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Developmental changes in longitudinal associations between academic achievement and psychopathological symptoms from late childhood to middle adolescence

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Background: Research reveals longitudinal bidirectional associations between changes in academic achievement and psychopathological symptoms. However, little is known about developmental changes in the magnitude of these associations, from childhood to adolescence. **Methods:** Participants were 648 Chinese children (347 males) who were followed from Grade 5 (mean age: 11.18 years) to Grade 9. Academic achievement and two types of symptoms (externalizing, depressive) were assessed annually. Structural equation modeling was used to examine longitudinal bidirectional associations between achievement and psychopathological symptoms, and developmental changes in effect sizes. Models were estimated using cross-lagged panel modeling (CLPM), as well as random intercepts cross-lagged panel modeling (RI-CLPM). **Results:** The data supported the hypothesized academic incompetence and adjustment erosion effects, as well as the hypothesized developmental change in the academic incompetence effect whereby prior achievement's effects on subsequent externalizing increased with age. Results were similar for both genders and unaffected by inclusion of common risk factors as covariates. **Conclusions:** There are bidirectional associations between symptoms and achievement that change markedly across the transition into adolescence. Interpreting the effects using a developmental perspective, changes in reciprocal effects may be dynamic. The findings suggest that targeting both psychopathology and low academic achievement is worthwhile, but that distinct treatment effects will be found in childhood versus adolescence. **Keywords:** Academic achievement; depression; externalizing problems; developmental change.

Introduction

Academic and psychosocial adjustments are two major aspects of development in the school context (Suldo, Gormley, DuPaul, & Anderson-Butcher, 2014). Youth's academic achievement is negatively related to psychopathological symptoms both concurrently and longitudinally (Hishinuma, Chang, McArdle, & Hamagami, 2012; Moilanen, Shaw, & Maxwell, 2010; van der Ende, Verhulst, & Tiemeier, 2016), but reciprocal effects over development are poorly understood. In the present study, we examined longitudinal associations between academic achievement (hereafter called achievement) and two types of psychopathological symptoms – externalizing problems and depressive symptoms (hereafter referred to generally as symptoms) – in an urban community sample of children followed annually from Grade 5 to Grade 9. As extensions to previous studies (e.g. Masten et al., 2005; Moilanen et al., 2010), we focused on developmental changes in the associations over the period from late childhood to middle adolescence. This study adds to our understanding of how achievement and psychopathology are interrelated over time, which is essential for intervention and prevention of symptoms and promotion of achievement.

Longitudinal associations

We focused on two types of symptoms that are prevalent among children and adolescents: externalizing problems that reflect an array of aggressive and rule-breaking behaviors (Achenbach, 1966), and symptoms of depression such as anhedonia and sadness (Twenge & Nolen-Hoeksema, 2002). Externalizing and depressive symptoms interfere with gaining academic competence (including skills, attitudes, and achievement; Suldo et al., 2014), which is a salient developmental task for children and adolescents (Masten et al., 2005). At the same time, failure in academic tasks causes risks for symptoms (Masten et al., 2005). Two hypotheses have been proposed regarding causality: the *academic incompetence* hypothesis (i.e. lack of competence increases risk for subsequent symptoms of maladjustment) and the *adjustment erosion* hypothesis (i.e. initial symptoms undermine subsequent academic competence; Moilanen et al., 2010).

Several longitudinal studies have tested these two hypotheses. Regarding externalizing, there is ample evidence for both (e.g. Chen, Huang, Chang, Wang, & Li, 2010; Masten et al., 2005; Moilanen et al., 2010; van der Ende et al., 2016; Zimmermann, Schütte,

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Taskinen, & Köller, 2013). The interpretation of the academic incompetence effect is that low achievement threatens self-worth, evokes frustration, and impairs social status among peers (Dishion, Véronneau, & Myers, 2010; Moilanen et al., 2010). Underachievers may respond with deviant behaviors (e.g. academic task avoidance, aggression) to defend their self-worth and 'act-out' their negative emotions and feelings (Moilanen et al., 2010; Zimmermann et al., 2013). They are also more likely to orient toward other socially and academically 'deviant' peers and to further reinforce each other's externalizing behaviors (Dishion et al., 2010). Regarding the adjustment erosion effect, evidence shows that involvement in externalizing behaviors undermines achievement by limiting engagement in academic-relevant activities (Moilanen et al., 2010), and engendering students' academic-avoidant behavior (Metsäpelto et al., 2015).

Turning to depressive symptoms, empirical support has been mixed. Some studies have supported adjustment erosion but not academic incompetence effects (Hishinuma et al., 2012), but other studies have found evidence for both (Verboom, Sijtsema, Verhulst, Penninx, & Ormel, 2014, only in females; Weidman, Augustine, Murayama, & Elliot, 2015), and still others have shown neither effect (Chen & Li, 2000; Defoe, Farrington, & Loeber, 2013; Verboom et al., 2014, only in males). Regarding depression and the academic incompetence effect, the interpretation is that poor academic achievement leads to negative feedback from teachers, peers, and parents, which reduces children's self-worth that in turn triggers depressive symptoms (Verboom et al., 2014). For adjustment erosion effect, the theory is that depressive symptoms undermine academic success by hampering cognitive functions and reducing or eliminating motivation to succeed (Weidman et al., 2015).

