIC, but it had larger RMSEA and BIC values.

However coupling coefficients from the developmental model showed no significant influences of externalizing severity on prosocial behavior, nor vice versa. This suggests that, although longitudinally related, prosocial behavior does not represent a significant leading or lagging indicator of externalizing severity.

Model Parameter	Baseline		Interpersonal Scar		**Interpersonal Risk**		Transactional		Developmental	
	Peer → MDD	MDD → Peer	Peer → MDD	MDD → Peer	Peer → MDD	MDD → Peer	Peer → MDD	MDD → Peer	Peer → MDD	MDD → Peer
Fixed Effects										
Intercept mean	1.93**	5.713	1.935**	5.631	1.802**	12.218	1.85**	12.641	2.0000	13.7330
Slope mean	0.255	4.801*	0.294	4.801*	0.377	-24.324*	0.049	-30.992	0.3380	-9.9620
Self-feedback	-0.081	-0.19	-0.107	-0.188	-0.12	-0.707**	0.095	-0.878**	-0.1790	-0.1220
Coupling	–	–	–	**0.001**	**16.266****	–	**20.386***	**-0.011**	**8.1906**	**-0.0028**
Random Effects										
Intercept Variance	0.09**	53.08**	0.09**	52.968**	0.087**	68.019**	0.098**	63.785	0.0930	50.4960
Slope Variance	0.008	6.145	0.008	6.088	0.009	25.499	0.008	37.505	0.0100	13.3270
Correlation $\rho 01$	0.403	0.233	0.42	0.23	0.526*	-0.045	0.248	-0.018	0.565	-0.005
Correlation $\rho p0m1$	0.243		0.247		-0.465		-0.529		-0.339	
Correlation $\rho p1m0$	0.064		0.028		0.208		0.363		0.365	
Correlation $\rho p0m0$	0.660**		0.658**		0.700**		0.748**		0.805	
Correlation $\rho p1m1$	0.756*		0.708		-0.243		0.406		0.213	
Fit Statistics										
Parameters	106		107		107		108		124	
Df	191		190		190		189		173	
Log Likelihood	-9960		-9960		-9953		-9951		-9941	
$\chi 2$	490		490		475		471		456	
CFI	0.85		0.85		0.86		0.86		0.86	
RMSEA	0.07		0.07		0.07		0.07		0.07	
SRMR	0.08		0.08		0.08		0.08		0.08	
AIC	20133		20135		20119		20118		20130	
BIC	20527		20533		20518		20520		20592	
$\Delta\chi 2$ to Baseline	–		0.04		52.79**		17.31**		25.75	

Table 4. Estimates from bivariate latent change score models between peer victimization and depression severity.[5]

	Baseline		Interpersonal Scar		Interpersonal Risk		Transactional		Developmental	
Model Parameter	Agg → EXTL	EXTL → Agg	Agg → EXTL	EXTL → Agg	Agg → EXTL	EXTL → Agg	Agg → EXTL	EXTL → Agg	Agg → EXTL	EXTL → Agg
Fixed Effects										
Intercept mean	0.859**	12.26**	0.851**	12.404**	0.885**	10.781**	0.844**	11.376**	0.8050	11.8330
Slope mean	0.039	2.199	0.079	1.915	0.043	0.944	0.145	0.181	0.1790	-1.7780
Self-feedback	-0.179	-0.255	-0.077	-0.234	-0.191	-0.566	-0.02	-0.594**	-0.0320	-0.4410
Coupling	–	–	–	**-0.01**	**7.146**	–	**8.604***	**-0.019**	**12.1546**	**-0.0132**
Random Effects										
Intercept Variance	0.073**	26.659**	0.072**	26.491**	0.07**	29.297**	0.067**	26.217**	0.065	23.228
Slope Variance	0.001	1.96	0.003	1.706	0.002	5.199	0.008	5.439	0.007	6.708
Correlation ρ01	0.133	0.57	0.187	0.555	0.179	0.472	0.308	0.547*	0.495	0.288
Correlation ρa0e1	0.377		0.331		0.02		-0.112		-0.345	
Correlation ρa1e0	0.094		0.61		0.191		0.775		0.766	
Correlation ρa0e0	0.590**		0.603**		0.510**		0.567**		0.625**	
Correlation ρa1e1	0.498		0.855		0.142		0.805		0.376	
Fit Statistics										
Parameters	106		107		107		108		124	
Df	191		190		190		189		173	
Log Likelihood	-7300		-7300		-7297		-7294		-7270	
χ2	453		452		446		441		392	
CFI	0.88		0.88		0.89		0.89		0.90	
RMSEA	0.06		0.06		0.06		0.06		0.06	
SRMR	0.10		0.10		0.09		0.10		0.09	
AIC	14812		14813		14807		14804		14788	
BIC	15207		15212		15206		15206		15249	
Δχ2 to Baseline	–		0.26		1.95		4.04		37.87**	