Developmental changes in the associations

Contemporary developmental theories suggest that changes in ecological settings and co-occurring biological development can work together to alter the dynamic processes in a developmental system (Sameroff & Mackenzie, 2003). The transition from childhood to adolescence coincides with the transition from elementary to middle school, a change in context characterized by significant shifts in academic routines and expectations, school settings, and social groups and relationships (Eccles & Roeser, 2009; Moilanen et al., 2010; Verboom et al., 2014). Specifically, learning is more challenging and competitive, and students are more strongly expected by adults to achieve academic success, in middle school compared with elementary school (Masten et al., 2005). Underachievers may become more distressed in middle school as they begin to experience chronic difficulties coping with the increase in academic pressure (Eccles & Roeser, 2009) – and more generally, experience failures at the developmental tasks that are increasingly salient in adolescence compared with childhood (Masten et al., 2005). Also, there is an increase in deviant peer affiliation in middle school compared with elementary school, which could connect poor achievement to subsequent problem behaviors more strongly (Dishion et al., 2010). While academic pressures are increasing, early adolescence is a period when vulnerability to symptoms increases (Petersen, Bates, Dodge, Lansford, & Pettit, 2014; Twenge & Nolen-Hoeksema, 2002). Thus, the academic incompetence effect might become stronger in the middle school years, compared with the elementary school years.

Regarding developmental changes in the adjustment erosion effect, some researchers have posited that symptoms are likely to impede academic competence acquisition most severely in the childhood years, when the malleability of academic competence is greatest and most readily influenced by other factors. Specifically, academic achievement becomes more strongly related to individual learning attributes (such as motivation and strategies) than the psychosocial context, as children enter and move through adolescence (Richardson, Abraham, & Bond, 2012). Accordingly, as academic competence become more coherently organized and steadily established (Chen et al., 2010; see also Masten et al., 2005), academic achievement becomes more robust against potential interference of behavioral or emotional problem symptoms. Therefore, the magnitude of adjustment erosion effects would be expected to decrease with age. In contrast, other researchers have posited that the adjustment erosion effect will increase with age, as symptoms increase in prevalence in adolescence (van der Ende et al., 2016).

Extant studies provide limited information about developmental changes in the associations between academic achievement and psychopathological symptoms across childhood and adolescence. In addition, because findings are mixed regarding temporal ordering between achievement and depression (e.g. Hishinuma et al., 2012; Verboom et al., 2014), it is difficult to tease apart age differences in adjustment erosion and academic incompetence effects. Several longitudinal studies of the transition to adolescence are relevant for consideration. Moilanen et al. (2010) found a developmental change from childhood to adolescence: in elementary school (6–10 years), prior externalizing predicted subsequent achievement, but during and after the transition to middle school (10–12 years) achievement predicted subsequent externalizing. Yong, Fleming, McCarty, and Catalano (2013) reported a similar pattern: externalizing predicted subsequent achievement in late elementary school years (Grade 4 to Grade 6), but achievement predicted subsequent externalizing

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in the middle school years (Grade 6 to Grade 8). However, another study showed the opposite developmental change in predictive effects in childhood and adolescence (Burt & Roisman, 2010).

To some extent, findings from longitudinal studies that do *not* span the transition to adolescence have hinted at potential developmental changes in the longitudinal associations between academic achievement and symptoms. Two longitudinal studies during childhood only suggest an adjustment erosion effect for externalizing and achievement (e.g. Chen et al., 2010; van Lier et al., 2012), and two longitudinal studies during adolescence only suggest an academic incompetence effect (e.g. Defoe et al., 2013; Vaillancourt, Brittain, McDougall, & Duku, 2013). However, again, there are contrary findings to these patterns (Metsäpelto et al., 2015; Zimmermann et al., 2013).

More to the point, only two prior studies explicitly tested for potential developmental age differences in effects. Van der Ende et al. (2016) examined age 12 years as a cut point and reported no age difference in the associations being estimated for the younger (6–12 years) and older (12–18 years) age groups. However, this study encompassed five consecutive birth cohorts, so cohort effects could have affected the results. Verboom et al. (2014) found no age differences (11–16 years) in lagged predictive effects of depressive problems and academic achievement. It is worth noting that externalizing was not investigated in Verboom et al. (see also Chen et al., 2010; Metsäpelto et al., 2015; Zimmermann et al., 2013). Given the co-occurrence of externalizing and depressive symptoms even in community samples (Wolff & Ollendick, 2006) and the possibility of cross-lagged relations between them (Masten et al., 2005), not taking both symptoms into account can bias results (van der Ende et al., 2016).

The present study

The focus of the current study was to test the presence of, and potential developmental changes in, academic incompetence and adjustment erosion effects using a five-wave longitudinal design spanning late childhood (11 years, Grade 5) to middle adolescence (15 years, Grade 9). We investigated (a) whether prior low achievement predicted subsequent externalizing and depressive symptoms (i.e. the academic incompetence effect), and whether prior symptoms predicted subsequent low achievement; and (b) whether the magnitude of these effects changed with age. Based on the literature, there was reason to expect academic incompetence and adjustment erosion effects. Also, prior findings led to the hypothesis that the academic incompetence effect would become stronger, and the adjustment erosion effect might become weaker with age.

To address these aims, we used the cross-lagged panel model (CLPM), which has been used extensively in contemporary developmental research; indeed, nearly all previous studies of achievement and symptoms have used CLPM. However, one concern with this model is that within-person and between-person effects are not adequately disaggregated (Hamaker, Kuiper, & Grasman, 2015). To address this, the random intercepts cross-lagged panel model (RI-CLPM; Hamaker et al., 2015) extended the CLPM by incorporating between-person effects while estimating within-person effects (i.e. autoregressive and cross-lagged paths). Specifically, random intercepts of each construct can be extracted to represent the stable trait-like components underlying the developmental processes of externalizing and depressive symptoms (Wolff & Ollendick, 2006) and achievement (Richardson et al., 2012). Correlations between the random intercepts capture the between-person effects. The random intercepts partial-out any between-person variances, so the lagged paths between the 'dynamic' residuals (containing measurement errors) left by the random intercepts represent the time-specific within-person effects. In the present study, both approaches were employed. CLPM results would be directly comparable to the literature, and RI-CLPM results would be more accurate and provide an example for future studies.