Table 5. Estimates from bivariate latent change score models between aggression and externalizing severity.[6]

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[6] ** $p < .01$; * $p < .05$, [a] Agg: Aggression scores on the HBQ, [b] EXTL: Sum of externalizing symptoms on PAPA/CAPA, For the Developmental model coupling coefficients are the mean coupling coefficient across all waves. Coupling coefficients Agg→EXTL from Developmental model non-significant except for the influence of time point 4 Agg on change in EXTL from time point 4 to time point 5 ($\gamma = 15.502$, $p = .027$).

5. Discussion

The current study sought to determine whether problematic peer relations represent leading or lagging indicators of psychopathology during development. This was achieved by identifying the theoretical models that best account for associations between peer relationships and psychopathology from early childhood to early adolescence. Based on prior research, we hypothesized that this association would dynamically change as a function of age—that the presence of early childhood psychopathology, specifically depression and externalizing symptoms, would precede and predict later disruptions in peer relations during childhood, but that deteriorations in peer relations would precede increases in psychopathology in early adolescence. This hypothesis was not globally supported. We did however find evidence for peer victimization as a leading indicator of depression, and peer-directed aggression as a leading indicator of externalizing symptomology. Notably, depression and externalizing disorders appear to be a stronger and/or more direct consequence of problematic peer relations than anxiety disorders.

We also found evidence for longitudinal relationships between most types of peer relationships and depression, anxiety, and externalizing symptoms. Rather than broadly conferring risk for general psychopathology, each aspect of peer relations was specifically related to some, but not all, psychopathology dimensions. For instance, while growth in peer victimization was positively associated with depression and anxiety, but not externalizing symptoms, growth in aggression was positively associated with depression and externalizing, but not anxiety symptoms. Likewise, growth in social withdrawal was positively associated with depression and anxiety symptoms, while growth in prosocial behaviors was negatively associated with depression and externalizing symptoms. This pattern of findings suggests that while

14

depression may be a common consequence of poor peer relations, externalizing symptoms may be more specifically related to aggression and deficits in prosocial behavior, while anxiety symptoms more related to victimization and social withdrawal. These findings emphasize the importance of measuring different aspects of peer relations, as they have differential relationships with psychopathology.

5.1 Peer victimization

Our results supported longitudinal relationships between peer victimization and depression and anxiety symptoms, whereby growth in peer victimization was positively associated with growth in depression and anxiety severity over development. Moreover, we found support for the interpersonal risk model, such that greater peer victimization preceded and predicted increases in depression. This adds to previous research on the association between peer victimization and depression (e.g., Kim et al., 2006; Prinstein & Aikins, 2004; Rudolph et al., 2011; Schwartz et al., 2005; Vernberg, 1990; Zwierzynska et al., 2013), lending even stronger evidence that peer victimization is a substantial risk factor for depression, in addition to other significant risk factors like adverse life events (e.g., Luby, Belden, & Spitznagel, 2006; Tennant, 2002), lower SES (e.g., Gilman, 2002), family history of mood disorders (e.g., Luby et al., 2006; Sullivan, Neale, & Kendler, 2000; Whalen et al., 2016), and past depression severity (e.g., Klein et al., 1999; Lewinsohn, Zeiss, & Duncan, 1989; Tram & Cole, 2006; Whalen et al., 2016) which were controlled for in our analyses. Our results also indicated that this risk was not different at different developmental stages as originally hypothesized, but rather began as early as preschool and continued into early adolescence. This suggests that early social stressors can have an immediate maladaptive impact. Coupled with prior findings that peer victimization increases risk of depression and suicidality in adulthood (Takizawa et al., 2014), victimization appears to have