We considered two additional issues. First, gender differences in associations between achievement and symptoms were seldom found in most previous studies (e.g. Burt & Roisman, 2010; van Lier et al., 2012), but we tested for it due to prior evidence (Verboom et al., 2014). Second, risk factors such as low socioeconomic status, attention problems, and negative maternal parenting have been found to account for some of the association between achievement and symptoms (Burt & Roisman, 2010; Defoe et al., 2013; Masten et al., 2005). To ensure that our path estimates were not spurious effects caused by common risk factors, we further examined whether the longitudinal relations would remain statistically significant when controlling for these three common risk factors as covariates.

Method

Participants

Data were from the Longitudinal Study of Chinese Children and Adolescents (LSCCA; see Appendix S1 for more information). Based on demographics (e.g. monthly family income; see Appendix S1), the sample was representative of the urban population in east and south China (the National Bureau of Statistics of China, 2007).

Starting at Grade 5, measures of achievement, externalizing, and depression were collected annually in the spring semester. Participants transited from elementary schools into middle schools in Grade 7. Due to policies of some school districts, exam scores were missing for some youth. In the LSCCA, there was a subsample of 648 participants (M_{age} at Grade 5 = 11.18 years, SD = 0.35; 347 boys) who had complete data on achievement from Grade 5 to Grade 9. Because we aimed to explore the longitudinal associations between achievement and symptoms from year to year, we analyzed data for this

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subsample. Participants in the subsample also had complete data on externalizing; 34 participants had missing data on depressive symptoms at one or two of the five waves. This subsample did not differ from the whole sample on age, covariates (i.e. socioeconomic status, attention problems, and negative maternal parenting), and externalizing and depressive symptoms at any wave (*p*s > .05); however, boys were slightly overrepresented in the subsample (53.5%) than the whole sample (51.8%).

Procedures

The study was approved by the ethics committee of Shandong Normal University. Informed assent (children) and consent (mothers and school principals) were obtained prior to data collection. At each wave, a self-report measure on depressive symptoms was administered, head teachers completed ratings of externalizing, and achievement data were obtained from school records. At each wave, each student received a gift worth about $1, and each teacher an honorarium of about $30. All covariates (SES, attention problems, and negative maternal parenting) were measured prior to Grade 5.

Measures

Academic achievement. Following previous studies (e.g. Chen et al., 2010), information concerning achievement was obtained from school records at each wave. Participants' final exam scores for Chinese, mathematics, and English were measured on a 5-point scale from 1 (*fail*) to 5 (*excellent*) during elementary school (i.e. Grades 5 and 6 in this study), and were graded a continuous scale from 0 to 120 during middle school (i.e. Grades 7–9 in this study). Given the difference in exam contents across grades and classes, raw scores on the three subjects were standardized within each class and then averaged to form a single index of achievement. Cronbach's alphas based on the scores for the three subjects in each grade ranged from .74 to .91, with an average of .84. More descriptions and psychometric properties of the achievement measure (as well as externalizing and depressive symptoms) are available in Appendix S2.

Externalizing problems. Given that teachers are knowledgeable and reasonably objective about children's aggressive and disruptive behaviors (Kraemer et al., 2003), teachers rated children's externalizing problems using the externalizing subscale of the Chinese version of Child Behavior Checklist–Teacher Report Form (CBCL–TRF; Achenbach & Rescorla, 2001; Zhang, Wei, Ji, Chen, & Deater–Deckard, 2017). The measure consisted of 15 items from the aggression subscale (e.g. 'gets in many fights') and 12 items from the rule-breaking subscale (e.g. 'breaks school rules'). Five items (i.e. 'mood change', 'suspicious', 'frustrated', 'demands attention' and 'screams') from the original TRF scales were excluded because we found in a pilot study that they showed small loadings on the externalizing problems factor. Given how difficult it would be for teachers to rate all participating students in their classes with a full TRF, no additional TRF items were administered. Teachers rated each item on a 3-point scale (0 = *not true*, 1 = *somewhat or sometimes true*, 2 = *very true or often true*). Cronbach's alphas were high at each time point (.88 to .92, average of .90).

Depressive symptoms. Because most symptoms of depression are difficult to detect by others, at each wave children completed the Chinese version of Children's Depression Inventory (CDI; Kovacs, 1992; Chen & Li, 2000), a 27-item measure assessing depressive symptoms experienced in previous 2 weeks on a 3-point scale from 0 (*absence of symptoms*; e.g. 'I am sad occasionally') to 2 (*definite symptoms*; e.g. 'I am sad all the time'). Cronbach's alphas were high for each wave (.88 to .89, average of .89).

Covariate: socioeconomic status (Grade 3). Information on family socioeconomic status (SES) was collected at Grade 3. SES was indicated by five items – household income per month, mother's and father's educational levels, and occupational prestige. Following the literature (Zhang et al., 2017), the items were standardized and averaged to compute a composite SES score.

Covariate: attention problems (Grade 3). At Grade 3, mothers rated eight items from the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) assessing their children's attention problems on a scale from 0 (*not true*) to 2 (*very true or often true*). Responses were averaged to indicate the severity of attention problems (α = .74).

Covariate: negative maternal parenting (Grade 4). Mothers reported their negative parenting on a Chinese version of Child Rearing Practices Report (CRPR; Zhang et al., 2017). Ratings on 11 items from the rejection and punishment orientation subscale were averaged into a negative maternal parenting score (ranged between 0 and 4; α = .81).

Data analysis

The CLPM and the RI-CLPM were used to model the associations between achievement and symptoms. Academic achievement was modeled as a manifest variable, while externalizing and depressive symptoms were modeled as latent variables. We used item parcels to form indicators for externalizing and depressive symptoms in modeling (Chen et al., 2010). Two indicators of externalizing were parceled according to the aggression and rule-breaking subscales of the TRF measure. Depressive symptoms were indicated by three randomly parceled indicators from the 27 CDI items. Given that longitudinal metric invariance was established (see Appendix S3), the factor loadings of each latent variable were fixed to be equal across waves. Residuals of the same indicators of matching latent variables were correlated over time to minimize biases (Zimmermann et al., 2013).

The hypotheses were examined by testing a series of nested models. As depicted in Figure 1, we estimated a stability model (Model 0) that only included within-time correlations and longitudinal stability of each construct. The subsequent models contained additional cross-lagged paths. Because the potential associations between externalizing and depression should be considered, Model 1 estimated the bidirectional cross-lagged paths between externalizing and depressive symptoms. The better fitting model between Model 0 and Model 1 was the baseline model for further comparisons. A group of four models (Models 2a–3b; see Figure 1) were then evaluated to represent the academic incompetence or adjustment erosion effects: Models 2a and 2b estimated paths from achievement to externalizing and to depression, respectively; Models 3a and 3b estimated paths from externalizing and from depression, respectively, to achievement. Models 2a–3b all were compared with the baseline model to examine the first hypothesis – the presence of the academic incompetence and adjustment erosion effects. We used the same series of nested model comparisons to test the RI-CLPM models, but additionally included correlations among the random intercepts of each construct; see Appendix S4 for an illustration.

The hypothesis regarding developmental change was examined by testing whether the cross-lagged paths could be constrained as time invariant. Based on model comparisons thus far, a combined model would be specified (Model 4). Finally, if Model 4 did not show worse model fit than a full model (Model 5) where all possible cross-lagged paths were

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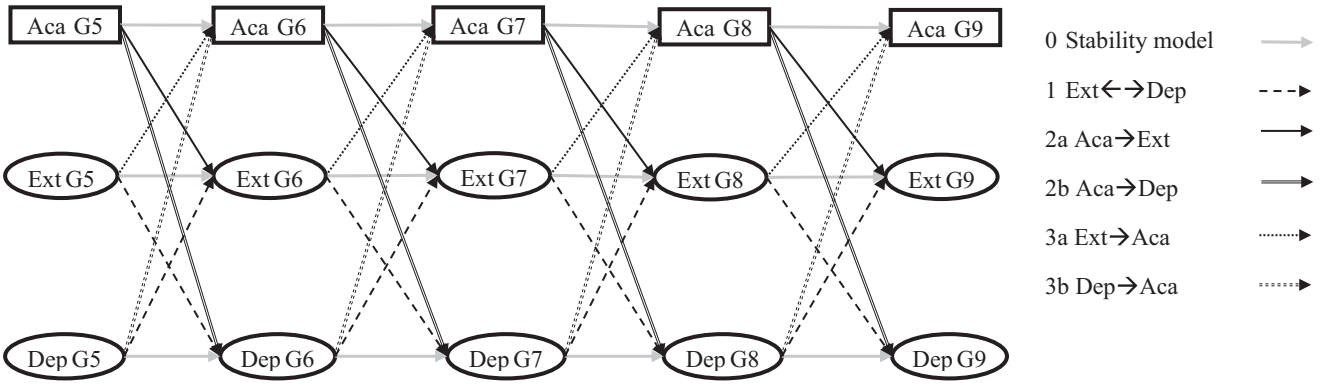

Figure 1 Illustration of nested models. Aca = academic achievement; Ext = externalizing problems; Dep = depressive symptoms. Within-wave correlations were estimated but not displayed

freely estimated, it would be selected as the final model. Two follow-up analyses were then conducted: (a) the cross-lagged paths (and correlations between random intercepts in the RI-CLPM) in the final models were examined for gender-invariance; (b) the final models were estimated again while controlling for three covariates of socioeconomic status, attention problems, and negative maternal parenting.

Models were estimated using Mplus 7.0 (Muthén & Muthén, 1998–2012). The maximum likelihood robust estimator (MLR) was used to account for nonnormally distributed data and missing data. Models were deemed to have adequate fit when the comparative fit index (CFI) and Tucker–Lewis index (TLI) > .95, and root mean square error of approximation (RMSEA) < .06 (Hu & Bentler, 1999). The Satorra–Bentler scaled chi-square difference test (Satorra & Bentler, 2001) was used for comparisons between nested models.

Results

Preliminary analyses

Means, standard deviations, and zero-order correlations are presented in Table 1. More information on the distributions of externalizing and depressive symptoms is presented in Appendix S5. Bivariate correlations revealed that achievement showed increasingly high consecutive-year stability of individual differences over time (with moderate correlations of .59 and .73 before middle school, but higher than .90 over the period of middle school). Adolescent externalizing and depressive symptoms showed moderate (r range = .41 to .76) consecutive-year stability over time. Also, there was evidence for low to moderate concurrent (r range = −.18 to −.36) and longitudinal (r range = −.15 to −.35) associations between achievement and the symptoms.

Associations between academic achievement and psychopathological symptoms

Model fit indices and model comparisons for the nested models are presented in Table 2, and path coefficients of final models are presented in Table 3. For CLPM models, as shown in the upper half of Table 2, all models fit well (CFIs and TLIs > .95, RMSEAs < .05). The stability model did not fit better if paths between externalizing and depressive symptoms were added (i.e. Model 0 vs. Model 1). Thus, Model 0 was chosen as the baseline model. Compared with Model 0, Model 2a (achievement to externalizing), Model 3a (externalizing to achievement), and Model 3b (depression to achievement) fit the data better. Thus, better fit required estimation of longitudinal reciprocal relations between achievement and externalizing, and unidirectional prediction from depression to achievement.