both immediate and long-lasting effects on depressed mood across development.

Notably, we did not find support for the interpersonal scar model, whereby symptoms of depression predict later peer victimization. This finding is especially notable, given that others have suggested such models would be *more* likely to be supported (than interpersonal risk models) in samples such as the one used in the current study: clinical samples enriched for children with early-onset psychopathology (Ladd, 2006). By finding support for the interpersonal risk model rather than the scar model among a sample of children selected for early-onset depression, we lend even stronger support for an interpersonal risk model of peer victimization in childhood and adolescent depression. That is, despite early and high prevalence and severity of depression in our sample, we did not find evidence for models that propose that depression influences and predicts later peer victimization.

5.2 Aggression

Our results supported longitudinal relationships between aggression and depression and externalizing symptoms, whereby growth in aggression was positively associated with growth in depression and externalizing severity over development. Moreover, we also found that, in the developmental model where coupling coefficients are allowed to take different values across assessment waves, increased peer-directed aggressive behavior predicted later increases in symptoms of externalizing disorders. Considering that externalizing disorders are often characterized by marked aggressive behaviors, this result suggests that bullying others, physically and verbally, is a risk factor for externalizing disorders. That being said, the best fitting model, the developmental model, showed significant coupling for only one time point (the influence of time point 4 (mean age = 9.04 ± 0.82) aggression on change in externalizing symptoms from time point 4 to time point 5; $\gamma = 15.502$, $p = .027$). It appears then that this risk

may strengthen over development, such that early aggressive behaviors do not confer as much risk as aggressive behaviors in early adolescence. Such a relationship is perhaps not surprising, if conceptualizing bullying as a potentially early indicator of some types of externalizing symptoms. It is possible that aggression in early childhood is more indicative of global dysregulation while aggression in later childhood indicates a precursor of disorders like oppositional defiant disorder (ODD). Nonetheless, the findings suggest that bullying, either physically, verbally, or relationally could be used to identify children at risk.

We caution however against interpreting these findings as evidence for a heuristic model of peer relations whereby victims develop depression and perpetrators develop externalizing disorders. We did find that aggressive behavior was longitudinally related with depression, and cross-sectionally related with anxiety. Further, previous research has shown this relationship to be more nuanced, with aggression and victimization often co-occurring and at times interacting with one another (Belden, Gaffrey, & Luby, 2012; Leadbeater & Hoglund, 2009; Reijntjes et al., 2011). Future research adding peer reports or observational measures of peer interactions could further elucidate more complex interactions between these constructs.

5.3 Social Withdrawal and Prosocial

Our results supported longitudinal relationships between social withdrawal and depression and anxiety symptoms, whereby growth in social withdrawal was positively associated with depression and anxiety severity over development. They also supported longitudinal relationships between prosocial behavior and depression and externalizing symptoms, whereby growth in prosocial behavior was negatively associated with depression and externalizing severity over development. However because no models yielded an improvement in fit and no significant coupling, these results suggest that social withdrawal and prosocial

behavior may not be leading or lagging indicators of psychopathology. Rather they change in parallel, potentially either by bidirectionally influencing each other concurrently or because a common third variable is driving them.