Turning to the developmental change hypothesis, also as shown in the upper half of Table 2, setting the cross-lagged paths to be equal across time intervals decreased the fit of Models 2a, 3a and 3b (see upper half of Table 2, Model 2a vs. Model 2a-1, Model 3a vs. Model 3a-1, and Model 3b vs. Model 3b-1). Thus, these longitudinal associations varied by age over time. Based on the above comparisons, Model 4 was specified, which included freely estimated cross-lagged paths of achievement to externalizing, externalizing to achievement, and depression to achievement. However, compared with the full model, Model 4 did not fit adequately (see upper half of Table 2, Model 5 vs. Model 4). In subsequent exploratory analyses, we tested each of the unspecified cross-lagged paths in Model 4, and found only one path – from Grade 6 achievement to Grade 7 depression – to be significant (β = −.11, SE = .04, p = .006). This path was added to Model 4, and this modified combined model (Model 6) had commensurate fit with the full model (see Table 2, Model 6 vs. Model 5). Model 6 was adopted as the final CLPM model.

Standardized autoregressive and cross-lagged paths of Model 6 are presented in the upper half of Table 3. All autoregressive paths were significant. Higher levels of externalizing problems predicted poorer achievement 1 year later (with the exception of Grade 8 externalizing to Grade 9 achievement). Higher depressive symptoms in Grades 5 and 6 significantly predicted lower achievement in Grades 6 and 7, respectively. Regarding academic incompetence effects, achievement had significant negative effects on externalizing in the following year (with the exception of Grade 5 achievement on Grade 6

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Table 1 Correlations, means, and standard deviations for variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	*M*	*SD*
1 AcaG5	—															0.00	0.98
2 AcaG6	.59***	—														0.03	0.95
3 AcaG7	.58***	.73***	—													0.07	0.96
4 AcaG8	.56***	.72***	.90***	—												0.08	0.96
5 AcaG9	.52***	.71***	.87***	.93***	—											0.08	0.96
6 ExtG5	−.24***	−.26***	−.31***	−.31***	−.29***	—										0.12	0.17
7 ExtG6	−.16***	−.22***	−.26***	−.25***	−.25***	.62***	—									0.13	0.20
8 ExtG7	−.19***	−.21***	−.32***	−.35***	−.33***	.39***	.41***	—								0.12	0.19
9 ExtG8	−.15***	−.18***	−.28***	−.29***	−.31***	.32***	.38***	.62***	—							0.12	0.18
10 ExtG9	−.21***	−.22***	−.34***	−.34***	−.36***	.39***	.43***	.57***	.59***	—						0.13	0.20
11 DepG5	−.26***	−.28***	−.31***	−.29***	−.28***	.22***	.16***	.12**	.13***	.14***	—					0.19	0.22
12 DepG6	−.19***	−.18***	−.22***	−.21***	−.19***	.19***	.13***	.11**	.08*	.14***	.63***	—				0.19	0.23
13 DepG7	−.23***	−.22***	−.29***	−.26***	−.26***	.13**	.06	.11**	.14***	.14***	.53***	.64***	—			0.22	0.24
14 DepG8	−.19***	−.24***	−.30***	−.30***	−.29***	.14***	.09*	.11***	.19***	.17***	.46***	.55***	.69***	—		0.26	0.25
15 DepG9	−.18***	−.24***	−.23***	−.25***	−.25***	.10*	.04	.09*	.10*	.14***	.40***	.51***	.61***	.76***	—	0.26	0.26
16 SES	.05	.28***	.34***	.33***	.37***	−.01	.04	−.04	−.02	−.08	−.04	−.05	−.02	−.07	−.12***	0.04	0.98
17 AttPro	−.20***	−.29***	−.37***	−.36***	−.35***	.21***	.16***	.18***	.21***	.12**	.21***	.19***	.22***	.20***	.19***	0.32	0.29
18 NPar	−.04	−.04	−.10*	−.12**	−.13***	.22***	.21***	.16***	.14***	.19***	.12**	.11**	.13***	.15***	.14***	1.44	0.47

Aca = academic achievement; Ext = externalizing problems; Dep = depressive symptoms; SES = family socioeconomic status; NPar = negative maternal parenting; AttPro = attention problem.

*$p < .05$; **$p < .01$; ***$p < .001$.

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Table 2 Fit statistics and model comparisons for nested models

Model	*df*	*c*	χ^2	CFI	TLI	RMSEA	Model comparison	*cd*	$\Delta\chi^2$	Δdf	*p*
CLPM models											
0 Stability model	353	1.36	799.84	.959	.950	.044					
1 Ext←→DEP	345	1.36	787.44	.960	.949	.044	0 vs. 1	1.18	11.54	8	.173
2a Aca→Ext	349	1.36	732.94	.965	.965	.041	2a vs. 0	1.01	87.20	4	<.001
2b Aca→Dep	349	1.35	790.93	.960	.950	.044	2b vs. 0	1.43	8.93	4	.063
3a Ext→Aca	349	1.35	714.86	.967	.958	.040	3a vs. 0	1.61	72.90	4	<.001
3b Dep→Aca	349	1.36	773.29	.961	.952	.043	3b vs. 0	1.23	28.31	4	<.001
2a-1 Aca→Ext(paths fixed)	352	1.36	743.79	.964	.956	.041	2a-1 vs. 2a	1.84	9.67	3	.022
3a-1 Ext→Aca(paths fixed)	352	1.36	734.55	.965	.957	.041	3a-1 vs. 3a	2.22	14.44	3	.002
3b-1 Dep→Aca(paths fixed)	352	1.36	789.18	.960	.951	.044	3b-1 vs. 3b	1.20	17.06	3	.001
4 Combined model	341	1.35	640.61	.973	.965	.037					
5 Full model	329	1.36	618.66	.974	.965	.037	5 vs. 4	1.18	21.86	12	.039
6 Modified combined model (Model4 + AcaG6→DepG7)	340	1.35	632.93	.973	.966	.036	6 vs. 5	1.17	13.23	11	.278
RI-CLPM models											
0 Stability model	394	1.34	700.94	.972	.969	.035					
1 Ext←→Dep	386	1.34	689.62	.972	.969	.035	1 vs. 0	1.42	11.47	8	.176
2a Aca→Ext	390	1.34	687.17	.973	.970	.034	2a vs. 0	1.66	12.50	4	.014
2b Aca→Dep	390	1.34	699.52	.972	.969	.035	2b vs. 0	1.35	1.46	4	.834
3a Ext→Aca	390	1.34	684.72	.973	.970	.034	3a vs. 0	2.00	13.21	4	.010
3b Dep→Aca	390	1.34	699.30	.972	.969	.035	3b vs. 0	1.56	2.40	4	.663
2a-1 Aca→Ext (paths fixed)	393	1.34	701.20	.972	.969	.035	2a-1 vs. 2a	1.60	12.61	3	.006
3a-1 Ext→Aca (paths fixed)	393	1.34	688.77	.973	.970	.034	3a-1 vs. 3a	1.99	4.45	3	.217
4 Combined model	389	1.34	674.14	.974	.971	.034					
5 Full model	370	1.33	656.00	.974	.969	.035	5 vs. 4	1.21	24.16	19	.190

The final model is bold. *c*/*cd* = scaling correction factor for chi-square test using MLR. Aca = academic achievement; Ext = externalizing problems; Dep = depressive symptoms.

externalizing). Pairwise Wald tests further depicted the pattern of the developmental change (see Table 3, upper half). Specifically, from Grade 5 to Grade 9, the magnitude of adjustment erosion paths gradually decreased in magnitude, while the magnitude of academic incompetence paths showed an increasing pattern. In addition, prior achievement in Grade 6 predicted subsequent increased depressive symptoms in Grade 7 – the school transition year.

As shown in the lower half of Table 3, following the same procedure of nested model comparison, the best fitting RI-CLPM model (Model 4) was identified. This model indicated cross-lagged effects from achievement to externalizing that varied across time, and a time-invariant effect from externalizing to achievement. In the final model, the random intercept of achievement was negatively correlated with the random intercepts of externalizing ($r = -.56$, $p < .001$) and depressive symptoms ($r = -.47$, $p < .001$), and the random intercepts of externalizing and depressive symptoms were positively correlated ($r = .33$, $p < .001$). These correlations indicated that the between-person effects linking the stable variances between achievement and symptoms: children who had lower achievement had more externalizing and depressive symptoms. Standardized paths are presented in the lower half of Table 3. After the between-person stability was partialled out, several autoregressive paths became nonsignificant (i.e. paths between achievement in Grades 5 and 6, between externalizing at Grades 6 and 7, and between depression at Grades 5 and 6). As for cross-lagged paths, the bidirectional within-person effects between achievement and externalizing were still evident, but the dynamic associations between depression and achievement found using CLPM were no longer significant. As shown in the lower half of Table 3, children who had lower achievement in Grades 7 and 8 showed elevated externalizing problems in the next year, but this prediction was not seen from Grade 5 to Grade 7. Pairwise Wald tests illustrated the developmental change – the emergence of the academic incompetence effect for externalizing over development. In contrast, the adjustment erosion effect for externalizing problems in Grades 5, 6, 7, and 8 (negatively predicting achievement 1 year later) was time invariant.

Additional analyses

Multigroup modeling was used to test whether the cross-lagged paths (and correlations among random intercepts in the RI-CLPM) differed across genders. For the final CLPM model, the model fit decreased significantly when paths were constrained to be equal across genders, $\Delta\chi^2(13) = 32.80$, $p = .001$, because the prediction from Grade 8 achievement to Grade 9 externalizing was stronger for boys, Wald's $\chi^2(1) = 7.224$, $p = .007$. The cross-lagged paths in the final RI-CLPM model were invariant across genders, $\Delta\chi^2(5) = 4.57$, $p = .471$. The correlations among random intercepts were not invariant, $\Delta\chi^2(3) = 48.65$, $p < .001$. The correlation between

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Table 3 Standardized autoregressive and cross-lagged path coefficients for the final models

	Grade5→ Grade6		Grade6 → Grade7		Grade7→ Grade8		Grade8→ Grade9	
Paths	β	*SE*	β	*SE*	β	*SE*	β	*SE*
Final cross-lagged panel modeling (CLPM) model								
Aca→Aca	.51***	.06	.68***	.03	.87***	.02	.91***	.01
Ext→Ext	.63***	.05	.51***	.06	.57***	.04	.59***	.06
Dep→Dep	.58***	.04	.65***	.03	.72***	.02	.77***	.02
Aca→Ext[a]	$-.03_{a}$	.04	$-.13^{*}_{a,b}$	.05	$-.11^{**}_{a,b}$	.04	$-.20^{***}_{b}$	.04
Aca→Dep			−.11**	.04				
Ext→Aca[a]	$-.16^{***}_{a}$	.05	$-.15^{***}_{a}$	.03	$-.07^{**}_{a,b}$	.02	$-.04_{b}$	.02
Dep→Aca[a]	$-.12^{***}_{a}$	.04	$-.07^{*}_{a,b}$	.03	$.00_{b}$	.02	$-.03_{b}$	.02
Final RI-CLPM model								
Aca→Aca	.00	.11	.21*	.10	.69***	.04	.78***	.03
Ext→Ext	.34***	.11	.16	.11	.51***	.08	.45***	.08
Dep→Dep	.31	.20	.41*	.14	.55***	.07	.69***	.05
Aca→Ext[a]	$.07_{a}$	.08	$-.02_{a,b}$	.10	$-.12^{*}_{a,b}$	.06	$-.19^{**}_{b}$	.06
Ext→Aca	−.07**	.03	−.09*	.04	−.10**	.04	−.10**	.03