This study represents the first uses of bivariate latent change score analysis in the study of peer relations and psychopathology. Previous studies have used variations of this and other structural equation models (e.g., growth models, cross-lagged model), however the bivariate latent change score model is uniquely well-suited for testing theoretical models of leading and lagging relationships, having been used in other areas to test the directionality of relationships such as reading and cognition (Ferrer et al., 2007) and reading and antisocial behaviors (McArdle & Grimm, 2010). Compared to auto-regressive cross-lagged models, bivariate latent change score models take into account growth (i.e. slope and intercept means and covariances). Compared to growth models, bivariate latent change score models account for the influence of one construct on another construct (or change in another construct) at the next time point, a technique especially useful for detecting changes in the relationship between peer relations and psychopathology over development. Therefore, the bivariate latent change score model represents the ideal tool for testing the influence of two constructs on one another while accounting for growth in both constructs.

5.4 Strengths

This study has a number of strengths in addition to the use of bivariate latent change score analysis. It was longitudinal, with six time points of data over a 7 year period, allowing us to test the relationship between peer relations and psychopathology across development and detect potential consistencies or changes in this relationship from early childhood to early adolescence. In addition, using both parent and teacher reports of peer relations allowed us to

incorporate different perspectives on each child's behavior and account for differences between contexts (e.g., home, school). Using clinical interviews to assess psychopathology further protected against possible common-informant or method bias.

5.5 Limitations

The results of the present work must also be considered in light of its limitations. First, we had relatively strict requirements to consider a bivariate latent change score model a good fit, in that it needed to show improvement over baseline model fit on most fit indices and significant coupling. At least one simulation study suggests that no one fit index is necessarily preferential in determining fit of latent change score models, with RMSEA, CFI, and AIC showing relatively moderate to high correct model selection rates (Usami et al., 2016), and better fit across different indices is considered stronger evidence for a better fitting model in SEM (Schreiber, Nora, Stage, Barlow, & King, 2006). Second, we used age as the primary measure of development, rather than in combination with other possibly more precise measures of biological development such as pubertal status. Indeed, particularly in late childhood and early adolescence, measures of pubertal status would more clearly demarcate specific periods of developmental (pre versus post-puberty). Third, potential interactions of sex and race are beyond the scope of the current study. Previous research suggests that such factors may differentially impact the relationship between peer relations and psychopathology (e.g., Rudolph et al., 2007; Spriggs, Iannotti, Nansel, & Haynie, 2007), leading to their inclusion as covariates in the current study. Fourth, the study did not include self-report of peer relations given the age of participants early on in the study. Self-report can provide unique information from parent and teacher reports, however it has also been shown to include inherent bias, with depressive symptoms related to over-reporting of peer victimization, and aggressive behaviors related to underreporting of victimization (De Los Reyes & Prinstein, 2004). Finally, the current study was correlational in nature. Controlled experimental

manipulations, such as interventions designed to improve peer relationships, are needed to fully identify causal pathways linking peer relations with psychopathology.

5.6 Conclusion

This study builds on a previous literature examining the relationship between peer relations and psychopathology in youth. Here, we identified aspects of peer relations that represent leading indicators of psychopathology. We did this by examining the relative fit of theoretical models of peer relations and psychopathology in a longitudinal sample of clinically-recruited children from early childhood to early adolescence using parent and teacher report of peer relations and clinician assessment of symptoms of depression, anxiety, and externalizing disorders. This study presents the first use of bivariate latent change score analysis for assessing the association between peer relations and psychopathology. Two primary findings emerged. First, peer victimization is a leading indicator of depression, as it predicted significant change in depression at the next assessment time point from early childhood all the way to early adolescence, over-and-above previous levels of depression severity and peer victimization. Second, aggression is a leading indicator of externalizing symptoms, as it predicted significant change in externalizing symptoms from age 9 to age 10. This emphasizes the importance of addressing and limiting the occurrence of peer victimization and aggression, in some cases even as early as preschool. Victimization and aggression not only put children at a proximal risk for developing significant depression and externalizing symptoms, but could have long-lasting distal impacts on adult mental health and function.

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