Aca = academic achievement; Ext = externalizing problems; Dep = depressive symptoms.
[a]The cross-lagged paths were time invariant. Paths across each interval were compared pairwise using Wald test ($df = 1$). Coefficients with different subscript letters (e.g. a or b) differ significantly from one another based on Benjamini–Hochberg procedure.
*$p < .05$; **$p < .01$; ***$p < .001$.

achievement and externalizing was stronger for boys, Wald's $\chi^2(1) = 22.43$, $p < .001$.

The final models were also re-estimated with the inclusion of covariates. SES, negative maternal parenting, and attention problems (all measured prior to Grade 5) were simultaneously modeled to predict achievement and symptoms in Grade 5 (and the random intercepts in the RI-CLPM). As are presented in Appendix S6, the models fit well (CFIs and TLIs > .96, RMSEAs < .040). The inclusion of covariates did not alter the overall pattern of statistical significance of lagged paths, and the parameter estimates were nearly unchanged. Thus, the lagged effects we found were not spurious effects caused by common preexisting covariates.

Finally, because data were clustered (students within classes), we evaluated whether clustering influenced estimates. As shown in Appendix S7, we found little difference in each path between the models we reported above, and models accounting for data clustering.

Discussion

To advance our understanding of the developmental dynamics between academic achievement and psychopathology in the transition from childhood to adolescence, we examined longitudinal associations between achievement and two types of symptoms (externalizing and depressive symptoms) from Grade 5 to Grade 9 in an urban community sample using two modeling approaches – the traditional CLPM and the RI-CLPM. We included the RI-CLPM, because it distinguishes two types of effects underlying the causal relations between constructs over development: the time-invariant between-person effects and time-specific dynamic within-person effects. The two types of effects together contribute to a comprehensive understanding of longitudinal patterns.

We found evidence for both the academic incompetence effect (i.e. low achievement statistically predicting subsequent increase in symptoms) and the adjustment erosion effect (i.e. symptoms predicting subsequent low achievement). Importantly, the findings revealed systematic developmental changes in the magnitude of the academic incompetence effects from late childhood to middle adolescence.

Regarding longitudinal associations between achievement and symptoms, the CLPM and the RI-CLPM approaches showed bidirectional longitudinal relations between achievement and externalizing problems. The reciprocal effects were consistent with prior studies (e.g. Moilanen et al., 2010; van der Ende et al., 2016; Zimmermann et al., 2013) and corroborated the idea that both the academic incompetence and adjustment erosion effect are present for externalizing and academic functioning during childhood and adolescence.

In contrast, findings for depressive symptoms did not converge across the two modeling approaches. Consistent with some previous studies (e.g. Verboom et al., 2014; Weidman et al., 2015), the CLPM indicated support for both types of effects – although the association between prior achievement and later depressive symptoms was specific to the school transition interval into middle school (i.e. between Grade 6 and Grade 7). Moilanen et al. (2010) reported that low achievement would be more likely to exacerbate symptoms in the school transition period, during which children experience drastic contextual changes. However, the RI-CLPM did not support any dynamic relations between achievement and depressive symptoms, even at the middle school transition. To be clear, the RI-CLPM results did not imply that achievement and depression were independent; to the contrary, their random intercepts were significantly correlated, indicating that the longitudinal relations between achievement and

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depressive symptoms mainly manifested as the relation between the nonchanging components of the two constructs over time.

Regarding developmental changes in effects, the cross-lagged effects in both the CLPM and the RI-CLPM from prior achievement to subsequent externalizing became significant and increased in magnitude during and past the middle school transition; the largest effect was from Grades 8 to 9. These findings supported our hypothesis that academic incompetence effects become stronger across the transition to adolescence. The change in school context also coincides with a noteworthy increase in academic pressure and salience of achieving academic success when students enter middle school. All these changes may contribute to the growth in the academic incompetence effect in the middle school years. The developmental findings were consistent with some previous studies (e.g. Defoe et al., 2013; Moilanen et al., 2010; Vaillancourt et al., 2013; Yong et al., 2013), but contradicted others (van der Ende et al., 2016; Verboom et al., 2014; Zimmermann et al., 2013). These mixed results are due, in part, to methodological differences between studies. Some of these prior studies include multiple cohorts (e.g. van der Ende et al., 2016), or were testing longitudinal models with mediators (e.g. Zimmermann et al., 2013). Also, most of the studies had different starting and end point in terms of the ages of the participants. These differences could contribute to variations in findings between studies.

Regarding developmental changes in the adjustment erosion effect, results of the CLPM indicated that the lagged predictions from prior externalizing and depressive symptoms to subsequent achievement decreased in magnitude from late childhood into adolescence, becoming nonsignificant by Grade 7 (for depressive symptoms) and Grade 8 (for externalizing). However, the decreasing magnitude of the adjustment erosion effect in the CLPM may reflect confounded between- and within-person stability effects that contributed to the strong annual rank-order stability of achievement found in the current and prior studies (e.g. Vaillancourt et al., 2013). Therefore, less variation in achievement was left for other factors to alter achievement trajectories. In contrast, the RI-CLPM distinguished between- and within-person effects, and the adjustment erosion effect from prior externalizing to later achievement was invariant over time. We would speculate that this temporal invariance in magnitude might arise from two opposing factors over adolescence: achievement becoming less sensitive to symptoms (Chen et al., 2010; Richardson et al., 2012), while symptoms are increasingly prevalent (Petersen et al., 2014; Twenge & Nolen-Hoeksema, 2002).

Although it was not a specific focus of the current study, the longitudinal relation between externalizing and depressive symptoms was also considered. The persistent co-occurrence between externalizing and depressive symptoms was indicated by the positive concurrent correlations at all waves, and the positive correlation between random intercepts in the RI-CLPM. We found no cross-lagged associations in the CLPM or the RI-CLPM. Overall, our findings suggest that the correlations between externalizing and depressive symptoms may reflect a common underlying cause (see Wolff & Ollendick, 2006).

Contributions, Caveats, and Conclusions

Consistent with contemporary theory and empirical findings on links between competencies and psychopathology (e.g. Masten et al., 2005; Moilanen et al., 2010), we confirmed the longitudinal reciprocal relations between competence (achievement) and symptoms (externalizing and depressive symptoms). Today, it seems obvious that individuals' symptoms are in many respects the outgrowths of the previous lack of competence, and vice versa. However, in consideration of the development in individuals' personal characteristics and differences in their ecological contexts across developmental periods, the extant literature is unclear regarding developmental change in the magnitudes of these effects. This is where the current study extended current knowledge. In most previous studies, the relation between achievement and symptoms was not assumed to be time-variant; even when likely differences in effects across developmental periods were found, their theoretical implications were seldom explicated (e.g. Moilanen et al., 2010; Yong et al., 2013). The main findings of the current study – a developmental increase in the academic incompetence effect and decrease in the adjustment erosion effect (though only in the CLPM) – highlight the necessity to consider longitudinal relations between academic competence and psychopathological problems using a developmental perspective. Several researchers have tried to examine developmental changes in effects over relatively long periods of time (e.g. van der Ende et al., 2016; Verboom et al., 2014), but they did not find age-based changes in effects. This is likely a consequence of methodological factors such as cohort effects, the lack of attention to co-occurrence of externalizing and internalizing problems.

We studied a Chinese sample, but we would expect cross-cultural generalizability of the findings. The Chinese culture strongly emphasizes achievement as the most important indicator of success (Chen et al., 2010). Given the salience of academic achievement in China, the links between prior achievement to later externalizing and depressive symptoms may be stronger compared with other cultures. However, we would anticipate the current results to generalize to any culture and nation that values academic success as an important indicator of developmental success. In this sense, there should not be qualitative differences in the relations between achievement and symptoms

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between China and other countries. This conclusion is bolstered by the fact that our study replicated bidirectional longitudinal effects between achievement and symptoms from Western studies. Our interpretation is that the developmental changes we found in these longitudinal associations reflect increases in academic pressure, academic salience, and competitiveness in middle schools compared with elementary schools. Such increases with this school transition are prevalent in most cultures (see Eccles & Roeser, 2009; for a review); therefore, the developmental changes we found could be expected in many other cultures. In addition, the developmental changes in effects in the current study of urban Chinese youth have been alluded to in previous findings from various cultures (e.g. Moilanen et al., 2010; van Lier et al., 2012; Vaillancourt et al., 2013), lending further support to cross-culture generalizability.

There are two caveats to bear in mind. First, we used exam scores which we consider as objective measures of achievement (Weidman et al., 2015). However, test performance has its limitations, and different assessment methods might lead to discrepant findings (see Chen & Li, 2000; Zimmermann et al., 2013). Second, although cross-cultural generalizability of the developmental changes in associations between achievement and symptoms could be expected, it remains to be evaluated empirically in non-Chinese samples.

Despite these limitations, the current study adds to our understanding of the developmental dynamics between achievement and symptoms in the transition to adolescence. As development proceeds from late childhood through early adolescence, there are personal and contextual changes that alter the patterns of interplay over time between symptoms and academic achievement. Findings inform decisions regarding the most optimal timing for prevention and intervention efforts for psychopathology and scholastic problems. For example, given that the academic incompetence effect was stronger during middle school, the academic underachievers in middle school deserve attention because of their elevated risk of behavior problems. In addition, an imparted message for educators and parents is the need to broaden an exclusive focus on children's academic achievement as an indicator of success and to include psychosocial functioning as well. Otherwise, psychosocial maladjustment in late childhood will spill-over into the academic domain, and in turn lead to long-lasting academic incompetence and exacerbated behavior problems.

Supporting information

Additional supplemental material may be found online in the Supporting Information section at the end of the article:

Appendix S1. Sample characteristics of Longitudinal Study of Chinese Children and Adolescents (LSCCA).
Appendix S2. Detailed descriptions and psychometric properties of measures of academic achievement, externalizing problems, and depressive symptoms in the present study.
Appendix S3. Measurement models and analyses on factorial invariance.
Appendix S4. Illustration of nested RI-CLPM models.
Appendix S5. Information on distribution of externalizing problems and depressive symptoms.
Appendix S6. Additional analysis: Final models controlled for covariates.
Appendix S7. Evaluations on the influence of data clustering on model estimates.

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Key points

- Low academic achievement exacerbates subsequent psychopathological symptoms (i.e. the academic incompetence effect), and prior psychopathological symptoms undermine academic achievement (i.e. the adjustment erosion effect).
- From late childhood to middle adolescence, academic achievement and *externalizing* problems dynamically predict each other. In contrast, dynamic relations between achievement and *depressive* symptoms were *not* found.
- The academic incompetence effect from academic achievement to externalizing problems strengthens with age. The adjustment erosion effect might be invariant with age.
- Prevention targeting both psychopathology and low academic achievement is worthwhile, but different treatment effects will be found in childhood versus adolescence.

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